Research Abstract

PROWESS

# Power and Cooling Challenges and Solutions for Data Centers

Overcoming power and cooling obstacles using intelligent power management and advanced cooling technologies for more efficient and sustainable data centers.

Data centers deliver critical services for businesses and consumers. They also offer data sovereignty and security advantages as an alternative to cloud service providers. However, data centers designed for yesterday's technologies must evolve. This abstract explores the issues and suggests solutions for data center power and cooling efficiency, emphasizing the need to balance performance and costs, while highlighting the urgency for more efficient energy management. In this research abstract commissioned by Dell, we include efforts made by Dell Technologies with its innovative tools for smart power and cooling management, which offer significant advancements in monitoring and managing energy efficiency and operational reliability.

### About this paper

This abstract focuses on the latest trends and best practices in data center power and cooling efficiency, emphasizing the need to balance performance and costs. Cooling technology presents a difficult choice, especially for older data center systems. Different cooling methods, such as air cooling, hybrid, and direct liquid cooling (DLC), each have their own distinct advantages and disadvantages.

## Impact of Energy Consumption from Traditional Data Centers

When discussing power for data centers, consider the following observations regarding current and future energy consumption.

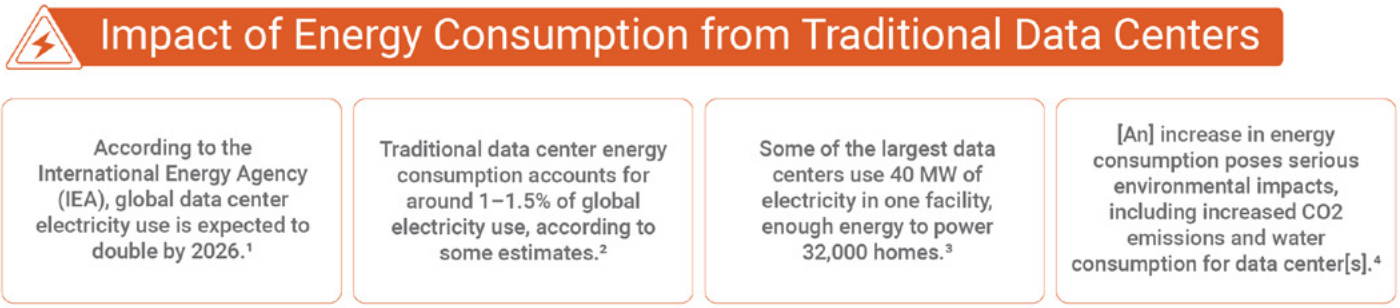


Figure 1. Impact of energy consumption from traditional data centers[1,2,3,4]

The overarching concern is that the demand for energy will only grow, straining electrical grids and resources. Energy efficiency while assessing sustainability for data centers is an important goal.

## Cooling Methods and Their Effects on Energy Consumption

Cooling is essential to prevent data center servers and equipment from overheating. Depending on the design and location of the data center, cooling systems can consume up to 40% of a data center's total energy usage.[5]

The choice of cooling technology presents challenges for data center operations. Air cooling uses air tubes to cool server racks and reroute hot air. Hybrid and liquid-cooling systems offer alternatives to air cooling alone. Hybrid cooling uses a combination of air and liquid cooling through heat exchangers, air chillers, and cooling towers. Liquid cooling, whether implemented in a hybrid approach or exclusively, has grown as a desirable choice because of its effectiveness, but may be restricted due to increased system complexity or the costs to adapt the technology to older data centers.

Liquid cooling technology utilizes different methods: coolant liquids circulating through cold plates on the server (also known as direct liquid cooling) or the more specialized immersion of the server in coolant liquids. These methods reduce the need for air conditioning and can deliver cost savings. When deciding between air cooling, hybrid, and liquid cooling, each method has its own distinct efficiencies, costs, and feasibilities for data centers.

Table 1. Comparison of the efficiency, cost, and feasibility of cooling technologies in data centers

| Type | Efficiency | Cost | Feasibility |
|---|---|---|---|
| Air cooling | Less efficient; struggles with high-density server configurations | Lower initial costs; higher ongoing energy and operational costs | Highly feasible for low- to medium-density data centers; straightforward implementation and maintenance |
| Hybrid cooling | More efficient than air cooling; capable of handling medium to high server densities | Moderate initial costs; improved operational cost efficiency over time | Feasible for medium- to high-density data centers; suitable for gradual transition |
| Liquid cooling | Most efficient; capable of supporting extremely high server densities | Higher initial costs; significant long-term savings in energy and operational expenses | Best suited for high-density, high-performance computing environments; requires investment in specialized infrastructure and maintenance |

## AI and Smart-Connected Devices in Data Center Management

Integrating AI and smart-connected device technologies greatly enhances the performance of energy management and advanced cooling solutions. AI programming, tied to data center operations, can help reduce energy waste. Smart sensors, connected via network or cloud-based systems, can be placed among server racks, inside white space regions, and inside liquid coolant conduits. Smart devices enhance real-time monitoring and provide continuous data collection, automated alerting, dynamic cooling adjustments, intelligent power scaling, and improved responses to alerting. These technologies enable intelligent control over power management and cooling operations, enhancing both reliability and sustainability.

## Dell Technologies: A Standout for Smart Power and Cooling

Prowess Consulting observed how Dell Technologies sets itself apart in smart power and cooling management. Through a holistic approach featuring advanced technologies and intelligent systems, Dell Technologies offers significant improvements in performance, energy efficiency, cooling, and sustainability for data center operations.

The Integrated Dell™ Remote Access Controller (iDRAC), embedded in every Dell™ PowerEdge™ server, enables real-time monitoring and control of individual servers. Dell™ OpenManage Enterprise Power Manager extends iDRAC and centralizes the management of all PowerEdge servers within the data center, providing unparalleled insight into power usage, carbon emissions, and thermal conditions. Dell APEX AIOps provides an AI-driven observability and management software-as-a-service (SaaS) suite, building on the technologies provided by iDRAC and OpenManage Enterprise Power Manager. With the OpenManage Enterprise Power Manager plugin, iDRAC users can manage granular power and thermal monitoring with the ability to report, cap, and optimize power consumption at the server, rack, row, or full data center level—driving energy efficiency and cost savings. OpenManage Enterprise Power Manager not only optimizes power usage, reducing the heat load on cooling systems, but also provides power and temperature metrics for proactive

adjustments and improved cooling efficiency. iDRAC accesses information about the health of each individual PowerEdge server, promoting more efficient cooling processes.

With iDRAC and OpenManage Enterprise (OME), operational information is accessible for up to 8,000 devices per OME instance. This reach effectively facilitates comprehensive lifecycle management for PowerEdge servers in one console as well as additional functionality for reporting.

Beyond power management, Dell also excels in innovative cooling solutions. By integrating advanced cooling technologies, Dell Technologies helps ensure data centers operate efficiently under varying workloads and environmental conditions. A wide range of cooling options include air cooling and liquid cooling, rear door heat exchangers (RDHx) on the rack or in-row, and rack enclosures for data centers with traditional and non-traditional spaces. Dell Technologies' proprietary AI-based fuzzy logic controller, embedded in iDRAC with extensive smart sensor integration, enhances cooling efficiency by fine-tuning fan speeds to match the exact cooling needs of the data center. This innovative approach can not only maintain the ideal operating temperature for servers, but also reduces energy consumption associated with air cooling.

The integration of advanced monitoring, control capabilities, and AI-driven optimizations sets Dell Technologies apart as a leader in the field, paving the way for more intelligent and cost-efficient power and cooling management for data centers.

## Conclusion

By adopting advanced power and cooling technologies and integrating AI and smart-connected devices, data center architects and administrators can optimize energy usage and subsequently reduce costs. Learn more about how **Dell Power and Cooling solutions** can improve data center operations and costs for your organization. Additionally, read Prowess Consulting's analysis concerning energy efficiency, sustainability, IT infrastructure, and data centers with our featured resource, "**Grow and Innovate on an Energy-Efficient, Sustainable IT Infrastructure**."

[1] International Energy Agency. "**Electricity 2024**." January 2024.

[2] International Energy Agency. "**Data Centres and Data Transmission Networks**." July 2023.

[3] EnergyStar. "**Is Energy Efficiency in Data Centers Still Important?**" Accessed August 2024.

[4] TechTarget. "**Assess the environmental impact of data centers**." July 2023.

[5] US Department of Energy. "**DOE Announces $40 Million for More Efficient Cooling for Data Centers**." May 2023.



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