INTELLIGENCE UPDATE

Operators warming up to dielectric cold plates


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Today, only a minority of operators have direct liquid cooling (DLC) deployed in their data centers — but many say they are considering using it in the future. Many of these future adopters are designing dedicated high-density space for DLC and/or gaining hands-on experience with small proof of concept (POC) installations. An organization's expectations for IT application performance and resiliency will determine their urgency (or hesitance) to deploy DLC, as well as the types of cooling technology it is willing to consider.

Results from the Uptime Institute Cooling Systems Survey 2025 show that more operators are now considering dielectric cold plates in their enterprise data centers compared with the past two years. Attitudes surrounding other cooling types have moved little, and the greatest number are still using (or considering using) water cold plates. Dielectric cold plates have narrowed the gap but remain in second place, ahead of single-phase full immersion.

This shift in long-term planning was not mirrored in active deployments, suggesting that those moving more slowly with DLC adoption may approach technology selection differently from those with an urgent need to deploy it today. Instead of converging on a single cooling technology, operators appear open to multiple DLC technologies— highlighting the need to align cooling to IT and application requirements. This report will focus primarily on operator attitudes toward cold plate systems and the factors that may differentiate them from each other as well as from immersion cooling methods.

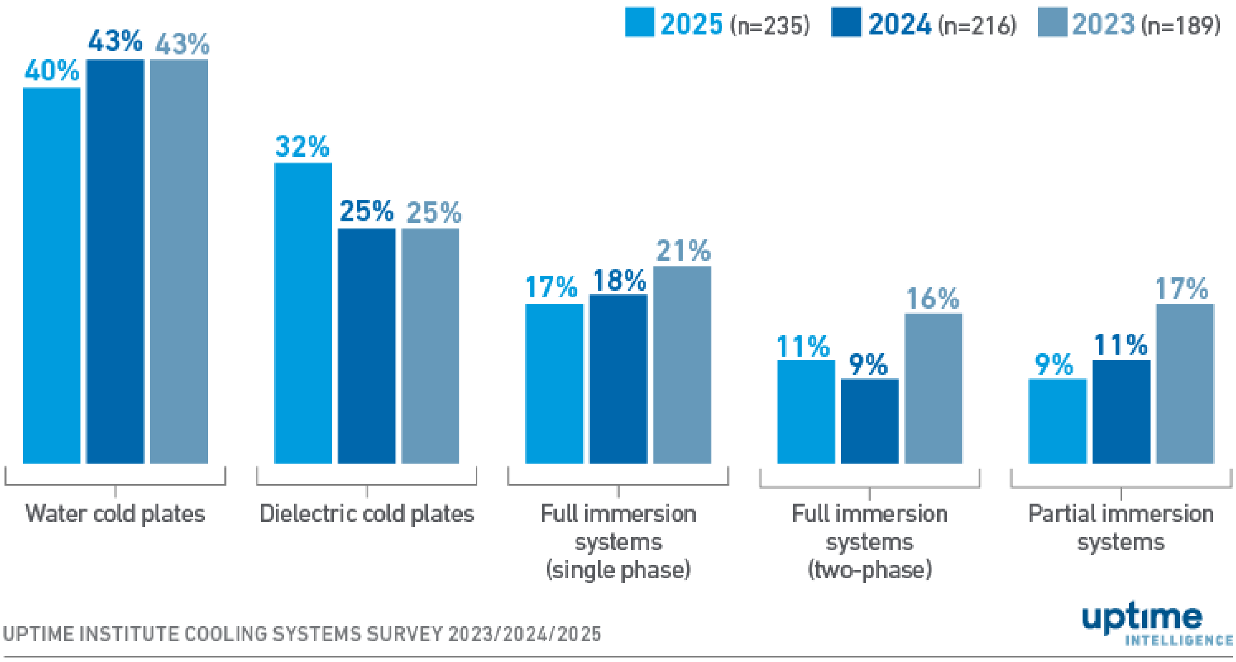
Deploying DLC by degrees

Operators consistently rank high rack density and high-powered IT electronics (CPUs and GPUs with high thermal design power) as the top two driving forces for DLC deployment, in both surveys and interviews. This pattern has held steady over time, and also holds regardless of the type of DLC respondents are considering.

Performance needs of generative AI and high-performance computing (HPC) drive many active liquid cooling deployments. Less than one in five operators (18%, n=387) currently use DLC in their enterprises. But for many, the IT applications that demand high performance and aggressive densification are still in the future. This can explain why 62% of operators are not yet using DLC, but are considering it in their long-term plans.

As operators progress from DLC planning to implementation, their preference is likely to narrow from a few cooling technologies to one, or may shift as they accumulate experience from POCs. However, shifts in a large sample of operators considering DLC can reveal patterns in decision making that are more broadly applicable than the needs of one organization. **Figure 1** shows the cooling technology options that are being considered by those operators that are assessing, but not yet using, DLC.

Figure 1 Operators considering DLC favor water and dielectric cold plates



Around one in three operators selected more than one DLC technology. A total of 40% of operators are considering water cold plates, topping the list and continuing a trend since 2023 (within measurement error). Today, water cold plates are also deployed by the greatest number of enterprise operators (60%, n=65), and others planning DLC deployments are likely hoping to benefit from early adopters' operational experience with these systems. A progressively smaller portion of survey respondents are considering full and partial immersion systems.

In enterprise DLC planning, dielectric cold plates remain the second most common choice, but the popularity held by water cold plates is shrinking (see *Water cold plates lead in the small, but growing, world of DLC*). Every liquid cooling technology has its own benefits and drawbacks. In the cold plate category, water and dielectric versions share many — although not all — of the advantages they offer operators.

A cold plate is nothing without its coolant

The form factors of cold plate systems tend to be substantially similar, regardless of the coolant used, and this is an advantage that water and dielectric cold plates have in common. Servers designed for cold plates are straightforward to deploy, as they typically fit in standard IT racks.

Since racks are not specialized for this type of cooling, they can be sourced from preferred vendors.

Crucially, operators have the option to install air-cooled and cold plate-cooled IT in the same rack — offering flexibility within the available power and cooling, and allowing for a distributed (instead of concentrated) installation of liquid cooling if needed. Hybrid environments where air cooling and liquid cooling share supporting infrastructure will likely remain commonplace for the next several years. This incentivizes many operators to choose cold plate designs that are practical to operate alongside air cooling and allow for future changes, including gradual DLC deployment. Cold plates also use less coolant than immersion systems, reducing total coolant cost and minimizing the scale of a worst-case leak.

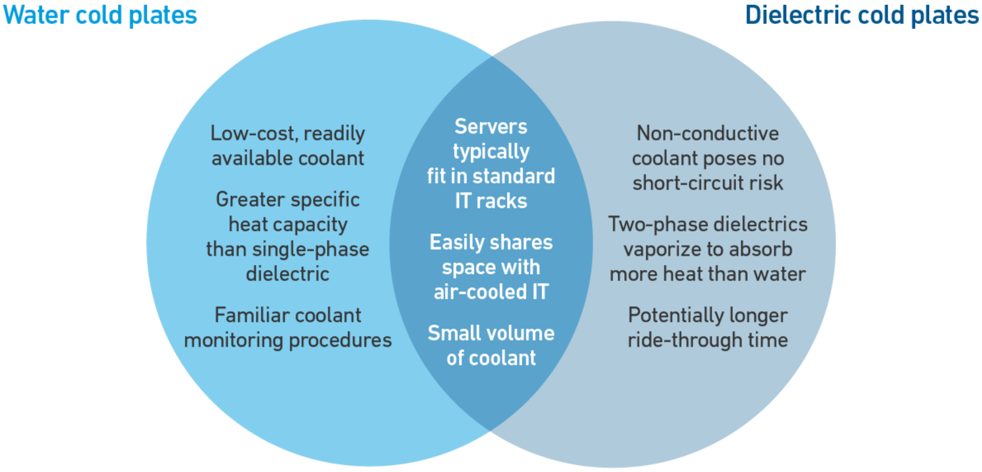
Not all advantages of water cold plates are shared by their dielectric relatives (**Table 2**). Compared with dielectric fluids, water is low cost, readily available and comes with no environmental or safety concerns. Water also has a performance advantage over single-phase dielectrics due to its greater specific heat capacity. Monitoring and maintenance of water-cooled IT is familiar to many data center operators because of its long history of use in mainframes and high-performance computing (HPC).

Other than being harmless to IT hardware in the event of leaks, there are some benefits specific to dielectric cold plates that can explain their growing appeal to operators with DLC plans. Cold plate systems using two-phase dielectrics require less pumping to achieve the same cooling capacity, compared with systems using water. As the coolant vaporizes in the cold plate (which some vendors may refer to by an alternate or proprietary name for the cold plate), IT heat is efficiently carried away as latent heat. This natural effect also provides thermal stability, allowing the system to react to sudden changes in thermal power. Passive boiling of coolant in the cold plate also offers the opportunity for designers to provide longer ride-through capability in the event of a failure in the coolant loop.

In both public discussions and private briefings, many operators still describe fears (or first-hand experience) of water leaks in the data hall causing short circuits, damaged IT and potentially prolonged application downtime. Typically, cold plate IT cooling loops require at least two tubing connections per IT chassis, and two more at the manifolds— and each represents an opportunity for a leak to form. Even with rigorous quality control and operational discipline, a coolant leak becomes almost inevitable in a large-scale cold plate cooling deployment. Negative-pressure (rather than positive-pressure) loops promise to eliminate leakage risks, but vacuum-capable coolant distribution units (CDUs) are less readily available and have more stringent design and operational requirements.

Leak risks are not fully eliminated with dielectric cold plates either. While dielectric coolants pose no short circuit risks, systems using dielectric coolant for IT can still require facility water plumbing inside the data hall, especially with in-rack CDUs. Pipes and leak detection equipment can typically be located under a raised floor at a safer distance from the IT — although this is not always the case.

Figure 2 Advantages of water and dielectric cold plates



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Survey data suggests that operators considering dielectric cold plates tend to be more concerned about the consequences of leaks, among other DLC system failures. When respondents described the greatest barriers to adoption, DLC system reliability ranked third (37%, n=818) behind lack of standardization (41%) and the high cost of the system (40%). Operators whose DLC plans include dielectric cold plates ranked cooling system reliability second, at 44% (n=73). Their top three concerns were the same as other respondents. Other concerns persist, with roughly one in four operators citing limited equipment options and complexity in capacity planning and maintenance.

The Uptime Intelligence View

A consensus on the single "best" cooling technology is unlikely to form anytime soon, as long as there remain heterogeneous expectations for IT application performance and resiliency. Many operators will likely evaluate more than one major type of DLC for future deployment, while watching the preferences (and pitfalls) of early adopters. Notably, the technologies that eventually succeed are not always the most "technically superior" solutions. Ultimately, any DLC system should be cost effective for its application, offer sufficient resiliency and provide clarity in operations — all of which are bolstered by a larger installed base.

Other related reports published by Uptime Institute include:

Water cold plates lead in the small, but growing, world of DLC
DLC adoption remains slow and steady

ABOUT THE AUTHOR

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