

# Address Your Data Center Power and Cooling Challenges Now and Into the Future

Enhance energy efficiency and reduce costs with Dell Smart Power and Cooling technologies.

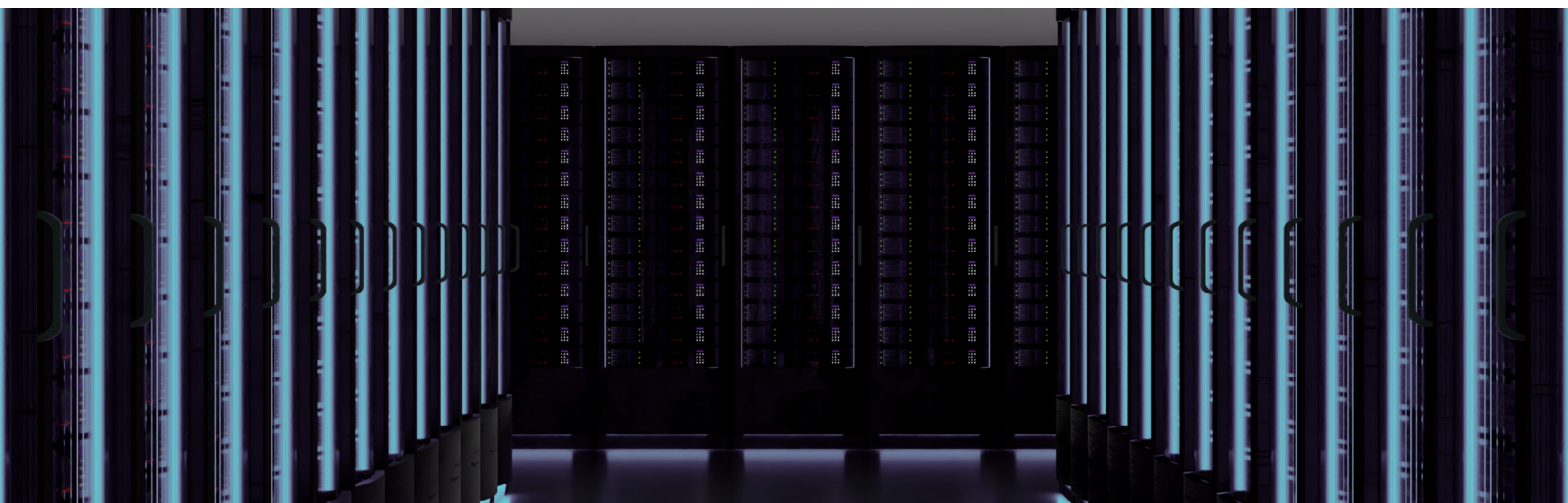
Global data center electricity use is expected to double by 2026.<sup>1</sup>

Data centers face growing pressure as AI, high-performance computing (HPC) and the exponential explosion of data demand more from their hardware. These trends drive servers to run hotter and hungrier as the need for more powerful hardware leads to higher energy consumption and higher operating temperatures. To maintain both system reliability and performance, businesses need effective power and cooling solutions more than ever.

Global data center electricity use is expected to double by 2026.<sup>1</sup> IT leaders face escalating operational challenges as a result. The strategic need to pack more computing power into smaller spaces amplifies energy requirements and heat generation, which pushes the limits of conventional data center designs.

These developments mean that effective power and cooling solutions for organizations are no longer just a technical necessity—they are a strategic imperative. Robust thermal management not only helps ensure optimal performance but also reduces operational costs. Effective thermal management also supports sustainability initiatives and provides a competitive advantage in a market that demands scalable, efficient infrastructures.

Dell Technologies expects AI to continue to transform how business operates. Because of this, we expect compute to become more powerful and increasingly complex. Organizations like yours are going to have to learn how to optimize their data centers in order to thrive. But by addressing these challenges, you can better equip your data centers to meet the growing computational demands of tomorrow.



**99%** of data centers still use air-cooling to some extent<sup>2</sup>

Investment in liquid-cooling at a **20%** CAGR<sup>3</sup>

## We Deliver Scalable Smart Power and Cooling Solutions for Your Data Center

Your data center faces increasing demands. Meeting those challenges requires the right balance of power, cooling and efficiency. At Dell Technologies, we understand that optimizing energy use and ensuring server reliability are critical to keeping your infrastructure running smoothly. You need solutions that meet your current workloads and are flexible enough to grow with you.

That's why we offer a full range of scalable Smart Power and Cooling solutions, designed to adapt to your unique needs. Whether you're focused on improving energy efficiency, enhancing reliability or preparing for future growth, our solutions give you the flexibility to optimize your data center. From advanced air-cooling systems to cutting-edge liquid cooling, we equip you with the tools you need to maximize performance and operate efficiently.

With the holistic Dell Technologies approach, you gain more than just cooling systems. You benefit from integrated power management tools and innovative cooling designs that allow your infrastructure to grow seamlessly as your requirements evolve. By balancing performance, reliability and sustainability, you can confidently meet your IT goals while reducing costs and environmental impact.

### Maximize Efficiency with Smart Power and Cooling Technologies

Your data center's power and cooling needs continue to evolve as your workloads grow more demanding. Dell Technologies offers a wide range of solutions designed to help you adapt quickly, improve energy efficiency and reduce operational costs. Our innovative cooling systems help ensure that your servers remain reliable, even under heavy workloads, while also helping you save on energy expenses.

Data centers have traditionally used air flow to cool servers; approximately 99 percent of data centers still use this approach in one form or another.<sup>2</sup> However, as modern workloads such as AI and HPC have grown more demanding, the servers running them have grown ever more power-hungry—and generate significantly more heat. Air alone is now proving insufficient to cool such servers. Enter liquid cooling, which takes advantage of liquids' greater thermal capacity to cool ravenous servers more efficiently. As the heat output of servers has grown, investment in liquid-cooling infrastructure has grown apace. Current estimates put the growth of investment in liquid cooling at a 20 percent compound annual growth rate (CAGR).<sup>3</sup>

### Air Cooling Solutions

Your data center faces increasing pressure to handle more demanding workloads, and traditional air-cooling methods often struggle to keep up. This can lead to overheating, reduced reliability and higher operational costs. You need solutions that adapt to your infrastructure's evolving needs while keeping energy consumption under control.

Dell Technologies offers advanced air-cooling systems designed to optimize airflow and cooling efficiency. With features like component-mapped fan zoning, intelligent fan controls and Dell Smart Flow strategic airflow channeling, our systems target the areas in your servers that need cooling the most. This reduces hot spots and helps ensure your servers maintain peak performance without wasting energy.

Advanced CPU heatsink designs and optimized motherboard layouts further streamline temperature regulation. You benefit from higher reliability and consistent performance, even under heavy workloads. These enhancements can help your data center stay efficient while avoiding thermal throttling, which can limit computing power and increase costs.

#### Dell Technologies Air-Cooling Solutions Benefits

- Energy-efficient cooling that minimizes operational costs.
- Improved system reliability and performance through real-time temperature regulation.
- Enhanced airflow and thermal dissipation for more stable server environments.

### Hot/Cold Aisle Configuration

Some advanced server workloads like AI and HPC incur escalating thermal demands that traditional air-cooling solutions cannot meet. However, the growing cooling needs of these servers might not yet be great enough to justify investment in liquid-cooling solutions.

The hot/cold aisle setup is a widely adopted solution for medium- to lower-density data centers. This configuration involves arranging racks in alternating rows of hot and cold aisles, which optimizes airflow and cooling efficiency. This configuration prevents the recirculation of hot exhaust air, reducing cooling energy consumption and extending hardware lifespan.

Some Dell PowerEdge servers have front input/output (I/O) and power for easier serviceability. This configuration can be of significant benefit for administrators and technicians who can service these servers from the cold aisle rather than the hot aisle.

#### Dell Technologies Hot/Cold Aisle Configuration Benefits

- Energy savings through efficient airflow management.
- Extended hardware longevity by maintaining optimal temperatures.
- Ideal for organizations that do not require immediate liquid cooling solutions.

## Liquid Cooling Solutions

Many organizations are approaching the stage (or have arrived at it) in which their advanced workloads generate more heat than can be handled by highly optimized and efficient air cooling alone. Liquid cooling is a technology that leverages the superior thermal conductivity of liquids to remove heat more efficiently than traditional air cooling.

### Servers Enabled with Direct Liquid Cooling (DLC)

For organizations with the most demanding workloads for which air cooling is insufficient, Dell Technologies offers Direct Liquid Cooling (DLC)-enabled PowerEdge servers. DLC on PowerEdge servers circulates fluid to cold plates placed on critical components such as CPUs and GPUs to efficiently cool the hottest parts of the servers. Because liquid cooling can dissipate heat at a much faster rate than air cooling, DLC enables higher

processing densities while minimizing energy loss.

Offered on approximately 80 percent of the PowerEdge server portfolio, DLC systems provide up to four times the cooling capacity of air cooling.<sup>4</sup> Beyond providing greater cooling capacity, these systems can drastically reduce fan power consumption, further improving both energy efficiency and performance.

#### Dell Technologies DLC Benefits

- Superior cooling capacity for high-performance workloads, with up to four times the cooling capacity of air cooling.<sup>4</sup>
- Reduced energy use and operational costs—up to 11 percent lower energy use than air-cooling alone.<sup>5</sup>
- Seamless integration with existing data center environments.

### Rear Door Heat Exchangers (RDHx)

Integrating DLC into individual servers can be impractical or costly for some organizations. For these businesses, concerns about complexity and potential risks or about incompatibility with certain servers make DLC less viable. Additionally, some companies find it more efficient to cool entire racks or rows of servers rather than handling each unit individually. In these cases, rear door heat exchangers (RDHx) offer a scalable and cost-effective alternative with minimal disruption to existing infrastructure. By cooling an entire rack, RDHx allows organizations to improve thermal management without the need for major infrastructure changes and without the complexities of DLC.

RDHx captures server heat via a liquid-cooled exchanger installed on the back of the server rack. Moreover, the cooling distribution units (CDUs) for RDHx can be either in-rack or in-row, depending on cooling needs.

### Dell Technologies RDHx Benefits

- Significant cooling improvements without major infrastructure changes.
- Scalable liquid cooling that can be retrofitted to existing racks.
- Increased energy efficiency and reduced cooling costs—up to 16 percent lower than with air alone.<sup>5</sup>

### Integrated Rack Solutions

As businesses grow and their data center needs expand, many organizations face challenges in scaling their infrastructures quickly and efficiently. Traditional data center setups often require significant time and effort to configure and install, leading to downtime and disruptions. Additionally, managing servers, power, networking and cooling across separate systems can increase complexity, consume valuable space and strain IT resources. For organizations looking to streamline operations while meeting growing demands, a more integrated, space-efficient solution is essential.

Dell Technologies provides enterprises with integrated rack solutions that are preconfigured, tested and installed by Dell Technologies experts. These rack solutions maximize efficiency and minimize setup time for businesses. Designed with liquid cooling in mind, these racks consolidate servers, power, networking and cooling into a single, optimized system, significantly reducing the data center's physical footprint.

Dell Technologies also offers an advanced, integrated rack service tailored for AI-intensive workloads. This offering includes compute sleds designed for Open Compute Project (OCP)-standard racks, consolidating power, cooling and networking into the rack itself, rather than within individual servers. This design streamlines operations for AI-dense environments by allowing for higher compute density and more efficient cooling. These racks, which are pre-assembled and fully tested in the Dell Technologies data centers, come with a white-glove service that ensures seamless deployment. They are rigorously tested upon delivery and then again post-installation to ensure optimal performance and reliability for HPC needs.

### Dell Technologies Integrated Rack Solutions Benefits

- Quick deployment with minimal disruption to operations.
- Compact design for efficient use of data center space.
- Fully tested solutions for reliable performance and compatibility.

### Modular Data Centers (MDCs)

Scaling data center operations to meet the growing demands of high-density workloads is often met with challenges. Building new data centers or retrofitting traditional older ones can be prohibitively expensive and time-consuming. For businesses that need rapid, scalable and energy-efficient solutions, a more flexible approach is necessary to ensure both growth and sustainability.

For organizations needing to rapidly expand their data center capacity, Dell Technologies offers Modular Data Centers (MDCs). These self-contained, scalable units are equipped with liquid cooling and are designed to integrate seamlessly with existing infrastructure. [Dell Technologies MDCs](#) provide a flexible, cost-effective solution for high-density workloads.

### Dell Technologies MDC Benefits

- Rapid deployment and scalability for growing workloads.
- High-efficiency cooling with full liquid cooling capabilities.
- Reduced energy costs and enhanced power usage effectiveness (PUE).<sup>4</sup>

### Rack Enclosures for Non-traditional Spaces

As businesses grow, many find themselves needing additional data center capacity, but they lack the physical space or budget to construct new facilities. Traditional data centers require specialized environments with precise cooling and power setups, making it challenging to repurpose non-traditional spaces like warehouses or office areas for IT infrastructure. This creates a dilemma for organizations needing to expand quickly without the time, resources or desire to build from the ground up. Additionally, managing the high heat output of modern high-performance servers in these unconventional spaces presents a significant challenge, as these areas are not designed to support the thermal demands of advanced workloads.

Dell Technologies' rack enclosures enable businesses to convert non-traditional spaces like warehouses into functional data centers. With integrated liquid cooling, these enclosures ensure efficient thermal management, allowing high-performance servers to operate safely in spaces not originally designed for IT infrastructure.

#### Dell Technologies Rack Enclosures for Non-traditional Spaces Benefits

- Flexible deployment in non-traditional environments.
- Efficient cooling without the need for new data center construction.
- Cost-effective solutions for repurposing existing spaces.

#### Immersion Cooling

Dell Technologies offers immersion cooling, where servers are submerged in non-conductive liquid to efficiently dissipate heat for high-performance workloads like AI and HPC. Available through the Dell Technologies OEM team, this solution is ideal for environments with limited air-cooling capacity.

### Optimize Data Center Performance with Holistic Power and Cooling Solutions

Dell Technologies offers a holistic approach to data center management by closely linking power and cooling optimization. Effective power management directly influences cooling efficiency, as reducing power consumption helps lower the heat generated by servers, thus easing the burden on cooling systems.

#### Power Manager

Dell Technologies delivers industry-leading power management through an integrated, intelligent set of tools, designed to optimize data center efficiency. At the heart of this system is the Integrated Dell Remote Access Controller (iDRAC), which enables real-time monitoring and control over individual server health. Dell OpenManage Enterprise extends this control, offering centralized management across your entire PowerEdge estate for streamlined operations. When combined with the OpenManage Enterprise Power Manager plugin, iDRAC users gain advanced capabilities for 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—ultimately driving energy efficiency and cost savings. Together, these tools provide a cohesive and powerful solution for modern data center management. Building on this foundation, the Dell APEX AIOps AI-driven observability and management software-as-a-service (SaaS) suite integrates AI-driven insights, enhancing the PowerEdge management experience.

#### Dell OpenManage Enterprise Power Manager Benefits

- **Energy efficiency:** Optimizes power usage, which in turn reduces the heat load on cooling systems.
- **Cost savings:** Minimizes both power and cooling costs through intelligent power and thermal management.
- **Real-time monitoring:** Provides comprehensive insights into power and temperature metrics, allowing for proactive adjustments.
- **Improved cooling efficiency:** Reduced heat generation helps cooling systems work more effectively, enhancing overall system performance.

By integrating power and cooling management, Dell Technologies helps organizations improve energy efficiency, reduce operational costs and maintain system reliability.

### Consulting Services for Current Data Centers and New Builds

Building or upgrading a data center can be a complex and daunting process for many organizations. The need to integrate new technologies like liquid cooling, handle increasingly demanding workloads and ensure energy efficiency all while maintaining scalability can overwhelm internal IT teams. Businesses might struggle to make the right infrastructure choices, properly design data centers or implement the latest advancements in cooling and power management. Without expert guidance, organizations risk increased operational costs, inefficient resource utilization and infrastructure that might not be ready for future expansion.



Dell Technologies offers a full range of consulting services to help organizations at every stage of their data center journeys, from selecting the right infrastructure to designing and setting up a new facility. These services help ensure that businesses aren't left navigating the complex process of building a data center alone. Whether integrating cutting-edge technologies like liquid cooling or modernizing existing systems, Dell Technologies experts provide hands-on support to create custom, energy-efficient data centers that are optimized for performance and future growth. Dell Technologies Services helps ensure seamless planning, design and implementation, allowing organizations to focus on their core businesses while knowing their IT infrastructures are in capable hands.

#### Dell Technologies Services Benefits

- Comprehensive support for infrastructure selection, design and implementation.
- Custom-built data centers designed for energy efficiency and scalability.
- Expert guidance to optimize cooling, power management and space utilization throughout the process.

## Empower Your Data Center with Dell Technologies' Smart Power and Cooling Innovations

Dell Technologies' Smart Power and Cooling solutions empower you to stay ahead in an ever-evolving data center landscape. With improved energy efficiency, scalability and reliable cooling capabilities, you can optimize your infrastructure and confidently meet growing demands. These innovations help reduce your operational costs and environmental footprint while simplifying management, so you can focus on driving your business forward.

As your data center evolves and the need for more powerful computing grows, Dell Technologies remains committed to delivering cutting-edge solutions that strike the perfect balance between performance, reliability and sustainability. With Smart Power and Cooling technologies from Dell Technologies, you can manage your power consumption and cooling with precision, allowing you to increase performance, enhance rack density and save on energy costs. This flexible approach gives you the option to adopt the right cooling strategy, whether transitioning to liquid cooling or using a combination of air- and liquid-cooled solutions that fit your unique needs.

Alongside innovative hardware, Dell Technologies offers comprehensive monitoring and management tools to help ensure seamless infrastructure control. With expert support and a forward-thinking approach, you can be confident that your data center will operate efficiently and scale effortlessly as you grow. Dell Technologies is here to help you stay efficient, sustainable and ready for whatever comes next.

<sup>1</sup> This growth will bring data center power usage up 2,000 terawatt-hours annually, or about half of the 4,000 terawatt-hours of electricity consumed by the entire United States in 2023. Source: International Energy Agency. "Electricity 2024." January 2024. <https://iea.blob.core.windows.net/assets/6b2fd954-2017-408e-bf08-952fdd62118a/Electricity2024-Analysisandforecastto2026.pdf>. Licensed under CC BY 4.0. <https://creativecommons.org/licenses/by/4.0/deed.en>.

<sup>2</sup> EMSNow. "The Rise Of AI Drives 9 Fold Surge In Liquid Cooling Technology." October 2024. [www.emsnow.com/the-rise-of-ai-drives-9-fold-surge-in-liquid-cooling-technology/](http://www.emsnow.com/the-rise-of-ai-drives-9-fold-surge-in-liquid-cooling-technology/).

<sup>3</sup> Research and Markets. "Data Center Liquid Cooling – Global Strategic Business Report." October 2024. [www.researchandmarkets.com/reports/4804589/data-center-liquid-cooling-global-strategic](http://www.researchandmarkets.com/reports/4804589/data-center-liquid-cooling-global-strategic).

<sup>4</sup> Dell Technologies. "6 Benefits of Direct Liquid Cooling." Accessed October 2024.

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<sup>5</sup> Dell Technologies. "Diving Deep into the Liquid Server Cooling Choices." May 2024. [www.dell.com/en-us/blog/diving-deep-into-the-liquid-server-cooling-choices/](http://www.dell.com/en-us/blog/diving-deep-into-the-liquid-server-cooling-choices/).



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