How to find the ‘sweet spots’ to build all those data centers

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The race is on to build new data centers. Many utilities, developers, and government agencies are searching for ideal locations to build data centers as quickly as possible while maximizing the economic benefits and minimizing the risks.

Determining where to build these data centers is increasingly high stakes and complex. Stakeholders must navigate an intricate web of siting decisions: electric grid infrastructure, fiber optic cables, environmental requirements, and government policies.

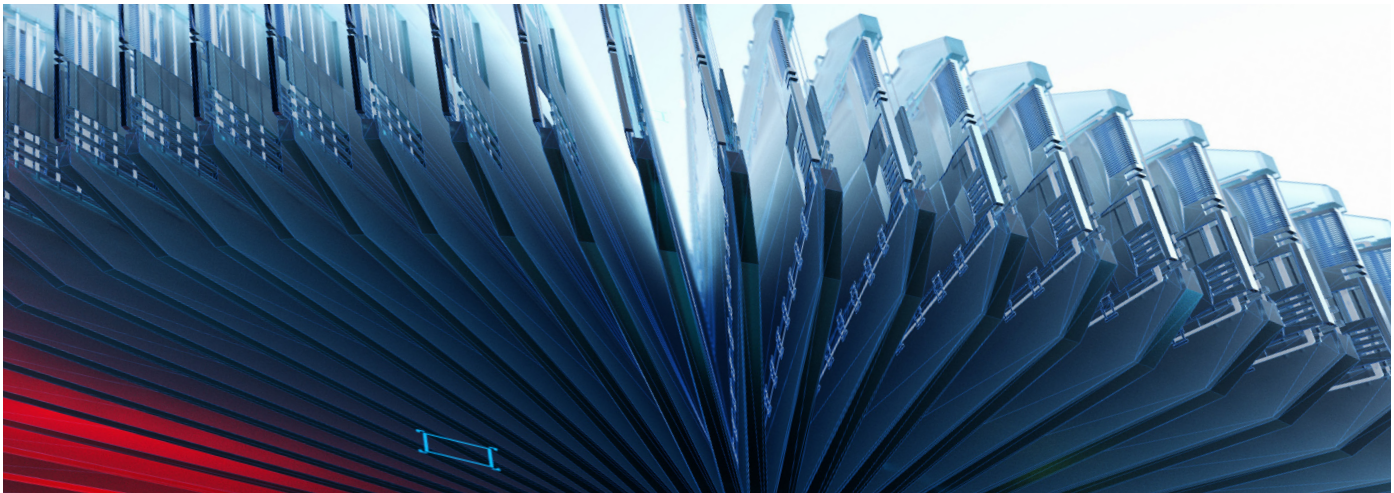
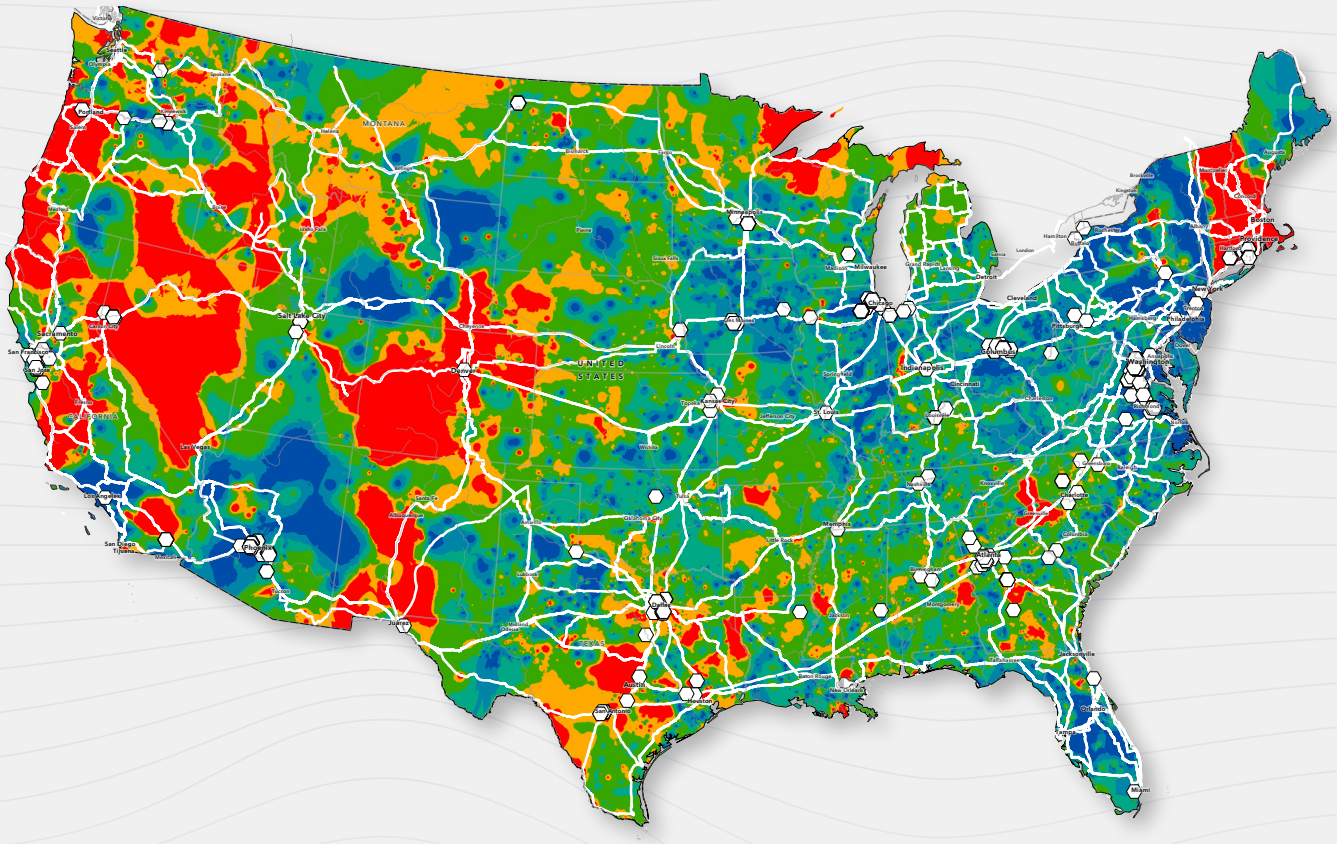


Figure 1 shows proposed data centers, expected available electricity withdrawal capacity through 2030 to serve those data centers, and existing long-haul fiber optic cables, which data centers need for high-speed data transmission. When you consider just these three factors, the ideal locations for data centers dwindle dramatically.

Figure 1: Planned data centers, 2030 incremental grid withdrawal capacity, and long-haul fiber optic network



Source:
ICF EnergyInsite®

But many more factors will determine the ideal locations for data center. Leveraging ICF's EnergyInsite platform, this paper explores critical considerations for utilities, developers, and government agencies that impact the feasibility and economic benefits of data center sites across four key areas:

- Energy infrastructure (power and gas)
- Fiber optic network infrastructure
- Environmental requirements
- Regulatory and policy environment

Whether you're developing data centers or preparing infrastructure to serve them, insights from EnergyInsite help you pinpoint the sweet spots to focus your work.

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Energy infrastructure

While all variables in the data center siting framework matter, energy typically carries the most weight. The reason is simple: Data centers supporting AI use a vast amount of electricity and spend a vast amount of money on it. Without a favorable energy supply and grid infrastructure, projects don't move forward.

Developers, utilities, and government agencies should consider several energy supply variables when identifying optimal sites or planning future development.

- **Powered land access:** Do parcels have existing or near-term access to electricity?
- **Grid capacity:** What are the local grid's withdrawal capabilities under near-term scenarios?
- **Grid stability:** Is substation-level reliability and system resilience, measured by voltage stability and short-circuit strength, adequate to ensure operational stability?
- **Interconnection:** What is the large load interconnection process and costs?
- **Gas infrastructure:** Are there natural gas pipelines nearby with available capacity to support paired or backup generation?
- **Power price outlook:** How will regional power market dynamics impact long-term energy procurement costs and contracted generation?

Grid capacity and interconnection

Historically, securing supply through interconnection to a utility-owned electric grid is the preferred choice for data center developers. It provides the necessary level of reliability, has generally been sufficiently timely, and does not require the data centers to have to undertake potentially complex and more costly energy management. However, sites where the electric grid has the capacity to serve data centers are disappearing rapidly as electricity demand skyrockets across the U.S.[1] Currently, data center developers make formal interconnection requests to utilities. For most utilities, it can take many months for a review. If the utility doesn't have capacity at the location, it rejects the request. This results in time lost going through the formal review processes.

Data center developers and grid planners alike need to be aware of locations where grid withdrawal capacity—the grid's bandwidth to deliver additional amounts of electricity across the transmission and distribution system—is sufficient for new large loads at the scale of modern data centers. Utilities have an opportunity to offer proactive guidance to data center developers before they formally submit interconnection proposals, publish grid capacity maps for their service territories, and publish preferred development zones that identify areas where favorable conditions for development converge. These sources of information would help developers submit interconnection proposals with a higher chance of success. It would also allow utilities to save time on reviews and effectively plan for grid upgrades.

Paired and backup energy supply

There's a mismatch between the speed and scale with which data center developers are racing to build new facilities and the pace with which utilities can make grid upgrades needed to meet data center demand. Rather than waiting on the grid, developers are increasingly working with partners to build their own generation.

[1] ICF. https://www.icf.com/insights/energy/demand-growth-challenges-opportunities-utilities

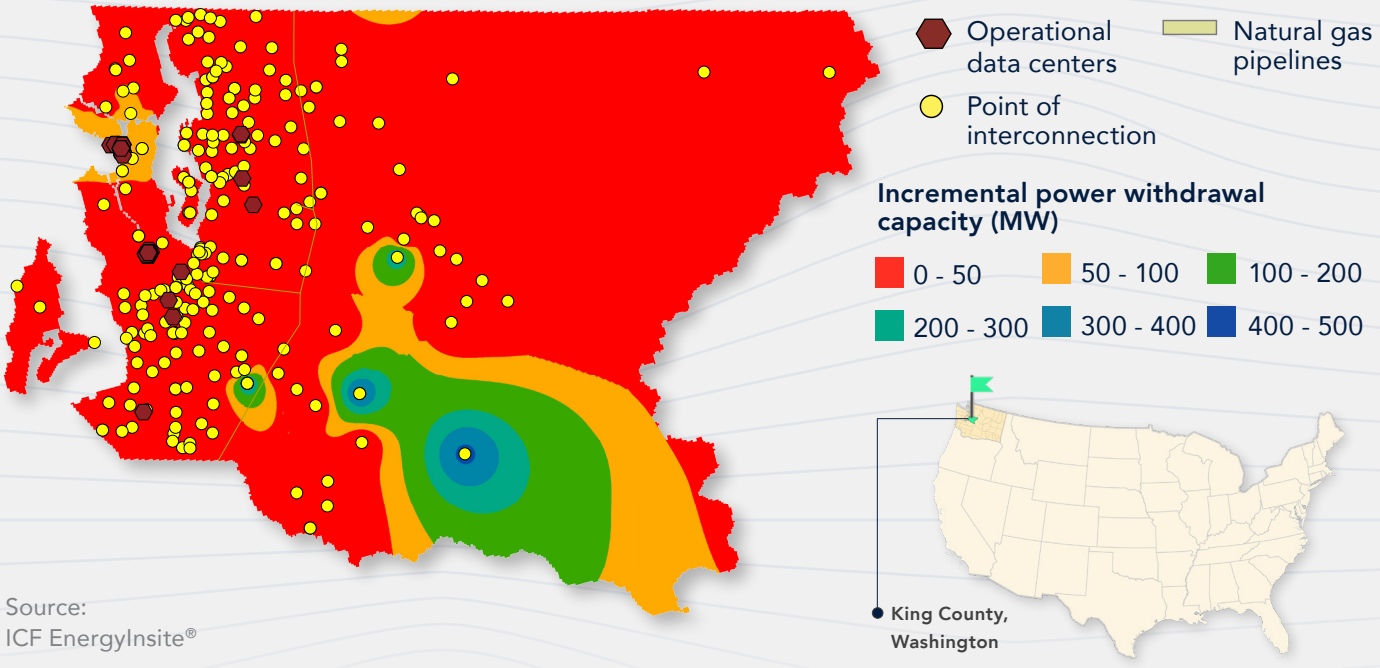
For example, xAI had 35 on-site gas turbines built to supply electricity for its Colossus supercomputer facility in Memphis, Tennessee to temporarily supply its 250 MW data center, before transitioning to a more permanent solution where 12-15 gas turbines will be permanently installed for back-up supply. Homer City Redevelopment and Kiewit Power Constructors announced a $10 billion plan to install 4.5 GW of gas generators[2] to serve a data center campus planned outside Pittsburgh, Pennsylvania.

For data center developers that can manage to get their hands on new gas turbines, the behind-the-meter energy strategy is only a real solution if natural gas infrastructure can provide the supply needed to fuel those turbines. In many parts of the country, gas pipelines are constrained, and some gas utilities have stated they expect to face new delivery bottlenecks within the next few years. Understanding pipeline networks and supply capacity is critical—both for developers considering gas turbines and midstream and downstream gas companies that may need to plan for new demand.

Figure 2 maps critical power grid and gas pipeline infrastructure, grid withdrawal capacity, and operational data centers in King County, Washington. There are no proposed data centers currently in King County, which could be a function of limited grid withdrawal capacity. However, gas pipeline infrastructure co-located with grid interconnection points presents a strategic opportunity: Developers could deploy behind-the-meter gas turbines as an interim power solution to accelerate project timelines, while simultaneously monitoring utility transmission plans and interconnection queue progression to determine the optimal timing to transition to grid-supplied power.

The deployment of gas power plants is contingent on technology trends and policies at a state-level. Washington State has an aggressive clean energy target—100% from zero-emitting resources by 2045—and high carbon allowance prices which can significantly constrain the economic feasibility of new gas-fired generation. With advances in carbon-capture technology, there are opportunities for new gas power plants to come online in the near future.

Figure 2: Energy infrastructure in King County, Washington



Source:
ICF EnergyInsite®

[2] Institute for Energy Research. https://www.instituteforenergyresearch.org/fossil-fuels/gas-and-oil/natural-gas-turbine-manufacturers-are-getting-huge-orders/

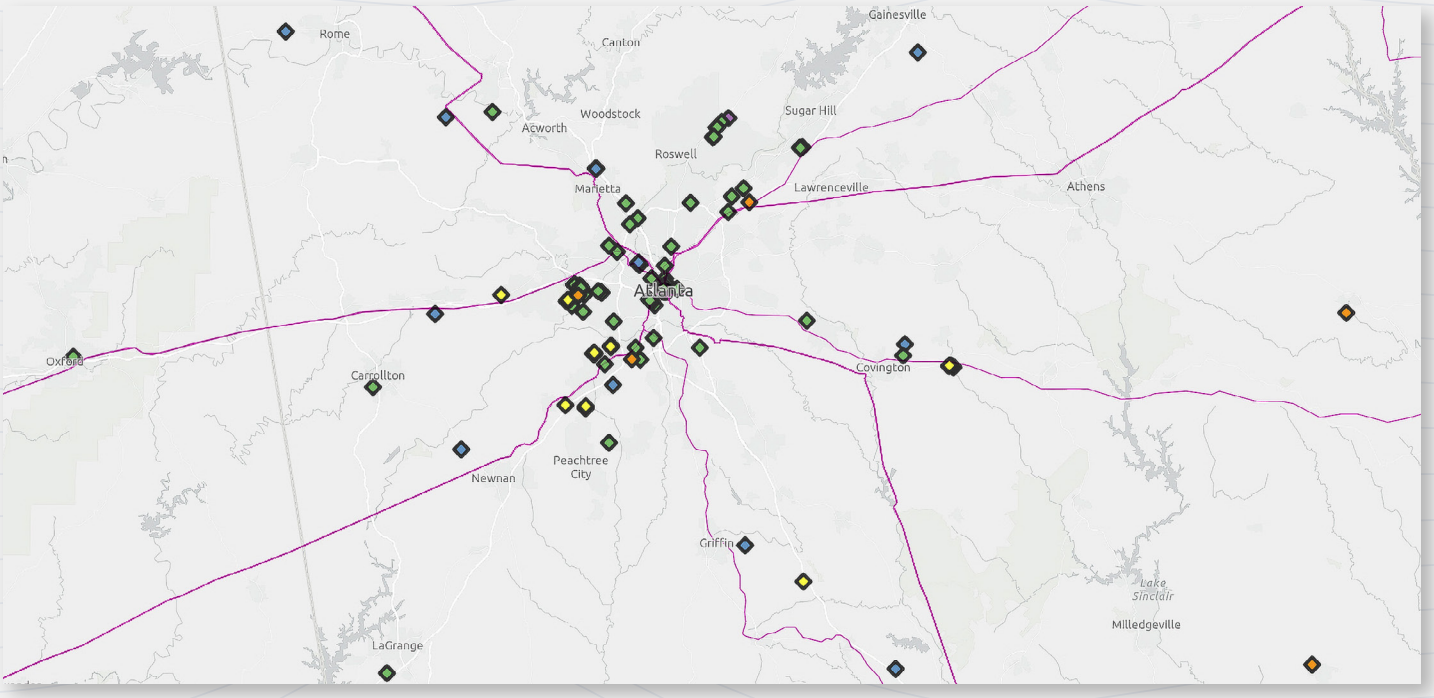
Fiber optic network infrastructure

In addition to energy, data centers need high speed, high bandwidth, and highly reliable internet connections to transmit data in real time. Fiber optic networks are the industry standard. Developers and government planners should consider two key variables when evaluating data center sites in relation to fiber-optic network availability.

- **Proximity to fiber optic network hubs:** Is the site as close as possible to long-distance fiber optic cable?
- **Data center clustering:** Is the site part of a data center cluster (or could it be), which would allow it to benefit from colocation and shared infrastructure?

The locations of long-distance fiber optic cable networks can be mapped across the United States. Figure 3 focuses on Georgia, which has become a hot spot for data center development, particularly in the Atlanta metro area. The map shows how existing data centers have been built along these primary fiber optic lines. Fiber optic networks in the Atlanta area are robust, supporting widespread data center campuses and colocation.

Figure 3: Fiber optic lines and data centers in Georgia



Source: ICF EnergyInsite®

Environmental and permitting requirements

Securing energy and fiber solutions is necessary but not sufficient for data center development success. Developers must simultaneously address environmental and permitting requirements, gauge community sentiment, and proactively engage with local stakeholders. The ability to navigate these factors efficiently can be as critical to project viability as the technical infrastructure itself.

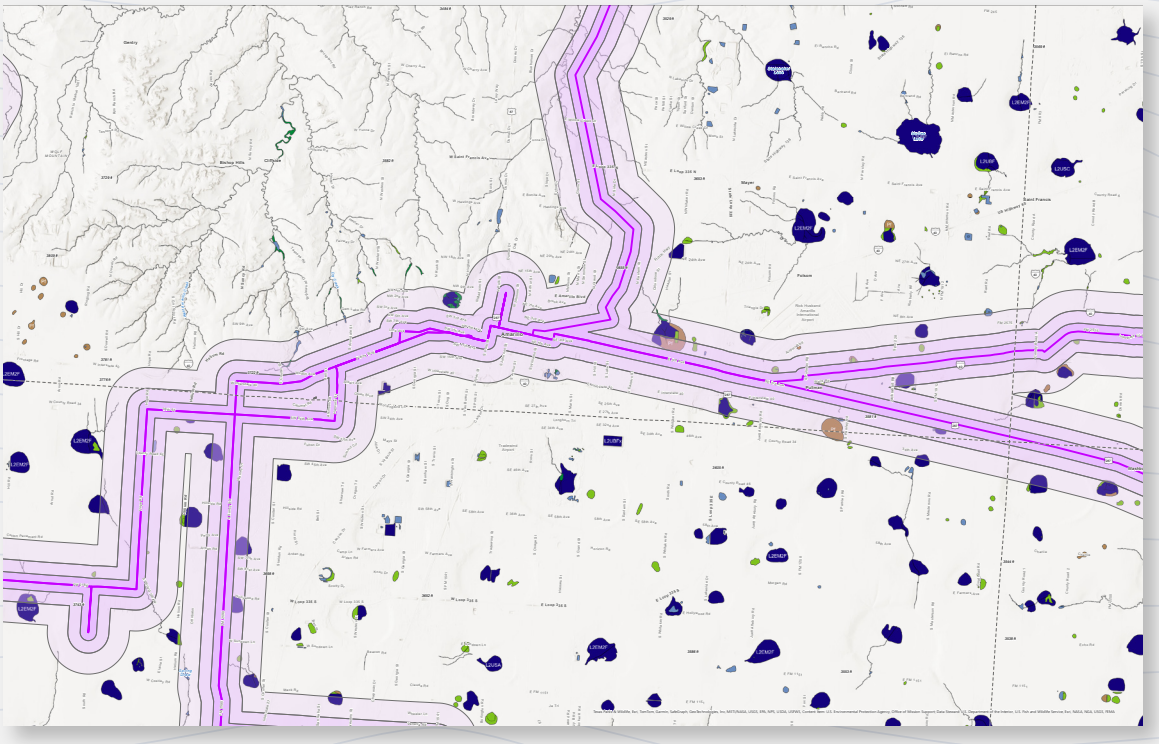
Variables that developers and planners should include in their decision-making framework include:

- **Water access:** Is there a sustainable source of water available to use for data center and onsite power generation cooling needs?
- **Long-term weather risk:** Are sites at risk from flooding, wildfire exposure, or other extreme weather events—and how are those risks expected to evolve?
- **Ecological impacts:** Does a site include any sensitive habitats like wetlands or threatened or endangered species habitats, which could increase development requirements?
- **Land availability and zoning:** Are suitable land parcels zoned for industrial and mixed use, and do they satisfy local zoning requirements?
- **Permitting complexity:** What are relevant local ordinances and environmental review requirements, and how will they impact project costs and timelines?

Designated waters of the U.S. are one of the most common environmental factors requiring federal, state, and local permitting. In many cases where an individual permit is required, wetland mitigation is required if data center development would impact greater than half an acre of wetland habitat. Data center developers could consider using excess lands not being used by the data center itself as wetland mitigation for on-site impacts or as wetland mitigation banks for on-site or off-site impacts.

The Texas Panhandle is an emerging data center development hot spot. Although the Texas Panhandle is often seen as dry and arid, wetlands are still prevalent, highlighting the importance of this factor across many geographies. Figure 4 shows National Wetlands Inventory data and fiber optic infrastructure in the Texas Panhandle. While mapping is an excellent tool for high-level data center site prospecting, on-the-ground verification is required to identify jurisdictional wetlands that require a permit. Understanding the environmental and permitting constraints—including the time and investment needed to develop a data center at a site—requires upfront site selection work, such as habitat studies, field evaluations, and permit matrices.

Figure 4: Texas panhandle national wetlands inventory



U.S. fiber optic data

Longhaul fiber links

Distance to fiber optic lines

1000 ft

2500 ft

5000 ft

Environmental metrics

National wetlands inventory – wetlands (Map service)

- Estuarine and marine deepwater
- Estuarine and marine wetland
- Freshwater emergent wetland
- Freshwater forested/shrub wetland
- Freshwater pond
- Lake
- Other
- Riverine

Source: ICF EnergyInsite®

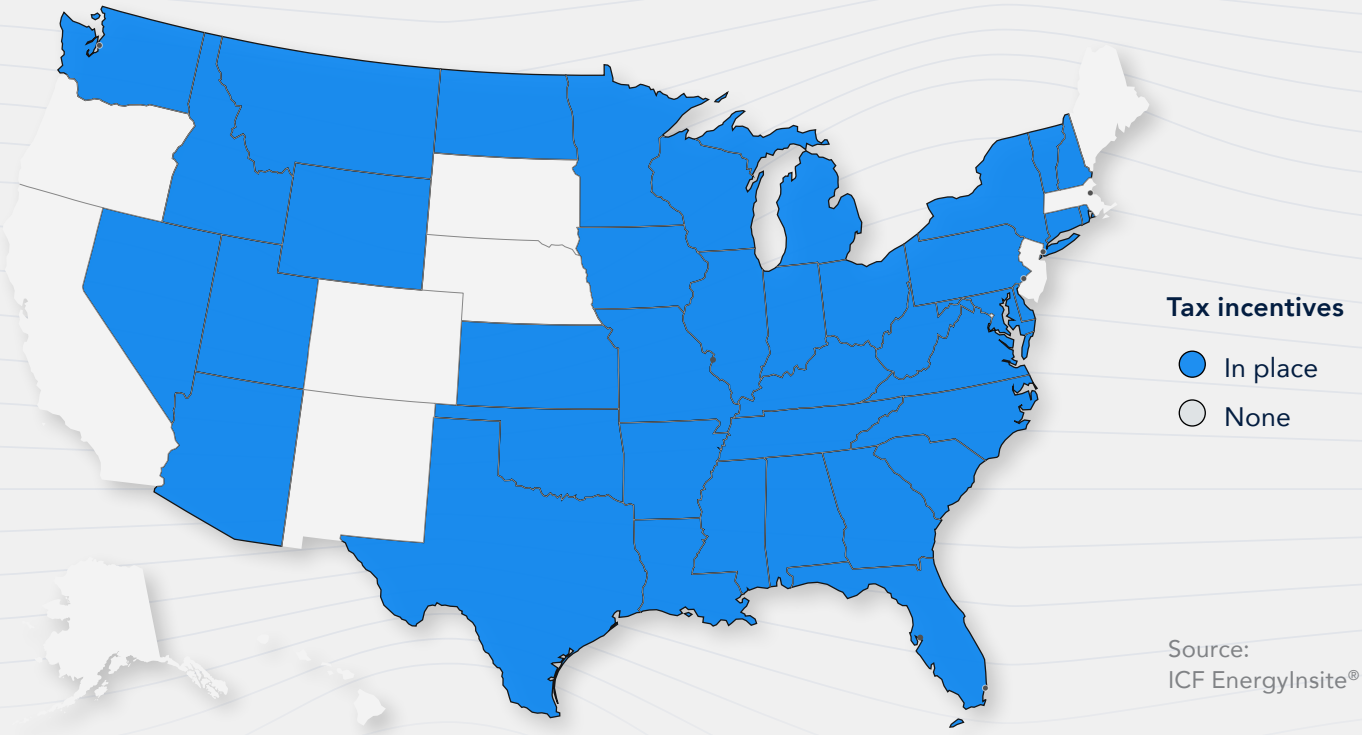
Regulatory and policy environment

Data center developers and utilities understand that jurisdictions differ significantly in how supportive—or not—the regulatory and policy environment is for development. Factors that contribute to the regulatory and policy environment include:

- **Federal and state drivers:** Are there programs that incentivize data center development at certain sites? Are there relevant policy restrictions related to emissions or noise?
- **Power market structure:** How do ISO or RTO market rules impact the interconnection timeline and energy procurement? Do vertically integrated utilities offer a faster approach for large load interconnection?
- **Tax incentives and financial support:** Does the site offer any location-based benefits, such as certain sales tax exemptions?
- **Local community acceptance:** How close is the site to nearby communities, and do those communities have a history of supporting or opposing data centers?

Tapping deep state and local knowledge, it's possible to map the regulatory and policy environment across metrics ranging from incentives to emissions restrictions in support of high-level data center site prospecting. Figure 5 shows states that offer data centers tax incentives, such as a sales tax exemption. California and Colorado have long been home to data center hubs and do not offer tax incentives, but Georgia has supported its growing data center industry with 100% sales and use tax exemptions at the state, county, and local level on equipment purchases for up to 10 years. Other states not traditionally known as data center hubs have created tax incentives in hopes of becoming one, such as Arkansas, which in 2023 passed a state law that created tax exemptions for data center equipment, eligible data center costs, and electricity used by qualified data centers.

Figure 5: States that offer tax incentives for data center development



But once you get to the local level, how do you know if the community will be in favor of data center development or not? Understanding community receptivity to data center development is critical to project success. A sentiment analysis provides valuable insights into community favorability and identifies key concerns before they become obstacles. Key elements of an effective sentiment analysis include:

- Online and media research
- Social media monitoring
- Public meeting review
- Statistical surveys
- Focus groups

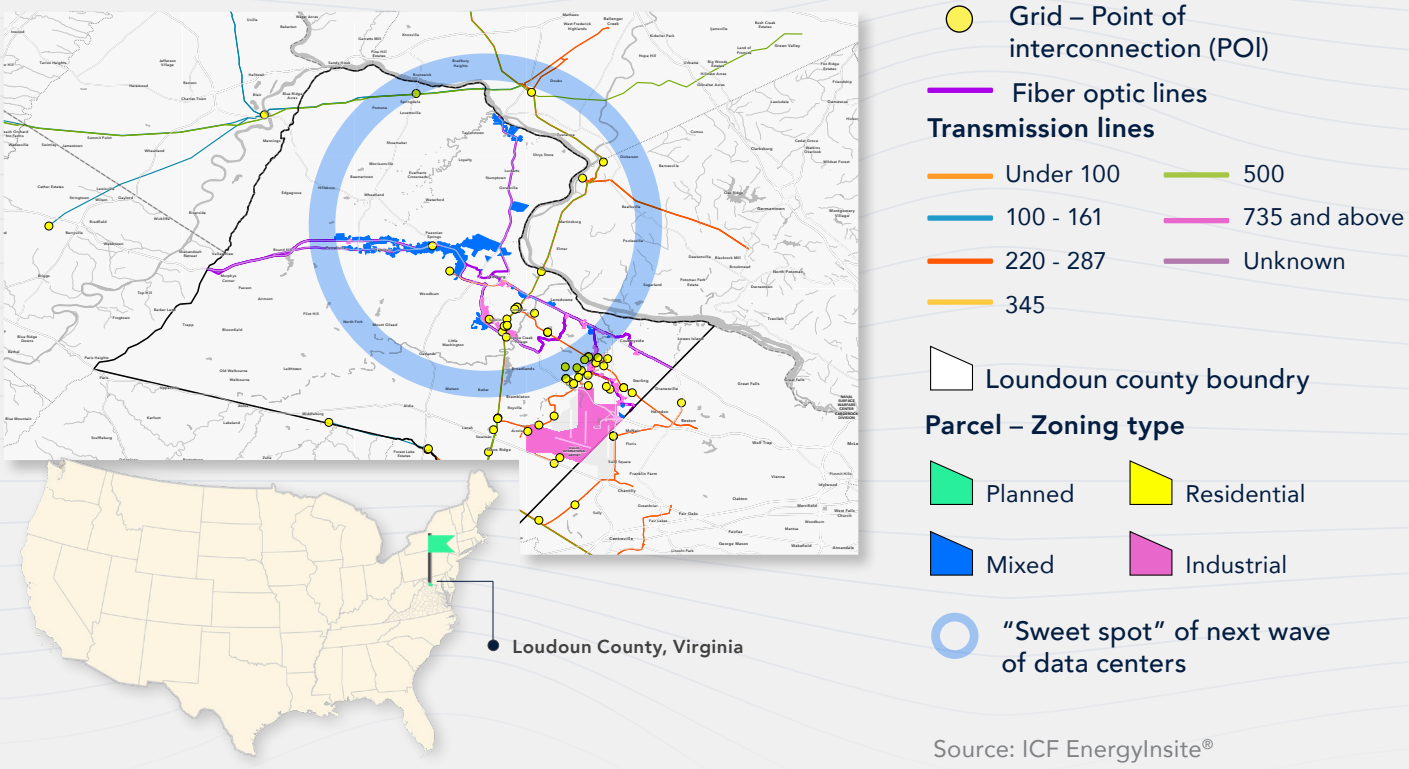
Bringing all the data together to find the sweet spots

Loudoun County, Virginia, is the home of Data Center Alley, the largest concentration of data centers in the United States. Due to favorable siting conditions, development in the county continues at a rapid pace. The area offers a compelling case study to understand the importance of a siting strategy that accounts for the critical considerations examined in this paper.

Developers, utilities, and government planners ultimately want the answer to the big question: What are the optimal sites for development that enable timely data center build?

Figure 6 maps Loudoun County's data center "sweet spots"— locations that fit all the key criteria. These sweet spots are defined as industrial/mixed-use zoned parcels within 1,000 feet of fiber optic lines and located close to substations with 100+ MW of incremental grid withdrawal capacity and minimal flood hazard risk.

Figure 6: Ideal locations for future data center development in Loudoun County, Virginia



Source: ICF EnergyInsite®

By combining those criteria, more than 1,500,000 land parcels are narrowed to just about 600 that may be suited to data center development. That's 0.04% of total land parcels in Loudoun County. While many of these sites are in industrial-zoned areas located near the existing Data Center Alley, the Leesburg area in central Loudoun County could also be an area to explore for data center development.

Together, this information could help inform the conversation about continued data center development in the county, recognizing that community input would be needed to further refine ideal sites for future development.

If data center development impacts your work, siting tools help you plan and prepare

Successful data center siting requires a holistic approach that considers energy infrastructure, communications network infrastructure, environmental and permitting requirements, and regulatory and policy factors. Using the wealth of data available to measure those variables and GIS-based mapping tools is a valuable first step in narrowing the search.

Once the search is narrowed with a site screening technology, like ICF's EnergyInsite, stakeholders should pursue a detailed site diligence and critical issues analysis to confirm suitability and profitability of the location. Importantly, this will set the stage to engage early with surrounding communities to build support.

In an era where every megawatt, mile of fiber, and acre of land counts, the winners in the data center race will be those who connect the dots fastest—and smartest. With EnergyInsite, ICF gives developers, utilities, and government agencies the clarity to pinpoint the sweet spots to develop data centers quickly and while helping to build community support.

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