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Memorandum

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TO: Interested Persons

FROM: Leena Vilonen, PhD, Science and Technology Policy Program Fellow

Max O'Connor, PhD, Science and Technology Policy Program Fellow

Samantha Lattof, PhD MSc, Science and Technology Policy Program Fellow

Dhivahari Vivek, MPP, Science and Technology Policy Program Fellow

Samantha Falco, MPA, Senior Research Analyst

SUBJECT: Data Center Impacts on the Environment, Public Health, and Energy Costs

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Summary

Data centers are growing rapidly across the United States. They require large amounts of electricity for computational power and water to cool the computer systems. This memorandum explores the impacts of data centers on technology, local economies, electricity, water, public health, and energy costs. It also covers recent federal and state legislation.

Data Center Classifications

Data centers are physical facilities that house and run large computer systems. Data centers typically contain multiple computer servers, data storage devices, and network equipment that can provide IT infrastructure service for organizations to store, manage, process, and transmit large amounts of data. Data centers are one of the largest and growing markets in the United States. The United States houses approximately 45 percent of global data centers, with approximately 4,000 data centers in the U.S. alone, located primarily in Virginia, Texas, and California. Approximately 57 data centers are located in Colorado.

There are several types of data centers, generally based on ownership or intended purpose. For example:

- **Enterprise data centers.** Private, on-premises data centers generally run by a large company. All IT infrastructure and data is hosted on-premises.
- **Managed data centers.** Also known as colocation data centers, these third-party facilities provide a shared rented space for organizations who may lack the space, staff, or IT resources to own and operate their own data centers.
- **Cloud (computing) data centers.** Data center resources are hosted by a cloud services provider (e.g., Amazon Web Services (AWS), Google Cloud Platform (GCP), Microsoft Azure, IBM Cloud). These types of online service providers operate geographically distributed and interconnected data centers, and allow multiple users to remotely access computing resources hosted by these data centers.
- **Edge data centers.** Smaller data centers operated and maintained by cloud computing service providers physically closer to users for a number of benefits, including reduced network latency and data communication delay, faster content distribution, optimized workloads, and improved application performance and user experience.

- **Hyperscale data centers.** Massive data centers that are designed to support very large-scale IT infrastructure, and so provide extreme scalability capabilities for purposes that include AI development, automation, and big data computing tasks. These facilities were developed in large part to address increasing demand for data storage and processing capacity.

The majority of computer servers nationwide (74 percent in 2024) were present in hyperscale and colocation data centers.

Current and Frontier Uses of Data Centers

AI innovation and competition may hinge on the availability of and access to advanced, secure, and sustained computing resources. Geographically distributed data centers are the primary means to house much of the IT infrastructure that develops, trains, deploys, and operates AI systems, which AI developers can access through Internet-based cloud computing services (Zhu 2025). Consumers, business, and governments may benefit if the development of large-scale data centers spurs technological advancements. Advancements in AI applications, machine learning, data analytics, and robotics spurred by large-scale data centers may lead to accelerated pharmaceutical development, efficient manufacturing, computational science, and more (Turner et al. 2025). Several industry reports indicate that data processing demands of AI and related cloud computing services have driven new construction and upgrades of data centers (Zhu 2025).

Many commonly used digital services rely heavily on data centers. Major cloud providers such as Microsoft, Google, Facebook, and Amazon rely heavily on data centers to support the increasing computational demand for their services. The large amounts of data that result from digital services like streaming, file sharing, searching, social networking sites, and e-commerce services can be stored and processed at cloud data centers. For example, Google data centers power a number of commonly used Google services, including Google Search, YouTube, Google Cloud, and Gemini. Large corporations have been shifting their on-premise email infrastructure to virtualized infrastructure running in a cloud data center (Henze, Martin et al. 2017). The motivations for this shift are cost reductions, lower maintenance efforts, and higher scalability and elasticity (the ability to quickly adjust computer processing, memory and storage resources to meet changing demands). Video streaming, which in 2021 accounted for more than 60 percent of internet traffic, increasingly demands more remote computing services (Li, Xiangbo et al. 2021). Currently, video streaming providers are extensively reliant on cloud service providers, which can relieve video streaming providers from the burden of maintaining and upgrading expensive computing infrastructure. For example, Netflix has outsourced the entirety of its computational demands to Amazon cloud.

The acceleration of scientific research will continue to rely on high-performance computing. Distributed computing environments are increasingly important in the throughput (the rate at which a system processes data or completes tasks) of most scientific computing tasks, and graphic processing units (GPUs) are used to accelerate dense numerical calculations. For example, computational chemistry can leverage high-performance computing and virtualization to accelerate the complex computations required during the drug discovery process (Jesús Banegas-Luna, Antonio et al. 2018). Computational drug discovery through the use of GPUs was pivotal in studying the SARS-CoV-2 protein targets and searching for drug combinations that could stop the virus from reproducing, with researchers using more than 27,000 GPUs to virtually test over a billion potential compounds (McDowell 2020).

Economic Impacts of Data Centers

Data centers create jobs for construction and operation, may bring in tax revenues, and increase local and operational spending. In Virginia, about 20 percent of total data center capital investment went towards data center construction, which the state recognized as the primary economic benefit.

Due to their large size, data centers employ up to thousands of construction workers. However, these jobs are temporary in nature and only last until the completion of the construction of the data center. Once the data center is constructed, data centers typically employ significantly less employees compared to the construction phase. One study estimates that the average data center employs approximately 43 workers per 100 megawatts of capacity. Per square foot, the number of employees is relatively low compared to other industries, since the buildings mostly consist of computer equipment. Some of these jobs include janitorial work, data center technicians, IT professionals, engineers, and managers with various ranges of expertise required. In Virginia, the state with the highest number of data centers, it is estimated that data center employees earn about twice as much as the average private sector employee in Virginia.

Data centers also bring in tax revenue to the states and local communities through state and local taxes including property tax, sales and use tax, utility tax, and corporate income tax. Several states, including Virginia, offer tax incentives for data centers. Loudoun County, Virginia, a county with the state's largest and most mature data center market, offers local tax incentives to the data centers. Despite these tax incentives, tax revenue from data centers still remains positive. Tax rates for residents in Loudoun have fallen due to excess tax revenue from data centers. Other Virginia local governments collect far less revenue as a result of reducing business personal property tax rates to attract industry.

At the state level, Virginia's Joint Legislative Audit and Review Commission issued a report that found "Like most economic development incentives, the data center exemption does not pay for itself when considering just the state portion of the exemption cost and the state return in revenue." For every dollar spent on the data center exemption, the state had a 48-cent return in state revenue, which exceeded the average Virginia incentive that returned 41 cents in revenue per dollar spent.

Local and operational spending from a data center may also contribute to the local economy by:

- sourcing their equipment locally;
- purchasing local construction materials;
- increasing consumer spending from construction workers and employees through the purchase of local food and beverage, housing, and more;
- employing security or hiring HVAC maintenance employees.

Environmental Impacts of Data Centers

Data center servers require substantial energy to perform their computations, and this computing process can generate significant amounts of heat within the servers. They require extensive cooling systems to keep computer hardware from overheating and to maximize the systems' performance, stability, and life expectancy. There is significant uncertainty about the total environmental impact of data center development due both to the rapid and recent growth of the industry, as well as a lack of reporting around electricity and water usage. The environmental impacts of data centers are discussed below, within the scope of energy usage, greenhouse gas (GHG) emissions, and water consumption.

Data Center Energy Usage

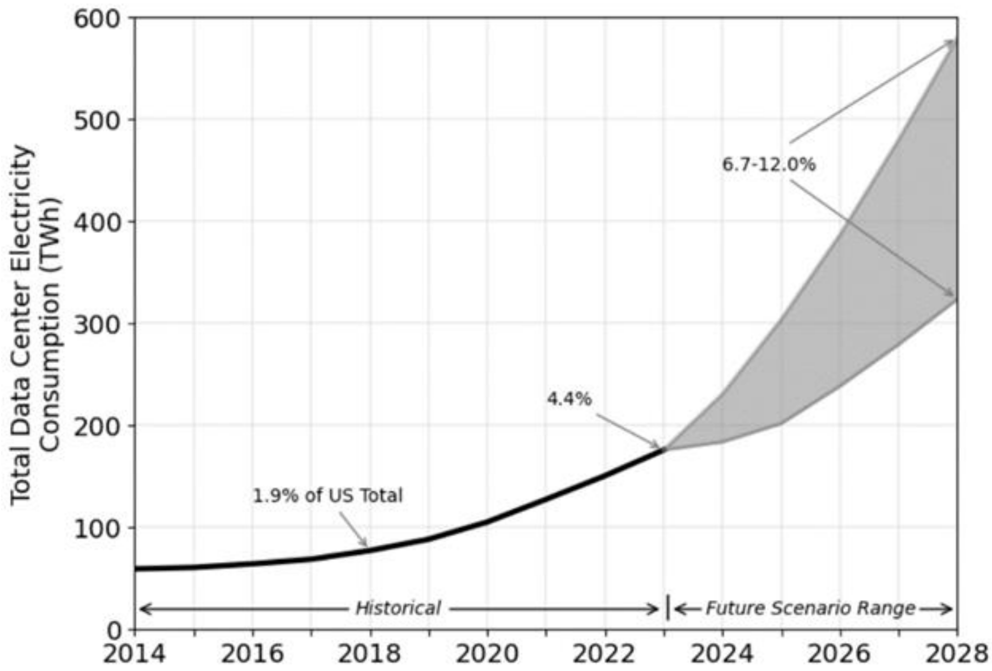
U.S. data center annual energy usage increased significantly in 2017 with the introduction of GPU-accelerated servers[1] for artificial intelligence (AI) development. According to the Grid Strategies 2025 load growth report, data centers are the largest driver of U.S. electricity demand

[1] While central processing units (CPUs) - generally thought of as the "brains" of a computer - can perform the same types of functions, GPUs are divided into many more processing units (called cores) that can do many different complex computations in parallel. While GPUs were initially created to handle graphics rendering tasks in gaming and animation that CPUs could not handle, they are now used for use cases like deep learning and high-performance computing - tasks for which technology companies rely on data centers.

growth. Other factors include electric vehicle adoption, onshoring of manufacturing, and the electrification of industry and buildings. The report notes that, when operating, an individual data center can consume over a gigawatt (GW) of power, which is equivalent to powering approximately 750,000 homes. While data centers tend to require energy steadily throughout the day, they can experience sudden, rapid changes in load that present unique challenges for grid planning.

A 2024 report from Lawrence Berkeley National Laboratory (LBNL) estimates historical data center electricity consumption back to 2014 and projects future demand out to 2028. From 2018 to 2023, data center energy consumption increased by approximately 100 terawatt-hours (TWh), representing a jump from 1.9 percent of total annual U.S. electricity consumption in 2018 to 4.4 percent in 2023. The report predicts that data centers would represent between 6.7 percent and 12 percent of total annual U.S. electricity consumption by 2028, depicted in Figure 1.

Figure 1
Historical and Projected Energy Consumption by Data Centers



Source: LBNL 2024 United States Data Center Energy Usage Report

Newer hyperscale data centers tend to consume more energy than older data centers due to their larger size and increased computational load. However, these newer facilities devote proportionally less energy to upkeep necessities like cooling, lighting, and power distribution, and proportionally more energy to useful computational tasks. This pattern of energy usage is more efficient, expressed by a better (lower) power usage effectiveness value (PUE).

Data Center Water Use

IT equipment in data centers generates high heat, which can cause the equipment to malfunction or fail. To keep the equipment at optimal temperatures, data centers use cooling technologies, such as:

- **Refrigeration cooling.** Hot air is cooled in a compressor unit using air or water and circulated throughout the building. Examples include air-cooled chillers and water-cooled chillers. Water-cooled chillers use cooling towers, which collect heat and then release this heat through evaporation. Cooling towers cause a large loss of consumptive, non-recyclable water to the atmosphere and leaving the immediate water system.
- **Free cooling**. This method takes advantage of outdoor ambient air or water to cool throughout the building. Examples include air-side economizers and water-side economizers. Air-side economizers only work in favorable climates that are dry and cold. Water-side economizers use a nearby river, lake, or ocean to cool air that is then circulated through the data center.
- **Liquid cooling**. Instead of cooling air around the equipment, the system directly absorbs heat from the equipment by piping the water directly next to or inside the equipment.
- **Adiabatic assist.** This method uses water to cool air or water in a closed circuit. When outdoor temperature is low, the dry coolers can reject heat using ambient air alone, without the need for water. When temperatures are not ideal, water is sprayed or circulated to pre-cool air prior to reaching heat exchanger coils and cooling towers are not used.

Just as data centers use PUE to measure electricity efficiency, they also use Water Use Efficiency (WUE) to measure water use efficiency per electrical demand of the IT equipment. High WUEs indicate lower efficiency in the system. LBNL's 2024 Data Center Energy Usage Report found that unlike PUE, WUE has remained relatively constant and is projected to increase in the future. The same report estimated both PUE and WUE for the different systems mentioned above:

- air-cooled chillers have high PUEs, but use no water and thus have WUEs of zero;

- water-cooled chillers have moderate PUEs and high WUEs;
- air-side economizers have moderate PUEs, but use no water;
- water-side economizers have low PUEs, but high WUEs; and
- liquid cooling systems that also use adiabatic assist have both low PUEs and WUEs.

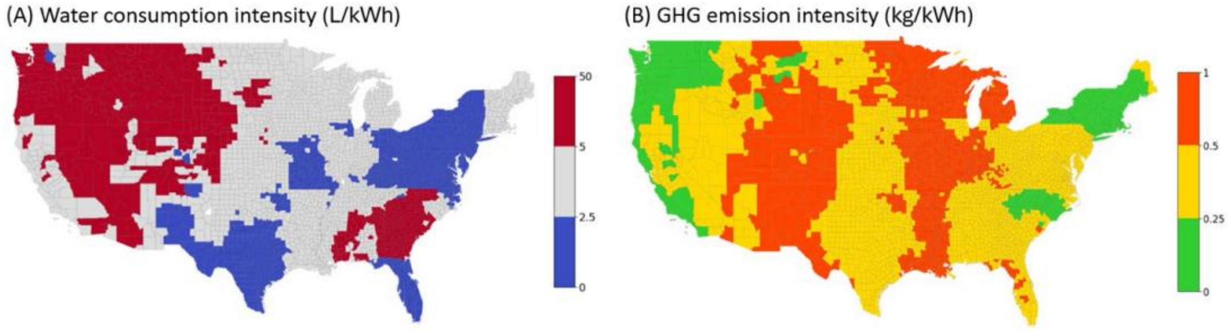
Measuring the exact amounts of water data centers in the U.S. consume is challenging due to proprietary nature of the information. Data centers often opt for cooling with water, since water has a higher heat capacity (the amount of heat absorbed before increasing in temperature) compared to air and is relatively inexpensive compared to the electricity necessary for other types of cooling. LBNL's 2024 Data Center Energy Usage Report estimated that data centers consumed 21.2 billion liters of water in 2014. By 2023 the DOE estimated that that number grew to 66 billion liters of water, or over 500,000 acre-feet of water per year.

Regional Dependence of Water and Greenhouse Gas Emissions Impacts

Water consumed upstream for electricity generation is not included in the estimates above. Electricity generation technologies differ in their water consumption. For example, wind and solar generation use no water once installed, fossil fuel-based thermoelectric plants require water for cooling, and hydroelectric reservoirs lose water through open surface evaporation (a consumptive loss of water). Electricity generators that rely on the fossil-fuel-based (coal, natural gas, and petroleum) combustion also generate greenhouse gas emissions as a byproduct of the combustion process. The water and GHG emissions associated with electricity use can be quantified using water consumption intensity, which measures the volume of water consumed per unit of electricity used, and GHG emission intensity, which measures the mass of GHG emitted per unit of electricity used. The annual average water consumption intensity and GHG emission intensity for electricity generation varies significantly across U.S. counties, as shown in Figure 2.

Figure 2

The annual average water consumption intensity (a) and the GHG emission intensity for electricity generation (b) across U.S. counties.



Source: LBNL 2024 United States Data Center Energy Usage Report

The specific water consumption and GHG emissions impacts of a data center vary depending on location because water availability and the mixture of generation sources supplying the electrical grid differs by region (Xiao et al., 2025). According to LBNL's 2024 Data Center Energy Usage Report, the total indirect water footprint of U.S. data centers in 2023 was nearly 800 billion liters, attributed to water consumed indirectly through electricity use, based on the regional electricity grid mix for U.S. data center locations. Concurrently, total GHG emissions for that same electricity grid mix would be 61 billion kilograms of CO_2 equivalent.

In addition to using energy supplied by the grid, data centers often use onsite generators for back-up or supplemental power. In 2025, the EPA determined that these generators can operate for up to 50 hours per year in non-emergency conditions as part of a financial arrangement with another entity.

Public Health Impacts

While more research is needed into long-term health outcomes in communities hosting data centers, the primary public health implications include air pollution, noise pollution, and potable water consumption.

Air Pollution

Data centers relying on fossil fuels for power and diesel backup generators emit localized air pollution (e.g., fine particulate matter, nitrogen oxides, ammonia, carbon dioxide). Exposure to air pollution increases rates of respiratory diseases, cardiovascular conditions, and premature death in impacted communities (Tao and Gao, 2025; Han et al., 2025). It also increases the risk of certain types of cancers (Pritchett et al., 2022; Kim et al., 2018).

Initial economic modelling of lifecycle pollutant emissions for data centers and computing tasks revealed that pollutants from data centers in the U.S. could cause approximately 600,000 asthma symptom cases and 1,300 premature deaths (Han et al., 2025). Additionally, the scientists from University of California Riverside and Caltech who conducted that modelling found that "growing demand for AI is projected to push the total annual public health burden of U.S. data centers up to more than $20 billion in 2028, rivaling that of on-road emissions of California. Further, the public health costs are more felt in disadvantaged communities, where the per-household health burden could be 200x more than that in less-impacted communities."

To mitigate emission-related impacts while waiting on longer-term research, scientists have discussed powering data centers with renewable sources, using battery storage or fuel cells instead of diesel generators, mandating public reporting of data center pollution, and building new data centers in low-density areas to reduce human exposure (Tao and Gao, 2025; Han et al., 2025).

Noise Pollution

Researchers found that average afternoon noise levels in part of Virginia known as "Data Center Alley" were 5.7 decibels higher in neighborhoods 200 feet away from data centers than neighborhoods two miles away (28.0 decibels versus 22.3 decibels, respectively) (Ngata et al., 2025). While noise exposure at these volumes does not contribute to hearing loss, the researchers noted that, "This low-frequency hum may affect local well-being and adds to the datacenters' environmental footprint." Residential noise complaints filed with one of the counties in this area corroborate the human impact of the noise pollution. Extended exposure to low-frequency noises (characterized by sound waves below 200 hertz) can negatively affect human health, wellbeing, and cognition, including "higher-order cognitive functions, such as logical reasoning, mathematical calculation, and data processing," (Liang et al., 2024). Industrial enterprise noise is a common source of low-frequency artificial noises.

Potable Water Consumption

A lack of transparency by data center operators can make it challenging to measure their water consumption. CoreSite, the company building a data center campus in north Denver, shared projections with the Denver Post that the facility may use up to 805,000 gallons of water a day to cool its computer systems.[2] However, it is unclear if this water consumption (equivalent to 16,100 Denverites' average daily indoor water use) relies on potable (drinkable) and/or non-potable water.

Non-potable water can be used for evaporative cooling, but it requires filtration to avoid contamination by minerals that might damage sensitive equipment. For this reason, data centers tend to rely on potable water. Some data centers source over half of their water from potable water sources (Mytton 2021). The type of water used for data center cooling (i.e., potable water versus non-potable water) can impact public health through water insecurity. Using non-potable or recycled water conserves limited potable water for communities.

Water insecurity is an issue in the United States, even in states perceived to be water-rich, like Oregon (Schimpf and Cude 2020). Inadequate or inequitable access to clean, safe, and affordable water impacts drinking, cooking, sanitation, and hygiene. Although scientific research has not yet examined water insecurity by households and communities where data centers are planned or operating, concerns with data center impacts on water security appear in public reporting and legal filings (Shah 2026). Reports by the New York Times, Environmental and Energy Study Institute, and others found that communities may experience water scarcity and other water-related challenges following the arrival of data centers. These challenges may be compounded in areas with pre-existing water scarcity.

Impacts on Energy Costs

According to the U.S. Energy Information Administration, national retail electricity prices have increased faster than inflation since 2022. Retail electricity prices reflect a complex mixture of costs associated with building, financing, maintaining, and operating the infrastructure to generate, transmit, and deliver electricity to customers, as well as taxes and other fees. Some for-profit utilities also include a financial return for owners and shareholders in their electricity prices. Electricity prices vary significantly by region and by type of customer, with many utilities splitting customers into residential, commercial, industrial, or transportation sub-groups.

The increased demand of data centers has resulted in larger energy loads, which can have downstream impacts on the electricity rates paid by residential customers. A recent report by the independent external market monitor for PJM Interconnection concludes that “data center load growth is the primary reason for recent and expected capacity market conditions, including total forecast load growth, the tight supply and demand balance, and high prices” within PJM’s

[2] The Denver Post journalist confirmed that this figure came directly from CoreSite’s spokesperson who verified the figure was accurate as of Friday, February 20, 2026.

mid-Atlantic and Midwestern service region, which has the nation's highest concentration of data centers.

In order to meet new large load demands, utilities often must add or upgrade transmission and generation infrastructure. According to the Federal Energy Regulatory Commission's 2024 State of the Markets Report, transmission projects driven by load growth represented the second-largest category of projects entering service in 2024 after reliability-focused projects. Depending on how rates are structured, these infrastructure costs can impact rates paid by other customers in the region.

Data centers development can be highly uncertain and developers can submit proposals with multiple utilities at the same time to optimize costs, potentially causing utilities to over-estimate needs for new generation and transmission resources. If a utility expands its transmission or generation system for this potential growth and then the data center either does not materialize, leaves after a short period, or uses less energy than expected, then those infrastructure investments may increase electricity costs for other customers. Rate contracts between data centers and utilities are often confidential and may not capture the cost of serving power to the data center. States are increasingly exploring more public and standardized large-load tariffs as opposed to special contracts.

In Colorado, the Public Utilities Commission (PUC) has the full authority to regulate the rates charged and the services provided by investor-owned utilities (IOUs), Xcel Energy and Blackhills Energy, in order to ensure fair pricing and reliable delivery of service. IOUs are required to file all rate changes with the PUC for approval. The PUC also reviews IOUs' infrastructure improvement plans and the effect of those plans on consumer electricity rates.

Xcel Energy has proposed Just Transition Solicitation (JTS), a form of electric resource plan, that may result in the acquisition of over 6,000 MW of new generation, a level that would make it the largest acquisition ever approved by the PUC. The JTS proposal reflects a significant increase in electricity demand that is a departure from decades of nearly flat growth. Data centers are one driver of this increase, in addition to home electrification, growth in electric vehicles, and electrification of oil and gas fields.

Legislation

The increased demand for data centers has resulted in a variety of legislation from federal, state, and local government entities. Legislation concerning land use and construction, water use, artificial intelligence, protecting residential customers, and studies and impact assessments have been passed throughout the country.

Federal Legislation

Executive Order 14179, Removing Barriers to American Leadership in Artificial Intelligence, is intended to promote the advancement of AI in the United States. The order revokes certain existing policies that the administration views as barriers to innovation. Regardless, there are a variety of regulations and permitting around data centers, primarily through the Clean Air Act. The Environmental Protection Agency created the Clean Air Act Resources for Data Centers webpage that provides support and a centralized location for regulatory resources, air permitting resources, and modeling guidance. The website states this effort to provide easy and comprehensible access to these resources will align with the executive order and promote efficiency in building data centers.

Additionally, through the Federal Data Center Enhancement Act of 2023, the Office of Management and Budget was directed to set requirements for data centers to meet standards for cybersecurity, resiliency, and availability. This resulted in Memorandum M-25-03, which provides federal agencies guidance on existing policies, risk management frameworks, and standards for the effective acquisition, design, and management of data centers. This is set to sunset on September 30, 2026.

State Legislation

States have enacted a variety of legislation and executive orders around data centers. The following table, current as of February 2026, summarizes state-level actions known as of the date of publication, but may be incomplete.

Table 1. State Legislation and Executive Orders Related to Data Centers

State	Bill Number	Brief Description
California	Senate Bill 57	The bill authorizes Public Utilities Commission to assess the financial impact of large data centers on electrical corporations and customers and identify opportunities to prevent or mitigate cost shifts.
Colorado	House Bill 25-1177	The bill modifies the requirements of economic development rates to: increase the maximum location load allowable, without approval; increase the maximum duration of a reduced rate to 25 years; and adjust considerations for existing clean energy programs.
Idaho	Executive Order 2025-02	The Strategic Permitting, Efficiency, and Economic Development (SPEED) Act creates the SPEED Council, comprised of several state agency directors, in an effort to expedite permitting processes for large scale projects.
Illinois	Senate Bill 25	Also known as the Cooperative Electric Utility Transparent Planning Act, the bill requires Clean Air permits for data center construction.
Indiana	House Bill 1007	The bill establishes expedited regulatory review for large-load customer projects. In order to qualify for the expedited review, large-load customers must make a capital investment of $500 million, create at least 50 full-time jobs, and provide financial assurances, including reimbursement of project costs.
Maryland	Senate Bill 937	Investor-owned utilities will be required to submit a specific rate schedule for large load customers to prevent residential customers from facing costs associated with the large-load customers interconnected to the grid.
Maryland	House Bill 270	The bill requires an analysis to be completed on the environmental, energy, and economic impacts of data center development in the state.
Minnesota	House File 16	The bill modifies environmental and energy regulatory requirements that govern data centers, authorizes a clean energy and capacity tariff, and modifies sales and use tax exemptions.
New Jersey	Assembly Bill 5466	The Board of Public Utilities must conduct a study regarding the impact of data centers on electricity costs, determine if ratepayers incur unreasonable rate increases due to data centers, and estimate the current portion of the average residential electricity rate that is attributed to data center demand.
Oklahoma	House Bill 2845	Rate tariffs are required for large-load facilities, ensuring recovery of service extension and costs without impacting other customers.

State	Bill Number	Brief Description
Oregon	House Bill 3546	The Public Utilities Commission must provide a classification and tariff schedule for large energy use facilities. The tariff must mitigate the cost shifting onto other classes of energy customers.
South Carolina	House 3309	The South Carolina Energy Security Act adjusts the net metering cap, allows utilities to offer large-load customers contracts with below-marginal-cost rates, and expedites agreements for co-located generation. Additionally, utilities may bypass certification requirements and shorten timelines, streamlining the process for certifying major large-load projects.
Texas	Senate Bill 6	The bill establishes a regulatory framework for large-load consumers.
Utah	Senate Bill 132	The bill allows large-load customers to enter private generation contracts or request large-scale service from the local utility, which may be denied.
Virginia	House Bill 2084	The State Corporation Commission is directed to review the existing classifications for utility customers and determine if they are reasonable.
Washington	Senate Bill 5431-2025-26	The bill encourages data center businesses that receive certain tax incentives to adopt water-efficient and conservation practices.
West Virginia	House Bill 2014	The Certified Microgrid Development Program is created, allowing for two microgrids for new electricity loads, including data centers. The microgrids are exempt from public utility connections and are isolated from other customers.
Wyoming	Senate File SF0022	Public utilities are enabled to enter individualized energy contracts with large commercial and industrial customers.

Source: Legislative Council Staff.