

# The Role of Liquid Cooling Solutions in AI-Ready Datacenters



**Ashish Nadkarni**  
Group Vice President and General Manager,  
Worldwide Infrastructure Research, IDC



**Kuba Stolarski**  
Research Vice President,  
Compute Infrastructure and Service Provider Trends,  
Worldwide Infrastructure Research, IDC



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# Executive summary

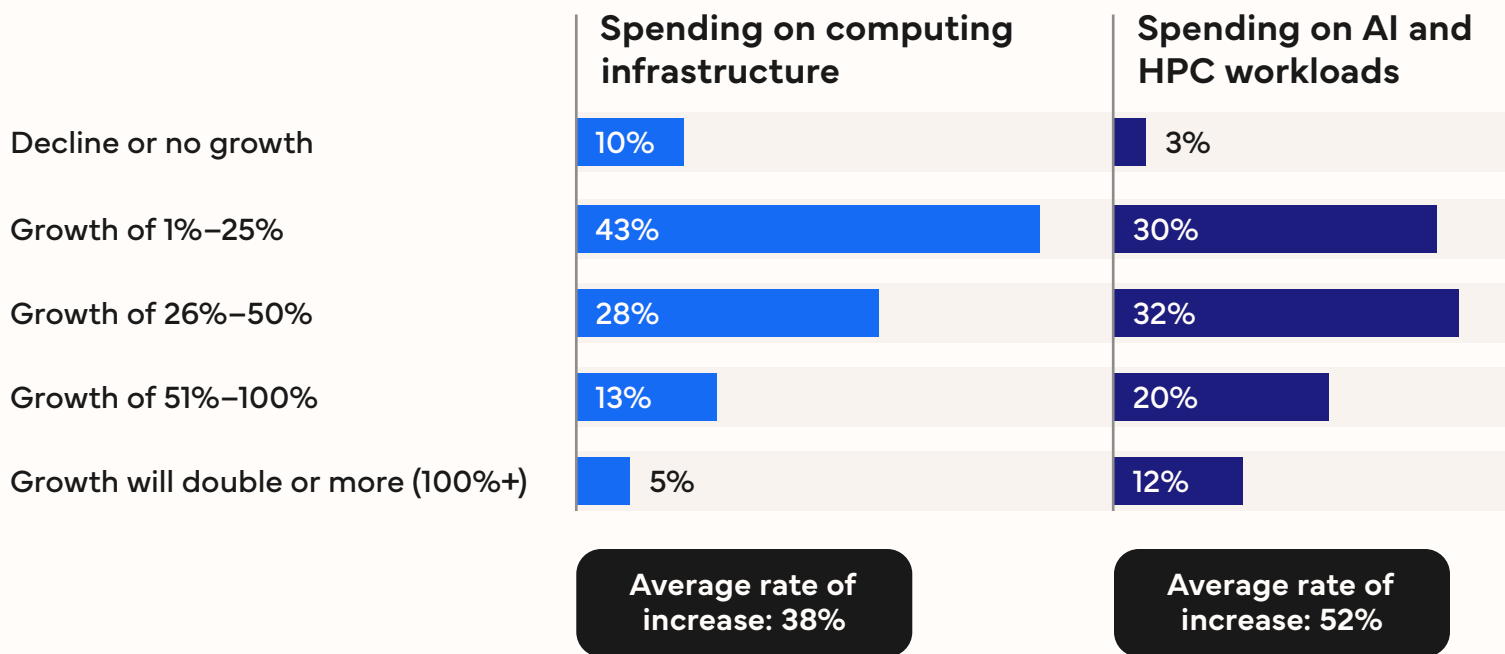
This InfoBrief explores the role liquid cooling solutions play in enabling scalable, efficient, and sustainable datacenter infrastructure to host performance-intensive computing (i.e., AI and HPC) workloads. It guides IT decision-makers (ITDMs) on ways to invest in liquid cooling solutions as part of their broader datacenter infrastructure deployment strategy.

## IDC's findings, based on a global survey of 1,230 IT decision-makers, show that:

- Over the next 12–24 months, companies are expected to significantly increase investments in performance-intensive computing infrastructure, driven by the need to shift AI and HPC environments into production rapidly.
- Investments in fit-for-purpose infrastructure to host these highly performant workloads call for specific attention to cooling technologies, such as liquid cooling, because the operational nature of these infrastructure stacks pushes the envelope on air-cooled approaches.
- With the advent of highly performant infrastructure, most ITDMs acknowledge the need for liquid cooling, but deployment and operational challenges have hindered widespread adoption.
- Most ITDMs acknowledge the need for significant levels of support across all stages of liquid cooling adoption, including strategy, design, deployment and installation, and ongoing management.
- By partnering with external service providers, specifically infrastructure systems vendors (aka OEMs), companies can address many of these challenges and gain the necessary support to implement liquid cooling solutions as part of investments in infrastructure for AI and HPC workloads.

# Performance-intensive computing workloads are expected to dominate enterprise IT spending

Most ITDMs expect significant growth in demand for computing resources in the next 12–24 months. Investments in fit-for-purpose infrastructure to host AI and HPC workloads will exceed those in general-purpose infrastructure to host enterprise workloads.



Organizations expect an increased demand for computing resources in the next two years.

Demand for performance-intensive workloads, such as AI and HPC, will be much higher than for general-purpose enterprise workloads.

See the figure data in an [accessible table format](#). | Q: What growth do you expect in compute demand for your overall IT needs and AI/HPC workloads within your organization over the next two years? | n = 1,230; Source: IDC's *Lenovo Liquid Cooling Survey*, July 2025

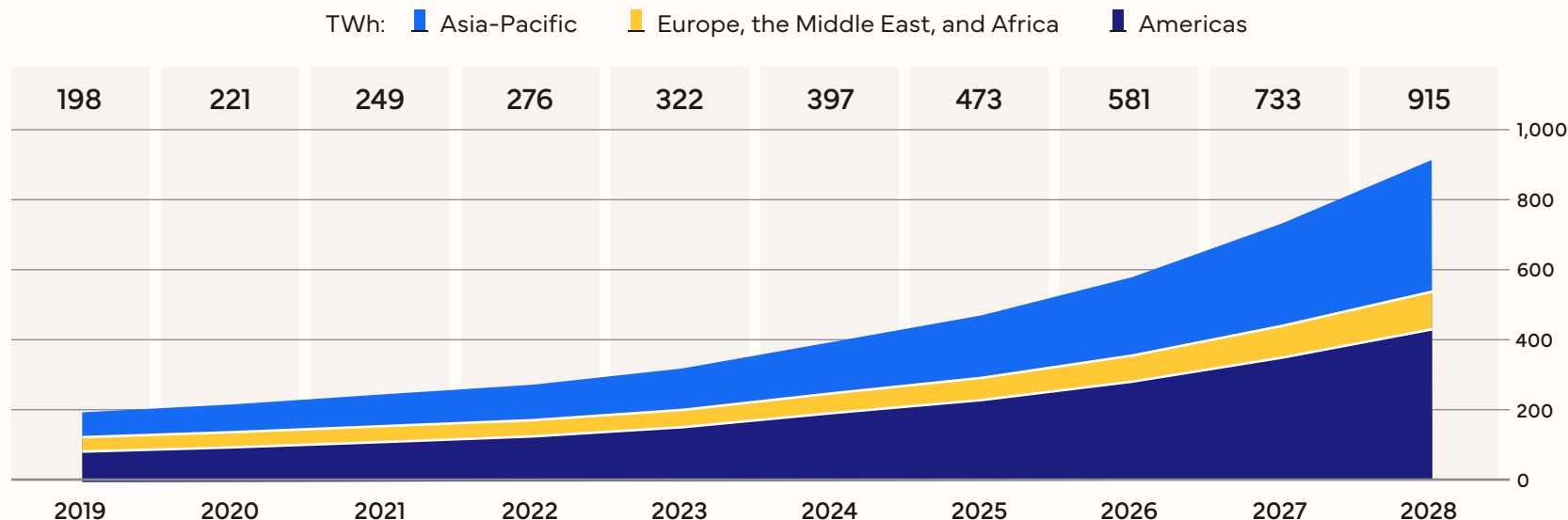
# Power-hungry infrastructure is driving the demand for datacenter energy

IDC anticipates that by 2026, driven accelerated computing infrastructure for AI and HPC workloads will be the predominant driver of datacenter energy consumption.

Insufficient power and cooling approaches can lead to suboptimal operating conditions. ITDMs must plan now to ensure their datacenters are configured to host these workloads and, crucially, to maintain their optimal operational state.

## Datacenter energy consumption

IDC estimates datacenter energy consumption to grow at a compound annual growth rate (CAGR) of 23.2%, from 397 terawatt hours (TWh) in 2024 to 915TWh by 2028.



See the figure data in an [accessible table format](#). | Source: IDC's 2H24 Datacenter Trends: Sustainable Datacenter Builds and CO2 Emissions, January 2025

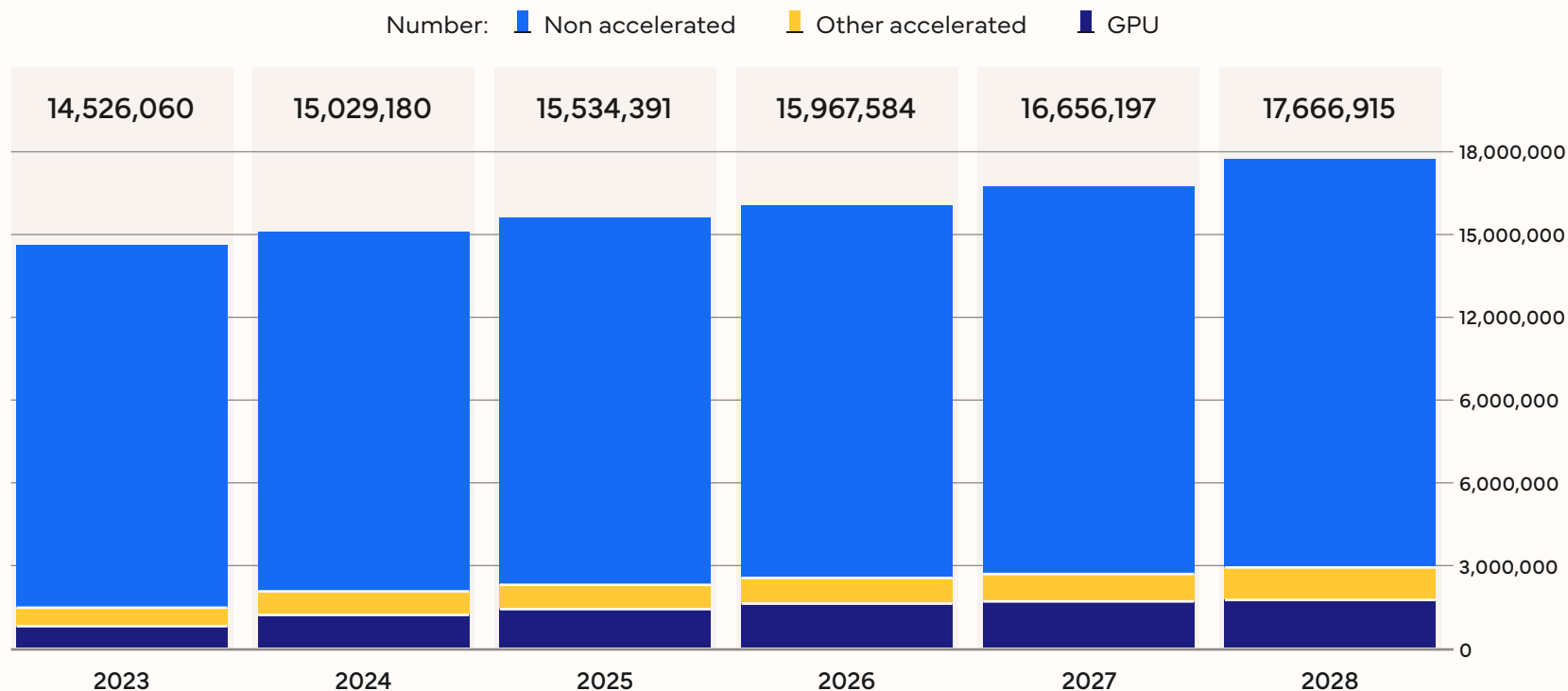
# Power-hungry infrastructure is driving the demand for datacenter energy (continued)

Accelerated computing infrastructure for AI and HPC workloads:

- ➔ Requires more power per server, per rack
- ➔ Generates more heat than general-purpose computing infrastructure

## Racks

IDC estimates that the number of accelerated racks will grow at a 15% CAGR. By 2028, 16.4% of all racks will house primarily accelerated servers.



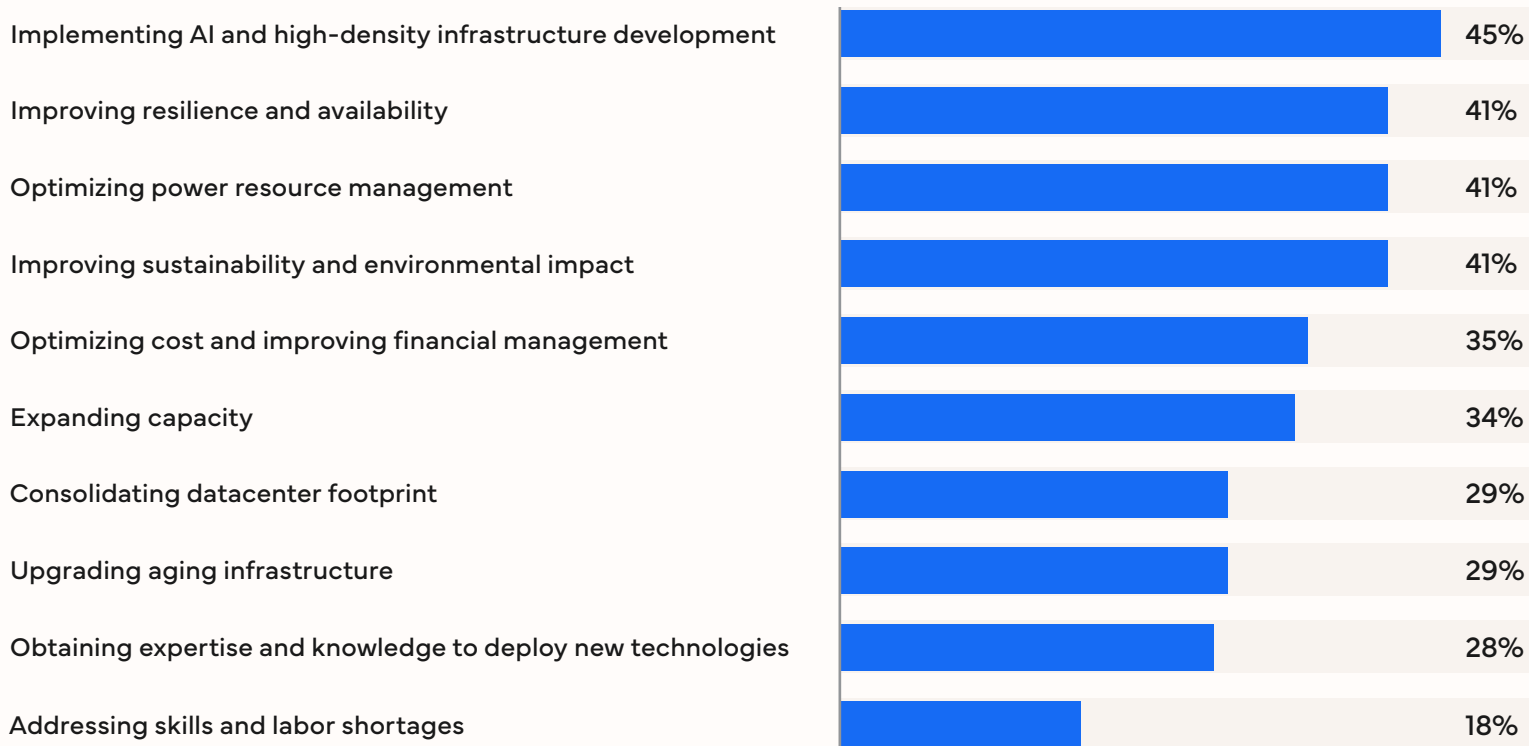
Note: IDC defines accelerated racks as racks that house servers containing GPUs or other accelerators. See the figure data in an [accessible table format](#). | Source: IDC's 2H24 Datacenter Trends: Sustainable Datacenter Builds and CO2 Emissions, January 2025

# Newer cooling technologies are imperative for datacenters

ITDMs see liquid-cooled servers as integral to AI and high-density infrastructure, with improving resilience and availability, optimizing power and resource management, and improving sustainability and environmental impact as additional reasons for investments.

## Solutions provided by liquid-cooled servers

For which of these datacenter priorities does the deployment of liquid-cooled servers provide a solution?



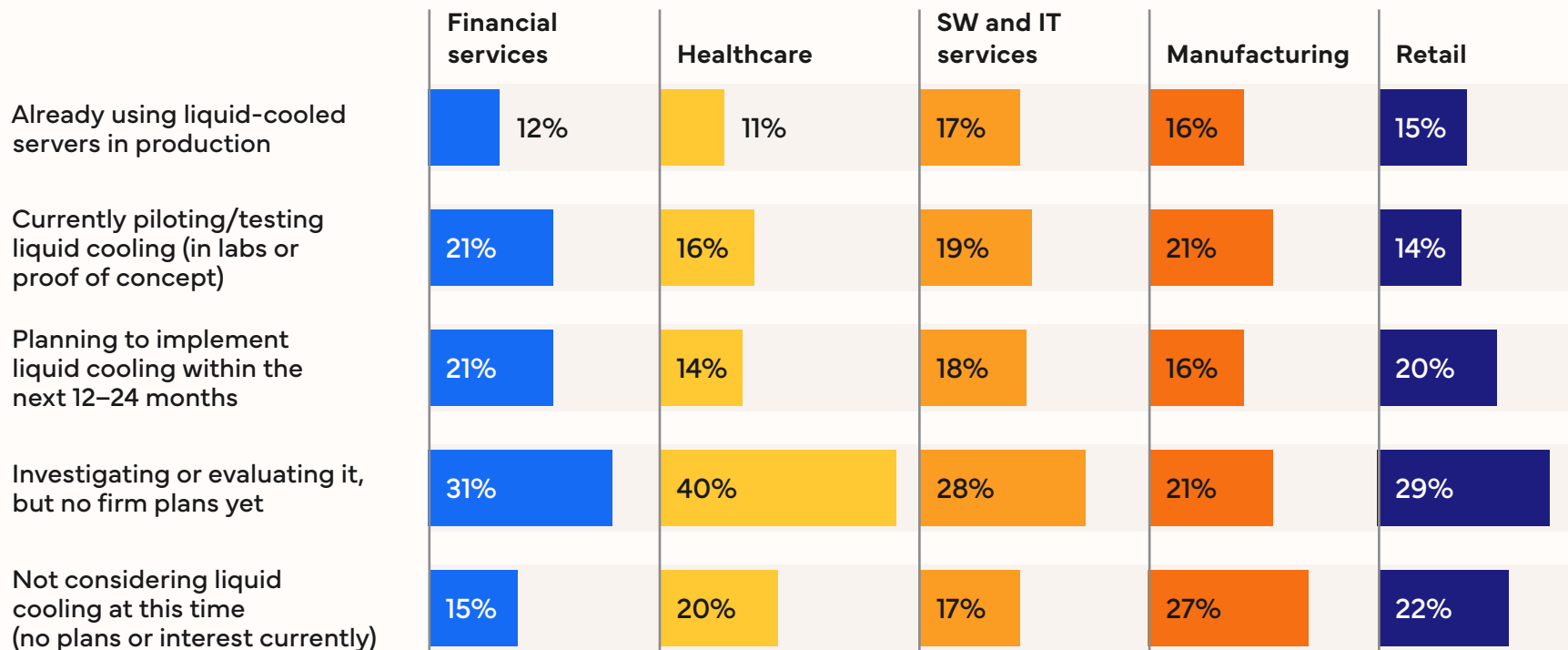
n = 1,230; Source: IDC's *Lenovo Liquid Cooling Survey*, July 2025

# Liquid cooling is poised to gain widespread adoption in the next two years

Software (SW) and IT services, manufacturing, and retail industries are more advanced in deploying liquid-cooled servers.

The healthcare industry is lagging, with a majority (60%) of respondents having no firm plans or not considering liquid cooling.

Financial services, typically one of the first to adopt new IT and datacenter technologies, currently has a lower level of liquid cooling adoption but is among the most active in testing liquid-cooled servers. Along with retail, it is also more likely to implement liquid-cooled servers within the next 12–24 months.



See the figure data in an [accessible table format](#). | Q. Which statement most accurately reflects the consideration or use of liquid-cooled servers in your organization's datacenters? | n = 1,230; Source: IDC's *Lenovo Liquid Cooling Survey*, July 2025

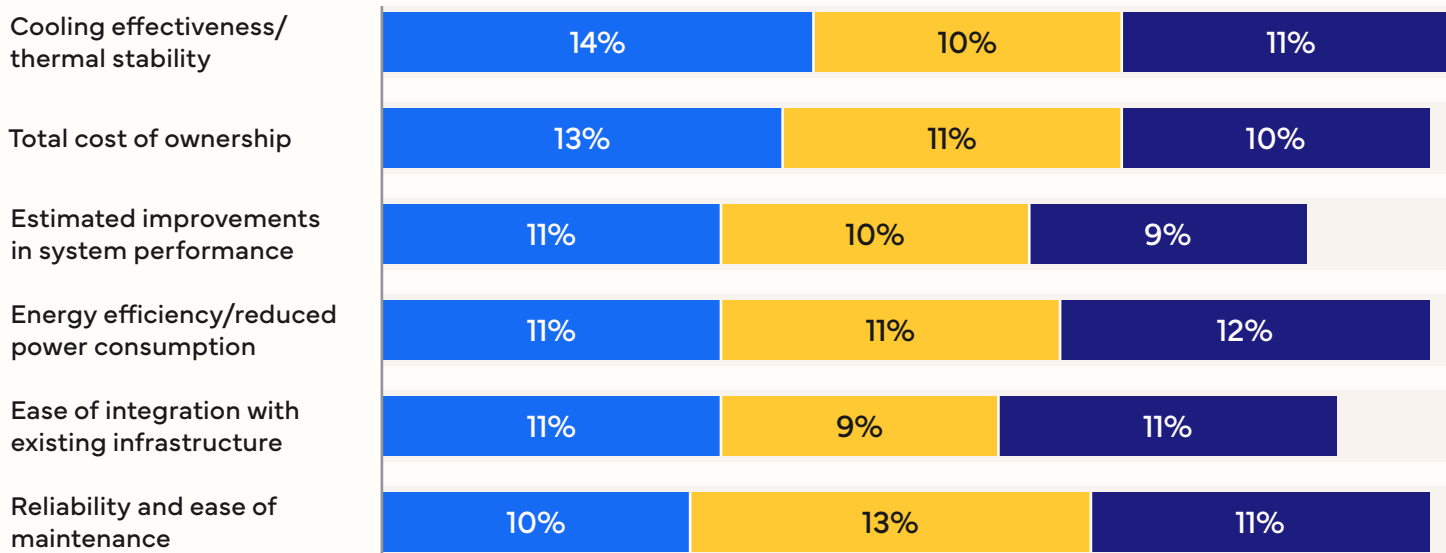
# Business and operational requirements drive selection criteria for liquid-cooled servers

Cooling effectiveness and TCO are the top requirements when selecting liquid-cooled servers, along with reliability, ease of maintenance, and energy efficiency.

**It is crucial for ITDMs to have a crisp and well-defined set of technical requirements when selecting liquid-cooled servers.**

- ➔ **For all stages:** Energy efficiency and reduced power consumption, ease of integration with existing infrastructure, and reliability and ease of maintenance
- ➔ **For the testing stage:** Cost effectiveness and reliability of maintenance
- ➔ **For the evaluation stage:** TCO, reliability and ease of maintenance, energy efficiency, and cost effectiveness

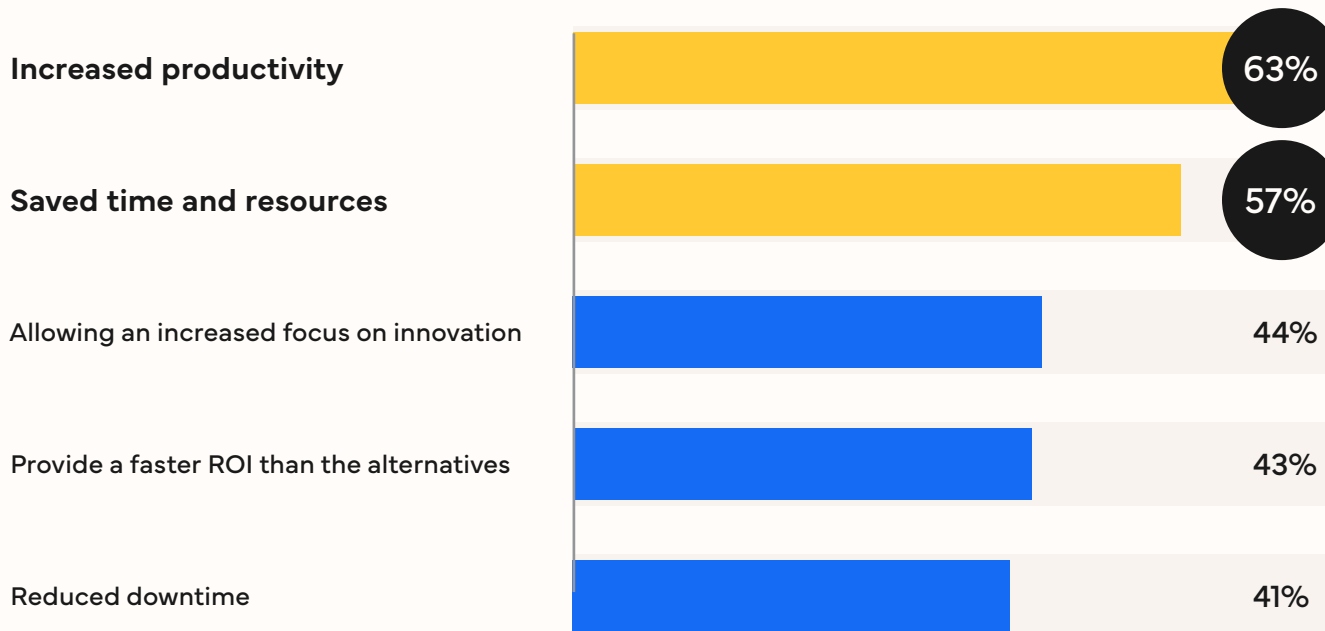
Percentage of respondents: ■ Most important ■ Second most important ■ Third most important



See the figure data in an [accessible table format](#). | Q. When selecting a liquid-cooled server solution, how important are the following factors in your organization's decision-making process? | n = 1,230; Source: IDC's *Lenovo Liquid Cooling Survey*, July 2025

# Business outcomes rank highest in the selection of liquid-cooled servers

Increased productivity and saved time and resources are the top desired outcomes driving the adoption of end-to-end suites of power and cooling solutions.



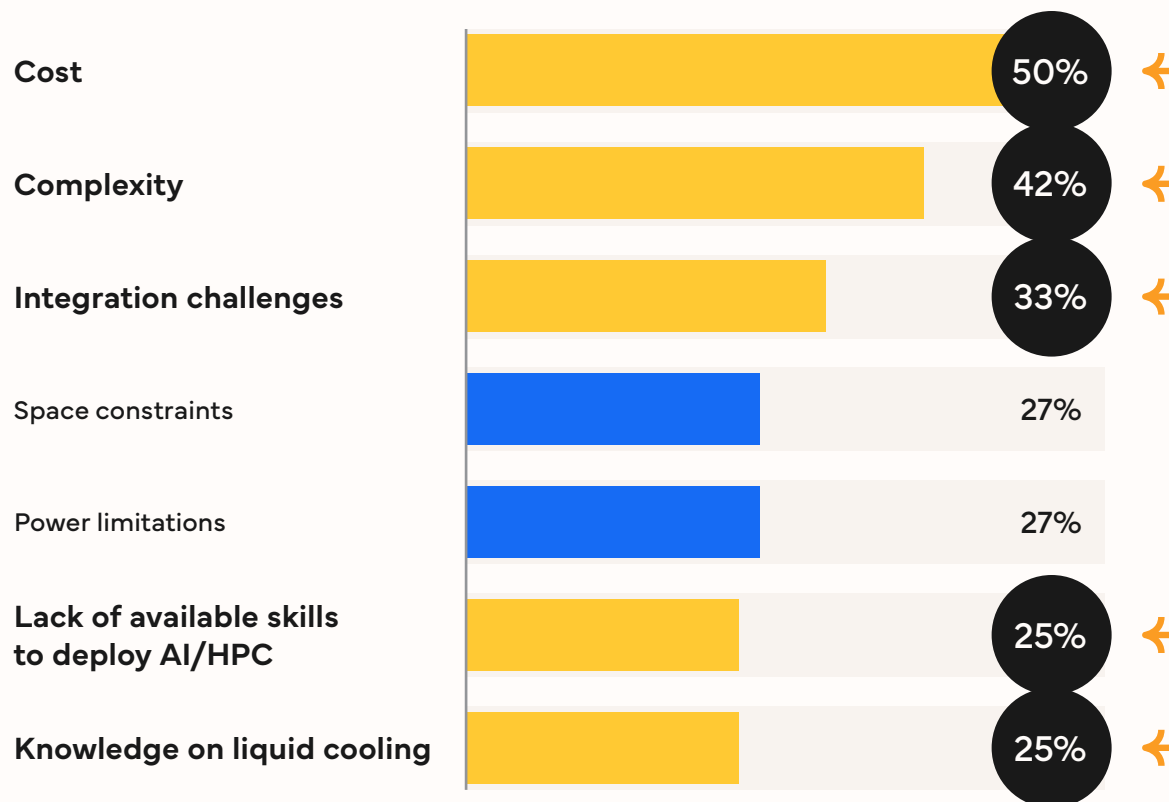
**It is also crucial for ITDMs to have a crisp and well-defined set of business requirements when selecting liquid-cooled servers.**

Although increased productivity and time and resource savings are the most important outcomes for all organizations to consider when using end-to-end suites of power and cooling services, a faster ROI than the ROI of alternatives is a vital factor for ITDMs who have currently deployed liquid-cooled servers in their environments.

Q. When selecting a liquid-cooled server solution, how important are the following factors in your organization's decision-making process? | n = 1,230; Source: IDC's *Lenovo Liquid Cooling Survey*, July 2025

# Cost, complexity, and integration challenges are barriers to the wider adoption of liquid-cooled servers

Most ITDMs acknowledge the necessity of investing in liquid-cooled servers; they are constrained by the perceived overhead associated with procuring, implementing, and managing the associated infrastructure. This can mean underinvestment in infrastructure, which can result in subpar outcomes from AI and HPC environments.



Partnerships with OEM vendors with expertise in liquid cooling can help ITDMs overcome these barriers.

Q. Which of the following are significant challenges or barriers to deploying liquid-cooled servers within your organization's datacenters over the next two years? | n = 1,230; Source: IDC's *Lenovo Liquid Cooling Survey*, July 2025

# ITDMs are concerned about operational challenges with liquid-cooled environments

Most ITDMs whose organizations plan to deploy liquid-cooled services acknowledge that a lack of in-house expertise is a top anticipated challenge related to maintaining these servers.



An OEM vendor with expertise in liquid cooling can help ITDMs address these operational challenges.

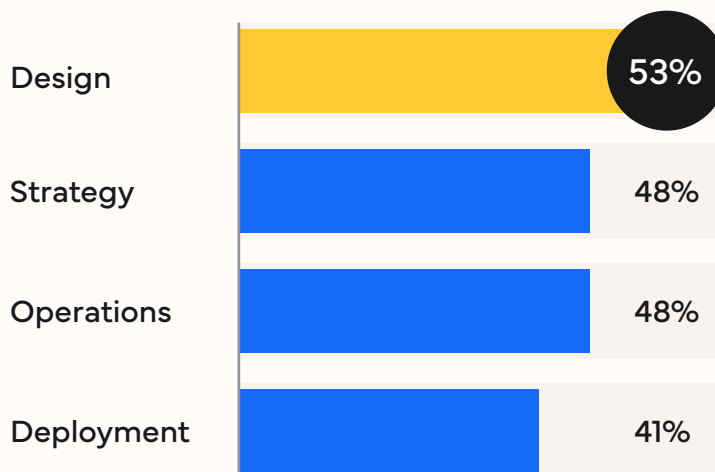
Q. If you were to deploy liquid cooling in your company's datacenters, what challenges, if any, do you anticipate having with respect to maintaining and servicing the liquid-cooled servers in your organization's datacenters? | n = 1,230; Source: IDC's *Lenovo Liquid Cooling Survey*, July 2025

# Strategic partnerships accelerate the adoption of liquid-cooled servers

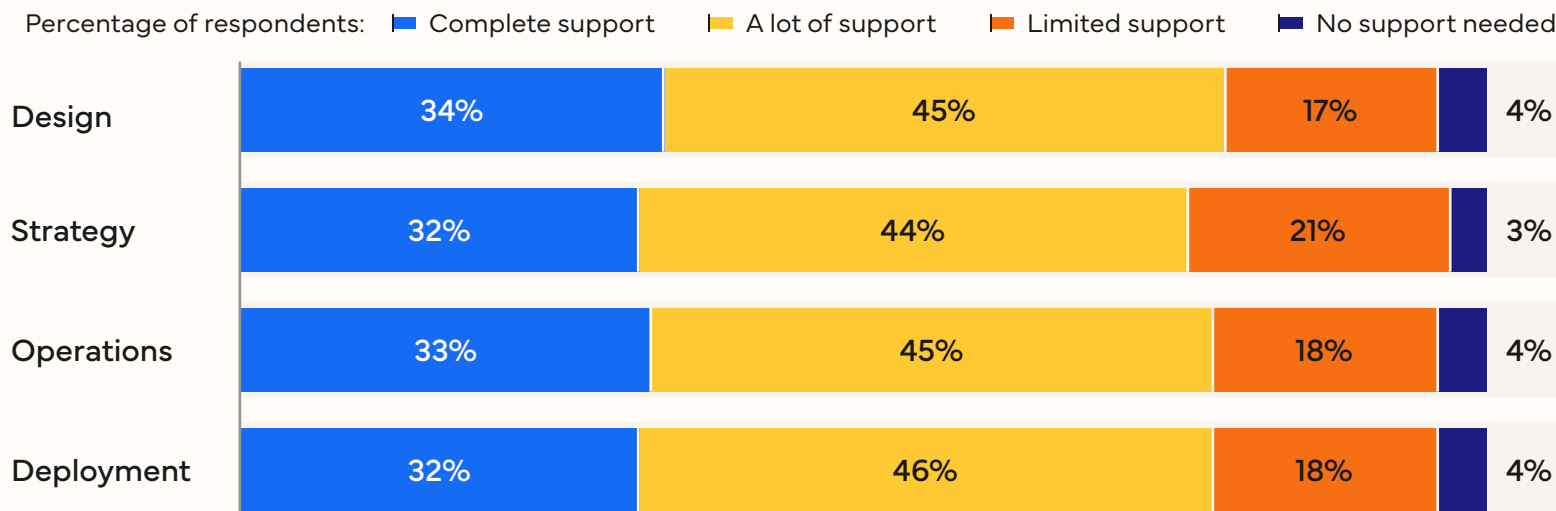
Most ITDMs acknowledge that their teams need significant support to plan, implement, and manage liquid-cooled servers.

Organizations that lack experience with liquid-cooled servers lean toward end-to-end or comprehensive support across strategy, design, deployment, and management, while organizations with some level of experience lean more toward limited support.

## Most crucial stage



## Required level of partnerships during each stage



See the figure data in an [accessible table format](#). | n = 1,230; Source: IDC's *Lenovo Liquid Cooling Survey*, July 2025

## Strategic partnerships accelerate the adoption of liquid-cooled servers (continued)

### Where are partnerships most needed?

- Design is one of the major challenges for most ITDMs.
- For companies currently testing liquid cooling technologies, ongoing maintenance is as big a challenge as design. ITDMs also cite strategy for planning and guiding the adoption as a challenge.
- Operations is a top challenge for companies running more than 10 datacenters.

### Stages of adoption of liquid-cooled servers

- 1 Strategy phase:** planning to evaluate needs, define goals, and guide adoption
- 2 Design phase:** engineering to meet workload, space, and thermal requirements
- 3 Deployment phase:** installation of specialized racks and other infrastructure required for liquid-cooled servers
- 4 Operations phase:** ongoing management, maintenance, and life-cycle support

# Server manufacturers are strategic partners

ITDMs acknowledge that server manufacturers have expertise in providing customized services, and most would consider partnering with an OEM vendor for their liquid cooling solutions.

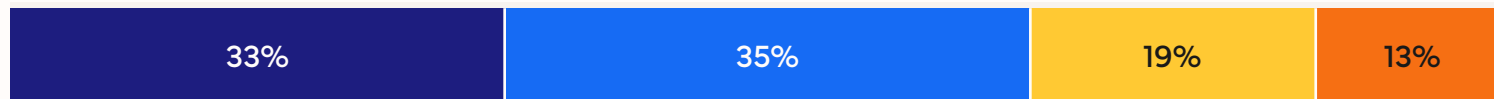
Agree with statements on the left

■ Much more   ■ Somewhat more

Agree with statements on the right

■ Somewhat more   ■ Much more

“Server manufacturers have the expertise to provide services that are customized to my business needs.”



“Server manufacturers’ IT services tend to be ‘one size fits all.’”

“I would consider buying IT services from a hardware OEM even if I am not also looking to buy its hardware.”



“I would not consider buying IT services from a hardware OEM if I am not also buying hardware from it.”

## Partnership sentiment

Companies that currently use or test liquid-cooled servers are more amenable to partnering with hardware manufacturers due to their expertise in providing services customized to business needs.

Those planning to implement, investigating, or considering liquid-cooled servers mainly agree that hardware manufacturers tend to be “one size fits all.”

All of them tend to agree that they would buy IT services from a server manufacturer even without buying its hardware.

Note: Totals may not sum to 100% due to rounding. See the figure data in an [accessible table format](#). | n = 1,230; Source: IDC’s *Lenovo Liquid Cooling Survey*, July 2025

# Essential guidance for IT decision-makers

IT decision-makers must view investments in liquid cooling technologies as strategic and necessary, in line with investments in AI and HPC environments to fuel their AI-driven digital future. IDC recommends that ITDMs take a comprehensive and carefully planned approach to these investments.



**Evaluate your medium- and long-term investments in AI and HPC environments** and, crucially, how quickly your company plans to move them into production.



**Consider the benefits of cooling technologies** such as liquid cooling when evaluating accelerated servers that form part of this fit-for-purpose infrastructure.



**Evaluate your deployment location and model for these environments.** For many ITDMs, on-premises or collocated private cloud environments are best suited from a security and compliance perspective.



**Investments in cooling solutions require a phased approach** (strategy, design, deployment, and ongoing management). Focus on key technical and business outcomes.



**In tandem, evaluate the need for investments in fit-for-purpose infrastructure** to host these highly performant workloads. These will likely include accelerators, such as GPUs, that are power hungry and require specialized cooling solutions.



**Partner with server manufacturers** to ensure consistent and reliable outcomes; they know their hardware.

# Essential guidance for vendors

IDC's research finds that less than 50% of the surveyed companies have adopted or are in the process of adopting liquid cooling solutions. Barriers to adoption are quite high, in addition to the business justification for such an investment.

At the same time, the need to shift more AI and HPC workloads into production, together with the need to keep these workloads in single-tenant environments, means that companies will need to eventually invest in liquid cooling solutions (within the next two to three years). This is not a question of if but when.

As strategic partners, server vendors can help their customers in planning for this scenario. They can:



**Assist ITDMs and other decision-makers with the strategy and design aspects of the solution** as part of their strategic bet on AI infrastructure. Be their advisor, not just their infrastructure provider.



**Provide blueprints for companies to implement liquid-cooled servers** as part of their datacenter modernization strategy. Discuss ways in which they can introduce liquid cooling in a phased manner as they institute newer fit-for-infrastructure stacks.



**Provide implementation and managed services to complement design and strategy services**, which will lead to consistent and predictable outcomes for the desired production state.

# Appendix: Accessible data tables

This appendix provides an accessible version of the data for any complex figures in this document. Click “Return to figure” to get back to the data figure.

## Page 4 accessible data

Performance-intensive computing workloads are expected to dominate enterprise IT spending

	Spending on computing infrastructure	Spending on AI and HPC workloads
Decline or no growth	10%	3%
Growth of 1%–25%	43%	30%
Growth of 26%–50%	28%	32%
Growth of 51%–100%	13%	20%
Growth will double or more (100%+)	5%	12%

n = 1,230; Source: IDC's *Lenovo Liquid Cooling Survey*, July 2025

[Return to figure](#)

## Page 5 accessible data

Datacenter energy consumption (TWh)

Year	Asia-Pacific	Europe, the Middle East, and Africa	Americas	Total
2019	72	41	86	198
2020	80	43	98	221
2021	91	45	113	249
2022	101	46	129	276
2023	118	49	155	322
2024	146	56	195	397
2025	178	63	232	473
2026	223	74	284	581
2027	292	90	352	733
2028	376	107	432	915

Source: IDC's *2H24 Datacenter Trends: Sustainable Datacenter Builds and CO2 Emissions*, January 2025

[Return to figure](#)

## Appendix: Accessible data tables (continued)

### Page 6 accessible data

#### Racks

Year	Non accelerated	Other accelerated	GPU	Total
2023	13,084,400	668,429	773,200	14,526,060
2024	12,997,300	854,294	1,177,620	15,029,180
2025	13,267,200	877,450	1,389,720	15,534,391
2026	13,450,100	928,144	1,589,300	15,967,584
2027	13,996,000	992,384	1,667,790	16,656,197
2028	14,772,800	1,174,210	1,719,900	17,666,915

Source: IDC's 2H24 Datacenter Trends: Sustainable Datacenter Builds and CO2 Emissions, January 2025

[Return to figure](#)

### Page 8 accessible data

#### Liquid cooling is poised to gain widespread adoption in the next two years

Roles for agentic AI	Financial services	Healthcare	SW and IT Services	Manufacturing	Retail
Already using liquid-cooled servers in production	12%	11%	17%	16%	15%
Currently piloting/testing liquid cooling (in labs or proof of concept)	21%	16%	19%	21%	14%
Planning to implement liquid cooling within the next 12–24 months	21%	14%	18%	16%	20%
Investigating or evaluating it, but no firm plans yet	31%	40%	28%	21%	29%
Not considering liquid cooling at this time (no plans or interest currently)	15%	20%	17%	27%	22%

n = 1,230; Source: IDC's Lenovo Liquid Cooling Survey, July 2025

[Return to figure](#)

## Appendix: Accessible data tables (continued)

### Page 9 accessible data

#### Business and operational requirements drive selection criteria for liquid-cooled servers

Requirements	Most important	Second most important	Third most important
Cooling effectiveness/ thermal stability	14%	10%	11%
Total cost of ownership	13%	11%	10%
Estimated improvements in system performance	11%	10%	9%
Energy efficiency/ reduced power consumption	11%	11%	12%
Ease of integration with existing infrastructure	11%	9%	11%
Reliability and ease of maintenance	10%	13%	11%

n = 1,230; Source: IDC's *Lenovo Liquid Cooling Survey*, July 2025

[Return to figure](#)

### Page 13 accessible data

#### Required level of partnerships during each stage

Stage	Complete support	A lot of support	Limited support	No support needed
Design	34%	45%	17%	4%
Strategy	32%	44%	21%	3%
Operations	33%	45%	18%	4%
Deployment	32%	46%	18%	4%

n = 1,230; Source: IDC's *Lenovo Liquid Cooling Survey*, July 2025

[Return to figure](#)

### Page 15 accessible data

#### Server manufacturers are strategic partners

Statement	Agree much more	Agree somewhat more
"Server manufacturers have the expertise to provide services that are customized to my business needs."	33%	35%
"Server manufacturers' IT services tend to be 'one size fits all.'"	13%	19%
"I would consider buying IT services from a hardware OEM even if I am not also looking to buy its hardware."	27%	34%
"I would not consider buying IT services from a hardware OEM if I am not also buying hardware from it."	19%	21%

Note: Totals may not sum to 100% due to rounding. n = 1,230; Source: IDC's *Lenovo Liquid Cooling Survey*, July 2025

[Return to figure](#)

# About the IDC analysts



## Ashish Nadkarni

Group Vice President and General Manager,  
Worldwide Infrastructure Research, IDC

Ashish Nadkarni is group vice president and general manager within IDC's Worldwide Infrastructure Research organization. Nadkarni oversees seven global research practices: infrastructure software platforms, cloud and edge services, storage and converged systems, performance intensive computing, compute infrastructure and service provider trends, enterprise and emerging workloads, and the future of digital infrastructure. Additionally, he oversees two regional research practices: Canadian infrastructure solutions and Latin America enterprise infrastructure and cloud services. Nadkarni and his team also curate BuyerView, an industry leading portfolio of primary research products that provide a voice of the IT buyer on technology and services adoption trends, including cloud and edge services, artificial intelligence, high performance computing, security and networking, XOps, and software development.

[More about Ashish Nadkarni →](#)



## Kuba Stolarski

Research Vice President,  
Compute Infrastructure and Service Provider Trends,  
Worldwide Infrastructure Research, IDC

Kuba Stolarski is research vice president within IDC's worldwide infrastructure research organization and global research lead for the compute infrastructure and service provider trends practice. Stolarski leads a team of analysts that deliver industry and market insights on computing systems, platforms, and technologies as well as the service provider space. In the compute infrastructure domain, Stolarski is IDC's lead server analyst. His research on compute covers areas such as OEM and ODM Direct vendor strategies, server and non-server form factors, processors and function-offload accelerators, memory technologies, edge computing infrastructure, cloud and non-cloud deployments, bare metal, virtualized and containerized infrastructure, and confidential computing. Stolarski oversees research on high-end, accelerated, in-memory, and heterogeneous computing infrastructure systems, platforms, and technologies. Stolarski and his team also contribute to IDC's Enterprise Infrastructure Trackers.

[More about Kuba Stolarski →](#)

# Message from the sponsor

The Lenovo logo, consisting of the word "Lenovo" in white, bold, sans-serif font, centered within a red rectangular background.

**Lenovo is a global technology leader with over 13 years of experience in liquid cooling and a strong commitment to high-performance data center infrastructure.**

Its proven Neptune<sup>®</sup> technology, capable of delivering up to 100% heat removal, enables organizations to maximize performance, increase density, and meet the demanding compute requirements of hybrid AI. Lenovo Power and Cooling Services extend this capability with expert planning, deployment, and management of Neptune<sup>®</sup> systems — engineered for density, optimized for performance, and supported by Lenovo specialists.

Lenovo Hybrid AI Advantage brings together the AI infrastructure, data, models, services, and proven use cases needed to help businesses activate AI across their entire workforce, operations, and data footprint. This combined approach empowers customers to build AI-ready data centers designed for performance at scale.

Together, these capabilities deliver the infrastructure readiness and operational efficiency required to confidently support next-generation AI workloads. Trusted globally for innovation and performance leadership, Lenovo provides the reliability essential for today's AI-driven enterprise.

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