



Data Centers in Virginia

JLARC data center study

- JLARC is a Virginia state legislative branch agency
 - Perform non-partisan, objective program and policy evaluation for the state
 - Topics selected by the Virginia General Assembly (the state legislature)
- In 2024, performed broad review of state's large and fast-growing data center industry
 - Energy, economic, environmental, and community impacts

Commission resolution (December 11, 2023)

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Background

Local Community Impacts

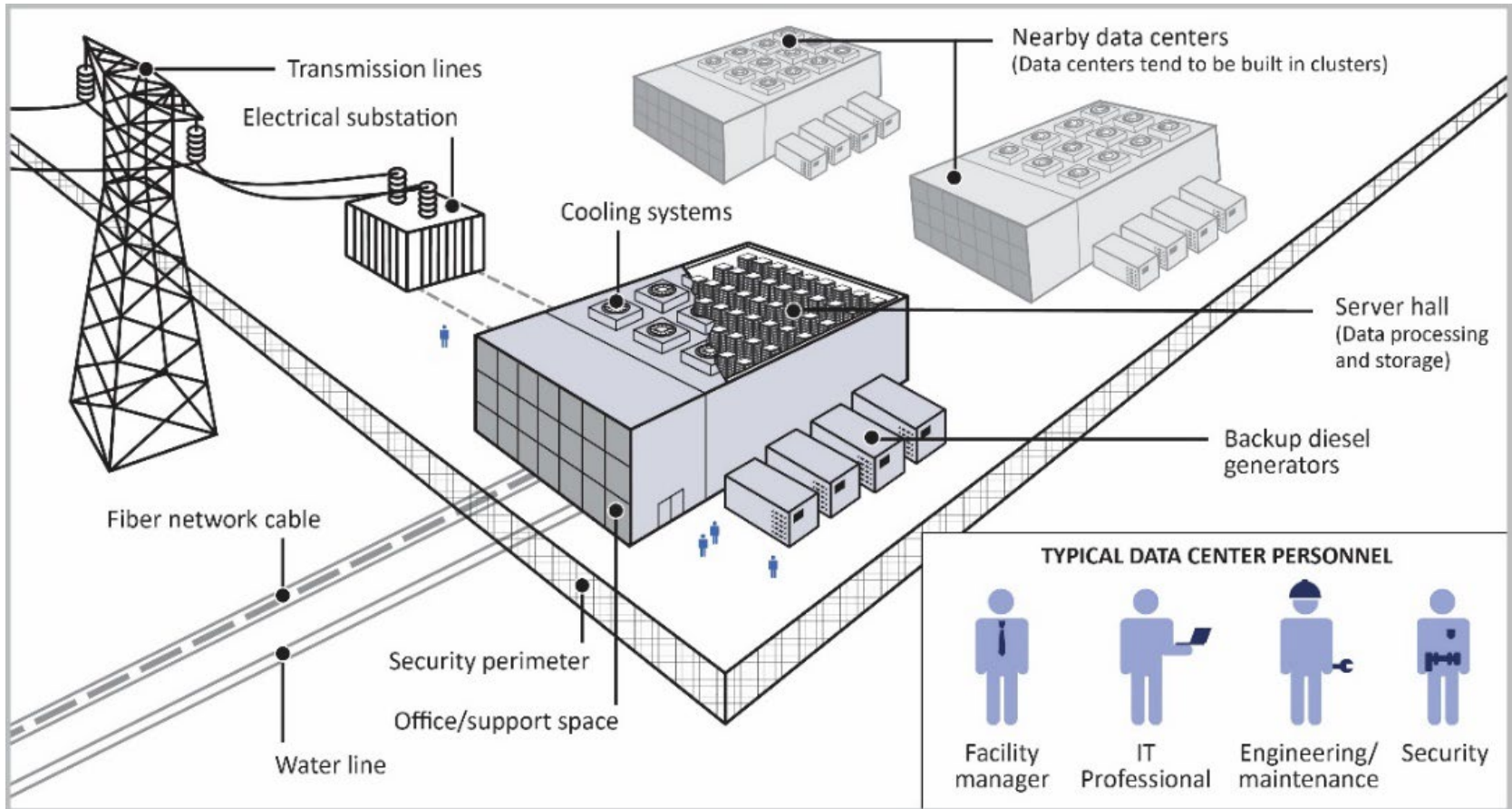
Environmental Impacts

Economic, Tax, and Energy Impacts

Data centers are key hubs of world's digital infrastructure

- Enable modern digital services and economy
 - Internet, cloud services (business, personal), media streaming, apps, financial transactions
- Industry is growing rapidly, driven by a combination of established and emerging trends
 - Existing uses accelerated by COVID-19 pandemic
 - Emergence of artificial intelligence
- Virginia (and US) dominated by a few large companies
 - Amazon Web Services, Google, Meta, Microsoft

Modern data centers are large industrial buildings, increasingly located together on “campuses”

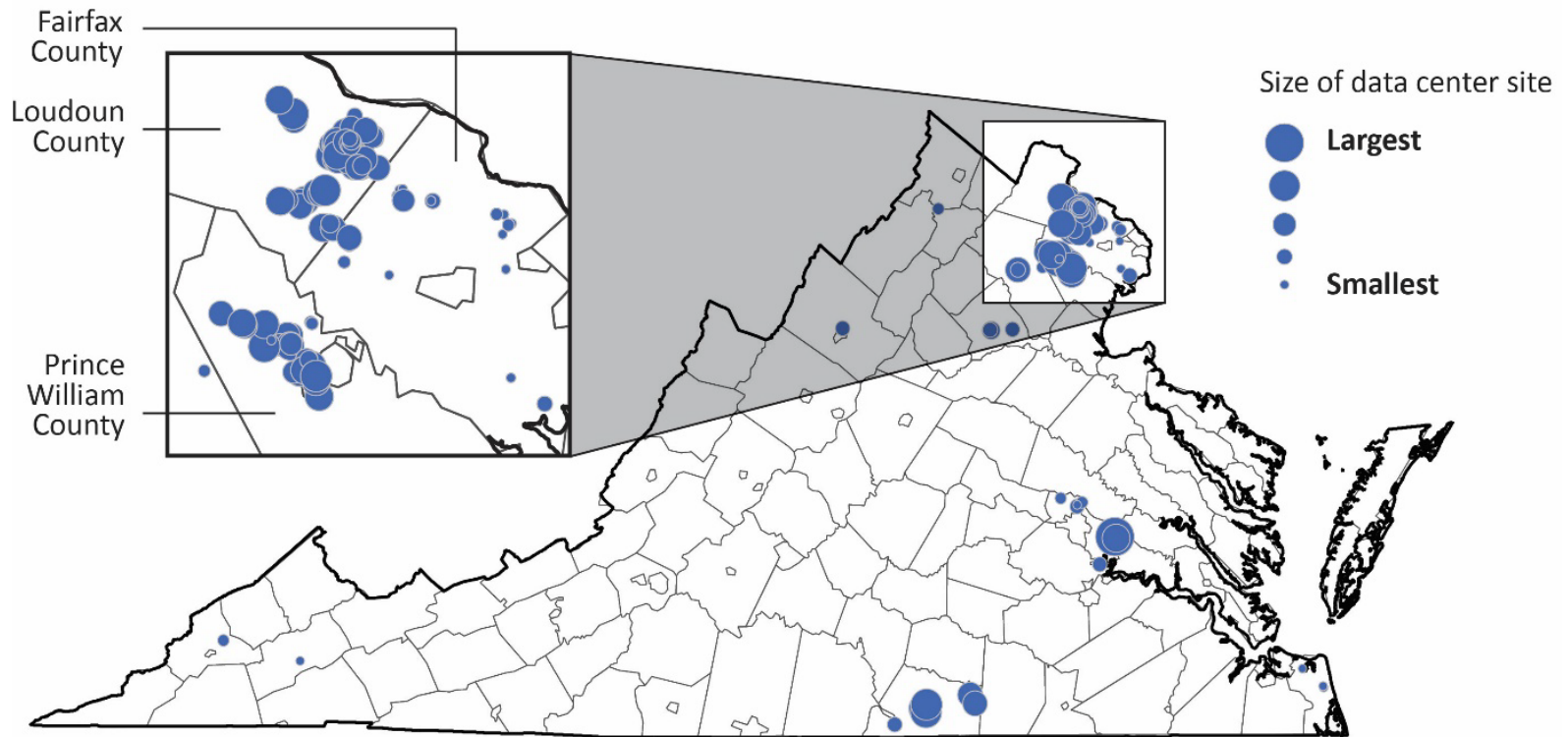


Modern data centers use substantially more energy than other commercial or industrial operations

- Old data centers were <1 MW to 20 MW
- New “hyperscale” data centers draw from 100 to over 200 MW, more than most Virginia industrial consumers
- Planned data center campuses are expected to consume well over 1,000 MW
 - Compare to Virginia’s two nuclear plants: North Anna two 950 MW reactors, Surry two 850 MW reactors

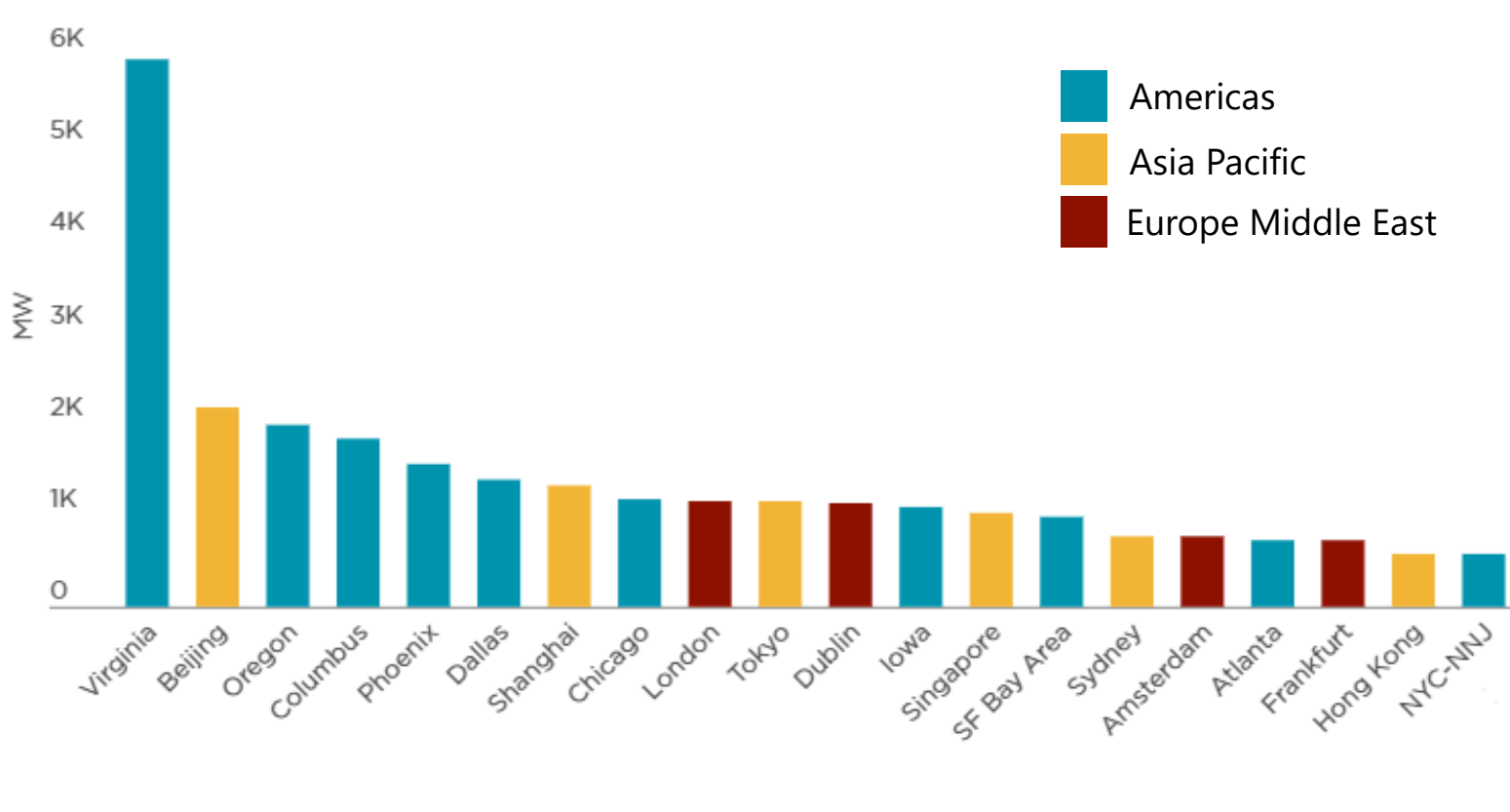
MW = megawatts of power capacity is the common metric for measuring data center size

Most of Virginia's data center industry concentrated in Northern Virginia



Data center size is measured using operational capacity, given in megawatts of power.

Virginia is the largest data center market in the world



Cushman & Wakefield 2025 Global Data Center Market Comparison

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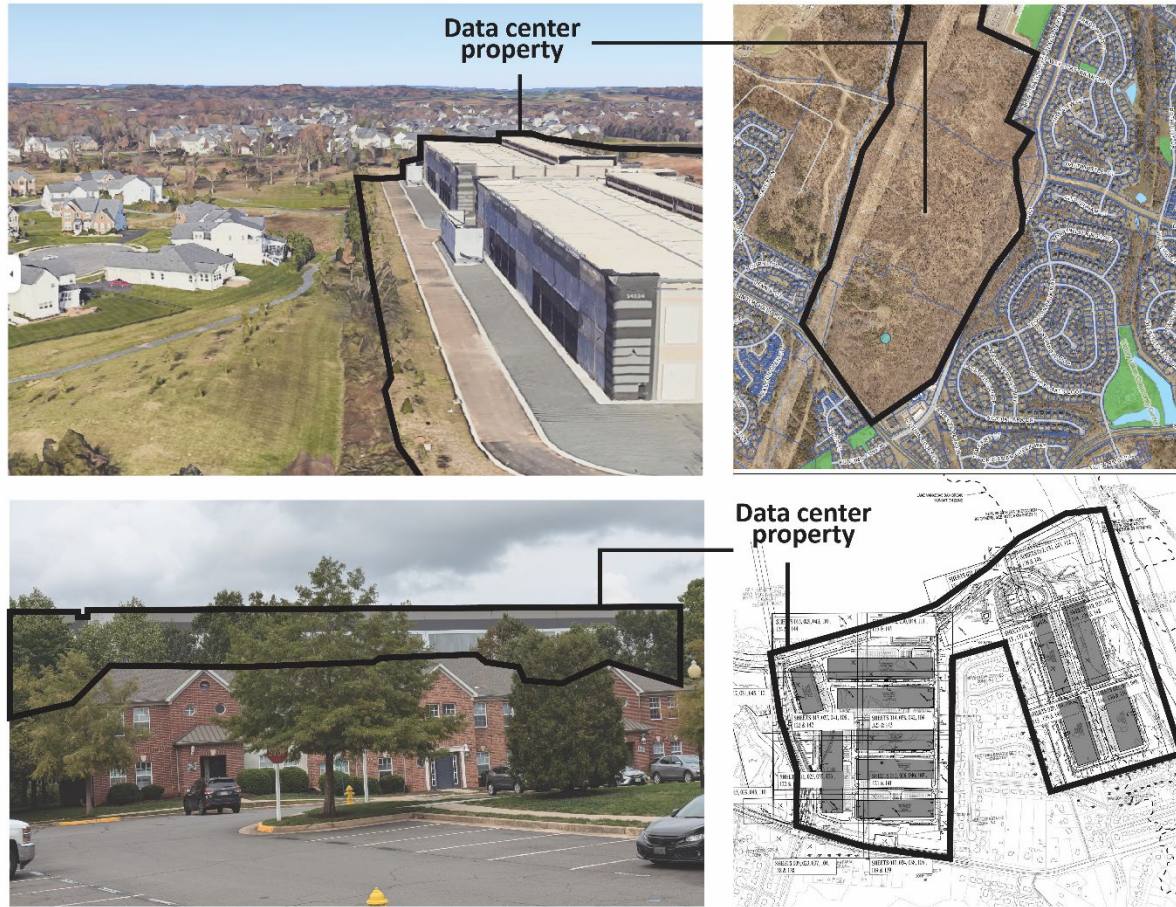
Finding

Growing number of data centers are being built close to residential areas, impacting nearby residents, and some localities have taken steps to minimize impacts.

Data centers are industrial facilities that are largely incompatible with residential uses



One-third of data centers are near residential areas, and industry trends make future impacts more likely



Some localities have allowed data centers near neighborhoods but are now taking steps to minimize future impacts

- Some localities have allowed data centers next to residential areas because of
 - Inadequate planning and zoning
 - Elected officials changing or granting exceptions to zoning requirements designed to reduce residential impacts
- Several Virginia localities have made or are considering zoning ordinance changes to reduce risk of residential impacts
- Effectiveness ultimately depends on elected officials

Noise has been an issue for a minority of data centers but can negatively affect nearby residents

- Only some data centers audible past property line, and noise has only been a problem when close to residential
 - Noise is typically a low-frequency “drone” or “hum” and is not loud enough to damage hearing
- In a few cases, noise has been significant enough to affect well-being of nearby residents
- Resolution has been difficult because noise ordinances are ineffective at addressing complaints
- Localities can take steps to mitigate data center noise, but some are unsure of their authority to do so

Like other developments, data center projects can disturb historic resources

- Historic resources include sites (e.g., battlefields and cemeteries), structures, and artifacts
- Development can disturb or destroy any *on-site* resources and affect viewshed of *nearby* historical sites
- Data centers have same potential impacts as other large-scale developments
 - Historic resources not always present
- Pre-development studies help identify and mitigate impacts on historic resources, but not always required
 - Phase I-III studies identify resources & preservation options
 - Viewshed analysis shows how nearby sites are impacted

Localities should implement several practices to minimize community impacts

- Classify data centers as industrial use
- Revise zoning maps to prevent by-right data centers next to residential
- Ensure sufficient minimum requirements for data center developments are sufficient (setbacks, building heights)
- Designate optimal locations for data center development (away from residential, close to transmission)
- Consider aesthetic building design standards (roof tiering, fenestration) and landscaping requirements (e.g., plantings or preservation of established forest for tree breaks)

Localities should implement several practices to minimize community impacts (continued)

- Require pre-development sound modeling for projects close to residential and other “sensitive” areas (schools, parks, etc.)
- Revise ordinances to better prevent and address noise conflicts
 - Establish noise requirements under zoning ordinances to better address noise concerns and provide teeth for enforcement
- Require historic resource (phase I) study, viewshed study prior to construction

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Finding

Data center backup generators emit pollutants, but their use is minimal, and existing regulations largely curb adverse impacts.

Data centers rely on large number of diesel generators for backup power (average 54 per site)

- Emit several harmful air pollutants, such as nitrogen oxides, carbon monoxide, and particulate matter
- Regulated by DEQ using state and national standards
 - All backup generators permitted and monitored by DEQ
 - Limits use and allowable emissions to protect air quality
- Backup generators rarely run for prolonged periods
 - Routine maintenance (10-30 minutes per month)
 - Few actual power outages (operators reported 0 to 2 outages at their facilities in last two years, lasting from 1 to 5 hours)

DEQ = Virginia Department of Environmental Quality

Backup generator emissions unlikely to harm regional air quality; localized effects under study

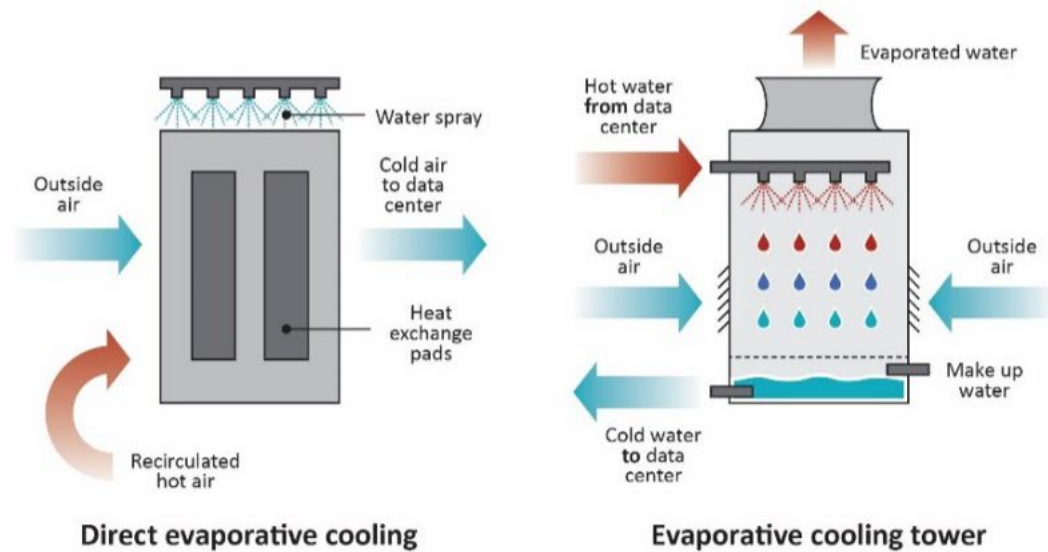
- Backup generators <4% of regional (Northern Virginia) nitrogen oxides emissions and 0.1% of carbon monoxide and particulate matter
 - Emissions only 7 percent of what permits allowed (2023)
 - Regional air quality has improved while industry has grown
- A “worst-case” prolonged, large-scale *regional* outage could contribute to temporary air quality issues
 - Such outages are rare, and air quality would return to normal after the event
- To identify any *localized* concerns, DEQ launched study to monitor data center generator emissions in Northern Virginia

Finding

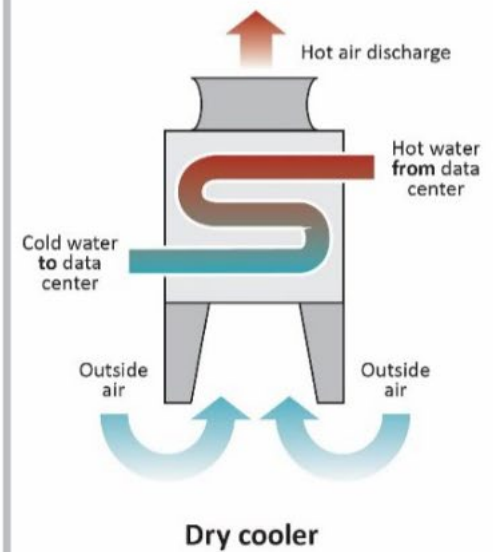
Data center water use is currently sustainable, and state ensures future sustainability through regulation.

Data center water use depends on type of cooling system used

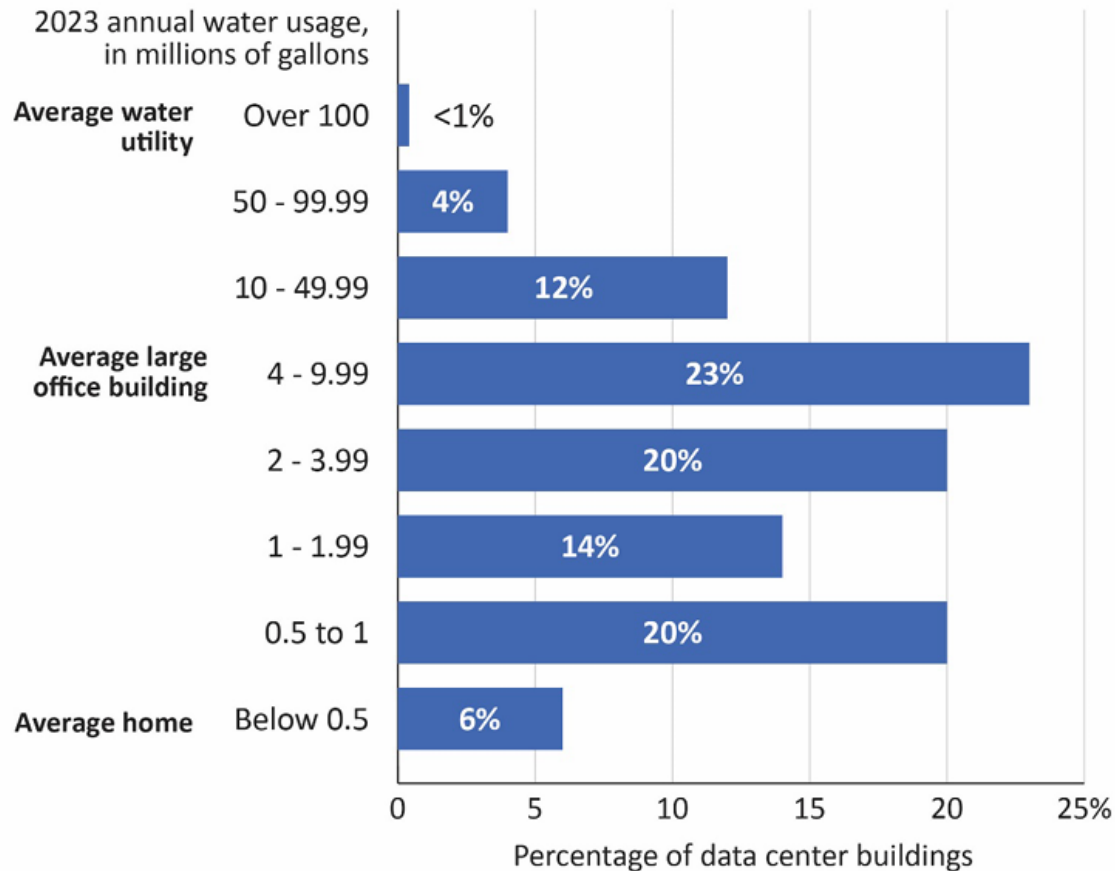
WATER-DEPENDENT COOLING PROCESSES



DRY COOLING PROCESS



Most data centers (83%) use same amount of water (or less) as an average large office building



State regulates sustainability of water withdrawals, but some localities should consider local impacts

- State regulates water withdrawals and requires permits for large scale withdrawals (surface, groundwater)
 - State models withdrawal impacts on water availability, flora, and fauna when permits are issued and renewed
- Virginia is relatively water rich, but some localities have limited water resources (e.g., lack direct access to surface waters or are in groundwater management areas)
- **Localities should consider whether data center projects could affect ability to meet future residential demand or pursue other development opportunities**

Finding

Data center impacts on water quality, native habitat, and agricultural lands are similar to other large-scale developments.

Data center construction has similar land and water impacts as other large-scale developments

- “Greenfield” development of forest and agricultural land changes characteristics and can create environmental risks and challenges
 - Destroys natural habitat, agricultural lands
 - Risks of stormwater runoff, wetland disturbance, and water quality issues
- Data center construction has similar impacts as other large industrial developments, high-density commercial, and residential developments
- State and federal regulations in place to mitigate water impacts from all types of developments, including data centers

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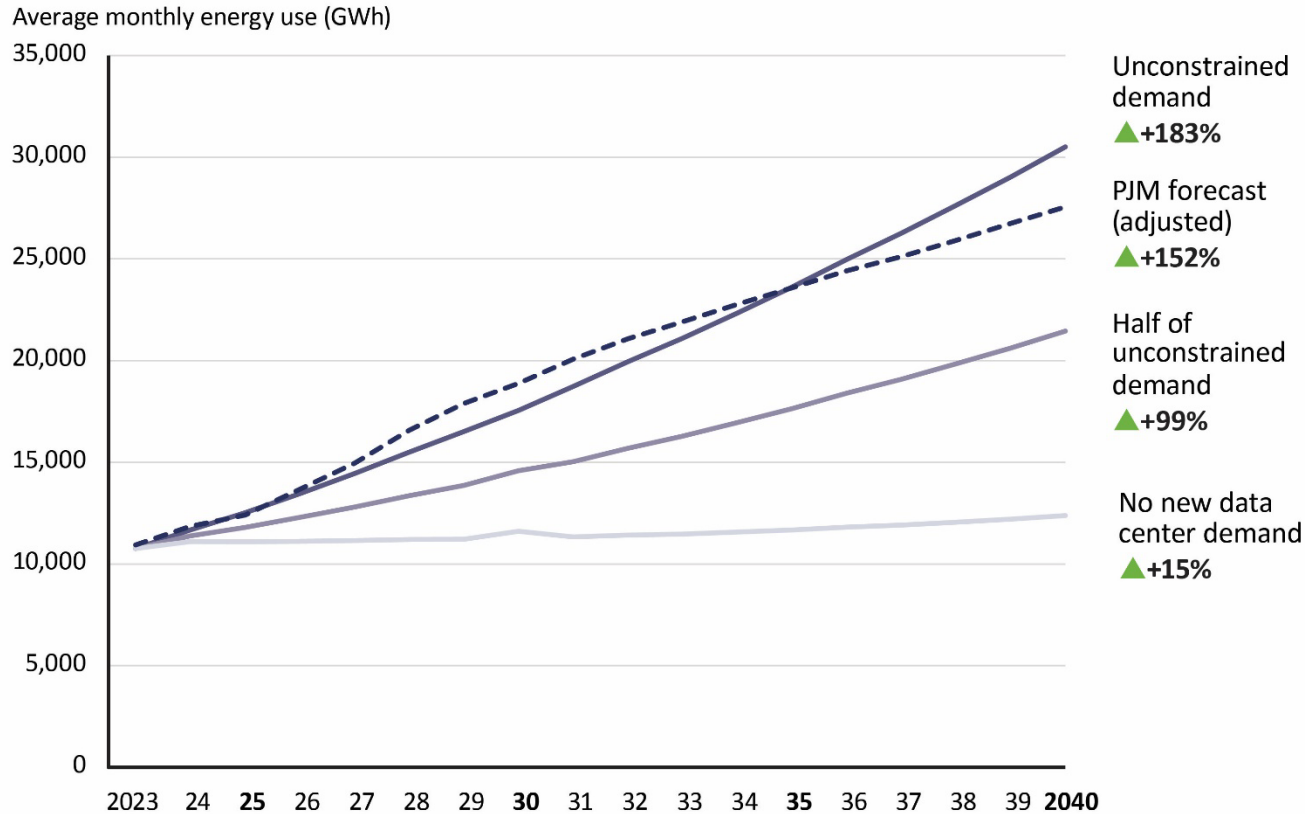
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Data centers have had positive economic and tax revenue impacts

- Data center industry has economic benefits, with ~80% benefits occurring during construction
 - Large projects with over 1,500 workers on-site during peak construction
 - Skilled “blue collar” construction and trade workers (steel workers, electricians, pipefitters)
 - ~50 jobs per facility, including IT and building management professionals, trade workers, and security
- Localities with data centers can collect substantial tax revenues from the industry
 - Amount of local revenue depends on several factors, such as size of data center market and local tax rates

Data center industry is forecast to drive immense increase in Virginia's energy demand



PJM, equivalent to Ontario's IESO, is the regional organization responsible for coordinating generation and transmission for Virginia and several other eastern and midwestern states.

Addressing energy demand would require substantially increasing current system capacity and energy imports

Change from 2025 to 2040

	Scenario 1: Unconstrained demand	Scenario 2: Half unconstrained demand
Generation (in-state)	+150%	+90%
Transmission (Interzonal)*	+40%	+35%
Imported energy (net)	+150%	+55%

Scenarios shown assume that Virginia Clean Economy Act (VCEA) renewable requirements are met.
*Transmission capacity is only interzonal lines to and from the Dominion transmission zone, where most data centers are located and most growth is expected to occur.

Growing data center energy demand is likely to increase costs for non-data center customers

- Generation and transmission costs could increase \$10B to \$18B by 2040, mostly because of data center demand
- Portion of “fixed costs” associated with new infrastructure would be billed to non-data center customers
- Energy supply may not keep pace with growing demand, so energy prices would increase for all customers
- Cost increases to non-data center customers can be mitigated by utility and state regulatory action to change customer classes, costs allocations, and implement contract requirements

Questions?

Mark Gribbin

mgribbin@jlarc.virginia.gov

804-371-4591