

Atlas

# Northern Virginia, US

Leonardo Mühlestein, Vithursan Manoharan, and Alberto Früh

Northern Virginia accounts for approximately 35% of the world's data center facilities. The region hosts over 275 facilities with a power demand of 2,600 megawatts. This transformation began in 1991, when the small farming community of Farmwell evolved into the tech hub now known as Ashburn. Major corporations like Amazon and Microsoft were drawn to the area by favorable tax incentives, a stable climate, and proximity to Washington D.C.

However, this rapid expansion has placed immense strain on the local power grid. Some new projects request twice the capacity of a standard local power plant, triggering a rare bipartisan “backlash.” While Republicans express concern over rising electricity costs, Democrats emphasize the environmental impact and heavy water consumption. Consequently, roughly \$64 billion in new projects are currently stalled or delayed across the United States.

The physical presence of these “cloud” buildings is equally controversial; maps show massive, windowless structures standing directly adjacent to residential neighborhoods and public schools. Furthermore, the offer of millions of dollars to farmers for their ancestral land has created significant emotional stress within the community. For Northern Virginia to sustain its growth, it must find a way to reconcile technological demands with the needs of its residents and the environment.

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## The \$33-Million-Knock



Ida Huddleston (left) and her daughter Delsia Bare. Photograph: Janet Garrison.

Ida Huddleston is 82 years old, and her roots in Mason County, Kentucky, run deeper than the crops she tends. Her family's story is the story of American resilience: her grandfather harvested tobacco when the Civil War erupted, her father plowed wheat through the First World War and the lean years of the Great Depression. Ida and her five siblings were raised on the beans, broccoli, and potatoes pulled from soil once seared by the Dust Bowl. In her family, no one went to college. The land was their education and their life.

But last May, the centuries-old rhythm of the Huddleston farm was interrupted. Two men arrived at Ida's door with a contract worth \$33 million.



The Huddleston farm in Mason county, Kentucky. Photograph: Janet Garrison.

The offer was for her 650-acre farm, but the details were shrouded in secrecy. The men represented an unnamed “Fortune 100 company” seeking land for an unspecified industrial development. To learn anything more, Ida would have to sign a non-disclosure agreement. She wasn’t alone; more than a dozen neighbors received the same mysterious knock.

The community went searching for answers in public records. What they found was staggering: a new customer had applied for a 2.2 gigawatt project from the local power plant, nearly double the plants entire annual generation capacity. The “industrial development” finally had a name: a data centre.



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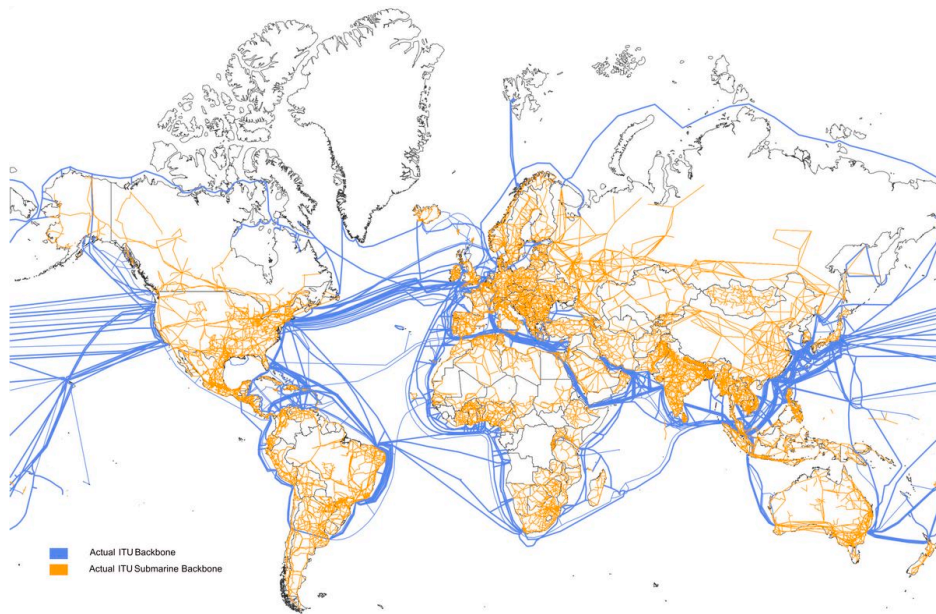
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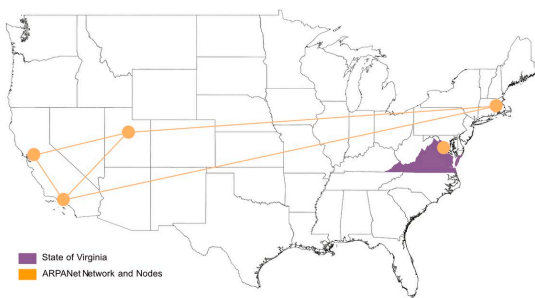
## Path Dependency or New Logic?

## INFRASTRUCTURAL GENESIS: FROM MILITARY SEED TO GLOBAL BACKBONES

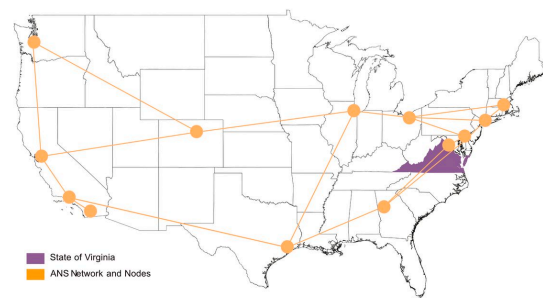


Submarine and terrestrial cable infrastructure of 2025.  
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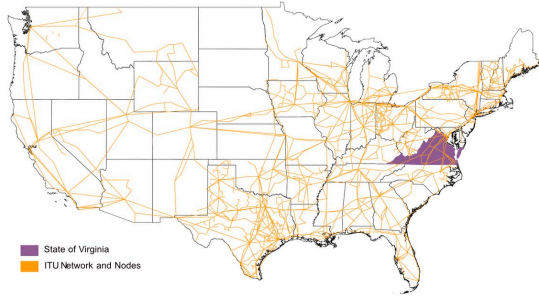
Northern Virginia's current centrality is the result of historical stratification that sees the region as the main hub for global data transit, accounting for up to 70 % of global traffic. As can be seen from the map, the largest flow of information is with Western Europe, but it is also growing towards more exotic destinations. Furthermore, the map highlights how global connectivity requires physical infrastructure such as electrical cables and fibre optics. Northern Virginia is interesting for this very reason: it offers some of the best infrastructure in the world.



Advanced Research Projects Agency Network (ARPANet) backbone as the first layer in the 1960s in North America. Map: the authors. Source: ARPANet Network [<https://www.junglekey.fr/search.php?query=Arpanet&type=image&lang=fr&region=fr&img=1&adv=1&code=302&dc=1>].



ANS (Advanced Network and Services) backbone as the start of a commercial network in the 1990s in North America. Map: the authors. Source: ANS Network [<https://cs.stanford.edu/people/eroberts/courses/soco/projects/2003-04/internet-2/architecture.html>].



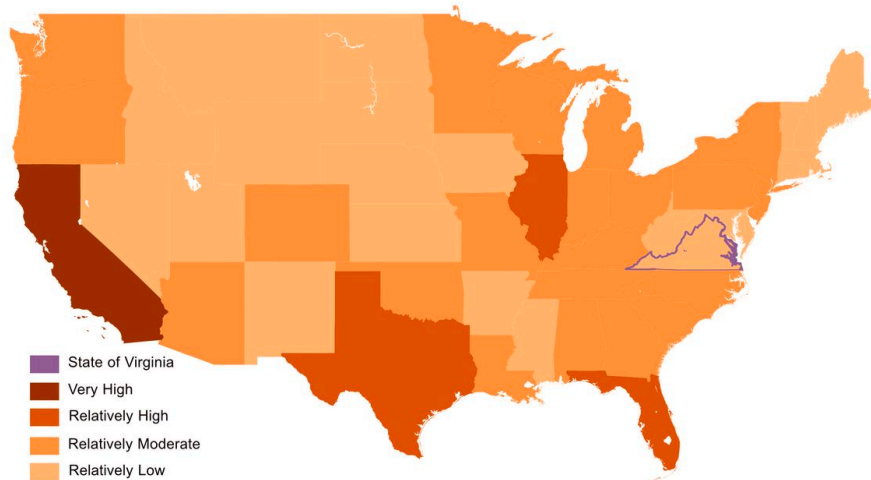
International Telecommunication Union (ITU) backbone as the actual infrastructure in North America. Map: the authors. Source: ITU Network [<https://bbmaps.itu.int/bbmaps/>]

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1990 marked a commercial turning point with the founding of Advanced Network and Services (ANS) and the creation of Metropolitan Area Ethernet-East (MAE-East) in Tysons Corner, the first major exchange point for transatlantic connections to Europe. In 1994, America Online (AOL) acquired ANS for \$35 million, moving MAE-East and its servers to Ashburn, in the heart of Loudoun County.

The territory's definitive hegemony was cemented during the dot-com bubble (1997–2002). As companies collapsed, they left thousands of kilometers of unused underground fibre, known as Dark Fiber, across Virginia. By acquiring this infrastructure at minimal cost, future giants like Amazon Web Services (AWS), Google, and Microsoft laid the foundations for today's hyperscale era. Now, the dominance of AWS and other tech leaders in the region is fully consolidated.

## ENVIRONMENTAL AND STRATEGIC LOGIC: NATURAL RESILIENCE AND POLITICAL PROXIMITY



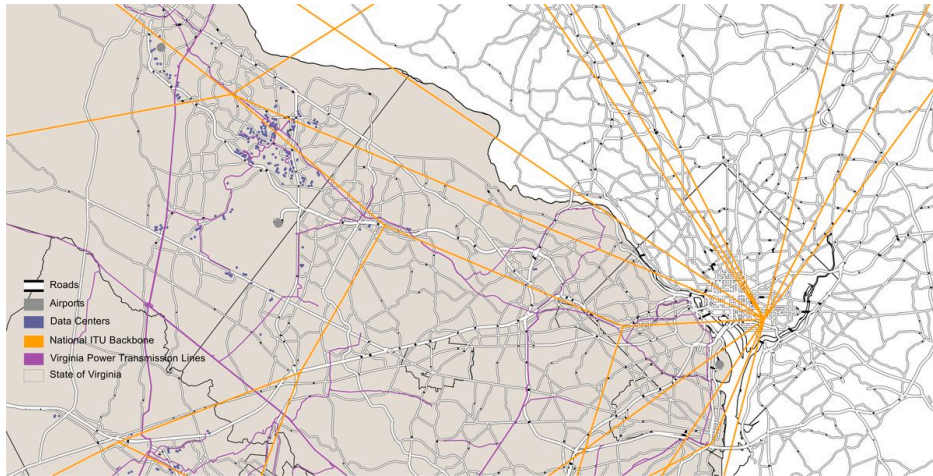
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The stability of a data centre is threatened by climatic hazards, as every extreme natural event poses a danger to operational continuity and the physical integrity of data. Northern Virginia has a relatively low overall risk profile. Minimising hazards means eliminating the variables that cause power outages, flood damage, or other issues. In this context, the territory is not only a physical support, but also acts as an environmental shield that lowers insurance costs and protects investments, making geological safety an economic asset.



Lake reserves for water and data centres collocation in the State of Virginia. Map: the authors. Source: Water Reserves and Data Center Location [[https://geohub-vadeq.hub.arcgis.com/datasets/b61083d6607d4dfa8b45ec811fad8ef1\\_178/explorer?location=38.867037%2C-77.087531%2C10](https://geohub-vadeq.hub.arcgis.com/datasets/b61083d6607d4dfa8b45ec811fad8ef1_178/explorer?location=38.867037%2C-77.087531%2C10)].

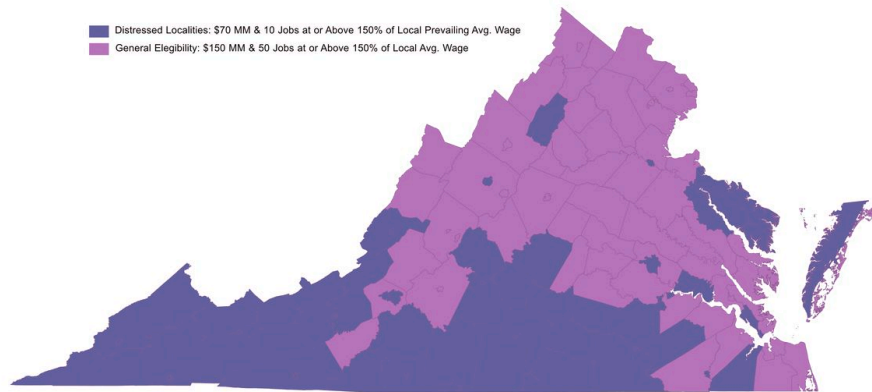
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Loudon and Fairfax counties are the most popular locations for data centres. Here, land availability is high and past logistics hubs have created a strategic location. Dulles International Airport serves as a global gateway not only for public air traffic, but also for commercial and “special” traffic (e.g. military). Around this hub, transport infrastructure such as motorways and rail corridors serve as privileged routes for laying fibre optics or vice versa, creating a widespread network that serves data centres. This technical density derives its ultimate value from political proximity: the proximity to Washington D.C. guarantees almost non-existent latency to federal command centres and national security agencies. In this territory, the material and the immaterial coexist, consolidating an ecosystem where logistical efficiency and decision-making power coincide.

## REGULATORY ACCELERATION: JURISDICTIONAL ADVANTAGE AND SPEED

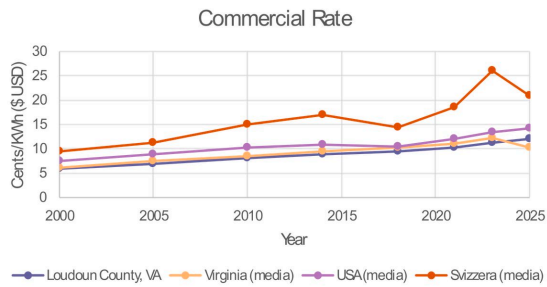


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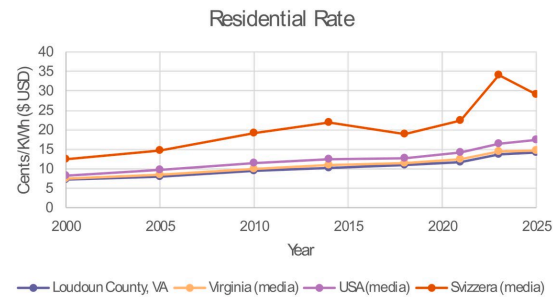
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Beyond these tax advantages, Northern Virginia's competitive edge is defined by its remarkable bureaucratic velocity. Through the "By-Right Development" model, land already zoned for industrial or office use can bypass public hearings and council votes, as the intended use is considered a pre-approved right. This administrative acceleration compresses approval timelines to just a few months—significantly faster than in other global tech hubs. This efficiency transforms the jurisdiction into a true business accelerator, allowing the region to meet the near real-time infrastructure demands of the global cloud market.

## ECONOMIC PERFORMANCE: RESOURCE ARBITRAGE AND PUBLIC REVENUE



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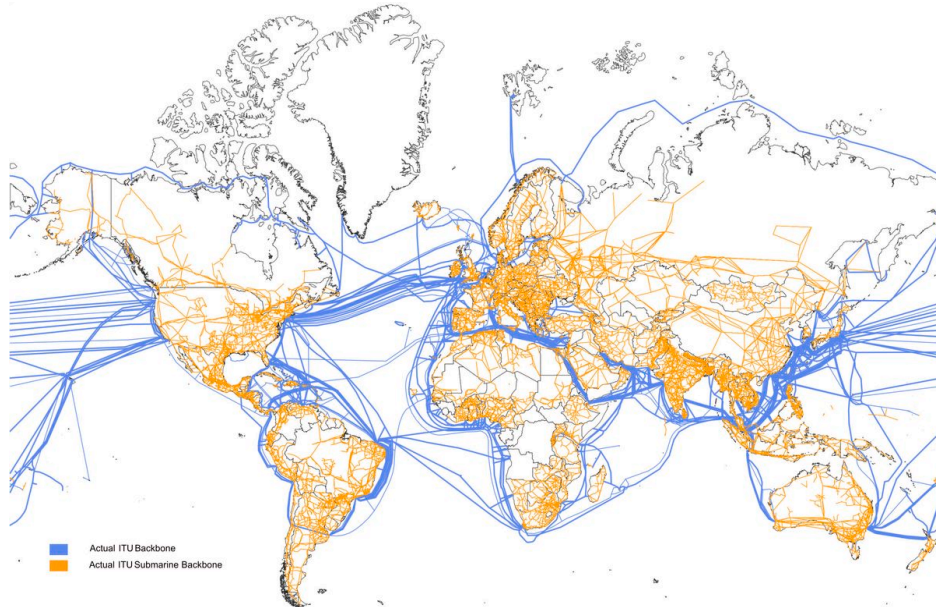
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Northern Virginia's economic pillar rests on "power arbitrage," fueled by a structural price gap that favors local data centres over global markets. While European rates, such as in Switzerland, have surged to 25–30 cents per kilowatt-hour (kWh) due to the energy crisis, Loudoun County has maintained stable commercial rates between 5 and 7 cents per kWh. This disparity makes it immensely more profitable to process data in Virginia and transmit it globally than to host it in high-cost markets.

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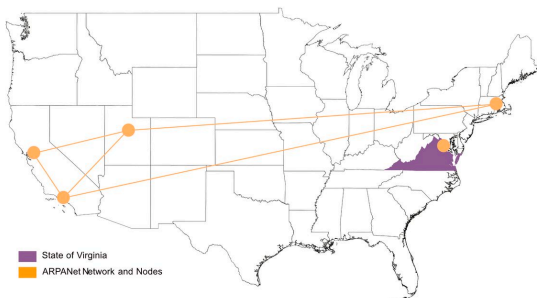
Beyond energy costs, the region's success stems from data centres acting as "ideal tenants" for local authorities, providing a massive, constant source of tax revenue with minimal public overhead. Loudoun County collects hundreds of millions of dollars annually from these facilities, covering a significant portion of its public budget. Crucially, unlike residential developments, data centres do not require schools, extensive public transport, or healthcare services. They occupy land needing only power and water, often privately funded, creating a financial surplus. This asymmetry allows authorities to keep citizen taxes low while financing high-quality public projects, creating a paradox where digital infrastructure materially subsidises local quality of life.

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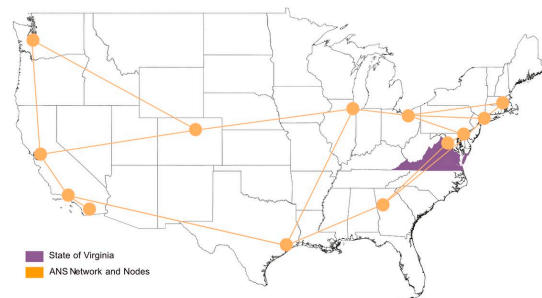


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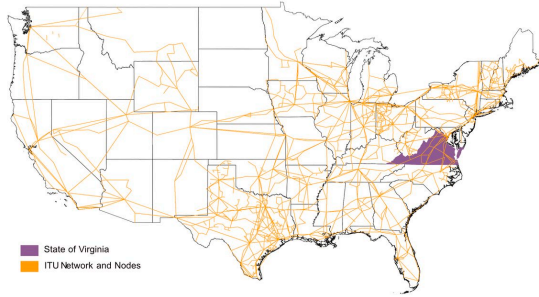
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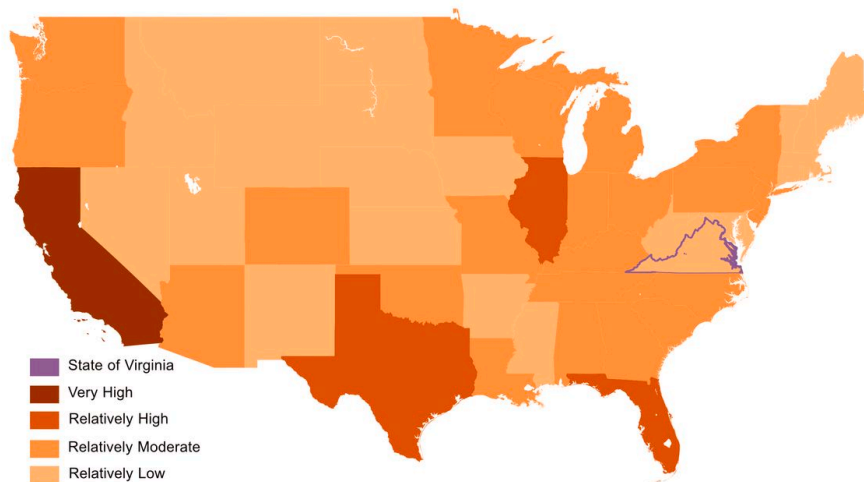
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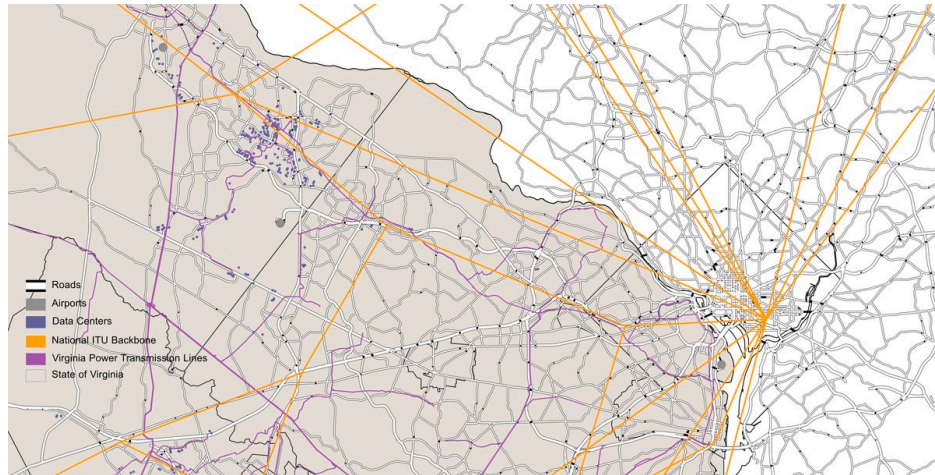
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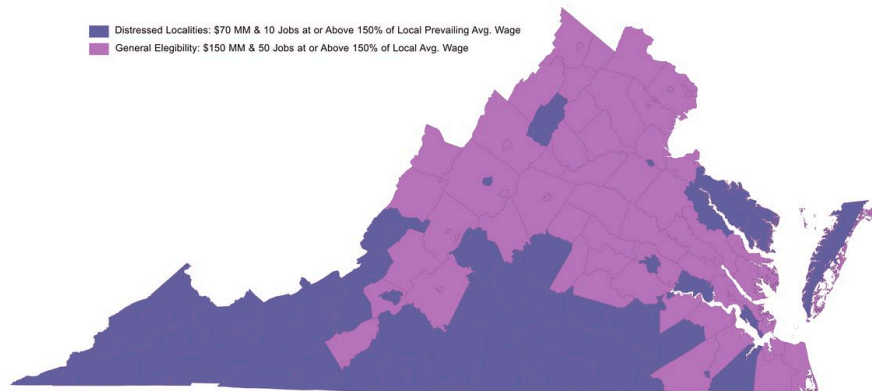
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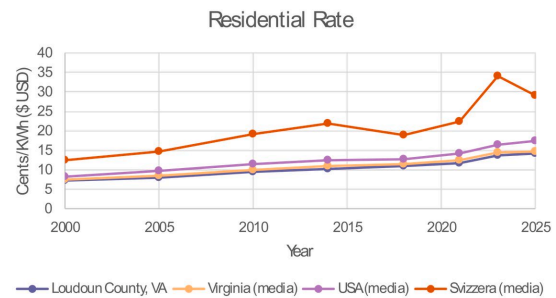
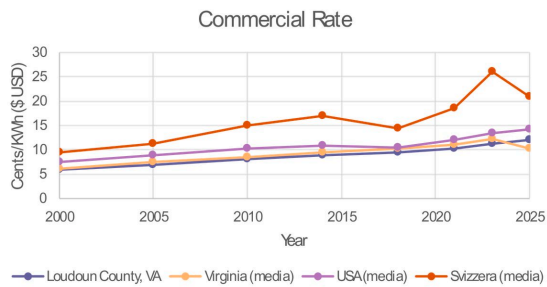


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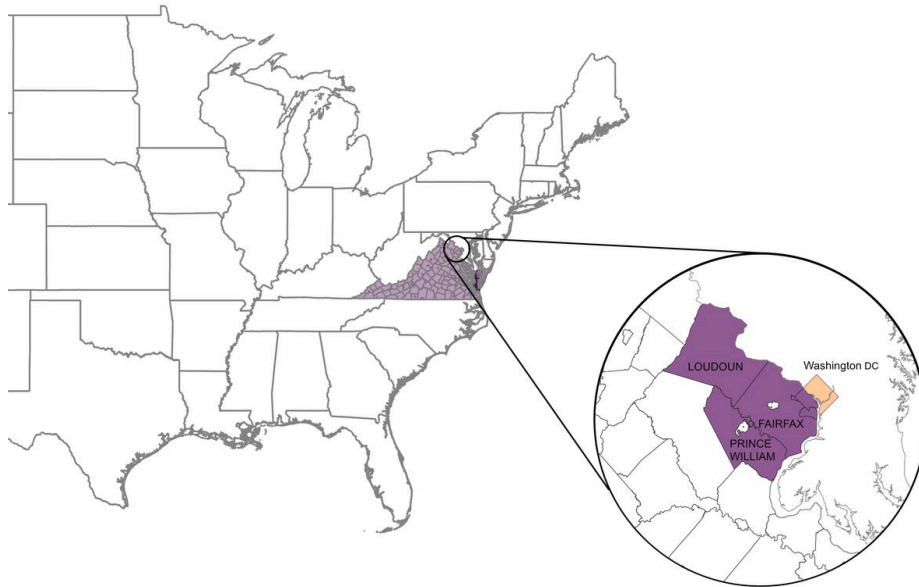
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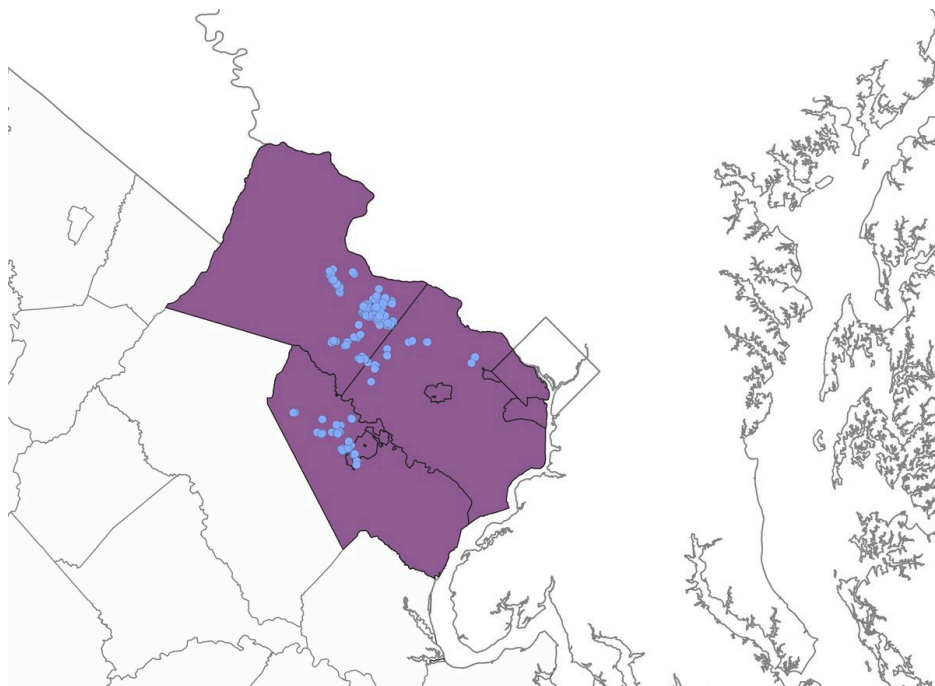
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# Anatomy of the World’s Largest Data Centre Cluster



Location of the Northern Virginia data centre cluster near Washington, D.C.

Northern Virginia has emerged as the largest data centre cluster in the world. Located at the intersection of major fibre corridors and within close proximity to Washington D.C., the region concentrates a critical share of the infrastructure that supports global cloud services, digital platforms, and financial networks. Over the past two decades, this accumulation of digital infrastructure has transformed the suburban landscape into a strategic node of the global internet.



Data centre concentration across Loudoun, Fairfax, and Prince William Counties.

Data centres in Northern Virginia are not evenly distributed but concentrated within three counties: Loudoun, Fairfax, and Prince William. This spatial clustering reflects the presence of fibre network corridors, available land for large-scale campuses, and direct proximity to Washington, D.C. As a result, suburban landscapes have been progressively transformed into specialised zones of digital infrastructure, forming the core of what is commonly referred to as “Data Center Alley.”

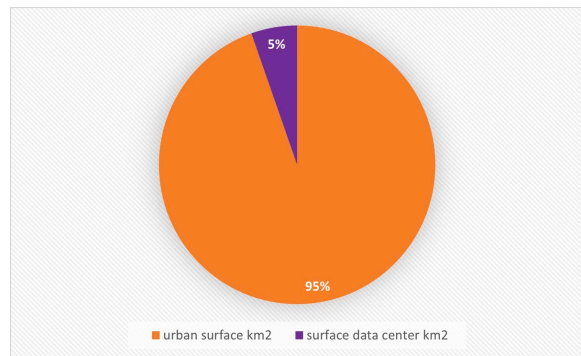
County / Region	# of DataCenters	Data Center Area (km <sup>2</sup> )
Loudoun County	115	2.51
Prince William County	33	0.51
Fairfax County	45	0.28

Loudoun County hosts the majority of Northern Virginia’s data centres.

The spatial distribution of data centres across the three counties reveals a strong territorial specialisation within the Northern Virginia cluster. Loudoun County has emerged as the dominant hub, concentrating the majority of facilities and large-scale campuses. Fairfax and Prince William counties host smaller but strategically located clusters that extend the regional infrastructure network and support the continued expansion of the data centre ecosystem.

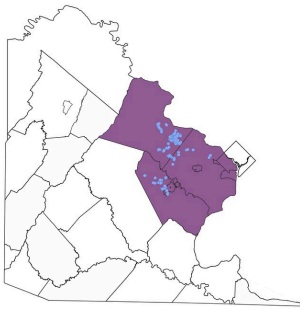


Ashburn.

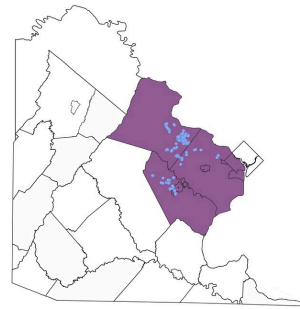


Percentage of land used by data centres in Ashburn.

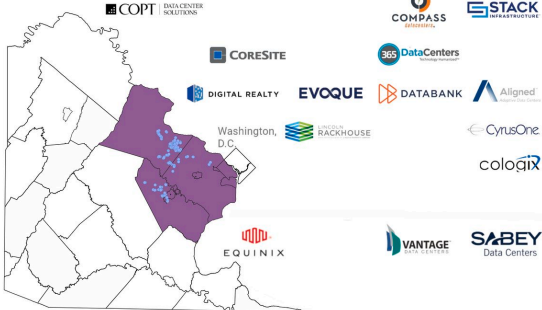
In Ashburn, the spatial presence of data centres has become a defining element of the urban landscape. Although they occupy a relatively small share of the total urban surface, their large-scale buildings and infrastructure concentrate a significant portion of the region’s digital capacity, transforming parts of the suburban territory into specialised zones of global data infrastructure.



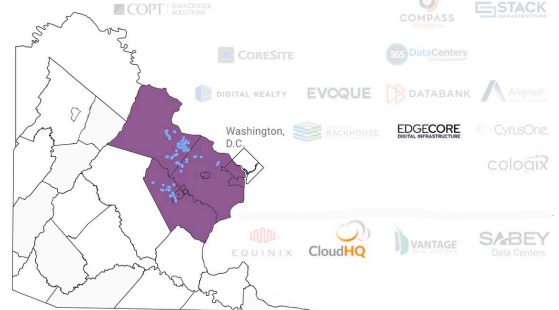
HYPERSCALER



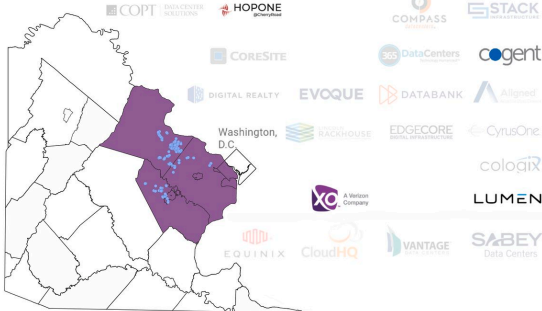
ENTERPRISE/BIG DATA CENTRE USER



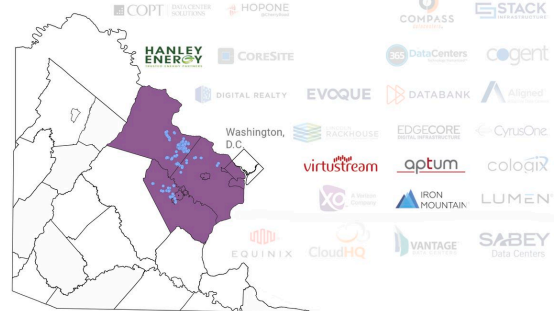
COLOCATION/DATA CENTRE OPERATORS



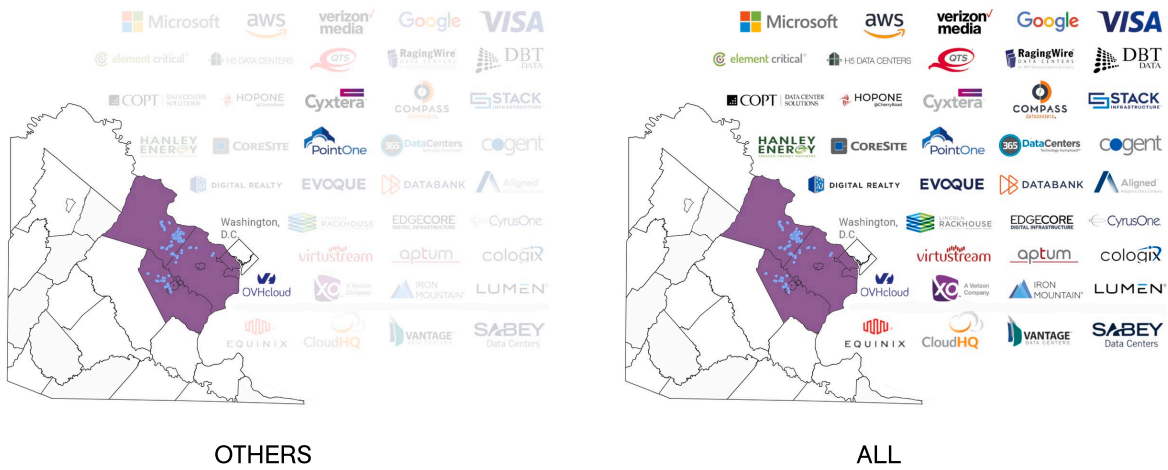
HYPERSCALE DEVELOPERS



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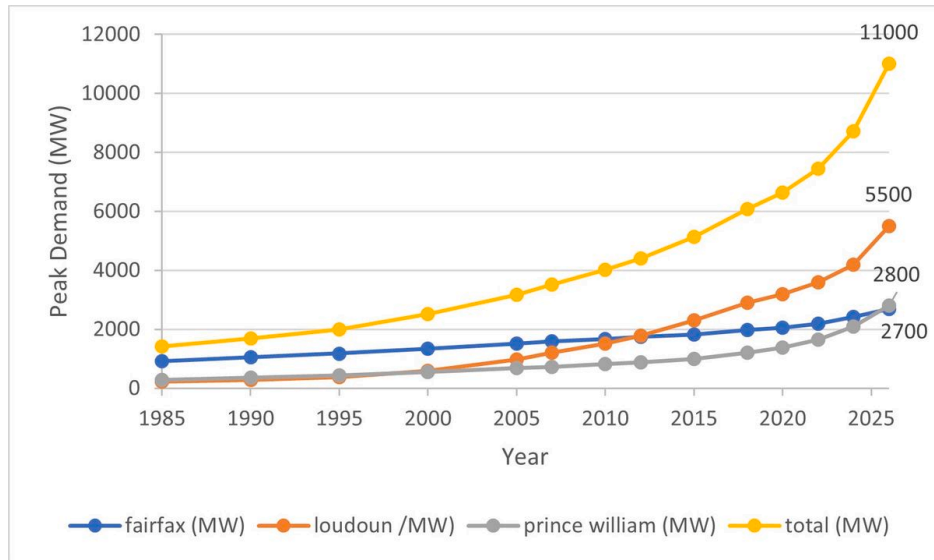


INFRASTRUCTURE/IT SERVICES/ENGINEERING



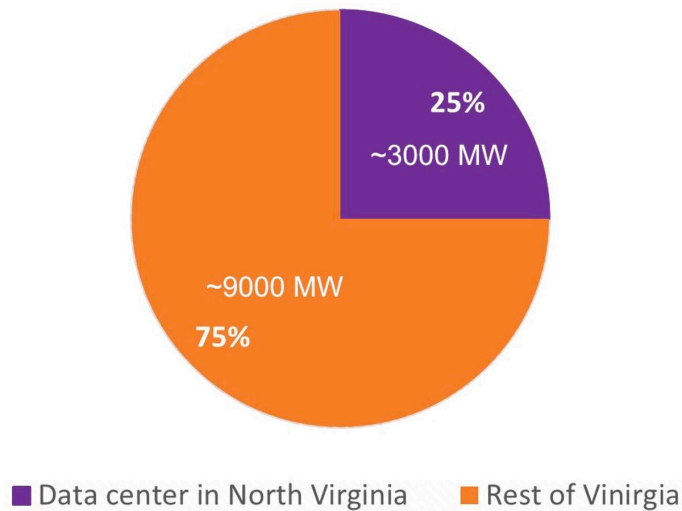
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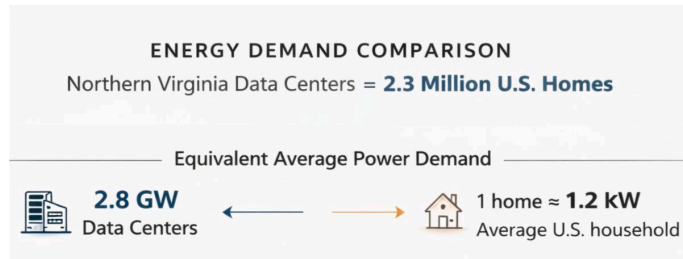


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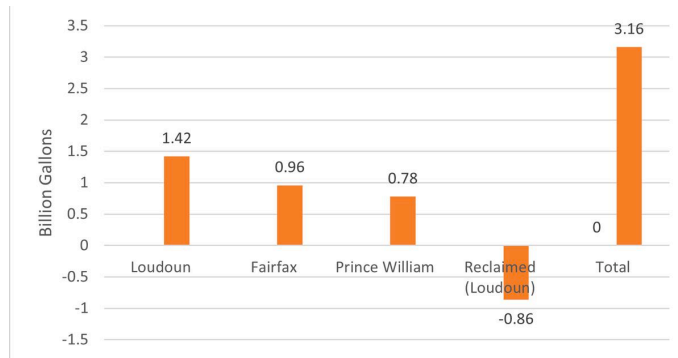
The rapid expansion of hyperscale infrastructure has dramatically reshaped regional electricity demand. What began as a relatively small digital infrastructure in the late 1980s has evolved into one of the largest energy loads in the region. Today, data centres represent a structural component of Northern Virginia’s energy system, driving major investments in generation capacity, transmission networks, and grid stability.



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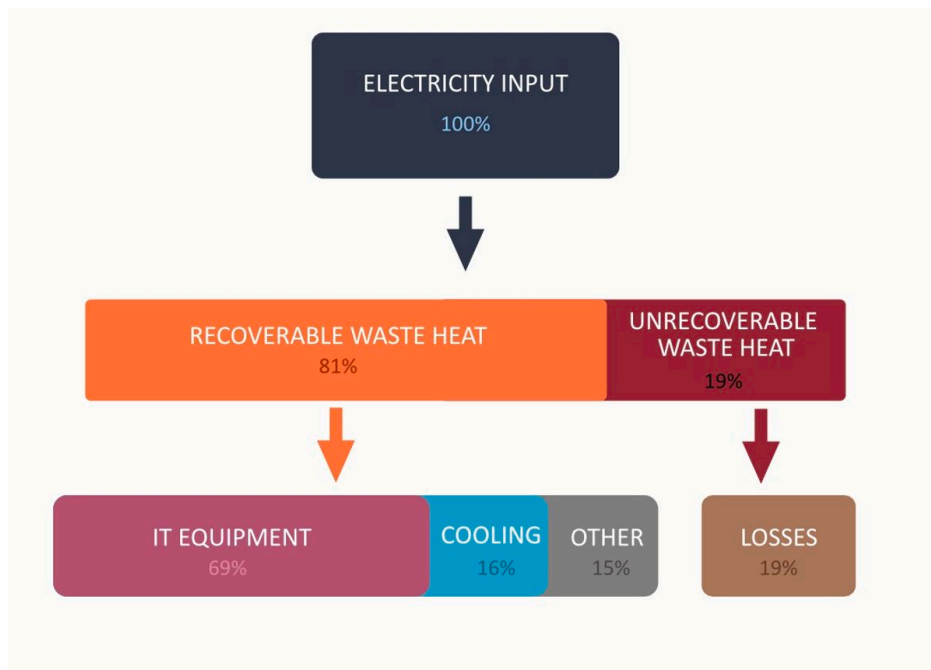


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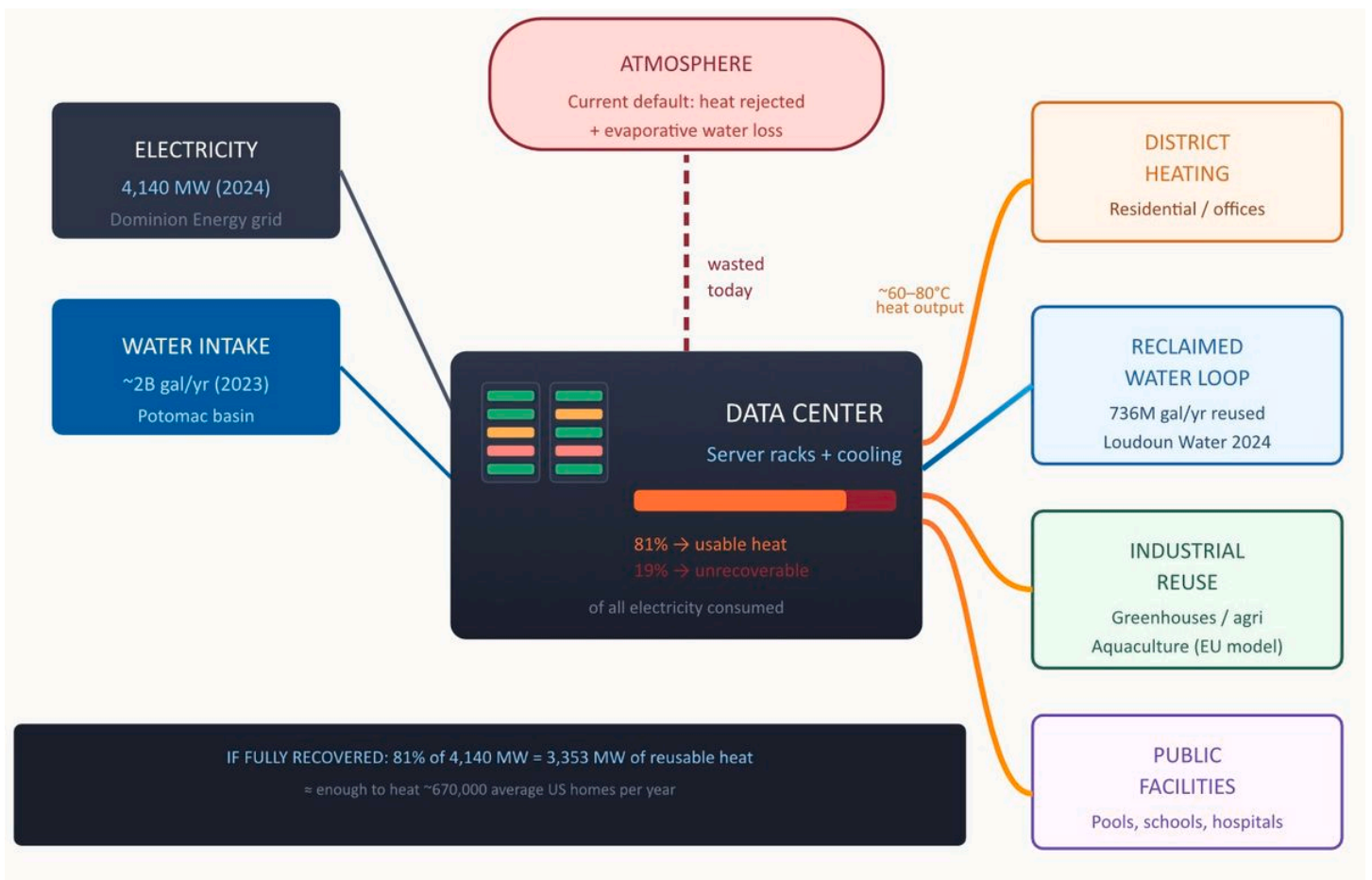


Data centre cooling systems require billions of gallons of water.

Beyond electricity, large data centre campuses depend on significant water inputs for cooling systems. As server densities increase, evaporative cooling technologies intensify the link between digital infrastructure and local water resources, introducing new pressures on regional hydrological systems.



Most electricity used by data centres is transformed into recoverable waste heat.

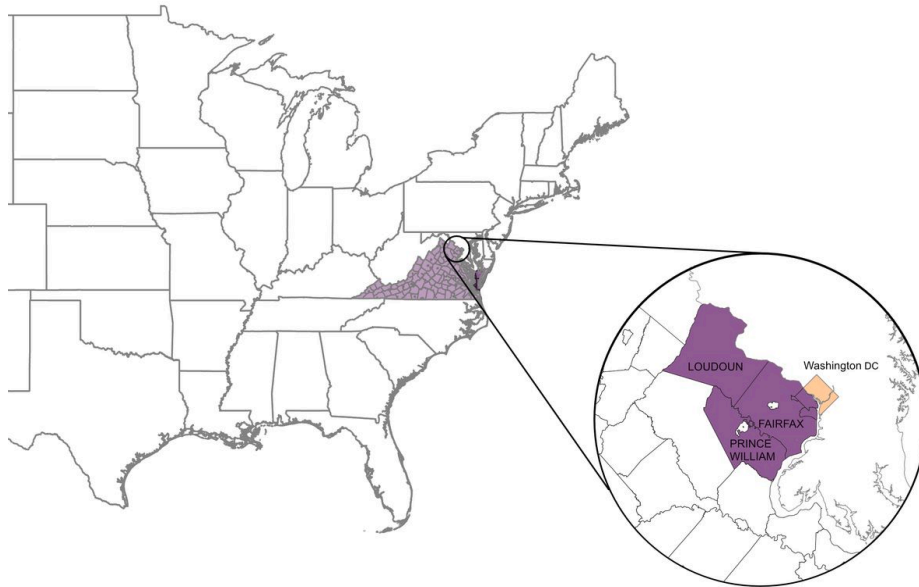


Waste heat from data centres could supply district heating and other urban uses. Sources: NVRC 2024, JLARC Dec 2024, Lawrence Berkeley Nat. Lab, Sierra Club VA, Equinix / Markham case study.

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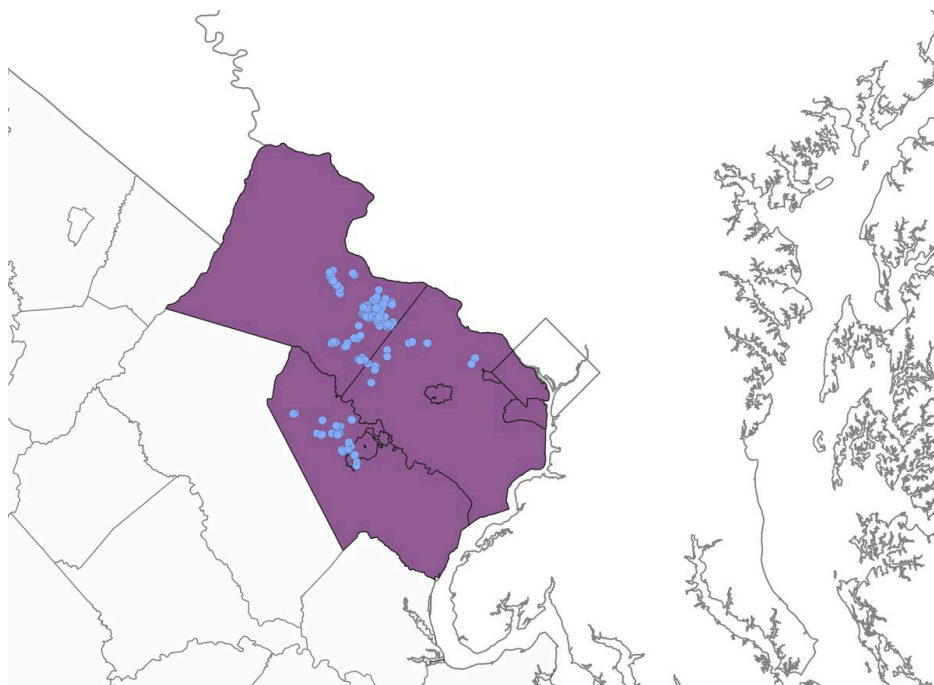
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Location of the Northern Virginia data centre cluster near Washington, D.C.

Northern Virginia has emerged as the largest data centre cluster in the world. Located at the intersection of major fibre corridors and within close proximity to Washington D.C., the region concentrates a critical share of the infrastructure that supports global cloud services, digital platforms, and financial networks. Over the past two decades, this accumulation of digital infrastructure has transformed the suburban landscape into a strategic node of the global internet.



Data centre concentration across Loudoun, Fairfax, and Prince William Counties.

Data centres in Northern Virginia are not evenly distributed but concentrated within three counties: Loudoun, Fairfax, and Prince William. This spatial clustering reflects the presence of fibre network corridors, available land for large-scale campuses, and direct proximity to Washington, D.C. As a result, suburban landscapes have been progressively transformed into specialised zones of digital infrastructure, forming the core of what is commonly referred to as “Data Center Alley.”

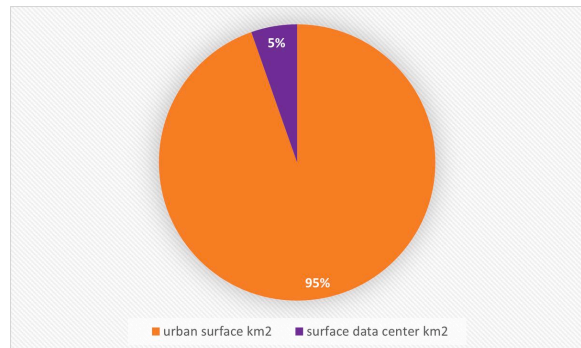
County / Region	# of Data Centers	Data Center Area (km <sup>2</sup> )
Loudoun County	115	2.51
Prince William County	33	0.51
Fairfax County	45	0.28

Loudoun County hosts the majority of Northern Virginia's data centres.

The spatial distribution of data centres across the three counties reveals a strong territorial specialisation within the Northern Virginia cluster. Loudoun County has emerged as the dominant hub, concentrating the majority of facilities and large-scale campuses. Fairfax and Prince William counties host smaller but strategically located clusters that extend the regional infrastructure network and support the continued expansion of the data centre ecosystem.

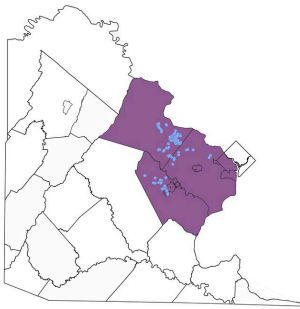


Ashburn.

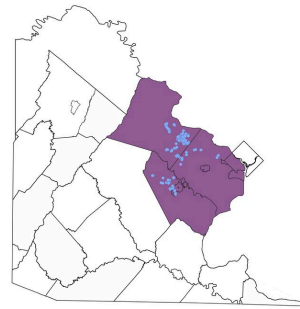


Percentage of land used by data centres in Ashburn.

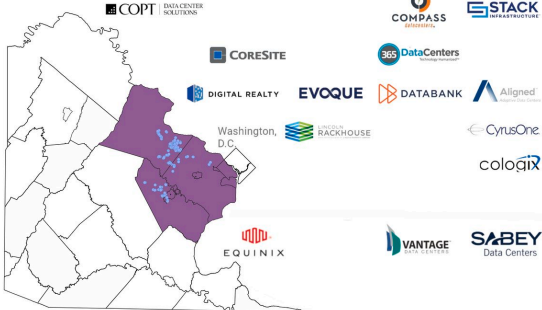
In Ashburn, the spatial presence of data centres has become a defining element of the urban landscape. Although they occupy a relatively small share of the total urban surface, their large-scale buildings and infrastructure concentrate a significant portion of the region's digital capacity, transforming parts of the suburban territory into specialised zones of global data infrastructure.



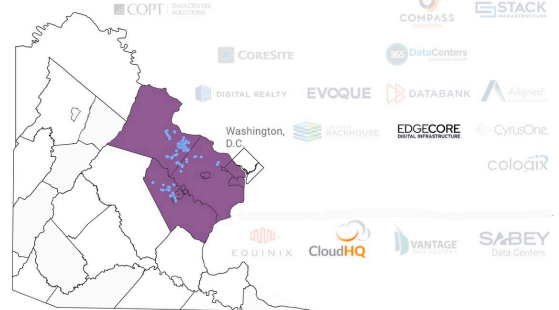
HYPERSCALER



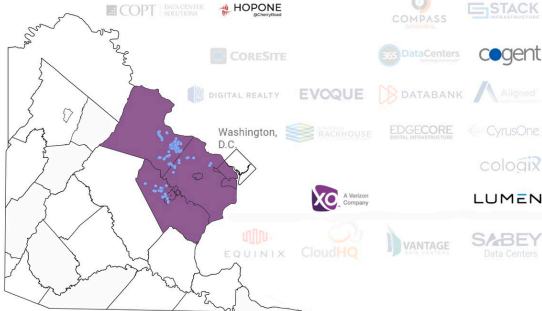
ENTERPRISE/BIG DATA CENTRE USER



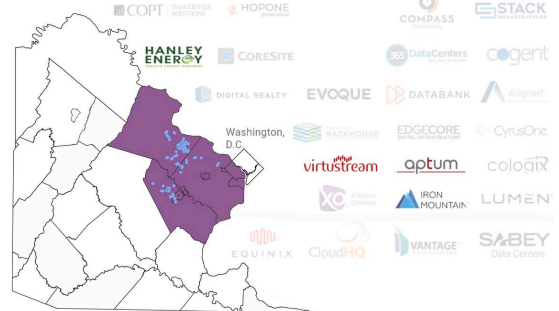
COLOCATION/DATA CENTRE OPERATORS



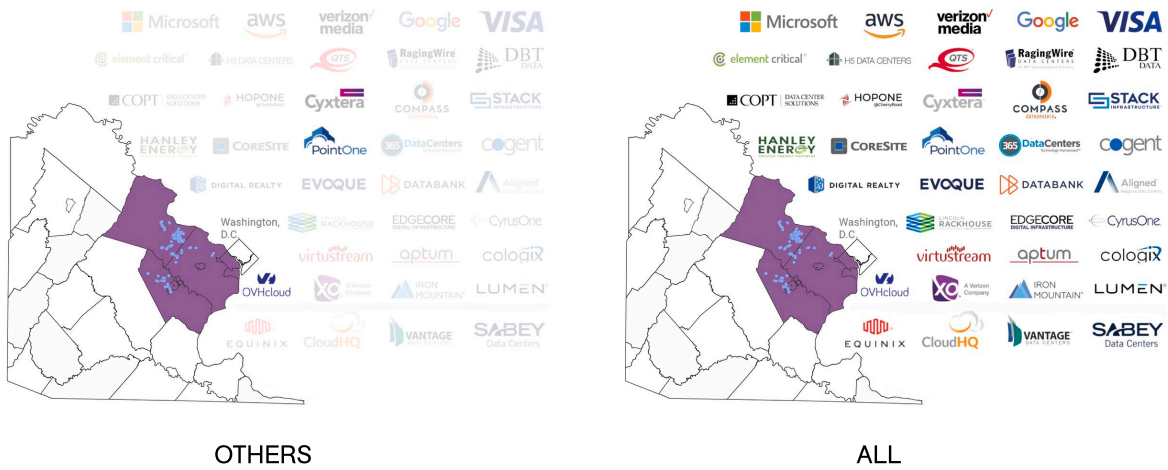
HYPERSCALE DEVELOPERS



NETWORK/TELECOM OPERATORS

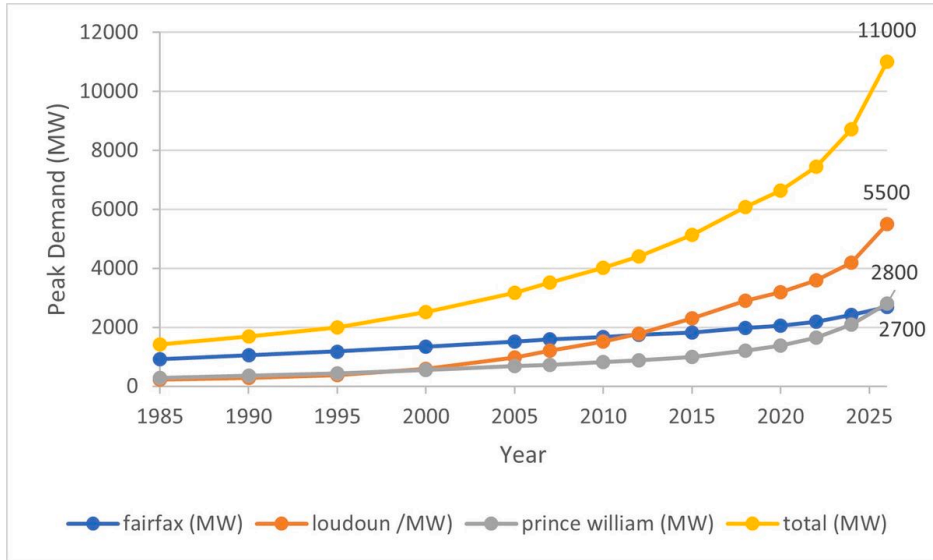


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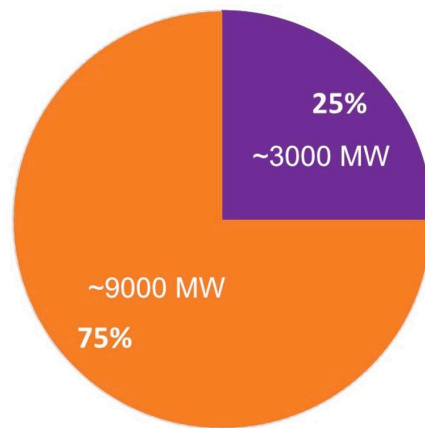
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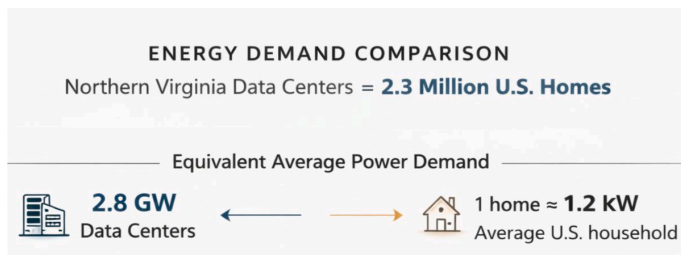
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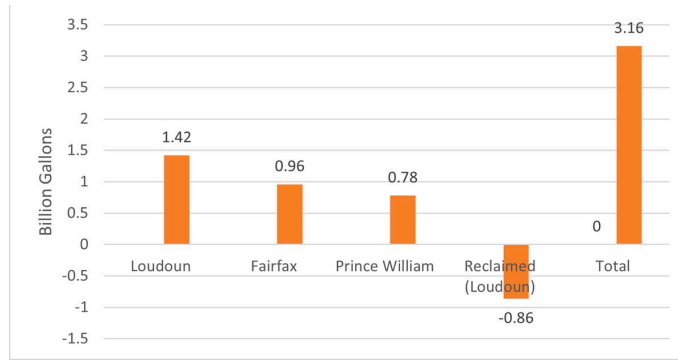


■ Data center in North Virginia ■ Rest of Virginia

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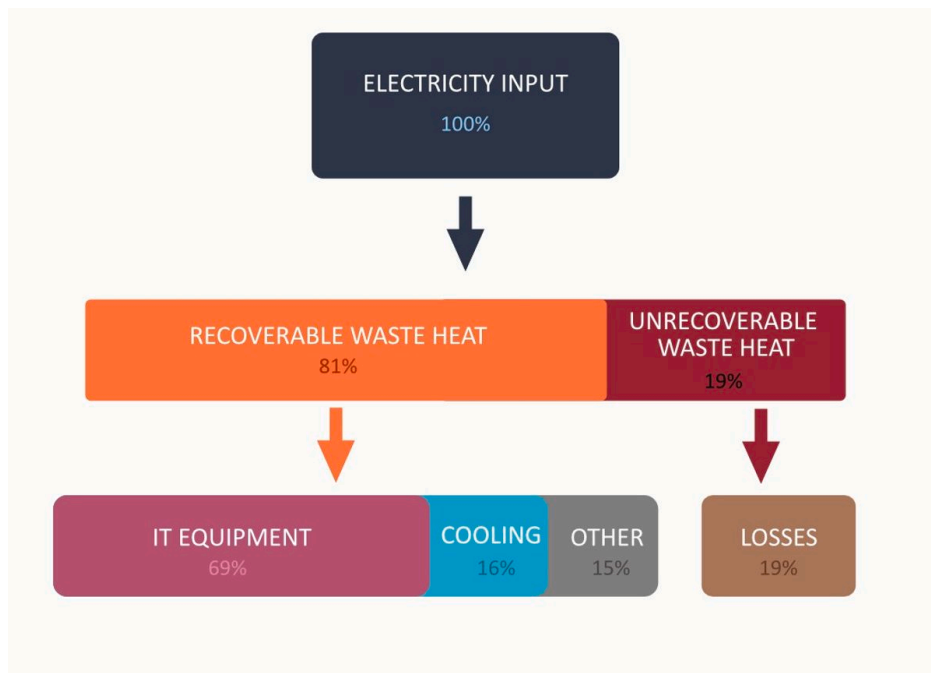


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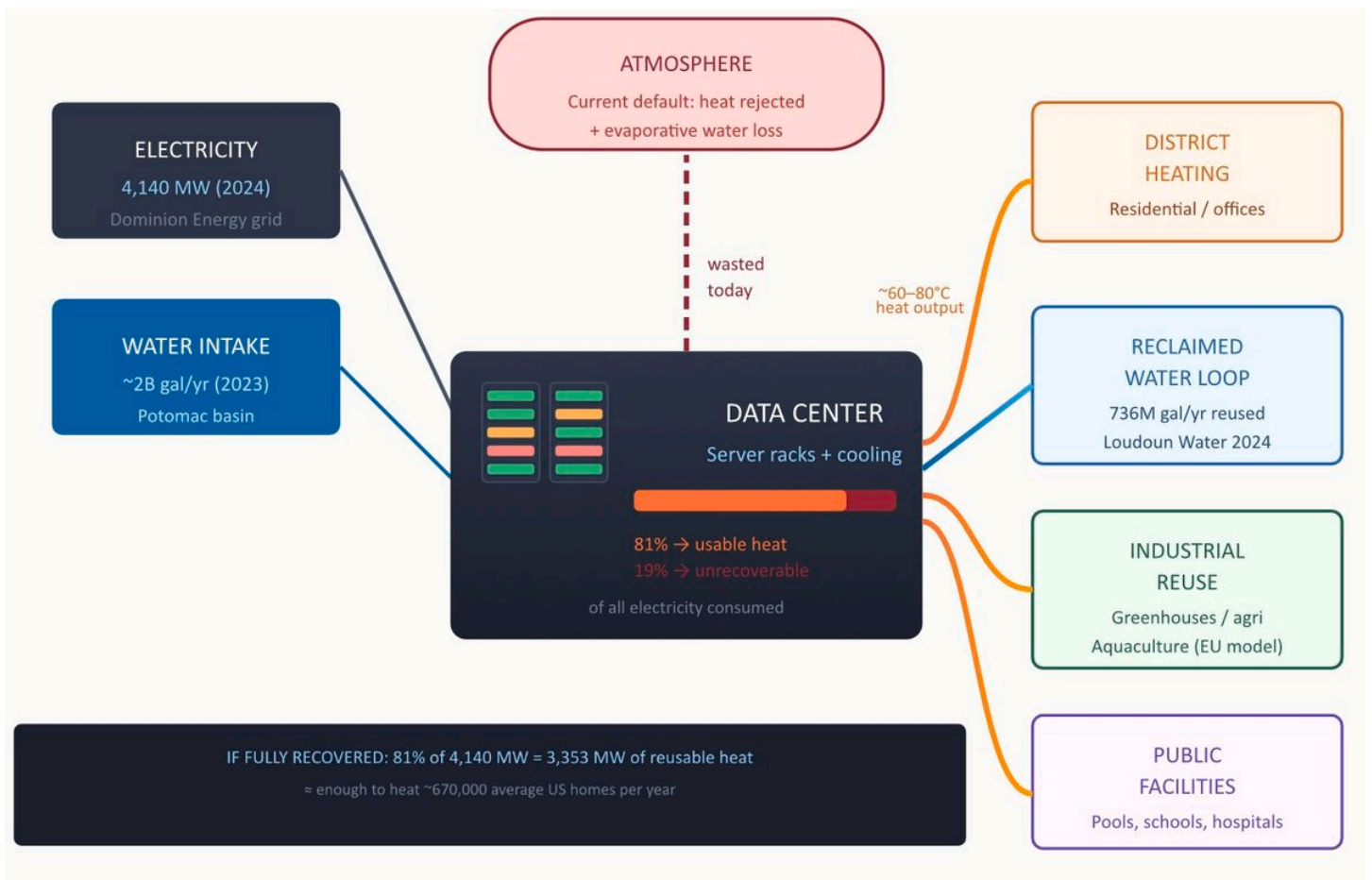


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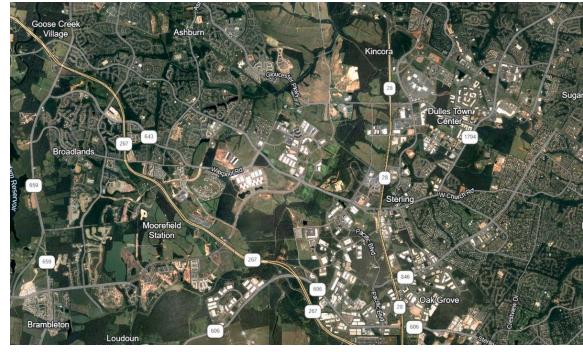
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## The Data Centre Backlash

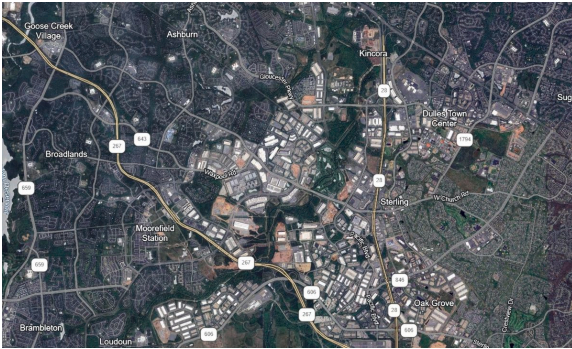
## FROM FARMWELL TO FIBRE



Ashburn, VA, 1991.

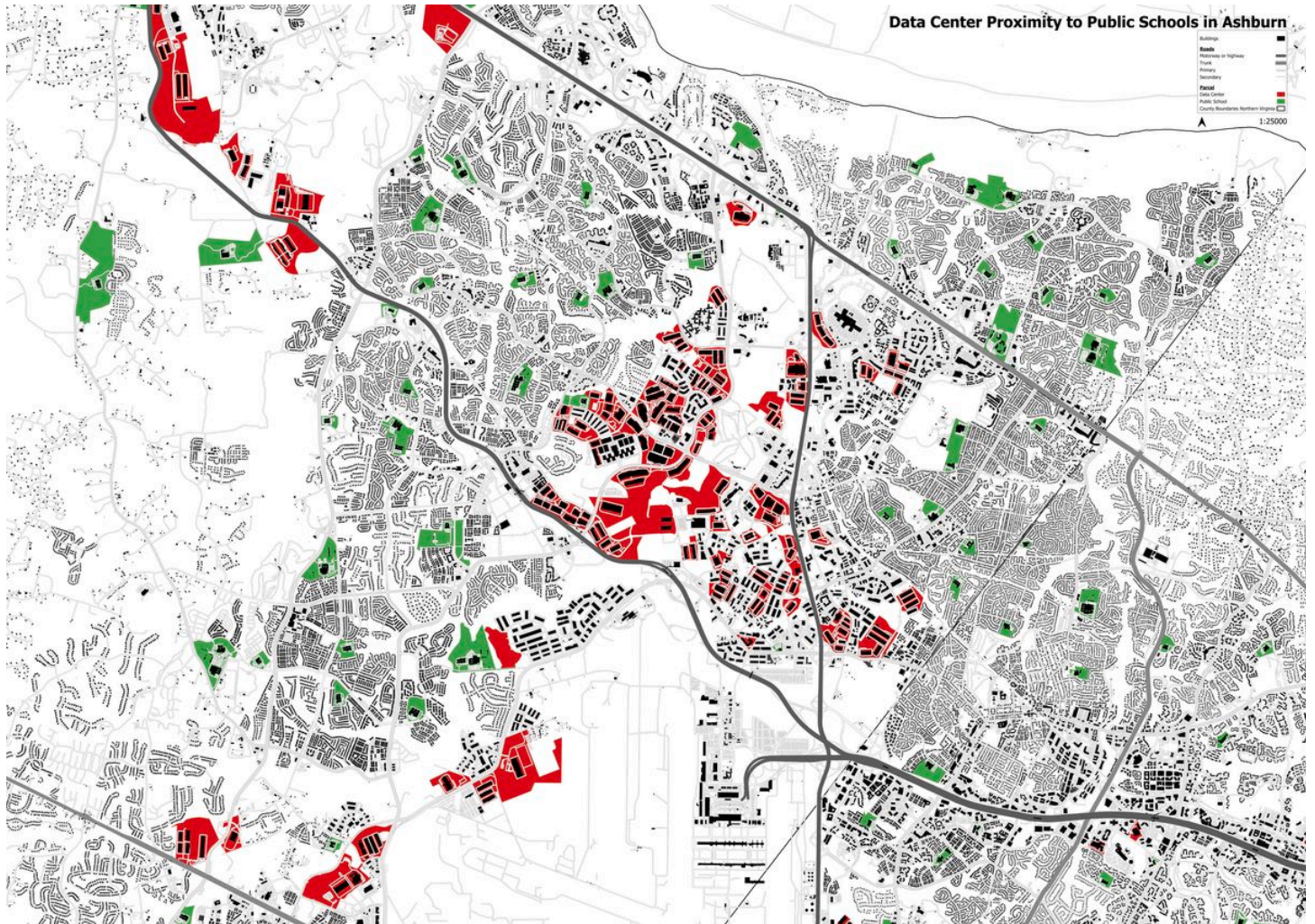


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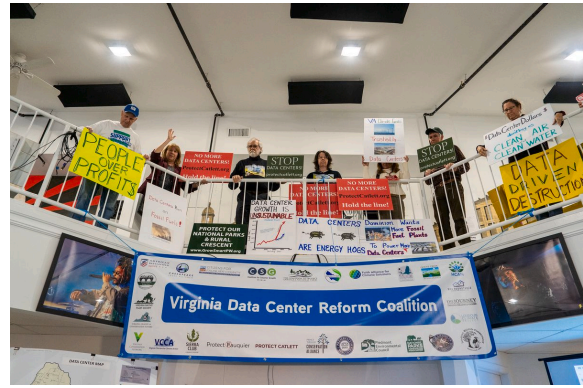


Data centre proximity to public schools in Ashburn. Drawing: the authors.

In Ashburn, large data centre developments (red) are located directly adjacent to local public schools (green). This close proximity illustrates how industrial-scale digital infrastructure has been integrated into the daily life of residential neighborhoods, often separated by only a single road or property lines. As Ashburn has transformed into a global technology hub, the shared landscape between server farms and educational spaces has become a visible symbol of the ongoing tension between rapid technological expansion and community-focused urban planning.



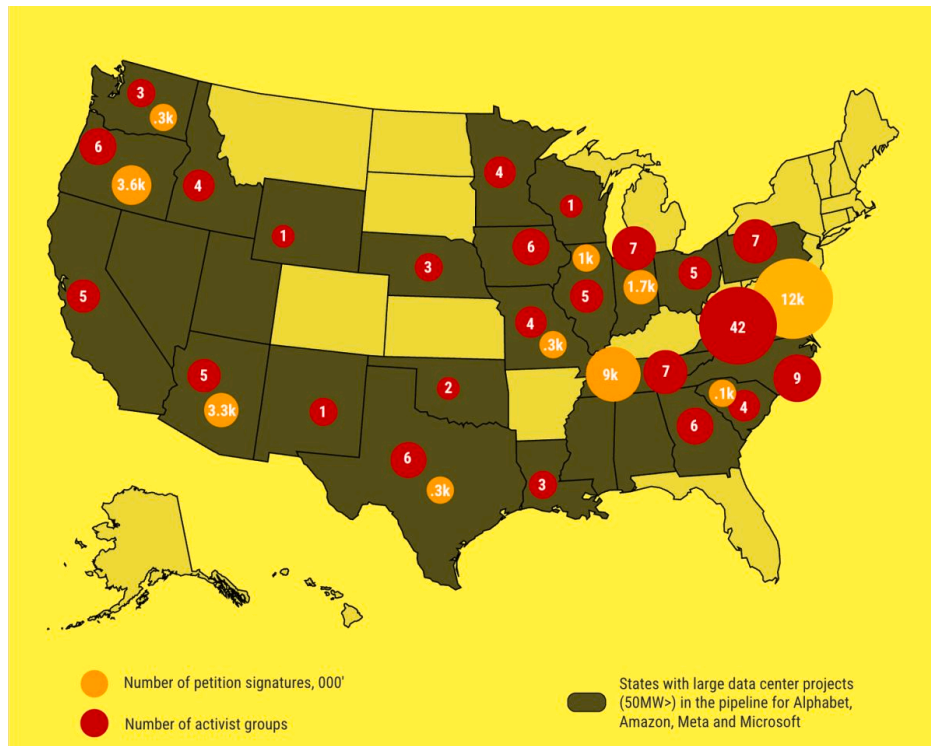
A protest against a data center in Saline, Michigan, on 1 December 2025. Photograph: Jim West, Universal West.



Data center reform coalition, Piedmont Environmental Council, 2018.

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This resistance bridges the political divide: while Republicans sound the alarm over energy grid strain and corporate tax breaks, Democrats are fighting for water conservation and environmental protection. Together, they are obstructing construction and championing restrictive zoning, effectively demanding that the “quiet infrastructure” of the cloud finally answer to the people on the ground.



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Microsoft's 5 point plan: <https://blogs.microsoft.com/on-the-issues/2026/01/13/community-first-ai-infrastructure/> [<https://blogs.microsoft.com/on-the-issues/2026/01/13/community-first-ai-infrastructure/>]

In response, tech giants like Microsoft and Amazon are abandoning their secretive “stealth mode.” The industry is shifting toward a “Community-First” model, offering legally binding agreements to replenish local water, fund schools and hospitals, and pay for their own grid upgrades.

## PRESERVING THE PAST



Environmental activist Gem Bingol in front of the historic slave cemetery. Photograph: Cheriss May, 2025.

As activists like Gem Bingol fight to protect historic sites, such as slave cemeteries now surrounded by the beeping of excavators, the message is clear: the digital future cannot come at the cost of our physical heritage. The next decade will be defined by this fragile negotiation between our global demand for data and our local desire to protect the land that fed us long before the “cloud” existed.

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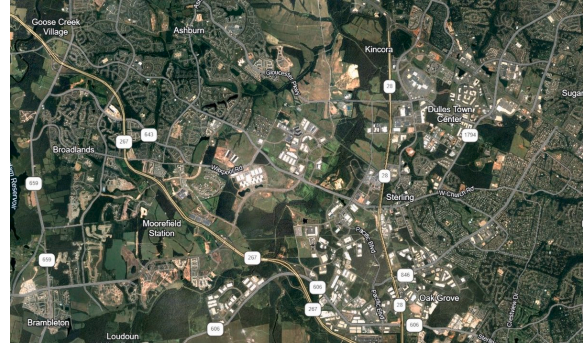
An aerial view shows a data centre situated near single-family homes in Stone Ridge, Va., in 2024. Photograph: Nathan Howard.

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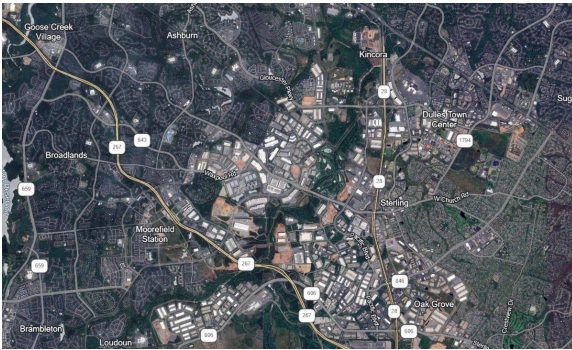
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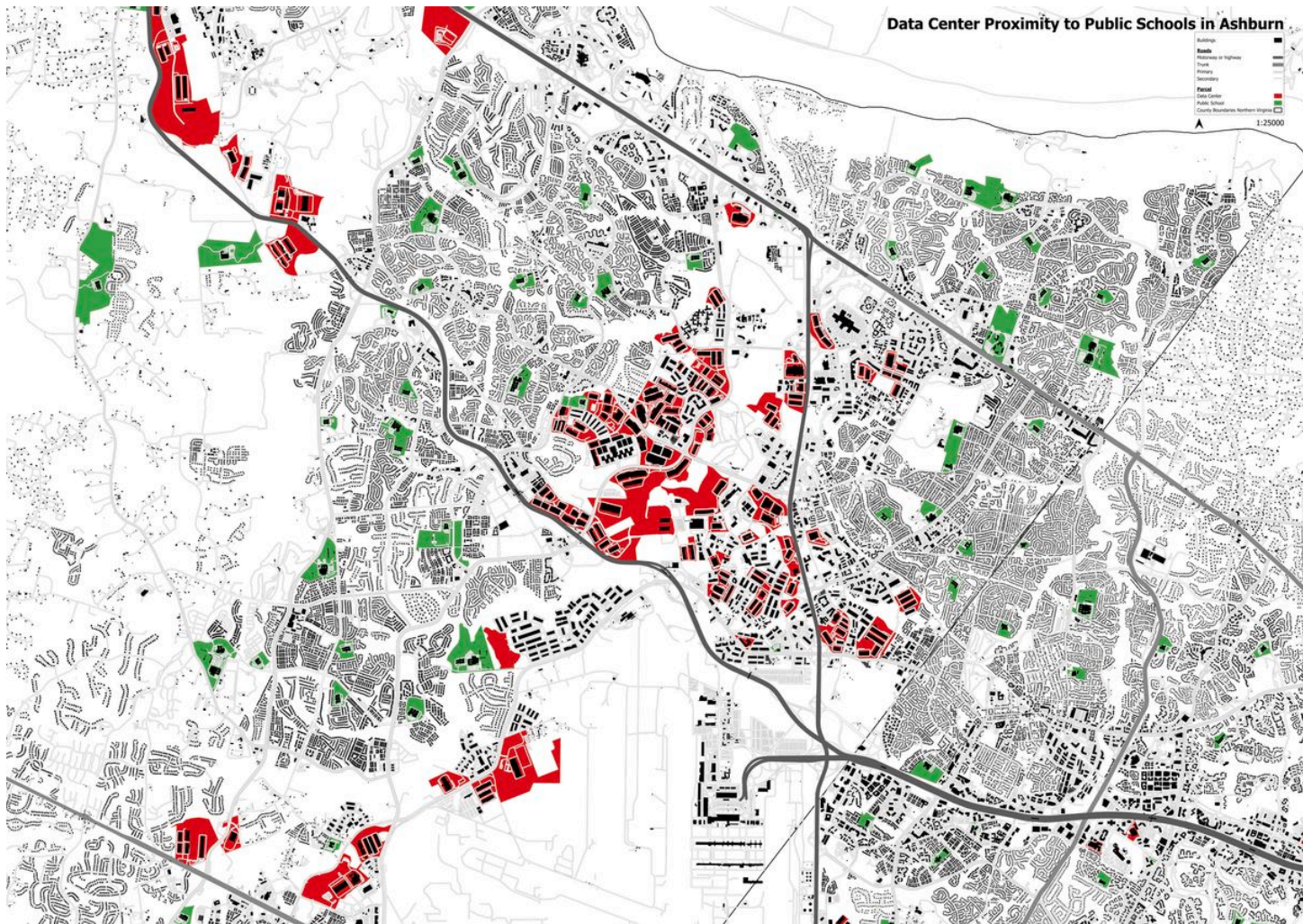


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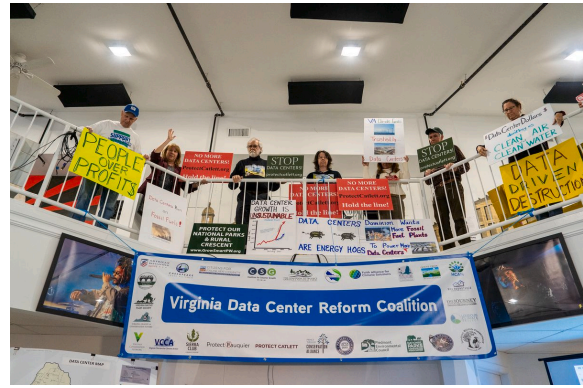


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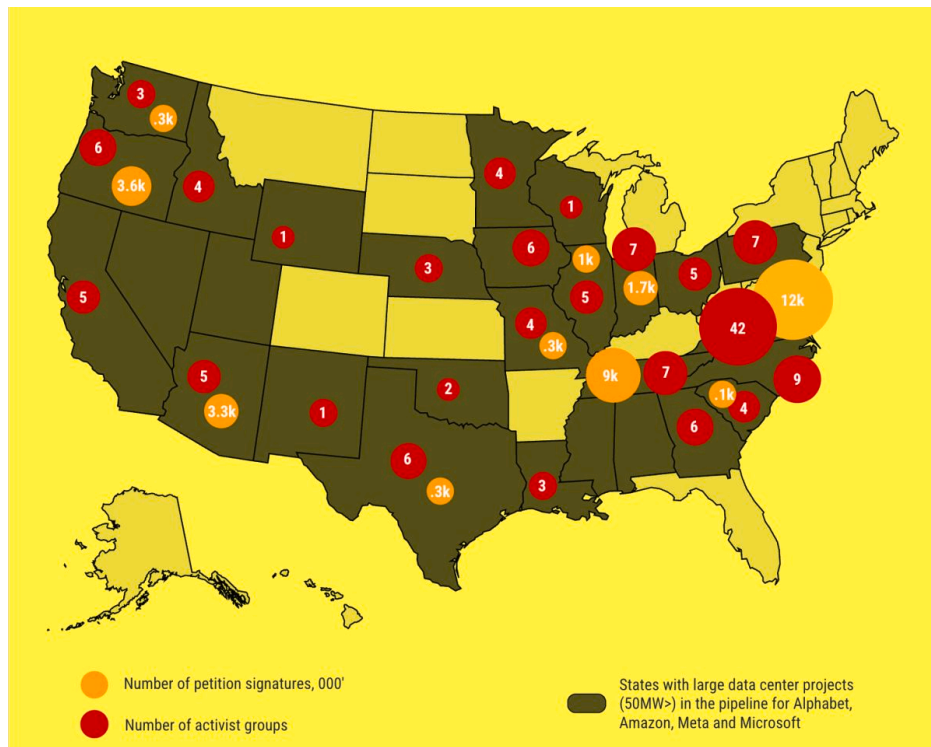
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