

Special Report

The Rise of Renewable Energy Importance in Data Center Location Decisions

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HYPERION RESEARCH OPINION

The growing utilization of high performance computing (HPC) and artificial intelligence (AI) has ushered in unprecedented demands for data storage and processing, making data centers a critical infrastructure in our modern world. However, these facilities' substantial energy requirements have become a pressing concern for both environmental sustainability and operational costs. Data center energy requirements are becoming an increasingly prominent topic in the worldwide power usage conversation. For example, the International Energy Agency (IEA) estimates that data centers consumed between 240 and 340 terawatt-hours (TWh) of electricity in 2022, accounting for about 1-1.3% of global demand, with expectations of this consumption potentially doubling by 2026.

In response to these energy consumption challenges, the data center market is undergoing a transformative shift in its approach to harnessing renewable energy sources and facility location selection. For example, according to Research and Markets, the U.S. sustainable data center market was valued at \$17 billion in 2023 and is projected to reach \$35.35 billion by 2029, reflecting in part a dramatic pivot toward renewable energy sourcing. This growth suggests a fundamental restructuring of how data centers operate and where they are located.

The transformation of data center energy consumption is being led by major hyperscale operators, including AWS, Google, and Microsoft, who are actively securing renewable energy for their facilities. These industry giants have set ambitious sustainability targets and are investing heavily in renewable energy infrastructure. Following their lead, colocation operators such as Digital Realty and CyrusOne have implemented comprehensive renewable energy strategies through Power Purchase Agreements (PPAs). Digital Realty's achievement of 100% renewable energy for its operations serves as a benchmark for the industry, demonstrating that large-scale sustainable operations powered by renewable energy sources are both feasible and economically viable.

Hyperion Research continues to monitor the increasing focus on sustainability in the HPC market and the evolving priorities of data centers in achieving these goals. According to a Hyperion Research recent global survey, 22% of sites currently prioritize renewable energy sourcing, a figure projected to rise to 25% within 12-18 months, as seen in Table 1. While the fastest-growing priority is smart power management (telemetry), which is expected to jump from 15% to 27% in the same period, renewable energy stands out for its ability to reduce a data center's carbon footprint rather than simply optimize it.

TABLE 1**Sustainability Goal Priorities**

- Q. Which of these priorities are you implementing today to reach your sustainability goals? Please select all that apply.
- Q. Which of these priorities are you planning on implementing in the next 12-18 months to reach your sustainability goals. Please select all that apply.

Priorities	Today	Next 12-18 months
Optimized cooling and power distribution	36%	27%
Efficient hardware configuration (higher performance per watt)	33%	36%
Optimized workloads (identifying efficient workloads on-premises and in the cloud)	30%	30%
Renewable energy sourcing	22%	25%
Efficient code (e.g., language, compilers, tools, libraries)	20%	23%
Extending equipment life	18%	22%
Smart power management (telemetry)	15%	27%
Effective equipment retirement (e.g., take back, recycling, proper disposal)	8%	12%
We are not yet implementing any priorities regarding our sustainability goals	0%	0%
Other	0%	1%

n=107

Source: Hyperion Research, 2024

MARKET TRENDS AND GROWTH DRIVERS

Growing investments in renewable energy infrastructure have coincided with rapid advances in green technologies and rising prices of traditional energy sources in some regions, making sustainable operations increasingly cost-effective (compared to their significantly higher costs in the past). In many cases, corporate sustainability commitments have evolved from voluntary initiatives to essential

business practices, driven by environmental consciousness, political pressure and economic benefits. Community pressure for environmental responsibility has intensified, making sustainable practices crucial for maintaining a positive social perception and local government support. Furthermore, the economic benefits of renewable energy sources have become increasingly apparent, with long-term cost savings sometimes outweighing initial investment requirements.

The transition to renewable energy sources in data centers presents a complex web of regulatory, infrastructure, and economic considerations that require careful navigation and strategic planning.

Regulatory Landscape

The regulatory landscape and growing emphasis on Environmental, Social, and Governance (ESG) commitments are reshaping the industry's direction. Government policies and incentives have created a framework that encourages sustainable practices, while corporate sustainability goals are becoming increasingly central to business strategies. These forces have combined to create a powerful impetus for change, extending beyond compliance to fundamentally alter how companies approach their energy consumption. The impact of these changes reaches into community relations, where sustainable practices have become a crucial factor in securing public support and maintaining positive relationships with local stakeholders.

The regulatory landscape presents its own set of intricate challenges, varying significantly across jurisdictions and adding layers of complexity to renewable energy implementation. Companies must navigate through varying jurisdictional requirements, often involving lengthy permit acquisition processes and detailed environmental impact assessments. Compliance with local energy policies requires careful attention to detail, particularly when operating across international boundaries where required frameworks can differ substantially. This complexity often necessitates significant investment in legal expertise and relationship-building with local authorities.

Infrastructure Decisions

Data center operators face a complex decision matrix when choosing between bringing renewable energy sources to existing facilities or relocating to areas with abundant renewable resources. This decision involves careful analysis of energy availability and grid stability in potential locations, as well as assessment of local infrastructure capacity. The regulatory environment plays a crucial role, as different jurisdictions offer varying levels of support for renewable energy initiatives. Operational costs must be carefully weighed against potential benefits, while community impact assessments help ensure that facility decisions align with local interests and needs. These considerations have led to innovative approaches in facility planning and energy procurement, profoundly altering how companies approach data center development.

Infrastructure challenges involve complex grid integration issues, including capacity limitations, stability requirements, and the need for stable transmission systems. Data centers must develop robust redundant power systems while simultaneously upgrading connectivity infrastructure and modifying cooling systems to accommodate renewable energy sources. Energy storage solutions have become particularly crucial, as they bridge the gap between intermittent renewable generation and the constant power demands of data center operations.

Economic Considerations

Economic considerations remain key in the decision to transition to renewable energy sources. While initial infrastructure investment costs can be substantial, the long-term operational savings can sometimes justify the expenditure. Companies must perform detailed ROI calculations that account for not only direct energy costs but also potential revenue impacts, competitive positioning, and risk mitigation benefits. The comparison with traditional energy sources must consider both current market conditions and projected future scenarios, including potential carbon pricing and regulatory changes that could affect operational costs.

RENEWABLE ENERGY STRATEGIES

Location-Based Approach

The strategic placement of data centers near renewable energy sources has emerged as a defining factor in facility planning, with companies increasingly selecting locations that offer natural advantages for sustainable power generation. This approach has yielded several notable implementations that demonstrate the viability of location-based renewable energy strategies:

- NVIDIA's 2022 data center implementation in Reno, Nevada exemplifies how location selection can maximize renewable energy potential. The facility leverages the region's abundant solar and hydroelectric power resources to support intensive AI research operations, demonstrating that environmental sustainability and computational performance are not mutually exclusive goals.
- Google's Cloud AI Center in Groningen, Netherlands, established in 2021, strategically utilizes the region's advanced renewable energy infrastructure, contributing to the company's goal of 100% renewable energy usage while serving as a model for international sustainability commitment.
- The CERN Data Centre in Switzerland has successfully integrated local hydroelectric power resources to support complex scientific computing needs, proving that even the most demanding computational workloads can be powered by renewable sources.
- The University of California, San Diego's data center renovation in 2022 showcases the potential for educational institutions to lead in sustainable practices, integrating with a campus-wide solar panel system in pursuit of net-zero emissions.
- Meta's New Albany facility, completed in 2022, further demonstrates how strategic location selection can support both operational requirements and broader corporate sustainability initiatives.

Energy Procurement

The data center industry's shift toward renewable energy has led to various procurement models and partnerships. Major renewable energy providers have developed specialized offerings for data centers, with varying approaches to meeting high-volume power demands. Wind projects, such as those developed by Invenergy and NextEra, have demonstrated technical viability for supporting large-scale operations, though their effectiveness varies by geographic location and grid infrastructure. While offering price predictability, long-term PPAs require careful evaluation of factors including regional energy market dynamics, regulatory frameworks, and potential grid constraints. Analysis of implemented projects suggests that successful renewable energy procurement often depends more on strategic timing and location than on the choice of a specific energy provider.

INNOVATIVE ENERGY SOLUTIONS

Heat Recovery and Recycling

The innovation in data center energy efficiency extends beyond renewable energy sourcing to encompass comprehensive energy recycling and heat recovery systems. These implementations demonstrate how data centers can transform from energy consumers to valuable contributors to local energy ecosystems:

- Meta's Odense facility in Denmark, represents a breakthrough in heat recovery implementation. The facility's advanced system supplies warm water to the local district heating network, creating tangible community benefits while maximizing energy efficiency.
- Google's Hamina facility in Finland has similarly integrated with local energy systems, capturing waste heat for nearby buildings and demonstrating the potential for data centers to contribute positively to local energy infrastructure.
- Microsoft's AI Research Center in Copenhagen, opened in 2023, has taken this concept further by actively participating in the city's district heating system, showing how data centers can become integral parts of urban energy infrastructure.
- The Large Unified Modern Infrastructure (LUMI) system, located in Finland, is one of the most eco-efficient HPC data centers in the world. Remarkably, LUMI uses 100% renewable electricity, recycles waste heat for district heating in the city of Kajaani, and was constructed on an existing industrial site, bringing its environmental impact to a minimum.
- Quebec City's Q01 facility earned the "2023 North American Data Center Project of the Year" award by combining high-performance computing with sustainable agriculture. Selected by Hewlett Packard Enterprise for its supercomputing capabilities, the facility channels waste heat from its data center into greenhouses, where it produces small fruit and tomatoes.

FUTURE OUTLOOK

The HPC market faces unique challenges in renewable energy adoption due to its massive, consistent power requirements. While traditional data centers can often adjust workloads to match renewable energy availability, HPC facilities typically require uninterrupted power for complex, long-running computations. Despite these challenges, major HPC sites are using innovative approaches to renewable energy integration. Some facilities are exploring hybrid PPAs that combine multiple renewable sources to ensure consistent supply, while others are optimizing workload scheduling around renewable availability.

The future success of renewable energy integration in data centers will depend heavily on the coordinated efforts of multiple stakeholder groups. Renewable energy vendors must focus on developing long-term partnerships while investing in technological innovation and reliable energy storage solutions. Their engagement with communities and flexibility in power purchase agreements will be crucial for widespread adoption. Data center operators need to approach location selection with comprehensive feasibility studies and develop diverse energy sourcing strategies. Their implementation of sustainability metrics and community benefit programs will be essential for maintaining social license to operate.

The transformation of data center location decisions reflects a fundamental shift in how the technology industry approaches sustainability and operational efficiency. The success of renewable energy

integration in data centers has proven dependent on strategic location selection, strong vendor partnerships, innovative technology adoption, community engagement, and supportive regulatory frameworks. The path forward represents both challenges and opportunities. By embracing renewable energy solutions, data center operators are addressing both the environmental and economic sustainability of future storage and processing demands.

About Hyperion Research, LLC

Hyperion Research provides data-driven research, analysis and recommendations for technologies, applications, and markets in high performance computing and emerging technology areas to help organizations worldwide make effective decisions and seize growth opportunities. Research includes market sizing and forecasting, share tracking, segmentation, technology, and related trend analysis, and both user & vendor analysis for multi-user technical server technology used for HPC and HPDA (high performance data analysis). Hyperion Research provides thought leadership and practical guidance for users, vendors, and other members of the HPC community by focusing on key market and technology trends across government, industry, commerce, and academia.

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