Virginia's Data Centers and Economic Development

The state's fast-growing data center industry continues to build on its early advantages

BY JOHN MULLIN

Data centers are essential to cloud computing and its ability to give users remote access to data, applications, and computing power over the internet. Yet they typically possess few of the ethereal qualities evoked by the term "cloud." With high concentrations in Northern Virginia's Fairfax and Loudoun counties, data centers are often housed in nondescript buildings whose stark forms resemble massive rectangular cubes. The buildings' interiors are packed with rows and rows of computer servers, vast quantities of cables and switches, and the considerable electrical power and HVAC hardware necessary to keep it all working.

In many ways, data centers are like utilities, where the main interest for outsiders often lies in what the utility makes possible for its customers rather than in the functioning of the utility itself. But, as with water and electrical power utilities, a lot of things in the economy simply cannot happen without data centers. As the authors of a 2020 article in the journal *Science* pointed out, "Data centers represent the information backbone of an increasingly digitalized world."

For Virginia, data centers have been a consistent contributor to economic growth. Leveraging some of its natural advantages, the state has encouraged the industry's development over the years through tax incentives and other initiatives. These efforts put Virginia in a position to become a major player in the data center industry and to take advantage of a global boom in the demand for cloud computing services.

Virginia now is home to hundreds of data centers. Much of the growth has occurred in Northern Virginia's "Data Center Alley." It is home to the data centers operated by public cloud providers such as Amazon Web Services (AWS), social media companies such as Meta, and financial firms such as Capital One.

The industry's outlook appears bright, but it is not without challenges. Its further expansion in Northern Virginia has become more difficult due to a diminishing supply of suitable new locations, and it continues to face pressure to mitigate its heavy use of electrical power and water resources.

REMOTE COMPUTING AND DATA STORAGE

Offsite data storage and computing services have been around since at least the late 1950s. At the time, corporations and public institutions were becoming increasingly reliant on mainframe computers. Big companies would often purchase their own mainframes and house them onsite in dedicated rooms. Soon, however, computer "bureaus" began to sell computing services on their mainframes to companies that could not afford to buy and maintain the massive machines.

The trend toward offsite computing received further impetus from the rise of the personal computer. When PCs became increasingly available during the 1980s, users began to link them to remote servers to access offsite data. The trend accelerated during the dot-com boom of the late 1990s, which saw a proliferation of new e-commerce sites and a huge increase in internet traffic. This period saw the emergence of a new type of data facility called internet exchange points (IXPs), which are important locations for the routing of internet traffic among major internet service providers.

More recently, data center growth has been spurred by an explosion in the demand for cloud computing services to support activities ranging from online gaming to the storage of social media profiles. Cloud computing arose from

technological developments that allowed users to remotely access multiple physical locations at once. According to a 2017 account from IBM, the term "cloud computing" became favored because it served to help visualize an environment in which a user could access resources across a "nebulous blob of computing resources." Amazon, through its AWS subsidiary, was the first company to market cloud computing services in their present form.

"As things now stand, there are now two types of data centers," says Josh Levi, president of the Data Center Coalition, which advocates on behalf of the industry. "Owner-occupied data centers, which are run by companies for their own purposes, and multi-tenant facilities."

Multi-tenant data centers — often referred to as "co-location" facilities — have faced increased competitive pressure in recent years. Cloud service providers, which have historically been major tenants at co-location centers, have increasingly been building their own data centers and using their market power to obtain more favorable terms for the space that they continue to lease at co-location centers.

VIRGINIA SEIZES ITS ADVANTAGES

To borrow an old phrase from real estate, Virginia's initial allure as a site for data centers was all about "location, location, location." The state's proximity to Washington, D.C., and the seat of the U.S. federal government gave it a decided advantage.

A major door was opened in the early 1990s when Metropolitan Area Exchange, East (MAE-East), one of the first IXPs, began operating in Washington, D.C., and soon extended into Northern Virginia. As one of the National Science Foundation's four network access points, MAE-East's presence generated a lot of activity and attracted other firms. In 1998, Equinix built its first large data center in Ashburn, Va. — in the heart of what would later be called Data Center Alley. Firms ranging from dot-com startups to established telecommunications companies were increasingly locating their facilities in Northern Virginia. The region's network of fiber optic cables grew rapidly as a result.

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The early investments in fiber optics created a virtuous circle. Increased bandwidth caused a decline in what is known as "latency" — the amount of time it takes for data to travel between its origin and destination. The decrease in waiting time, in turn, attracted additional firms and additional investments in fiber capacity.

"It's something of a snowball effect," says Levi. "There are some applications where latency does not matter much. But there are some applications where it is essential. For example, Visa, the credit card company, has a data center in Loudoun County that processes many thousands of transactions per second."

In 2008, Virginia provided further inducements for the industry by establishing a sales tax exemption on computer equipment. The state expanded the exemption in 2010, after losing a bid to attract Apple, which instead built a $1 billion data center in Maiden, N.C. "Virginia became the sixth state to enact a sales tax incentive for data centers, where you qualify for a sales tax exemption if you invest at least $150 million and create 50 jobs with wages that are at least 150 percent of a county's average," says Levi. "The reason that is so critically important is that the equipment inside a data center must be regularly refreshed and replaced at substantial cost."

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But the industry's growth in Virginia was supported by factors above and beyond its first-mover advantage and tax incentives. According to economics consultant Fletcher Mangum, "Virginia also offered a large high-tech workforce, proximity to end users and corporate headquarters, relatively low electricity prices, power companies that could deliver new service on aggressive timelines, and local governments that aggressively courted data center companies by streamlining the development approval process."

Virginia has continued to make major infrastructure investments to help maintain its advantage. Some of the largest investments were made to build landing facilities in Virginia Beach for two subsea trans-Atlantic cables: MAREA and BRUSA, which connect Virginia with Europe and South America, respectively. This created opportunities for Henrico County, which adjoins Richmond and is located roughly halfway between the cable landings in Virginia Beach and Data Center Alley. Numerous firms have been attracted to the area to take advantage of its access to the high-capacity, low-latency international cables.

"The cable landings are definitely correlated with the stunning growth of the data center industry in Virginia," says Mangum. "The rapidly expanding Facebook and QTS data centers are in Henrico County to take advantage of MAREA and BRUSA."

All of this has added up to rapid growth. Today, the data center market in Northern Virginia is bigger than the next five largest markets in the United States combined. Its perceived importance to the global economy is highlighted by the oft-cited, but difficult to verify, claim that some 70 percent of the world's internet traffic travels through Data Center Alley each day.

DATA CENTERS AND LOCAL ECONOMIES

When people think about an industry's local economic effects, their initial focus is often on job creation. As highly capital-intensive businesses, however, data centers require relatively few workers. In 2021, for example, Virginia's data centers directly employed only 5,500 workers in their

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operations — a figure scarcely greater than 0.1 percent of the state's workforce of more than 4 million people.

The flip side of the story is that the jobs that data centers do create tend to be highly productive jobs that require elevated skills and pay high wages. In 2020, the average private sector employee in a Virginia data center earned an estimated $134,308, which was more than double the estimated $62,250 earned by Virginia's average private sector employee. This wage gap has been growing for roughly the past two decades, as wage hikes in Virginia's data industry have outpaced those of other industries in the state on average.

In addition to creating high-paying jobs, data centers also support local economies through their demand for services. "Data centers purchase unusual amounts of services such as security and HVAC maintenance, so their impact through business-to-business purchases tends to be disproportionately large," says Mangum. The industry has also employed a lot of construction workers. In 2021, there were almost twice as many people employed in the construction of new data centers as in operations of preexisting centers.

Mangum's firm, Mangum Economics, recently conducted an economic impact study of Virginia data centers on behalf of the Northern Virginia Technology Council. The study estimated the ripple effects that data centers create as their expenditures — both on operations and new construction — work their way through Virginia's economy. Taking these effects into account, the study estimated that data centers supported 45,460 jobs and $15.3 billion in economic output in Virginia in 2021. Those figures corresponded to roughly 1 percent of Virginia's jobs and 2.5 percent of its economic output.

Mangum's study also included estimates of data centers' effects on the budgets of the counties in which they operate. Although Virginia offers sales tax incentives to qualifying firms, the data center industry has paid substantial amounts in state and local taxes over the years. But they have also used state and local resources. To estimate data centers' overall fiscal cost to Virginia's counties, Mangum's analysis focused on the main costs that businesses impose on local governments — the costs of providing primary and secondary education as well as other services to the business' employees.

Mangum estimated that, in 2020, Loudoun County received $424.7 million in tax revenue from data centers — more than thirteenfold their estimated budgetary cost of $32.3 million. The figures for Prince William County were smaller but in similar proportion, with revenues estimated at $64.2 million and costs of $4.8 million. Mangum views his estimates as conservative. "The benefits only take into account the direct local revenue generated by data centers as reported to us by the localities themselves," says Mangum. "They do not include any local tax revenue generated by employees."

In 2019, Virginia's Joint Legislative Audit and Review Commission published a report in which it evaluated the effectiveness of the state's tax incentive program for data centers. Looking at the period between fiscal years 2010 and 2017, the study noted, "The data center sales and use tax exemption is by far Virginia's largest incentive in terms of forgone revenue, representing more than one-fifth of Virginia's total spending on economic development incentives during this period." Despite the program's cost, however, the report found that it had been relatively effective, stating that it had "a sizable influence on data center decisions to locate or expand in Virginia." The report, which found that the incentive program had yielded positive net benefits, asserted that it is reasonable for the state to continue the program.

ENERGY AND POWER USAGE

While many localities appreciate data centers for their fiscal benefits, the centers have received a lot of scrutiny over their voracious use of electrical power and water. According to a 2021 article in *Environmental Research Letters*, "Data centers require a tremendous amount of energy to operate, accounting for around 1.8% of electricity use in the United States." They also use large amounts of water, ranking among the top 10 U.S. industries in terms of water use. Some of the water is used directly by liquid-based cooling systems; some of it is used indirectly, as when utilities draw power from electrical grids supplied by hydroelectric generators.

While not denying that there are valid reasons to be concerned about data centers' use of electricity, a 2020 article in *Science* by researchers at Northwestern University, Lawrence Berkeley National Laboratory, Koomey Analytics, and the University of California, Santa Barbara pushed back against some of the more dire scenarios that have been advanced about the industry's energy footprint. The article took particular issue with how "several oft-cited yet simplistic analyses claim that the energy used by the world's data centers has doubled over the past decade and that their energy use will triple or even quadruple within the next decade." These scenarios are too pessimistic, according to the article, because they are based on extrapolations of trends in demand for data center services and, crucially, do not account for countervailing trends in energy efficiency.

Between 2010 and 2018, according to the researchers, traffic increased more than tenfold, while storage capacity increased about twenty-five-fold. But the same period saw substantial improvements in data centers' computational and storage efficiency. The energy required to power a single computation was quartered, while the energy used per terabyte of installed storage capacity declined by an estimated factor of nine. Energy consumption has also been dampened by the migration of users from older, less efficient data centers to newer centers that use servers more efficiently and devote a much higher percentage of their total energy usage to powering servers as opposed to keeping them cool.

Combined, the efficiency improvements and migration have had a huge countervailing effect. Despite the explosive growth in data center services between 2010 and 2018, their overall energy usage increased by only 6 percent cumulatively (less than 1 percent annually), according to the researchers.

Data centers' heavy use of water has also raised concerns. One of the issues is that many operators find that they can cut costs by using water-based evaporative cooling systems instead of systems that rely solely on electricity. While the water usage problem is most glaring in the drought-prone West, it also exists in the East. Several years back, for example, Google made a permit request to remove 1.5 million gallons of water daily from a depleted aquifer to cool its growing data center operations in Goose Creek, S.C. The permit was opposed by the South Carolina Coastal Conservation league, which was concerned about the plan's effect on local groundwater supplies. After two years of negotiation, Google got the go-ahead for a substantially scaled back usage plan.

The data center industry has taken notice of concerns about its resource usage. Microsoft's Suzie Adams has touted the firm's new facility in Boydton, Va., and its proximity to "green-friendly" hydroelectric and nuclear power feeds. AWS has entered into a long-term agreement with Dominion Energy to purchase energy from several solar energy projects. The largest firms — AWS, Google, and Microsoft — have also made steps toward reducing their water usage through new cooling technologies, including free-air and immersion cooling.

From an economic perspective, these stories raise a big question: What is the role of market prices? Economic theory says that resources such as power and water will be used efficiently if they are priced to reflect the resources' marginal costs to the society. Yet, historically, water has been underpriced in the United States, according to Newsha Ajami, chief development officer for research at the Lawrence Berkeley Lab's Earth & Environmental Sciences Area.

As Ajami sees it, progress toward more efficient water usage will require action by localities to make sure that their water resources are allocated in a manner that reflects the resources' true marginal costs. "I think local awareness is extremely important," she says. "Communities need to make sure that they properly account for a data centers' short- and long-run water footprints before they issue construction permits."

NEW OPPORTUNITIES FOR RURAL AREAS

There are some good reasons to think that data centers will be increasingly built in some of Virginia's less densely populated areas. Indeed, the industry is starting to feel some constraints on its growth in Loudoun and Fairfax.

One of the destinations of new investment has been Prince William County, Va., which is further from Washington, D.C., than Loudoun and Fairfax counties. "Prince William County is the beneficiary of a whole lot of investment," says Levi. "Loudoun is running out of land suitable for data center projects, and costs are getting high."

The industry's efforts to seek alternative energy sources may also prove to be a boon for rural areas. According to Levi, "Solar farms are being developed to provide power for data centers. You can't build many solar farms in Loudoun County with any scale, there's just not enough land, it's too expensive."

Microsoft, for one, has been making major solar and data center commitments in rural Virginia. In 2018, it announced the purchase of 315 megawatts of energy from two solar facilities in Spotsylvania County, known as Pleinmont I and II, in what has been described as the largest corporate purchase of solar energy in U.S. history. More recently, the company filed for permits to further expand its data center footprint in Mecklenburg County.

Rural Virginia has also benefited from firms' investments in facilities to manufacture capital equipment for the data center industry. A prime example is Airedale by Modine, which built a manufacturing plant in Rockbridge County in the Shenandoah Valley to produce air chillers for data centers. "Our clients around Data Center Alley really value the fact that we are close by," says Robert Bedard, the firm's general manager for data centers in North America.

This sort of spillover effect comes above and beyond the benefits that data centers can provide through their high-paying jobs and tax payments. Of course, that does not mean that data centers are going to be welcomed in every community. Neighbors in Manassas, for instance, complain about the constant humming sound from the facilities' cooling systems, while some residents of Prince William County are pushing for a pause in new data center development pending a study of its effects on the Occoquan Reservoir, which supplies drinking water to over 2 million people. For appropriately situated locales with ample water resources, however, their allure is likely to continue. **EF**

READINGS

"Data Center and Manufacturing Incentives: Economic Development Incentives Evaluation Series." Report of the Joint Legislative Audit and Review Commission, JLARC Report 518, June 2019.

Masanet, Eric, Arman Shehabi, Nuoa Lei, Sarah Smith, and Jonathan Koomey. "Recalibrating Global Data Center Energy-Use Estimates." *Science*, Feb. 28, 2020, vol. 367, no. 6481, pp. 984-986.

Siddik, Md Abu Bakar, Arman Shehabi, and Landon Marston. "The Environmental Footprint of Data Centers in the United States." *Environmental Research Letters*, May 2021, vol. 16, no. 064017, pp. 1-11.

"The Impact of Data Centers on the State and Local Economies of Virginia." Northern Virginia Technology Council, March 2022.