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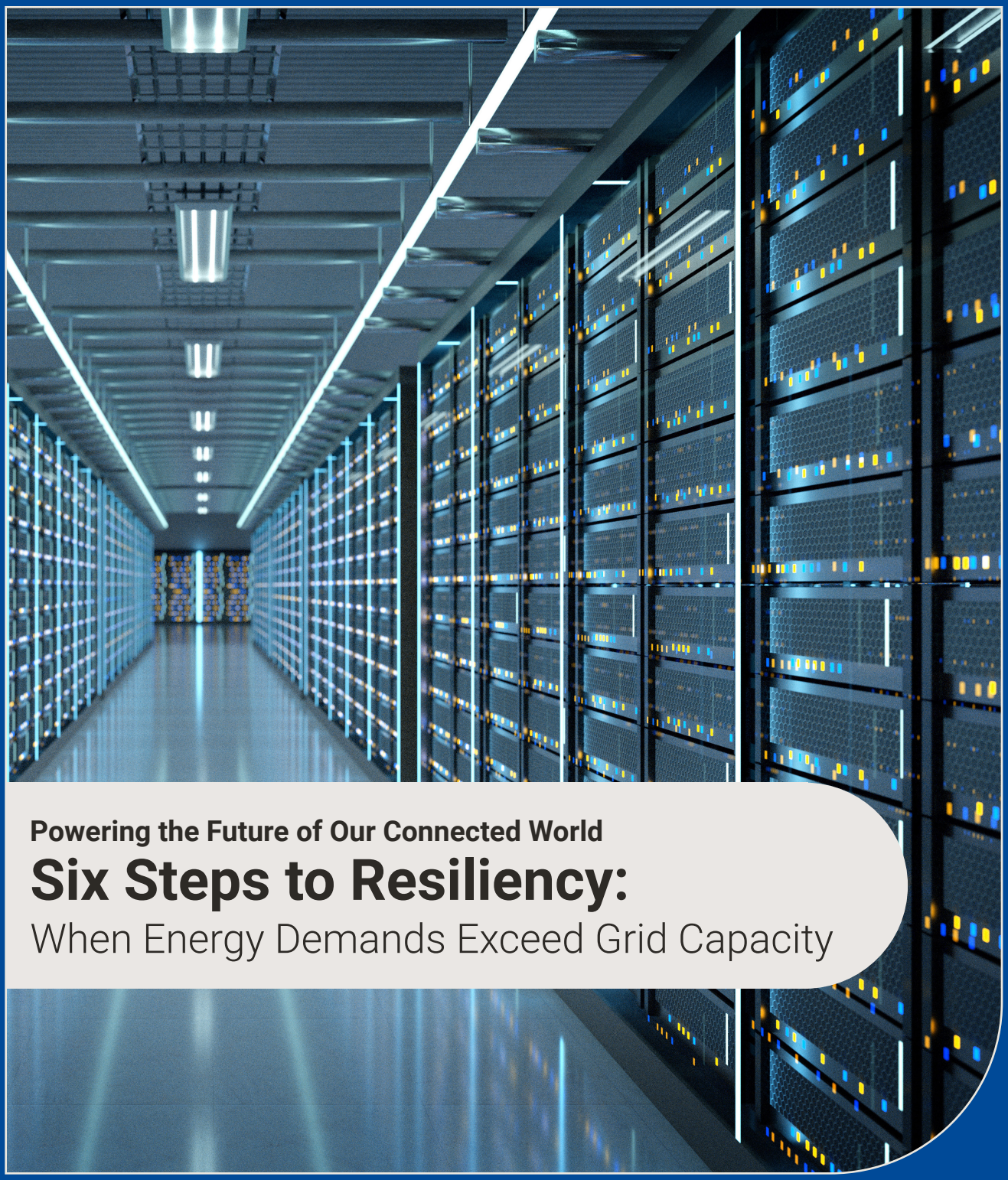

Powering the Future of Our Connected World

Six Steps to Resiliency:

When Energy Demands Exceed Grid Capacity

With the increase in AI cloud-based services, digitalization, and electrification, access to “always on” power is critical. In some regions, energy demands of data centers may exceed current and future grid capacities. When data centers can no longer rely solely on the traditional power grid, they must seek creative solutions. Reliable, accessible and affordable power is a competitive advantage for data center developers, owners and operators.

Energy is the critical, yet often invisible, determining factor in the viability of site selection, design, construction and operation of data centers. Ensuring you have the right power infrastructure — whether that's selecting a site for a new facility, filing interconnection applications, or building a substation — is essential to achieve your capacity needs and protect your investments. To meet the energy demands of your data center in the near and long-term, follow these six steps toward resiliency:

Step 1. Assess Existing Infrastructure

While the market transitions to more sustainable and renewable power, transmission systems also need to be modernized to ensure grid stability and reliability. To assure a strong return on data center investments, data centers must operate at their greatest potential. Assessing not only the power grid, but also your data center's power needs (now and in the future), identifies any potential gaps which may keep you from reaching your desired-state and outlines the solutions to get there.

- **Power Utility Infrastructure.** Evaluate existing power infrastructure access and availability. During the site due diligence process for greenfield and developed sites, identify available power sources and evaluate the cost of building new transmission facilities. Determine if the utility can meet the unique needs of your facility—and if not, consider alternative solutions that offer you independence from the central grid and/or provide bridging power until grid capacity is available.
- **Existing Data Center Infrastructure.** Review your data center's current capabilities including space, connectivity, capacity, power and cooling systems. A thorough assessment can solve gaps in capacity, resiliency and concurrent maintainability. With this information in hand, you can identify short and long-term deficiencies to prioritize corrective actions based on specific vulnerabilities and risk.

Step 2. Conduct Energy Capacity and Reliability Studies

Data centers and high-tech manufacturers are motivated to modernize infrastructure to ensure continuous operational efficiency. To perform accurate grid capacity and reliability studies, you must consider utility-provided power availability and costs, Independent System Operation (ISO)/ Regional Transmission Organization (RTO)/utility specifications, and your facility requirements. Based on your facility's unique needs, digital models can be built to predict performance and grid impacts that will inform your site selection, strategize scalability planning, and identify necessary transmission line or substation upgrades. In this phase, an understanding of power capacity can also to validate if your data center will have access to the energy needed for site growth plans.

Step 3. Align with Power Market Forecasts

Data centers require "big picture" financial analysis to understand how one operational change can significantly impact your profits, assets, technology integrations, employees, and customers. Facility owners and operators can work with expert advisory partners to provide economic, regulatory and strategic investment consulting. Consider performing an analysis of power rates, potential incentives, and tax benefits and how they directly affect the economics of your facility. Market price forecasting will provide you with insightful, customized assessments to optimize your portfolios of operating assets. These analytical efforts will support your facility's long-term financial viability, define adaptive strategic pathways, and enable performance-driven management of power market assets.

Step 4. Plan for Grid Interconnection

Data centers need power, but the interconnection queue is long; faster interconnection time means faster time to market. A comprehensive injection and extraction study can identify appropriate points of interconnection that won't disrupt schedules or budgets. Detailed system analysis and modeling enables you to confidently plan and manage your interconnection process (and understand the time required). It's especially beneficial to select a "one-stop shop" EPC partner with in-house capabilities to develop transmission lines, distribution substations, and interconnection stations. If transmission, substation, or network upgrades are needed to support additional power flow, these companies can provide comprehensive EPC services for quicker deployments.

Step 5. Identify Substation Upgrades

Substations are essential to new advanced energy systems. With challenges to accessibility and affordability of energy, building on-site power generation infrastructure gives you more control and flexibility. Control over your power can mitigate pain points related to supply chain delays, speed to market, operations, and maintenance. Whether your facility needs an air- or gas-insulated switchgear or modular substation, proven methodologies can be leveraged to meet current and future needs. Turn-key solutions available on the market go beyond physical infrastructure including Virtual Protection Relay (VPR) and automated controls to facilitate timely decision making and reliable power.

Step 6. Consider Microgrid Integrations

While utilities have adequate generation capacity, their distribution infrastructure may not be capable of delivering the amount of energy when and where your data center needs it. Guaranteed utility capacities often vary by season, with a greater availability in non-peak months. Many data center developers are installing microgrids as they become more common to address needs for energy resiliency, reliability, sustainability, flexibility, and cost reduction. Consider the following benefits of deploying a microgrid at your data center:

- Serve as control centers to seamlessly transition to different types of power generation (such as renewables, combined heat and power, fuel cells and other onsite generators), allowing you to diversify your options for greater resiliency
- Enable operation strategies that can minimize demand charges and time-of-use rates, sometimes allowing for utility agreements for different power capacity guarantees in peak and off-peak months
- Facilitate off-grid operational strategies for existing data centers and full grid independence for new developments

New energies (including Carbon Capture Utilization and Storage (CCUS), Battery Energy Storage (BESS), hydrogen, sustainable fuels, and advanced power cycles) and on-site power generation make microgrids and grid-independent facilities possible.

Case Study: Confidential Data Center Substation Design

Black & Veatch recently supported a confidential technology client to efficiently develop their portfolio of hyperscaled data centers. The team provided engineering peer reviews, detailed design, procurement support, and construction administration for the client's 11 greenfield N+1 redundant substations, operating at 13.8 kV secondary voltage. The original design schedules were upwards of 20 to 24 weeks followed by construction support; with optimized processes and standards, Black & Veatch was able to complete designs in 11 to 13 weeks. A shortened schedule decreased project costs for the client, and the standard optimizations improved quality. Additional value was added through self-perform Supervisory Control and Data Acquisition (SCADA) system integration. It was essential to this project's success to develop substation designs that met the compressed schedule, addressed long-lead time constraints, and aligned with transmission owner interconnection requirements.

Bonus Step: Leverage Digital Twin Technology

Digital twin technology has gone from a futuristic ideal to a present-day reality that benefits your entire facility lifecycle. While Building Information Modeling (BIM) is impactful throughout design and construction, digital twin technology takes this a step further by enabling data-driven, real-time simulations of power infrastructure operations. Here are two major benefits of using digital twins to optimize energy solutions at data centers and high-tech manufacturing facilities:

- **Cost-Effective Planning and Design.** Digital twin technology eliminates geographical barriers in the initial site due diligence and design phases. Stakeholders can virtually walk the project (such as a new substation construction, microgrid installation, etc.) to proactively identify and mitigate issues. It's much more expensive to make changes after construction has started; it's best to "design twice, build once".
- **Strategic Operations and Maintenance.** Data-driven intelligence streamlines operations and maintenance practices. Digital twins allow developers and/or operators to use real-time data to visualize grid system behavior. These highly specialized models can also be used to simulate energy demand response impacts, evaluate backup generator systems, identify pressure points, and monitor operational costs.

When energy demands of data centers and high-tech manufacturing facilities threaten to exceed grid capacity, a strategic and proactive approach is essential. While these six steps to energy resiliency may seem daunting, the power industry is home to many knowledgeable professionals employed by firms with in-house EPC capabilities. When it comes to the key steps outlined in this whitepaper, the right partner will deliver the following:

- Existing infrastructure assessments
- Capacity and reliability studies
- Power market forecasts
- Substation upgrade recommendations
- Grid interconnection plans
- Microgrid integration considerations
- Digital twin expertise

Black & Veatch's energy solutions encompass transmission, distribution, and the automation and communications needed to connect, visualize, and optimize the grid. As your trusted infrastructure partner, we design and build resilient, reliable, efficient, and future-proof grid systems. Learn more about Black & Veatch's custom energy solutions for data centers and high-tech manufacturing facilities at bv.com/industries/data-centers