

Achieving data center decarbonization and energy conservation with next-generation cooling systems

As digitalization advances worldwide, data centers are becoming an essential part of infrastructure. With demand set to grow even further, the decarbonization and conservation of power consumed by data centers are emerging as key issues. To solve these issues, MHI Group is aiming to provide total energy solutions that combine power supply, cooling, control, and monitoring systems for data centers in an integrated package.

Issues Facing Data Centers

The term “data center” is a catchall for a specialized facility in which a variety of equipment, including servers and data transmission systems, are installed and operated. Along with ongoing efforts toward digital transformation (DX) in recent years, the role of data centers handling massive amounts of data is expanding in tandem with business continuity planning (BCP) to prepare for natural disasters, among other measures. By 2025, global data volume is predicted to swell by roughly 150 times compared to 2010. In line with this, the proportion of global electricity consumption by data centers is projected to increase from 1% in 2018, to around 8% in 2030.

Moreover, greater use of AI and digital twin technologies, upgrades to and expansion of 5G and 6G infrastructure, and the rollout of new IT-related technologies and services will spur calls for increased data bandwidth and transmission speeds, which are expected to lead to the generation of even more heat by servers. Breaking down total global power consumption by data centers in

2021, about 60% of power was supplied to servers, the most essential component, with roughly 30% of power used for cooling. Cooling in many cases also consumes a significant amount of water, which is an issue from the standpoint of water resource conservation. In coping with the increasing functionality and density of IT devices, the traditional approach to cooling servers with air cooling systems is likely to become challenging. Accordingly, new technologies for efficiently and effectively cooling high heat-generating servers will become indispensable for efficient data center operations.

As such, ensuring the sustainability of data centers, which are essential next-generation infrastructure, will require decarbonization of both energy supply and demand, from securing zero-carbon power sources to energy conservation solutions for IT equipment cooling. In the next section, we detail recent progress in R&D and validation testing, showcasing an immersion cooling system that is inching closer to commercial implementation.

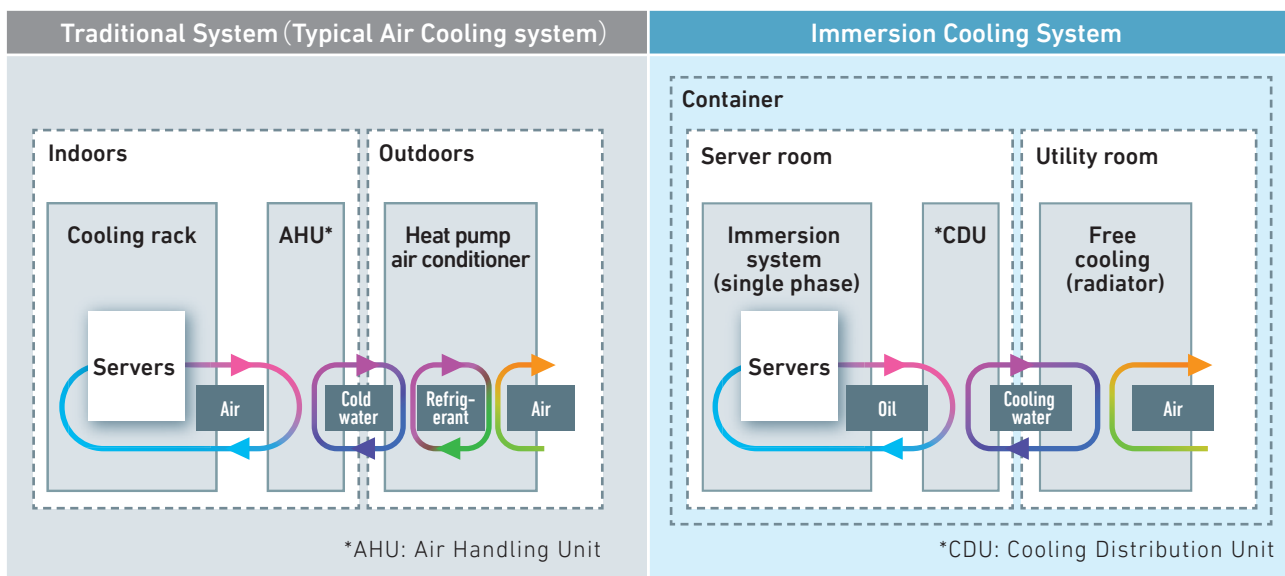
Next-Generation Cooling Systems

The main approaches are immersion cooling, direct to chip cooling, and rear door cooling. Of these, MHI has begun development and validation testing of immersion and direct to chip cooling systems.

Immersion cooling is an approach that involves the immersion of servers in an insulating cooling medium (oil, for example) with higher thermal conductivity than gas (air). Heat from the cooling medium is directed through a heat exchanger, where it exchanges heat with cooling water. The heat collected by the cooling water is then

cooled by outside air. Furthermore, the cooling water line is a closed loop, which prevents evaporation and reduces water usage. Compared to typical air cooling systems currently in use, these innovations enable adequate cooling of servers in high temperatures environments, with cooling possible even in rooms with air temperatures as high as 40°C. The most significant merit is that this approach allows for reduction in the energy consumed by the air conditioning systems used to produce cooling air in existing data centers.

▶ Diagrams of Device Layout and Heat Transfer



In FY2021, MHI, KDDI Corporation (KDDI) and NEC Networks & System Integration Corporation (NEC Net SI) jointly conducted validation testing of a compact data center housed in a shipping container. The system was comprised of a 50 kVA server and immersion cooling system installed in a shipping container. The result of the tests showed adequate cooling performance, successfully reducing power consumed by server cooling by 90%, and reducing overall data center power consumption by 43% compared

to existing data center models. This test also achieved a power usage effectiveness (PUE)*—a measure of data center power usage efficiency—of 1.07, compared to the 1.7 of a typical data center in operation today. This marks an enormous leap toward the practical use of immersion cooling technology.

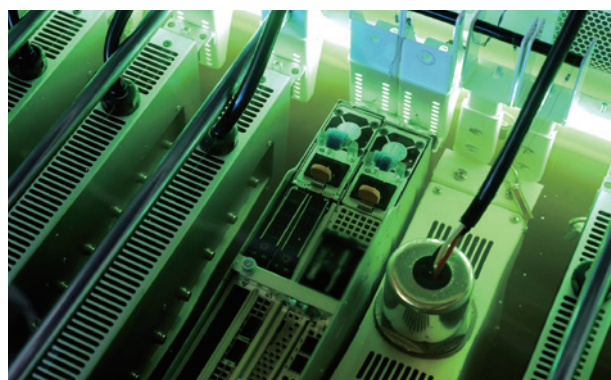
*PUE: The proportion of overall data center power consumption used by IT devices. 1.0 is the minimum value. The smaller this number is, the less power is consumed by non-IT devices, and the higher the efficiency of a system.

Similarly, in FY2022, KDDI, NEC Net SI and a number of server and chip suppliers joined MHI in the validation testing of an immersion cooling system concept in a hyperscale data center at KDDI's Oyama Network Center. The test results confirmed a 94% reduction in power used for server cooling compared to traditional data centers, achieving a PUE of 1.05. Additionally, elevating the capacity for stable system operations enabled the achievement of Tier 4 operation stability, the highest degree of data center quality.

MHI is also working with NTT Data Corporation on a development of a new rack-based immersion cooling system to meet a variety of data center customer needs. Data center devices are placed onto racks of a uniform size – the standard length is 19 inches – for more efficient installation, replacement and positioning. By designing an immersion cooling system that can fit into a 19-inch rack configuration, we are aiming not only to boost performance but also to deliver a high-efficiency cooling system incorporating high-performance dry coolers produced by MHI. Validation testing achieved a 92% reduction in power used to cool servers compared to previous performance

levels. Moreover, by designing a system with a widely used size, we aim to facilitate implementation at existing data centers.

MHI Group is working to solve a variety of technical issues, including those pertaining to system operations and controls, in the runup to the commercialization of immersion cooling technology for hyperscale data centers sometime in FY2023.



Using liquid to cool a device

Total Solutions

Beyond standalone cooling systems, MHI Group is seeking to provide solutions to the issues that data centers face through three approaches targeting power supply, cooling, and integrated control of these two areas. In the area of energy supply, alongside the use of renewable energy, MHI Group will provide high-efficiency, high-reliability power generation systems and hydrogen power generation technologies, while operating these power sources in an integrated fashion, thereby achieving Carbon Neutrality.

Furthermore, by applying our flagship monitoring and integrated control technologies, the Σ SynX (Sigma SynX) automation and intelligence platform and the TOMONI® intelligent power plant solution, to data centers, MHI provides integrated, one-stop solutions to optimize power generation and the power usage of cooling equipment and servers. This will ultimately contribute to achieving Carbon Neutrality not only at data centers but for infrastructure as a whole.

To that end, in July 2023, MHI signed an agreement to acquire shares of Concentric, LLC, a company specializing in power system solutions primarily for data centers and logistics centers in the United States. Concentric has a network of locations spanning the entire United States,

the world's largest data center market. Adding MHI Group's technological capabilities to their robust service network will allow us to develop a solutions business for data centers.

► One-Stop Solutions for Data Center Decarbonization



MHI Group Vision

By 2030, the data center equipment market, anchored by continued year-on-year expansion primarily in the United States, is expected to grow to a global scale of ¥8 trillion. By combining decades of technology in the areas of power

generation, HVAC, and control systems, MHI Group is developing solutions seeking utility-side decarbonization and high efficiency for data centers in a push to capture the largest share of this market.