BLACK & VEATCH

# Future-Ready Data Centers

## Sustainable Design for Reliability and Continuity

# Contents

# Introduction

Data center owners and developers are setting environmental, social and governance (ESG) goals to actively protect the environment and mitigate climate change impacts.
A top approach is to reduce the carbon footprint of their operations by building and occupying green buildings and campuses. These sustainable structures are designed to enhance society, environment, culture and economy. Built-in design benefits prioritize energy, water and resource efficiency, cut operational costs, slash carbon footprints, and speed corporate decarbonization.

Enhancing sustainable design elements can increase sustainable operations. Through green development and retrofits, developers can divest from carbon-heavy assets that will likely depreciate as the globe transitions to net-zero and instead focus on in-demand, green-certified structures. Sustainable operations are intentional and best deployed when comprehensively planned for maximum cost-efficiency and system integration. Stay ahead of the net-zero curve by planning and designing sustainable infrastructure for a future-ready data center.

# Data Center Evaluation and Assessment

## Leverage Data to Drive Design

Future-ready data centers are designed to be sustainable. From technology that enhances energy efficiency to predictive analytics used to prepare for future climate impacts, it's no secret that data drives strategic decisions. Data center owners should consider leveraging data analytics in the following ways.

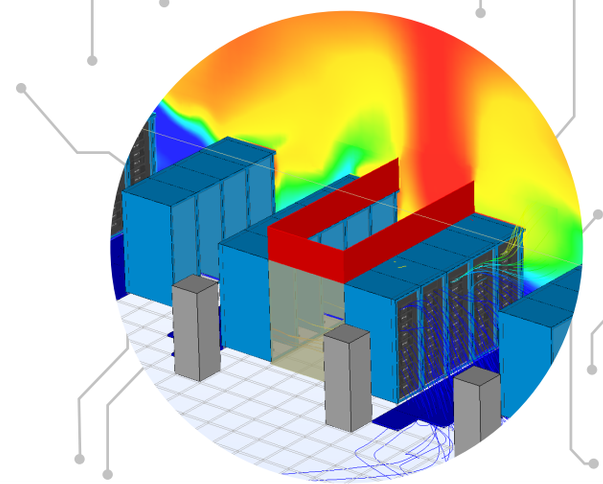
- **Conduct climate trend analysis for risk mitigation.** As severe weather events continue across the globe, predictive climate trend analytics assess whether your existing infrastructure and physical assets are at risk in the near and long term. These insights help you determine what, where and when to prioritize climate risk mitigation.
- **Utilize Geographic Information System (GIS) tools to maximize cost savings.** Data center developers can use customized GIS-based automated routing tools during the site selection process to address specific environmental, landowner, historical or other geographic concerns.
- **Follow infrastructure rating programs to reduce emissions and optimize resource use.** Sustainable data center development benefits from adhering to infrastructure rating systems such as Envision™. These systems identify local sourcing options, help with carbon emissions reduction strategies, and optimize energy and water use.
- **Leverage digital twin technology to guide operations and maintenance practices.** 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 building operations.

Using data analytics, developers have the power to design future-ready data centers at the intersection of innovation and sustainability. These practices will strengthen your reputation as a sustainable company and increase the marketability of your facilities as needs for efficiency, reliability and resiliency in the face of climate change continue to increase.

## Computational Fluid Dynamics

Hydraulic and computational fluid dynamics (CFD) modeling capabilities drive sustainability and resilience through informed design. CFD modeling and analysis can accurately simulate turbulent fluid flow, and temperature transients, sediment and pollutant propagation, data server and storage assets, and data center cooling equipment operations. CFD modeling enables facilities to identify and analyze problems before they start, and provides the design basis of power and cooling storage capacities. Specific benefits from CFD:

- Drives design excellence and evaluates operational alternatives, minimizes operations issues, reduces maintenance costs, equipment performance, and mitigates risks in a virtual environment.
- Provides a better understanding of fluid behavior to optimize cooling and improve efficiency.
- Enables the rapid simulation and visualization of different cooling scenarios, including chilled water equipment operations.
- Identifies hot-spots to allow for design and flow alterations.
- Impacts environmental sustainability by optimizing the model of fluid flow in data center environments and identifying solutions to reduce energy consumption.
- Reduces Opex and Capex expenditures with the analysis of operating transients during loss of power and other accident conditions.



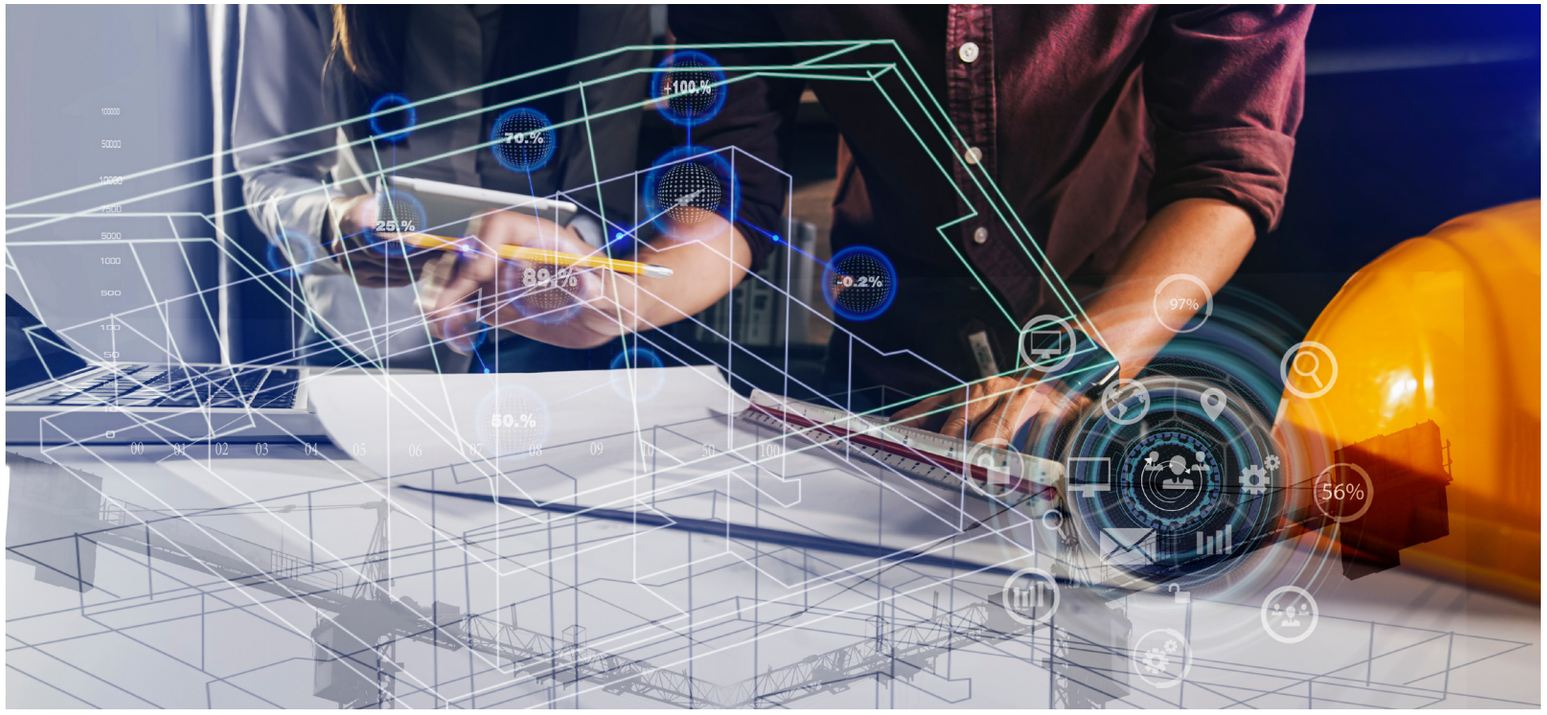
## Evaluate Structural Risk Category Selection

**American Society of Civil Engineers (ASCE) Standard 7:** Minimum Design Loads and Associated Criteria for Buildings and Other Structures is an integral part of U.S. building codes in determining loads for structural design.[1] In the design phase of your data center development, there are various technical intricacies that factor into ASCE 7 risk category selection and its impact on structural engineering, downtime prevention and overall facility performance.

According to the National Institute of Standards and Technology (NIST), there is a common misconception that complying with local building codes and standards will guarantee data centers immune to seismic events, tornadoes, floods and heavy snow loads. Some regions such as the earthquake-prone U.S. West Coast require seismic bracing regardless of risk category. However, building codes and standards in the U.S. simply represent minimum design standards with the intention of protecting human life.[2] Facilities are designed to allow occupants to safely evacuate the building following a high-risk event, but the building still may be significantly damaged and not immediately (or ever) habitable again. Voluntarily designing the structure in adherence with a higher risk category that exceeds minimum requirements may enhance data center resilience and reliability by reducing the probability of structural failure in the wake of high-risk events.

When it comes to data center operations, downtime can have severe economic consequences. For example, large financial institutions rely on their data centers to process billions of dollars in daily transactions. Disruptions to data center operations can result in significant monetary losses, damage to reputation and credibility, and even legal repercussions.

While mechanical, electrical and plumbing systems are expected to be repaired and upgraded on a semi-regular basis, the structure of a facility is intended to be permanent. Scalability and speed-to-market are key to success in the data center business. Rather than making costly retrofits down the road, at the expense of potentially disrupting data center operations, it's more cost-effective to exceed structural risk category requirements on the front end of project development.




### Protect Your Hardware From Vibrations

If you are making structural upgrades to an existing data center, consider installing vibration-monitoring devices to protect your equipment from adjacent construction activities such as drilling and hammering. External vibrations can cause hard drive heads to go off track, resulting in latency issues while the head resettles. Vibration-isolating fans can minimize vibration and noise transmission.[3]

# Infrastructure Considerations

## Implement Resilient Energy Solutions

In the U.S., commercial buildings consume 35% of electricity and generate 16% of all carbon dioxide emissions.[4] On average, 30% of the energy used in commercial buildings is wasted due to system inefficiencies.[5] Given the rapidly growing number of data centers, the infusion of resilient energy solutions would radiate positive impacts worldwide.

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. To meet the energy demands of your data center in the near and long term, consider the following:

- **Assess existing infrastructure.** During your site due diligence process, identify available power sources and evaluate the cost of building new transmission facilities. Determine if the utility can meet your data center's needs — and if not, consider alternative solutions that offer independence from the central grid.
- **Conduct energy capacity and reliability studies.** Based on your data center'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.
- **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.
- **Identify substation upgrades.** With challenges to accessibility and affordability of energy, building onsite power generation infrastructure gives you more control and flexibility. Whether your facility needs an air- or gas-insulated switchgear or modular substation, proven methodologies can be leveraged to meet current and future needs.
- **Consider microgrid integrations.** Microgrids 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. Microgrids can operate independently from the central grid, allowing mission critical data center operations to continue even during an outage. Off-grid, onsite power generation is even required for grid interconnection in some regions.
- **Plan for alternative energy.** The reality of alternative sources of energy is on the near horizon. Planning now for future adaptability will put you in the front of the line when new sources are available and ready to implement.

## Deploy Smart Facility Systems

Rocky Mountain Institute estimates that "green" facilities have a 3% to 7% higher occupancy rate and can charge almost 4% more rent. In fact, a developer that immediately sells the building upon project completion will benefit from a 17% higher sale value over a similar facility that was not constructed with sustainability (and therefore the future) in mind.[6] About 60% of real estate developers who lease space to tenants plan to invest in "smart" technologies to enhance sustainability in the next six to 12 months.[7]

To ensure the seamless integration of smart facility systems, it's essential to proactively consider future needs to avoid costly efficiency upgrades as building codes become increasingly rigorous and climate events become more unpredictable. Smart sensors gather data about facility functions so data center owners can make insightful decisions to enable greater operational performance. Data center owners also can use this data to hyper-personalize building services for tenants as a value-added, billable service.[8] Automation of lighting, HVAC, security, parking, water and energy systems enable remote management of data center operations, which is often more secure, productive and profitable than traditional management and can align with sustainability goals.

With thoughtful design, data center developers will receive positive returns on investment from their green, intelligently managed facilities.


## Install a Private Fiber Network

The private fiber network market is expanding to address data center developers' rising needs for reduced latency, better reliability, and lower operational costs. A private fiber network connects two points (such as a data center to the information "highway") without relying on another carrier's pre-existing networks. Private fiber networks are not exactly new technology, but many network providers are still not familiar with supporting mission critical operations; in contrast to data centers, their other customers do not face the same severe consequences for going offline for short periods of time. Although many types of facilities benefit from having their own private fiber networks, the security, performance and economic aspects are especially important for data centers.

When installing a private fiber network, data center owners should consider working with a reputable engineering, procurement and construction (EPC) provider to develop a GIS representation of all fiber assets, typically more accurate than what the network provider can offer. This GIS representation mitigates risk by identifying which parts of your network are most prone to service interruptions. Diversity of networks is key to reliability; if one fiber network is damaged due to a traffic accident, for example, your redundant private fiber network can continue to provide connectivity.

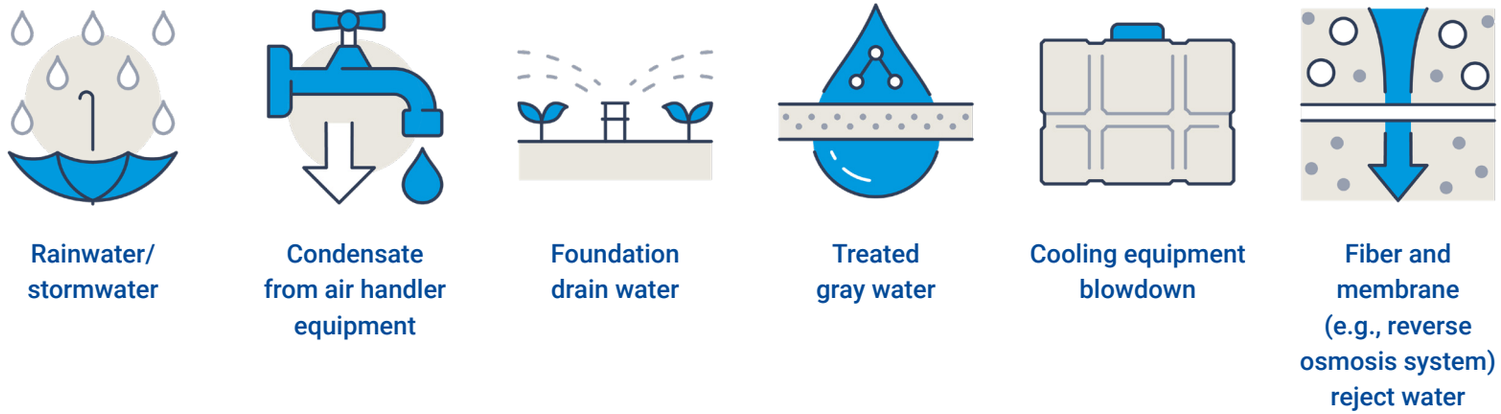
## Consider Integrated Water Resource Strategies

Commercial and industrial facilities are the second-largest consumer of public water in the U.S., accounting for 17% of withdrawals from public water supplies.[9] Particularly water-hungry aspects of data centers include cooling technology, process rinses, equipment cleaning, restrooms and landscaping.[10] To save on operational costs and protect the planet for future generations, data center owners should consider reusing water from several onsite sources.

In many cases, data center owners can make operations and maintenance changes to optimize the use of water resources with strategic up-front capital investments that offer cost savings down the road. For example, stormwater capture and wastewater reuse are sustainable alternatives for data center processes that do not require potable water to cool servers and other equipment. Reused water also can be used for landscaping irrigation and toilet flushing.

Making informed decisions to integrate water utilization strategies is a huge step towards a more sustainable data center. As you prepare your facility for the future, consider making the following changes to your facility operations:

- Consider water-efficient cooling systems such as air-cooled condensers, closed-loop liquid cooling or glycol-based immersion cooling.
- Implement computational fluid dynamics to identify and mitigate hot spots, which will reduce energy costs and water efficiency.
- Conduct a water audit to characterize water use, locate and fix leaks, and identify opportunities for water capture and reuse.
- Choose water-efficient fixtures, machinery and equipment.
- Align water treatment processes with overall sustainability goals.
- Leverage digital tools and data analytics to guide efficient water use.
- Look for incentives offered by or partnerships with water utilities for making efficient upgrades.



## Facilitate Collaborative Project Delivery

Planning for high-performing data centers of the future begins with strategic engineering and construction. Data center developers have many approaches when it comes to designing and building their new facilities, but some methods foster innovation more than others:

- **Consider alternative delivery methods.** By keeping their engineering and construction partners separate, the traditional "design-bid-build" method of delivering projects quickly is becoming outdated. Integrated design-builders offer minimized risk, more flexibility and better communication by serving as your single point of accountability from project conception to completion. The design-build delivery method also optimizes the schedule, as design and construction can happen concurrently.
- **Manage facilities holistically, rather than individually.** Rather than navigating relationships and agreements with dozens (if not hundreds) of contractors, developers benefit from having a single trusted partner to manage all construction operations across their numerous sites. Consider working with an expert program manager to save time, money and headaches in ways that wouldn't be possible if sites were managed individually.

## Conclusion — What's Next?

Data centers increasingly are focused on green buildings, facilities and campuses. Investors, developers and building owners turn to sustainable design and engineering to employ cleaner versions of essential systems, slash resource consumption and evolve their building portfolio into the decarbonized era. A modular approach to green building design is a smart way to future-proof investments. Consider partnering with a holistic technology integrator who can implement smart facility functions with an eye on the future to plan, estimate, conceptualize and accommodate retrofits for energy, communications, clean transportation and water use technologies as they mature. With this insight, data centers will continue to evolve and align with new standards, regulations, technologies and climate change impacts.

## Sources


1. American Society of Civil Engineers
2. National Institute of Standards and Technology
3. Tech Target
4. United States Department of Energy
5. United States Department of Energy
6. Rocky Mountain Institute
7. Honeywell
8. Deloitte
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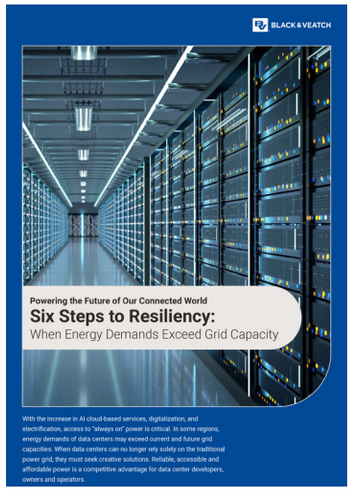
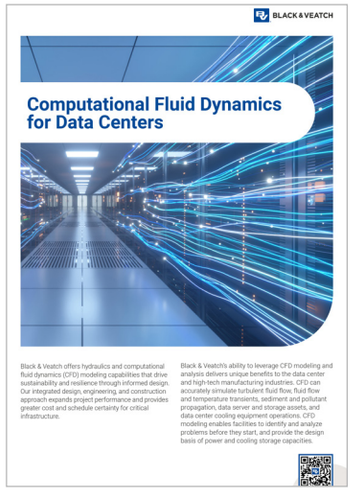
At Black & Veatch, our mission is to build a world of difference through innovation in sustainable infrastructure. We help organizations integrate a range of technologies to cost-effectively achieve resilience, sustainability, and growth.

## Check Out These Other Free Resources to Prepare Your Data Center for the Future.






**Want to design sustainability and energy resilience into your facility?**

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