Energy-efficient dual-carbon data center



Overview

The Commission will regularly assesses the energy efficiency and sustainability of EU data centres that have reported their data and indicators.

Key Takeaways

Energy-efficient dual-carbon data centers minimize both energy consumption and carbon emissions through advanced design, renewable integration, intelligent cooling, and workload optimization.

Key Strategies for Dual-

Carbon Efficiency1. Sustainable Design and Site Selection Selecting sites with access to low-carbon electricity, cooler climates, and reliable water sources reduces operational energy needs and carbon intensity. Leading operators like Google and Microsoft prioritize grid carbon intensity and long-term clean-energy agreements to secure low-carbon power for their facilities.

2.

Advanced Cooling and Thermal Management High-density A

I workloads require efficient cooling. Hybrid-liquid and direct-to-chip cooling systems, as well as immersion cooling, are increasingly used to reduce energy consumption. Waste heat recovery can further lower the carbon footprint by repurposing heat for nearby buildings or carbon capture systems.

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3. Renewable Energy Integration Incorporating solar, wind, or other renewable sources reduces reliance on fossil fuels. Dynamic workload allocation can align energy-intensive tasks with periods of high renewable output, optimizing both performance and carbon efficiency.

4. Intelligent Workload and Energy Management Energy-aware management strategies include dynamic workload scheduling, AI-driven analytics, and automation to optimize server utilization and minimize idle power. These approaches reduce both electricity costs and carbon emissions while maintaining high performance.

5.

Power and Automation Optimization Upgrading I

T hardware to state-of-the-art efficiency, deploying integrated automation systems, and monitoring power usage in real time help achieve the lowest possible carbon footprint. Automation also prevents outages and reduces energy spikes from backup systems. 6.

Metrics and Continuous Improvement Power Usage Effectiveness (PUE) remains a key metric, with best-in-class data centers achieving values as low as 1. 09. Lifecycle analysis, including scopes 1–3 emissions, can identify opportunities to reduce overall carbon footprint by up to 69% using commercially proven technologies.

Benefits of Dual-

Carbon Data Centers

Environmental Impact: Significant reduction in greenhouse gas emissions and energy consumption. Economic Efficiency: Lower operational costs through optimized energy use and renewable integration. Resilience and Reliability: Intelligent monitoring and automation improve uptime and prevent energy-intensive failures.

Scalability: Frameworks for energy-aware management allow expansion without proportionally increasing carbon emissions.

Future Directions

Emerging technologies, such as heat pumps for carbon-negative operations and AI-driven predictive energy management, are expected to further enhance dual-carbon efficiency. Combining renewable energy, waste heat reuse, and advanced automation can enable data centers to approach carbon neutrality or even carbon-negative operation. By integrating these strategies, operators can build next-generation green data centers that balance high computational performance with minimal environmental impact, supporting global sustainability goals.

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Article Content

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Energy-efficient approach to lower the carbon emissions of data

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Data Centers require enormous amounts of electrical energy to operate. The resultant emissions in the form of heat, directly, and carbon, indirectly, are cause for concern among Data

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Data center energy-saving strategies must consider differences in geographical location, natural resources, and economic bases. Therefore, this study examines the necessary steps for

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This document is for preliminary research. Verify specifications against current standards, product documentation and project requirements.

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