VERTIV.

# 2023 Data Center Liquid Cooling Technology and Market Update

## Entering the Mainstream

As it continues to evolve from a niche to a mainstream solution, liquid cooling is positioned to benefit from two trends building momentum in 2023 and beyond.

The first is the increased adoption of processing-intensive business applications across industries and how technology vendors have responded to the requirements of those applications. Businesses are employing artificial intelligence (AI) and machine learning (ML) for applications ranging from supply chain optimization to medical research. The integration of AI into search engines has put this powerful technology at the fingertips of anyone with a computer or mobile device. Generative AI[1] ended 2022 as a nearly $11 billion market and is expected to grow to **$152 billion by 2032**.

Chip manufacturers have responded with a new generation of high-power, liquid-only central processing units (CPUs) and graphics processing units (GPUs). Intel for example, has released XEON scalable processors with AI accelerators that push processor power to 400 watts (W), and NVIDIA's H100 accelerator module requires up to 700 W at peak power.

Server manufacturers have also responded to this trend by advancing the commercialization of solutions that simplify the deployment of liquid cooling. Dell EMC, Supermicro, HP Enterprise, and others have expanded the number of stock keeping units (SKUs) available with integrated direct-to-chip cold plates to enable "plug-and-play" liquid-cooled servers.

The second trend is the increased focus data center developers and operators have put on reducing carbon emissions within their operations. While liquid cooling isn't the only solution being considered to address this challenge, it is increasingly being seen as a viable and important technology for driving down data center power consumption, cutting emissions in facilities using carbon-based fuel sources, and reducing the costs related to transitioning to and operating net-zero facilities.

A recently released paper by Vertiv and NVIDIA documented results from the first major analysis of the impact of **introducing liquid cooling into an air-cooled data center**. That analysis showed a better than 15% improvement in total data center power usage effectiveness and a 10.2% reduction in data center power resulting from the introduction of liquid cooling. The availability of studies such as this can only increase the number of organizations integrating liquid cooling into their environmental, social, and governance (ESG) plans.

In short, the market is embracing applications that benefit from liquid cooling. IT and infrastructure vendors are moving quickly to advance their solutions and processes to minimize the risks and maximize the benefits of this technology. That has created a very dynamic market that is evolving quickly. To gain insight into the changes that occurred in 2022 and what to expect in 2023, we talked to two experts who have been working to support liquid cooling deployments.

## Contributors

**Fred Rebarber**

President, NSW Precision Environmental and Power, LLC

**Nigel Gore**

Senior Director of Liquid Cooling, Vertiv

[1] Reference: ***https://digitalcxo.com/article/the-generative-ai-market-is-set-to-soar/***

**1. How has the liquid cooling market progressed in the last year?**

**Nigel:** From a broad market perspective, we saw two significant trends emerge in 2022. The first was a dramatic increase in the size of liquid cooling deployments. In the early part of the year, the majority of projects were for fewer than 50 racks and many of those involved fewer than 20 racks. By the fourth quarter, we began to see projects that involved hundreds of racks, and in a couple of cases, more than a thousand racks.

That indicates operators are preparing for a future where liquid cooling plays a much larger role than perhaps many expected a year ago. These operators weren't planning to deploy hundreds of high-density racks in the short term but were instead focused on ensuring the data center was future-ready by bringing liquid to every row. They are beginning to think more holistically about the role liquid cooling will play in their facilities. That move to more holistic design thinking related to liquid cooling represents the second major trend we saw emerge in 2022.

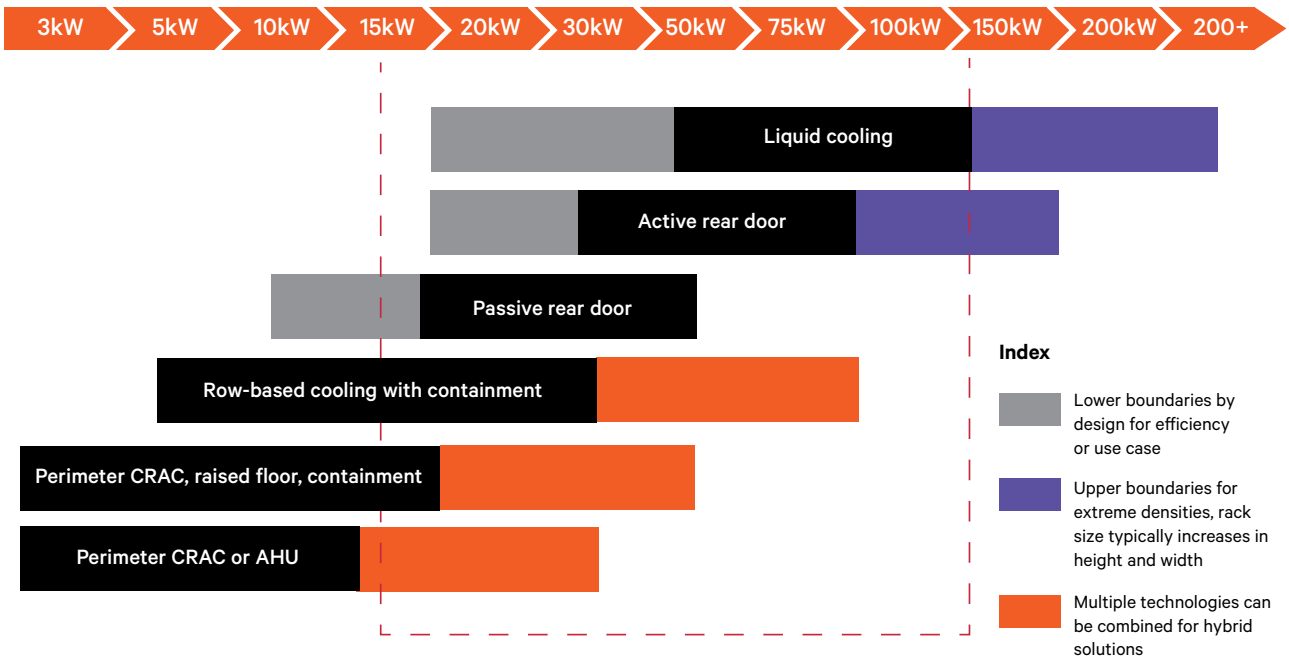
**Fred:** The past year was really a breakout year for liquid cooling. The market demand for processing-intensive applications has been building for the last several years. In 2022, we saw technology vendors responding to that demand with the release of high-power, liquid-only CPUs and GPUs. There was also a significant expansion in the number of server SKUs with integrated cold plates available for high-density applications. So when we look back on 2022 five years from now, we'll recognize it as the year when the technology foundation for simpler and more standardized liquid cooling deployments began to take shape.

**2. What market segments are taking the lead in deploying liquid cooling?**

**Nigel:** AI and ML are being used by a broad range of industries, from financial services to medical research to academia, and that is driving the need for high-density racks across multiple market segments and in all regions of the world.

Cloud providers have actively explored opportunities to use liquid cooling to create a competitive advantage, while colocation providers are opening liquid-cooled suites to meet customer demand. In the last year, we have deployed multiple megawatts of direct-to-chip and immersion cooling for cloud and colocation providers seeking to meet market demand and support higher capacities within their facilities. Large enterprises are also deploying liquid cooing pods in their air-cooled data centers to support higher capacities and processing-intensive applications.

### How cooling technology evolves as rack density increases in the data center



**3. Compared to a year ago, how is liquid cooing technology or its application different today?**

**Fred:** From a technology perspective, the increased availability of servers with integrated direct-to-chip cooling, which I mentioned previously, was a big development in 2022. Moving forward, operators will have a much broader range of liquid-ready servers available to them. They can have more confidence that cold plates are properly integrated into the server because that is happening at the factory.

From an application perspective, we gained a lot of experience integrating liquid-cooled high-density pods into air-cooled data centers. That has provided a deeper understanding of the challenges and best practices in deploying and managing liquid cooling in air-cooled facilities. Operators want to know the best method for introducing liquid, how to manage the transition from liquid to air, and the benefits of accelerating that transition. Today, we have much more clarity around those questions than we did a year ago.

The other thing that has happened is that liquid cooling expertise has been more widely distributed within organizations like Vertiv, so we are better prepared to scale our support and deliver more holistic solutions that extend from chip to atmosphere.

**4. What's the outlook for liquid cooling in 2023 and beyond?**

**Nigel:** We are preparing for high demand in liquid cooling in 2023. I expect the trend toward larger deployments to continue, and we'll see more organizations moving out of proof-of-concept and into wider-scale deployments across their networks. This will be particularly true for immersion cooling, which has been somewhat held back by the lack of standards around fluids. That is being addressed on an industry level and as standards emerge, immersion cooling will become more popular.

**Fred:** In 2023, we will build on recent developments and continue to take the complexity out of liquid cooling deployments to allow the application of liquid cooling to scale with the demand for AI. Technology advances will be supported by more mature deployment processes and better data around the total cost of ownership (TCO) of liquid cooling.

### Colovore Case Study

Located in the heart of Silicon Valley, **Colovore** was created specifically to meet the area's need for data center infrastructure able to support the next-generation, high-performance computing that has evolved from data-intensive technologies. And by standardizing on Vertiv solutions, the company continues to optimize its server footprint for maximum power, cooling, and operating efficiency.

**5. What are the key challenges operators face in deploying liquid cooling, and how are they being overcome?**

**Fred:** We see fewer operators questioning whether they need liquid cooling and more facing the challenge of how to transition to liquid and how fast to make that transition. Introducing liquid cooling into an air-cooled data center can be disruptive. Operators need to balance deployment costs against current and future demand, which can be challenging to predict at this stage. For example, a colocation provider may know they can fill one liquid-cooled suite today, but it's much more cost-efficient in the long run to equip two or three suits with liquid cooling, so they need to balance the immediate need with the costs of meeting future demand.

**Nigel:** The vendor landscape is becoming more complex as new suppliers enter the market. Operators must ensure their chosen vendors have the stability and resources to support growing demand, particularly in light of persistent supply chain issues. There is also a lack of appreciation around the requirements of coolant distribution in terms of consistency of supply and ability to respond seamlessly to spikes in performance. This is often overlooked during the design phase of liquid cooling implementations but plays an important role in the effectiveness of the solution.

**6. Any new developments in liquid cooling technology/ infrastructure about which you are particularly excited?**

**Fred**: One of the developments I'm excited about is the work being done on TCO models for liquid cooling by the **Green Grid** as this will address a key question in the market. We're also learning more about how optimizations to supply air, chilled water, and secondary inlet temperatures can influence TCO. Hot water cooling, in particular, has proven effective at maximizing system efficiency while creating more opportunities to reuse waste heat. Finally, the maturation of best practices around installation, commissioning, and maintenance over the life of liquid cooling systems will continue, resulting in simpler, more standardized deployments.

**Nigel:** The standardization occurring around both direct-to-chip and immersion technologies will prove to be a significant development in the coming year.

In immersion cooling, we are seeing progress on the standardization of fluids in terms of material compatibility that will resolve some of the warranty coverage issues that have been a barrier to the growth of this technology. Direct-to chip technology will benefit from work being done by **Open Compute Project (OCP)** and **Open19** to create standard rack/architectures with integrated liquid cooling manifolds.

Beyond the technology, I'm most excited about the changes in how the market perceives liquid cooling. Liquid cooling has entered the mainstream, and as it evolves, will increasingly be considered the primary data center cooling technology for new data center developments.

Read the Vertiv white paper, **Understanding Liquid Cooling Options and Infrastructure Requirements** for more information on liquid cooling technologies and infrastructure.


**Vertiv.com |** **Vertiv Headquarters,** 505 N. Cleveland Ave., Westerville, OH, 43082, USA



(R05/23)