

2025 data center progress report

Digital transformation and energy management in the wake of AI

Introduction

Data centers can justifiably be considered the beating heart of the digital economy, and their importance is set to expand in 2025 and beyond. For data center operators, this presents both opportunities and challenges.

Thanks to rapid acceleration in the capabilities of AI and machine learning (ML)—especially the emergence of generative AI (GenAI) powered by large language models (LLMs)—data centers face accelerating demand for high-performance, resilient and low-latency compute. That demand is proliferating across existing and new venues, from cloud to on-premises data centers to the edge, leading operators to upgrade existing facilities and build new ones, forging a path to significant growth as they capture these new workloads and revenues.

But the swift pace and mission-critical nature of that expansion comes with considerable challenges. Data center operators must deploy new compute infrastructure in spaces ranging from the largest facilities to much smaller, but no less critical, edge locations. At the same time, they must optimize current space and address significant new energy, power and cooling requirements, all while pursuing sustainability goals and embracing renewable energy sources. And they must leverage an ever-growing set of digital technologies, including security platforms to fend off cyberattacks, as well as AI and analytics tools to transform and optimize operations. To cap things off, they must do all of this in a way that balances immediate needs with long-term goals in an industry that is rapidly evolving.

In this paper, we look at five trends that will transform data centers in 2025, including indicators of how quickly they will arrive, the likely scope of their impact, and how data center operators and owners can prepare now for an ever-changing future.

Note: This whitepaper includes data from S&P Global Market Intelligence and its 451 Research service, as indicated, as well as Eaton's Brightlayer Report 2024, [The Evolution of Digital Transformation: Adoption, Execution and Expansion in the Wake of AI](#), with data collection and analysis by S&P Global Market Intelligence 451 Research.

Trend 1: Adjust to meet exploding capacity demands

The need to serve compute-heavy AI workloads has become “job one” for both commercial and enterprise data centers. AI workloads, GenAI in particular, present extremely high computational and storage requirements, compelling operators to build new locations, add capacity to existing facilities, and optimize and stretch their current capabilities. Related challenges, such as understanding the compute needs of model training versus real-time inferencing, managing graphics processing unit (GPU)/tensor processing unit (TPU)/AI accelerator chip shortages and supply chain hiccups, and perhaps most notably, dealing with associated increases in data center power and cooling needs, place the broad-based issue of capacity atop the list of data center challenges.



Powering Business Worldwide

The increasing demand for data center capacity is largely driven by the rise of AI applications, particularly those using GPUs, which require significantly more power than traditional central processing units (CPUs). The coming wave of accelerated computing is forecast to increase annual electricity demand from data centers in the US alone to more than 280 TWh in 2024, according to 451 Research's Voice of the Enterprise: Data centers, Data center Infrastructure 2024 survey. By 2028, this is expected to nearly double to 530 TWh.

Today, more than four in five enterprises (82%) say they run accelerated computing workloads in their data centers, according to the 2024 survey. Rack density over 10 kW is prevalent and will continue to rise, with the largest proportion of respondents (35%) employing rack densities of 21-50 kW. The proportion of respondents with rack density of more than 100 kW is projected to increase from 9% currently to 15% in five years. Those higher rack densities are also changing the data center cooling picture, with liquid cooling technologies moving to the forefront. Among respondent organizations that operate high-density racks of 11 kW or more, the vast majority (89%) use at least one type of liquid cooling today, and that proportion is projected to rise to 94% within five years.

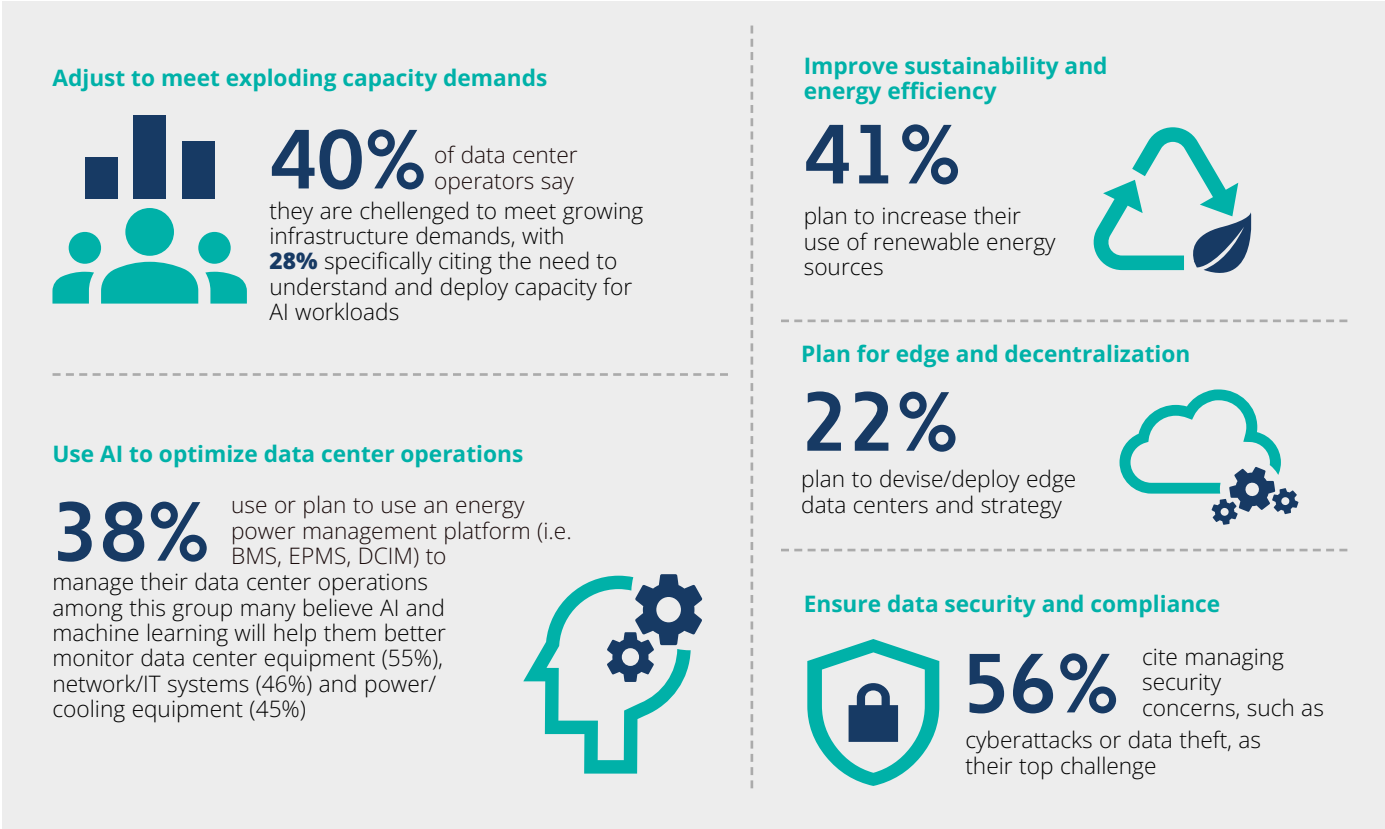
One can see how growing data center capacity demands ripple across the sector, impacting decisions on data center upgrades and new construction, energy and power planning, and infrastructure operations.

Trend 2: Use AI to optimize data center operations

As data center demand changes, owners of both commercial and enterprise data centers face intense operational challenges. While high-dollar capital expenditure decisions, such as building new facilities or increasing renewable energy usage, often draw the most attention, data centers that leverage new digital tools and capabilities to decrease costs and optimize operations can gain a significant competitive advantage.

Data center operators can leverage AI, ML and advanced analytics to optimize their operations in several ways. AI can enable predictive maintenance of network/IT, and power and cooling systems by comparing historical and real-time operations data to foresee equipment failures, allowing for proactive maintenance and reducing downtime. Machine learning algorithms can optimize energy consumption by adjusting cooling systems and power usage based on real-time data, leading to significant cost savings. Advanced analytics can also aid in capacity planning and demand forecasting, allowing existing operations to scale to demand. AI and ML algorithms will make electrical power monitoring system (EPMS) and data center infrastructure management (DCIM) software more intelligent and proactive, further automating data center operations. Data center operators are warming to such systems as a path to leveraging AI-enabled software systems to help run their operations: 38% of data center

Figure 1: Five trends that will most impact data center operations in 2025



Q. Which of the following, if any, are challenges your organization faces in operating its data centers?
Q. Which of the following technologies, tools or applications have you deployed or plan to deploy in the next 12 months to support your organization's operational digital transformation?
Q. Which of the following digitally enabled data center management use cases has your organization deployed or plan to deploy in the next 12 months to improve how it operates its data centers?
Q. Thinking specifically about data center efficiency and sustainability, which considerations or goals guide your organization's efforts today?
Q. Which of the following data center projects, if any, is a priority for your organization over the next 12 months?
Base: All respondents, data center industry (n=345).
Source: The Evolution of Digital Transformation, Brightlayer Report and Survey 2024, with data collection and analysis by S&P Global Market Intelligence 451 Research.

operators say they use or plan to use such a platform. Among this group, many believe AI and machine learning will help them better monitor data center equipment (55%), network/IT systems (46%) and power/cooling equipment (45%), according to [The Evolution of Digital Transformation, Brightlayer Report and Survey 2024](#), with data collection and analysis by S&P Global Market Intelligence 451 Research.

Trend 3: Address sustainability and energy efficiency

Data centers are one of the world's largest energy consumers. The sector also has some of the most aggressive sustainability goals, with large data center operators, such as Google and Microsoft, promising 100% use of renewable energy within the decade. By comparison, the European Union target for renewable energy use by manufacturers is just 50% by 2030, with heavy industrials unlikely to reach even that target, according to the International Energy Agency.

That said, growing AI demand creates both additional power capacity and density requirements for data center operators, further complicating the issue. While immediate compute capacity challenges and opportunities are urgently driving data center decision-making today, medium- and long-term sustainability goals, such as reducing carbon footprint, increasing the use of renewables and managing climate change risk, are a priority today and will likely remain so across the coming decades. Balancing near-term capacity needs against long-term sustainability requirements is a tough challenge, even for the most advanced data center operators. For instance, Google reported a 13% rise

in carbon emissions in 2023, primarily attributed to increased data center energy consumption, despite significant investments in clean energy.

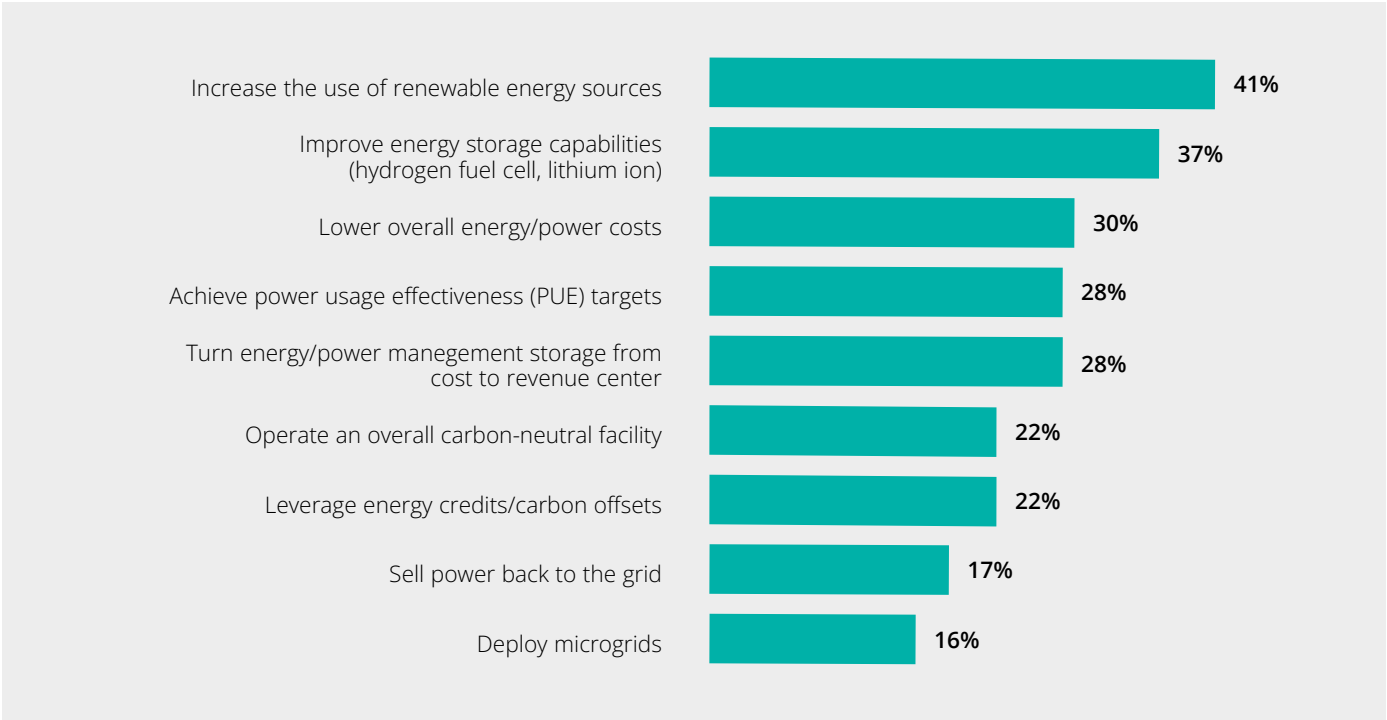
To address sustainability challenges, data centers are focused on the use of renewable energy sources, such as solar and wind, as well as improved energy storage to help deal with the intermittency of such sources—the two most direct paths to a greener future (see Figure 2). For instance, Europe wind and solar capacities remain set to double between 2023 and 2030, according to S&P Global Ratings, enabling the European Union to approach, if not fully reach, its 2030 target of 42.5% share of renewables.

Meanwhile, data center operators are also relying on electrical grid transmission and distribution upgrades. For instance, major US investor-owned utilities have announced plans to spend nearly \$400 billion on upgrades over the next five years, according to S&P Global Market Intelligence, addressing data center capacity demand while improving overall grid resiliency and efficiency, to the benefit of other sectors as well. All of these factors—renewables, energy storage and grid improvement—must play a role for data centers to be a positive force toward societal sustainability goals.

Trend 4: Plan for edge computing and decentralization

In recent years, there has been a growing demand for compute, whether it is accessed as a service via edge providers, on-premises via micro data centers, or in an enterprise-owned or

Figure 2: Data center energy/power-focused operational priorities



Q. Thinking specifically about data center efficiency and sustainability, which considerations or goals guide your organization's efforts today?
Base: All respondents, data center industry (n=345).
Source: The Evolution of Digital Transformation, Brightlayer Report and Survey 2024, with data collection and analysis by S&P Global Market Intelligence 451 Research.

colocation data center facility. Enterprises are looking to distribute and orchestrate workloads across venues for cost, latency, performance and security reasons. Data center operators are scrambling to find the best ecosystem partners and infrastructure topologies, as well as right-sized venues to serve this growing demand.

Edge data centers have changed the industry paradigm. Rather than placing large amounts of compute and storage in a single

facility, which simplifies management and centralizes energy requirements, edge centers are highly distributed. Edge venues present significant location, space and capacity challenges from a planning perspective. The operational story is no less vexing because this model complicates system monitoring and maintenance, and poses unique energy sourcing and management hurdles. Moreover, demand for edge computing can be hard to predict. Early public edge providers, such as mobile operators, have struggled to find near-term consumer-

centric edge use cases. On a more positive note, enterprise demand for private edge computing appears strong, particularly in industries, such as healthcare and manufacturing, that have high-performance demands. But the edge data centers serving those use cases, often linked to nearby 5G mobile towers or deployed in non-traditional on-premises locations, present their own operational challenges.

Trend 5: Ensure security and compliance

A data center going offline—especially due to cyberattack—can have catastrophic impacts. With data volumes increasing, along with more sophisticated attack vectors, data centers must focus on security, both to maintain operations and to keep customer or stakeholder data and AI models safe. In addition, data sovereignty, compliance and privacy requirements are becoming ever more pressing, adding yet another challenge to securing the data center. Managing security concerns, such as protecting customer data from cyberattack or theft, is the top data center challenge today, cited by 56% of respondents to the Brightlayer Survey 2024.

As a physical location that houses critical digital assets, today's data center security posture must include strong facility access control and surveillance, as well solid defenses against cyberattack, made all the more challenging by the increasingly distributed nature of data center environments. Zero-trust architectures are becoming the norm, especially at larger data centers, where attacks are often frequent and attackers probe infrastructure for weaknesses. The other side of the cybersecurity coin comes in the form of enterprise requirements for data privacy, localization and retention, requiring data center operators to partner effectively with their enterprise customers to uphold compliance and regulatory standards.

Conclusion

Data center operators sit at the intersection of great opportunity and great challenge—a juncture where tomorrow's winners may be determined by the strategic and operational decisions they make today.

Call to action

Eaton provides hardware, software and services to help organizations design, build and operate more sustainable, efficient and economical data centers—from power conditioning, quality and backup systems to power distribution solutions and monitoring software. [Connect with us today](#) to explore how we can help you prepare for an ever-changing future.

Methodology

This report is based on a commissioned web survey conducted in March and April 2024. The respondents were qualified based on their expertise in their organization's adoption of digital transformation strategies. Respondent companies were from diverse industries and had 100+ full-time employees. Surveyed organizations were based in geographies including the United States, Mexico, United Kingdom, France, Germany, the Netherlands, Switzerland, Italy, Nordic countries, the United Arab Emirates and Saudi Arabia. Sample size for the commercial data center owners and operators in this study was 345. Respondent roles included data center owner/provider (including colocation and edge). Survey invitations reached executives at the director level and above in IT, technology, facility operations, power management and environmental management job roles. Respondents were screened to be purchase decision-makers for embedded operations technology, having responsibility or connection in their role to operations technology for the site/facility. Their connection to operations technology could be either for IT or other mechanical operations. The survey was executed blindly. The survey sponsor name was not revealed to the participants at any stage of the project.

About the author

Rich Karpinski is principal analyst and channel lead for the 451 Research Internet of Things and Applied Infrastructure & DevOps channels within S&P Global Market Intelligence. His recent areas of concentration include IoT connectivity and managed platform services, IoT edge computing, IT/OT collaboration, IoT market sizing and data flow analysis, IoT digital maturity analysis, and the adoption of IoT use cases across a variety of sectors.

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