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## Physical Attributes of a Typical Loudoun County, Virginia Data Center

Given your background in environmental policy and energy infrastructure planning in New York State, understanding Loudoun County data center characteristics provides important context for comparing development patterns across regions. Loudoun County, Virginia—specifically the "Data Center Alley" area around Ashburn and Sterling—hosts the world's highest concentration of data centers, with approximately 199 operational facilities totaling around 47 million square feet as of 2025.[1] [2]

### Building Footprint and Physical Dimensions

**Individual Building Size**: A typical data center building in Loudoun County ranges from **300,000 to 430,000 square feet** per structure. However, facilities can be significantly larger, with some buildings exceeding 1 million square feet. The average building size reflects the need to house thousands of servers and associated cooling equipment across multiple floors.[3] [4] [5]

**Campus Scale**: Data centers are increasingly developed as multi-building campuses rather than standalone structures. A typical campus requires a **minimum of 40 acres** of land, though many developments span much larger areas. For example, CloudHQ's Dulles Berry project encompasses 93 acres with plans for up to 4.05 million square feet across multiple buildings. Peterson Companies is developing a 525-acre campus in nearby Stafford County that could eventually total more than 25 buildings and 5.5 million square feet.[6] [7] [8] [3]

**Building Height**: Data centers typically range from **one to three stories**. Loudoun County's design guidelines encourage data centers to "approximate a multi-story office building" in appearance. The relatively low profile is driven by the need to efficiently distribute heavy IT equipment loads and facilitate cooling systems.[9] [3]

**Floor Area Ratios (FAR)**: The Board of Supervisors has reviewed building densities for data center properties, with FARs varying based on specific site conditions and zoning districts.[8]

### Energy Consumption and Power Demand

**Typical Power Requirements**: Energy consumption represents perhaps the most significant physical impact of Loudoun County data centers. A single large data center can require **100 megawatts (MW) of power**—enough to supply approximately 25,000 homes and representing about 10% of a full-scale nuclear power plant's output.[10] [11]

**Campus-Level Power Demand**: Modern data center campuses in the region are increasingly designed for **300 MW to 2,000 MW** (2 gigawatts) capacity. The Peterson Companies' Stafford County campus alone plans for 1.8 GW across a 525-acre site. PowerHouse's development in

nearby Spotsylvania County spans 145 acres with 800 MW capacity and up to eight three-story buildings totaling 3.5 million square feet.[2] [3]

**Per-Rack Power Density**: Traditional data centers operate at **4-6 kW per rack**, while large cloud service providers operate at **10-14 kW per rack**. AI-ready data centers push densities significantly higher, with power requirements of **20 kW to 120 kW per rack** depending on GPU configurations.[12] [13]

**Aggregate Regional Impact**: As of December 2024, Dominion Energy reported approximately **40 GW** of contracted data center power capacity across Northern Virginia, an 88% increase from just 21 GW six months earlier. Loudoun County data centers accounted for 21% of Dominion Energy's total electricity sales in Virginia as of late 2022. The utility expects power demand to double in the next 15 years, with data centers as the largest contributor.[14] [15] [2]

**Infrastructure Requirements**: Each data center requires dedicated high-voltage transmission lines and electrical substations to deliver power. Dominion Energy is actively developing two new 500 kV transmission lines that will add 6 GW of capacity to Eastern Loudoun alone.[11] [2]

## Noise Levels and Acoustic Characteristics

**Regulatory Limits**: Loudoun County's noise ordinance establishes a maximum of **55 decibels (dBA)** measured at the receiver's property line (adjacent property owners). For comparison, 55 dBA is approximately the noise level of a business office—quieter than a vacuum cleaner (75 dBA) but louder than a refrigerator hum (55 dBA). Major cities maintain stricter limits: New York's limit is 42 dBA, Boston's is 50 dBA, and Washington, D.C.'s is 55 dBA.[16] [17] [18]

**Actual Measured Noise**: Compliance measurements at operational facilities have recorded noise levels **consistently between 60 and 65 dBA** during normal operations. One analysis found noise levels from a 330,000-square-foot data center at 500 feet distance, with attenuation following a distance ratio of approximately 1.55. Measurements at the True North/Compass Datacenters facility confirmed compliance with the county's 55 dBA threshold, though the company voluntarily reduced fan power by 20% after resident complaints.[17] [19] [20]

**Noise Sources**: Data center noise originates from three primary sources: server equipment hum, cooling fan operations, and continuous HVAC system activity. The noise is characterized as a constant, low-frequency hum that operates 24/7 without interruption.[18] [17]

**Community Impact**: Residents have reported hearing data center noise **more than 3 miles away** from facilities, particularly at night when ambient noise decreases and cooler temperatures require increased cooling system operation. The U.S. EPA identifies 52 dBA as the threshold for speech interference at 10 meters and 60 dBA at 1 meter. The continuous nature of the sound, rather than peak volume alone, creates the primary annoyance factor for nearby residents.[20] [17]

**Acoustic Modeling**: Noise calculation standards typically employ ISO 9613-2 for outdoor noise prediction, with measurements conducted using A-weighted sound level meters (dBA). Some communities have requested assessment of additional acoustic characteristics including tonality, frequency content (particularly low-frequency components), and amplitude modulation, as these factors can increase perceived annoyance even at compliant decibel levels.[21] [20]

### Water Consumption

Data centers require substantial water resources for cooling systems. Large facilities can consume **5 million gallons of water per day**. Water usage in Loudoun County data centers increased by more than **250% between 2019 and 2023**, with total consumption reaching over 1.85 billion gallons in 2023 across the Northern Virginia region. Many facilities use evaporative cooling methods, meaning the water is not returned to wastewater systems but is instead lost to the atmosphere.[22] [23]

### Backup Power Generation

Data centers maintain extensive backup power systems, typically consisting of **diesel generators** ranging from 600 kW to 3,500 kW each. A single large facility may have **40 to 150 generators** for emergency backup and grid stability support. While these generators are permitted primarily for emergency use and testing, Virginia DEQ has considered allowing their operation during peak summer demand periods to address grid instability—a controversial proposal given diesel's air quality impacts.[24] [25]

### Comparative Context for New York

As you analyze energy infrastructure development in New York State, particularly regarding facilities like the Micron chip fabrication plant, Loudoun County's experience offers relevant insights. The region now faces grid capacity constraints that are limiting further data center expansion, transmission infrastructure costs that may be stranded with existing customers, and growing community resistance to quality-of-life impacts including noise pollution and overhead transmission lines. These challenges mirror concerns about how New York's electric system will accommodate major new industrial loads while maintaining reliability and managing ratepayer costs.[26] [1] [2]

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