Metropolitan Washington Council of Governments

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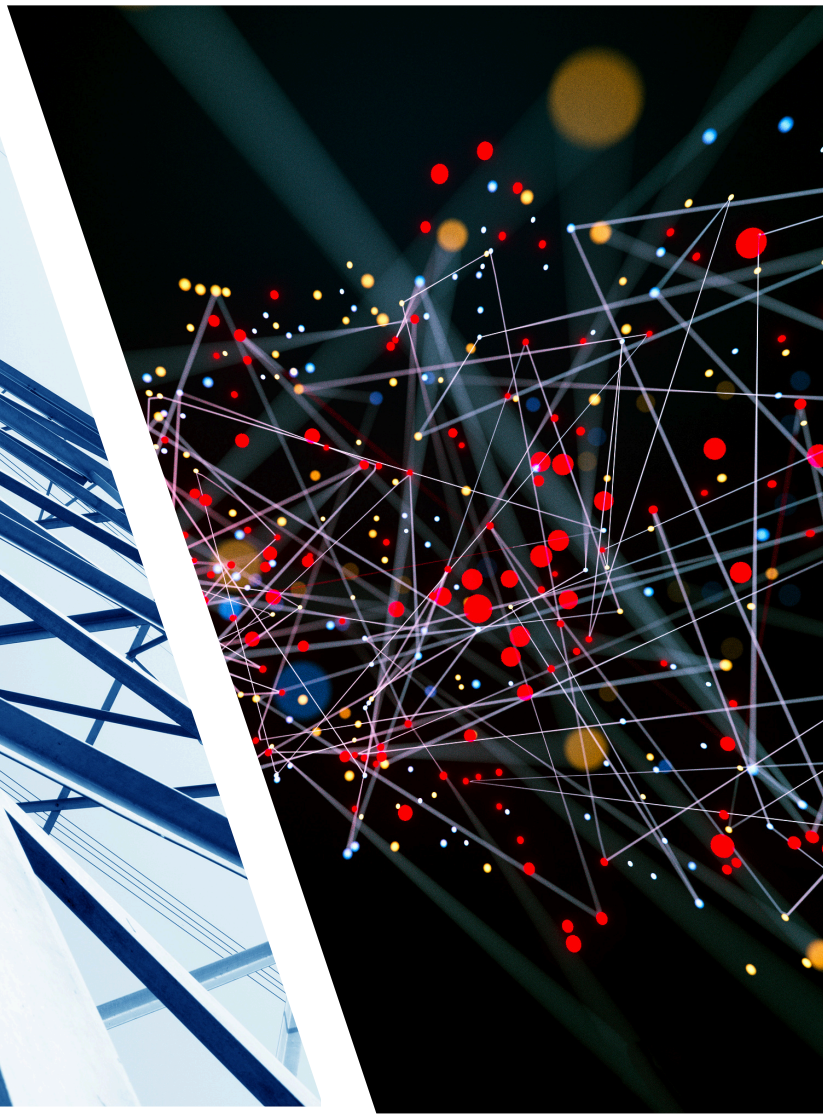

Data Centers in the DMV Series

DATA CENTER PRIMER

Metropolitan Washington:

Data Center Capital of the World

Northern Virginia—anchored by Loudoun, Prince William, and Fairfax counties—is home to "Data Center Alley," the largest concentration of data centers in the world. 25% of data center capacity in the Americas is located in Northern Virginia, placing Metropolitan Washington at the center of the global technology ecosystem.[1]

Since 2012, data centers have chosen to locate in Northern Virginia due to its extensive underground fiber optic network, tax incentives, and availability of developable land. At the same time, rapid growth has sparked community concerns across the region related to electricity demand, rising energy costs, zoning changes, and noise.[2]

There are

63 million ft²

of operational data centers in Virginia statewide.[1]

80%

of this square footage is located in Loudoun, Prince William, and Fairfax counties.[1]

Types of Data Centers

A data center is a facility that houses servers and supporting infrastructure used to store, process, and transmit digital information. Core components typically include computing and storage equipment, networking systems, backup power, cooling systems, and physical security. Data centers can be categorized by ownership, IT purpose, or facility type. Common classifications include:[3]

Edge data centers are smaller facilities that are located closer to end users at the edge of a network to provide low-latency computing. They offer the same services as a traditional data center but have a smaller footprint.

Enterprise data centers are owned or leased by a single organization and used to support that organization's internal IT needs. Enterprise data centers can be a full capacity data hall built for a specific customer within a colocation data center or an on-premise data center built by an organization. Enterprise facilities are built to suit that organization's needs.

Internal data centers are typically integrated into larger buildings and managed by businesses with their own IT systems.

Colocation (multi-tenant) data centers provide space, power, cooling, and connectivity for the servers and other hardware of multiple organizations. The organizations that rent space at these facilities are known as tenants. Space in a colocation data center is often leased by the rack, cabinet, cage or room. These facilities are also referred to as multi-tenant data centers.

Hyperscale data centers are extremely large facilities built by or for one major technology company to serve its cloud or AI workloads. These centers are engineered for high efficiency, scalability, and uniformity.

Drivers of Energy Demand

Virginia is estimated to host the highest electricity demand associated with data centers in the U.S.[3] Most power consumption comes from two sources:[4]

Powering servers and IT equipment

Cooling systems needed to remove heat generated by the IT load

Cooling alone can account for nearly as much energy use as computing equipment. Additional contributors—such as storage, networking, lighting, power distribution, and uninterruptible power supplies—make up a smaller share.

Energy demand varies by workload. As processing chips grow more powerful, they require more electricity and generate more heat per square foot. AI and hyperscale server racks today commonly exceed 30 kW and are trending significantly higher.[5]

Spotlight on Hyperscale Facilities

Hyperscale data centers are the most energy intensive type of data center, with average server utilization around 50%, increasing to 80% for AI training workloads.[5] Colocation and small- to mid-sized data centers typically operate bewteen 15-30% utilization.[3] Figure 1 shows the total annual electricity use by data center space type and by component, highlighting the demand from servers/IT equipment.

In 2023, hyperscale and colocation data centers accounted for almost 80% of server energy use.[3] By 2028, energy growth will hinge heavily on the number and intensity of AI workloads.[4] Hyperscale facilities are growing rapidly, with Amazon, Microsoft, and Google collectively owning more than half of them.[3] Both hyperscale and colocation centers tend to locate near population hubs and major fiber networks to ensure high availability and low latency.

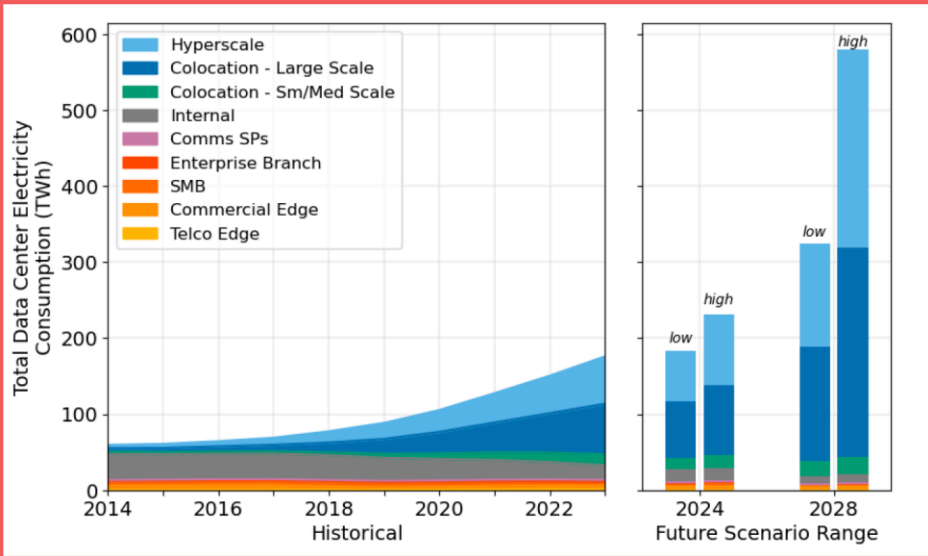

Figure 1: Total Data Center Electricity Use 2014 - 2023, Projected 2024 and 2028 by Space Type and by Equipment Type[3]

Improving Data Center Efficiency

Energy savings from IT equipment upgrades often generate “multiplier” benefits: reducing server power reduces the energy needed for cooling and other supporting systems. Significant opportunities remain to improve efficiency across servers, storage, networking, and IT management practices.[3] Data center operators can reduce energy demand through:

- **Deploying more efficient IT hardware**
- **Increasing server utilization**
- **Virtualizing workloads**
- **Improving monitoring, environmnetal controls, and airflow management**
- **Consolidating underused equipment**

Measuring Data Center Efficiency

Two key performance metrics are widely used:[3]

PUE (Power Usage Effectiveness): Measures how efficiently a data center uses energy; a value close to 1.0 indicates that nearly all power goes to IT equipment.

- Average PUE in 2023: 1.4
- Projected average by 2028: 1.15–1.35, driven by more efficient hyperscale and colocation facilities and broader adoption of liquid-cooled AI servers.

WUE (Water Usage Effectiveness): Measures water use for cooling.

- Average WUE today: 0.36 L/kWh
- Expected by 2028: 0.45–0.48 L/kWh, reflecting increased use of liquid cooling systems.

Data Center Cooling Technologies

Most data centers cool equipment using:

Air cooling, where chilled air is circulated over servers

Liquid cooling, where cold water or another fluid is brought directly to or around the equipment

Liquid cooling delivers up to

40%

in energy savings, as compared to traditional air cooling.[5]

Effective airflow management—keeping hot and cold air separate—is essential for efficiency. Poor airflow requires systems to work harder, increasing energy use and operating costs.

For many small and medium-sized data centers, with server loads under approximately 10-15 kW power density per rack, air cooling remains a viable option. However, as power densities increase, air cooling presents certain drawbacks, including elevated cooling costs, risks of performance throttling due to thermal issues, and limited scalability. While liquid-cooled equipment generally has higher upfront costs, many of these costs may be offset through energy savings and opportunities to use waste heat for nearby buildings or district heating.

Current liquid-cooled rack systems are often bespoke, but Lawerence Berkeley National Laboratory has identified the need for standardized rack designs to support long-term reuse across multiple hardware refresh cycles.[3] Immersion cooling, where equipment is submerged in a non-conductive fluid, is an emerging technology but still faces hardware warranty limitations.

End Notes

1. Joint Legislative Audit and Review Commission. December 9, 2024. “Data Centers in Virginia: Report to the Governor and the General Assembly of Virginia,” Commonwealth of Virginia. Available: https://jlarc.virginia.gov/pdfs/reports/Rpt598.pdf. Accessed February 4, 2026.
2. J. Abamu, M. Barthel, and A. Koma. December 11, 2025. “How rising energy bills and AI demand are fueling local data center debates,” WAMU. Available: https://wamu.org/story/25/12/11/reporter-roundtable-how-rising-energy-bills-and-ai-demand-are-fueling-local-data-center-debates/. Accessed February 4, 2026.
3. A. Shehabi, A. Newkirk, S. J. Smith, A. Hubbard, N. Lei, M. A. B. Siddik, B. Holecek, J. Koomey, E. Masanet, D. Sartor. 2024. “2024 United States Data Center Energy Usage Report,” Lawrence Berkeley National Laboratory, Report #: LBNL-2001637. Available: http://dx.doi.org/10.71468/P1WC7Q. Accessed February 2, 2026.
4. K. Ramachandran, D. Steward, K. Hardin, G. Crossan, and A. Bucaille. November 19, 2024. “As generative AI asks for more power, data centers seek more reliable, cleaner energy solutions,” Deloitte. Available: https://www.deloitte.com/us/en/insights/industry/technology/technology-media-and-telecom-predictions/2025/genai-power-consumption-creates-need-for-more-sustainable-data-centers.html. Accessed February 4, 2026.
5. Metropolitan Washington Council of Governments. November 2025. “Comprehensive Climate Action Plan: Washington-Arlington-Alexandria.” Appendix I. Available: https://www.mwcog.org/assets/1/6/Draft_COG_CCAP_for_Public_Comments_October_2025.pdf. Accessed February 4, 2026.