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Why Early Grid Studies Ensure Data Center Success In A World Driven By Hypergrowth

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AS AI-DEMAND ACCELERATES, POWER AVAILABILITY DETERMINES WHETHER PROJECTS MOVE FORWARD OR STALL

Across the U.S., data centers are scaling faster than the grid was designed to absorb. Artificial intelligence (AI) workloads, cloud expansion, and hyperscale growth are pushing facilities into load ranges once reserved for major generation assets. For utilities and developers alike, this growth is colliding with a combined system of permitting, cost allocation, regulation, and supply chain, all built for reliability, not speed at scale.

At the same time, regulatory expectations continue to tighten, infrastructure lead times are stretching, and workforce shortages are limiting utilities' ability to execute. Decisions that once felt routine such as where to site a facility, how to source power, and when to engage the utility, now carry hefty consequences for cost, schedule, and long-term viability.

PLANNING CYCLES ARE LOCKED IN EARLIER THAN MOST REALIZE

For large loads, the grid was not designed to respond perfectly on queue. It responds on timelines measured in years. Early power system and siting studies help surface this reality before capital is committed.

When a project triggers network upgrades, the consequences are immediate and tangible. Large transformers and breakers can carry lead times of 18 months or more. Transmission reconductoring often requires seasonal outages that can only occur during narrow windows, with limited crews available to perform the work. Miss one window, and schedules slide by six months.

Without rigorous studies upfront, these constraints emerge after a developer acquires the land, designs are underway, and expectations are set. Early studies shift the conversation from what is theoretically possible to what is realistically achievable within a given schedule and budget.

NOT ALL POWER SUPPLY MODELS CARRY THE SAME RISK

Data center power strategies generally fall into three categories, each with distinct reliability and cost implications.

Some facilities rely on onsite generation, often natural gas, due to its dispatchability. While this can accelerate early phases, onsite generation typically operates at lower availability than the transmission grid and still requires a reliable backup for outages and maintenance.

Others pursue hybrid approaches using onsite generation as primary supply with the grid serving as backup. This model introduces flexibility but depends heavily on utility tariffs, regional practices, and the ability to tolerate limited curtailment risk.

The most traditional model, primary grid service, offers high reliability but often triggers the most extensive network upgrades. Utilities typically plan transmission systems to withstand multiple sequential contingencies, a standard that can drive significant infrastructure requirements for large new loads.

When these models are selected without early study, mismatches emerge between operational expectations and grid realities. Early analysis allows developers and utilities to align power strategies with both reliability needs and economic constraints.

CURTAILMENT IS BECOMING A STRATEGIC LEVER, NOT A LAST RESORT

Historically, curtailment has been something utilities managed around generation. As large loads become more prevalent, that dynamic is shifting.

In some regions, the ability for a data center to reduce load for a limited number of hours per year can substantially reduce the scope and cost of required network upgrades. This flexibility can change the economics of interconnection entirely.

Understanding whether curtailment is feasible depends on regional grid conditions, market rules, and the difference between interconnection studies and deliverability analyses. The former tests worst-case scenarios; the latter looks statistically across most of the year, accounting for maintenance, outages, and operational downtimes.

Without early evaluation, curtailment opportunities are often discovered too late to influence design decisions. With it, they become a proactive tool for balancing cost, reliability, and speed.

SITE VIABILITY IS ABOUT MORE THAN PROXIMITY TO POWER

A transmission line on a map does not guarantee viable interconnection.

Power system design is governed by reliability criteria intended to limit cumulative transmission-related outages to less than a single day over a 10-year period. Every new load must be studied to design a reliable transmission system to meet that framework, serving existing demand, forecasted growth, and new facilities even during contingency events.

Urban density, the ability to build overhead versus underground lines, access to substations, and the feasibility of new rights-of-way all factor into whether a site can realistically support large-scale load. In many cases, the most constrained sites are not those far from infrastructure, but those where infrastructure cannot be expanded.

Early feasibility studies help distinguish between locations that appear attractive and those that actually have a viable path to interconnection under real-world constraints.

POWER QUALITY AND FAST LOAD DYNAMICS ARE EMERGING RISKS

As data centers grow, it is not just how much power they draw, but how they draw it.

AI-driven workloads can cause rapid, millisecond-level swings in demand, far faster than traditional generation can respond. The grid was built around inertia and gradual adjustment, not instantaneous oscillation.

Inverter-based resources with onsite battery systems is one example of a way to smooth these fluctuations before they spread into the broader system. This type of analysis is becoming part of early due diligence to assess how large, fast-changing loads interact with system stability.

About the Author

Jeffrey Norman serves as TRC's senior director for integrated grid advisory services in the power division. Jeffrey is a power industry leader with more than 20 years of experience in the electric utility sector and over a decade of leadership experience guiding high-performing technical teams. He brings deep expertise in utility operations, engineering strategy, and organizational improvement, helping utilities solve complex operational and infrastructure challenges.

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