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How New-Generation High-Efficiency Chiller Technologies Improve Modern Data Center Performance



Background

Specifically designed for high-performance GPU workloads (like AI, video streaming, and cryptocurrency transactions), new-generation data centers can consume anywhere from 50 to 100+ megawatts (MW) of power. Because nearly all incoming power converts directly to heat, operators must maintain continuous, reliable cooling to keep dense GPU racks operating 24x7x365.

Cooling requirements for these facilities often reach 15,000 to 30,000 tons of capacity. As GPU clusters grow more power intensive and thermally dense, traditional chiller technologies struggle to maintain stable performance. To meet rising demand, operators are turning to advanced, high capacity chilled water systems engineered specifically for modern AI driven environments.

One rapidly growing European-based organization – specializing in GPU-as-a-Service (GPUaaS) and AI-optimized infrastructure – recently faced this high-capacity cooling challenge. The organization provides its customers with:

- High-performance AI-focused data center infrastructure engineered for multi-megawatt power delivery, dense GPU clusters, and low-latency networking.
- Sustainability through renewable energy, coastal seawater cooling, and circular heat reuse.
- Advanced cooling via closed-loop direct-liquid cooling and rear-door heat exchangers.
- Scalable capacity from tens of megawatts to gigawatt-scale deployments.

The organization's chip agnostic architecture supports rapid GPU scaling without vendor lock in, enabling large scale AI training and inference workloads. As customer demands accelerate, the organization has begun to introduce next generation chiller solutions capable of rapid deployment of high-efficiency cooling at high capacity.

Challenges

The organization needed a chiller solution that could:

- **Support extreme GPU heat loads** with stable, efficient cooling
- **Scale quickly** to meet expanding AI demand
- **Integrate seamlessly** with both liquid cooled and air cooled systems
- **Deliver high reliability, redundancy, and rapid restart capability** in the event of a power interruption
- **Provide measurable improvements in energy efficiency and operational cost**

The company also needed a large capacity chiller in a very small footprint. They wanted a footprint of 43.5' or less.

Company executives selected **Airsys VectorCool™** chiller technology and continued to partner with Airsys for performance validation prior to installation. Airsys was able to customize their solution, so the chiller unit was wide enough and small enough to be transported on the highway without any special escorts or permits. This reduced the overall cost.

At a glance

Challenge:

Provide data centers with rapid delivery of the cooling capacity they require to manage exponential growth of power-intensive AI processing.

Solution:

Airsys VectorCool™ chiller

Results:

- Passed all 9 key test facility evaluation categories during globally recognized AI-load stress testing
- Tested at 100%, 75%, and 50% load levels
- In restart testing, achieved Full Load capacity in 160 seconds
- Provided up to 500 tons of cooling capacity per chiller unit

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Solution: VectorCool Chiller Technology

The VectorCool chiller provides chilled water to both server-rack-level liquid-cooled and air-cooled portions of data center facilities and offers multiple compressor configurations and customization options.

Key advantages of VectorCool include:

- Variable speed mechanical components (like EC condenser fans, pumps, and compressors) that reduce peak power consumption and deliver high efficiency at full and partial loads
- Embedded redundancy, which allows one circuit to remain operational while the other is serviced
- High Power Compute Effectiveness (PCE), indicating that a larger share of the data center's total provisioned electrical capacity remains available for compute
- Open architecture, which enables easy integration with other facility systems
- Broad scalability, up to 500+ tons of cooling capacity, which supports long term growth planning
- High level of operational and economic sustainability are achieved through AI-driven controls and remote sensor automation which optimize performance in real time, cutting energy waste. In addition, standardized sub-modules cut maintenance time and material waste.

What is PCE?

Power Compute Effectiveness (PCE), a metric introduced to the marketplace by Airsys that the Open Compute Project (OCP) has accepted into their contributions database, measures how effectively a data center converts provisioned power into usable compute output, going beyond traditional efficiency metrics like Power Usage Effectiveness (PUE).

PUE is always > 1.0 but strives to be as close to 1.0 as possible, whereas PCE is always < 1.0, while still targeting 1.0.



Results reveal significant efficiency and environmental gains

A globally recognized third-party facility tested the VectorCool chiller at 100%, 75%, and 50% load points, along with a fast restart scenario simulating an unexpected power outage. The restart test measured how quickly the chiller could return to operation once backup generators engaged. The VectorCool unit achieved full load capacity in just 160 seconds. In fact, the facility issued high marks across all evaluation categories, validating the VectorCool's ability to support demanding AI workloads.

Evaluating performance at multiple load levels is critical to validate the chiller's ability to operate across varying data center workloads and seasonal conditions. Fast restart testing is important because it proves the chiller's ability to restart in case of unanticipated power outages. The data center owners wanted to determine how quickly the chiller could restart once generators began providing backup power. Key findings revealed:

Energy savings

Between 20% and 70%

The system operates efficiently when supporting AI-level compute loads, reducing utility costs. The design delivers energy savings through technologies such as magnetic bearing compressors (which eliminate mechanical friction and wear in the bearing system) and pumps that consume 50% less energy.

Low ambient temperature

Operates at -13°F

This low ambient temperature directly affects heat rejection efficiency, cooling capacity, energy use, and equipment life. Cooler ambient air allows the condenser to reject heat more easily, reducing condensing pressure and temperature. The compressor therefore works less, lowering energy consumption and wear on components.

High capacity

500+ tons

High chiller capacity is important because it determines how large a heat load the equipment can manage while still maintaining stable cooling performance under demanding conditions.

Water use

Zero water consumption

Because the data center targeted for the VectorCool installation featured a closed-loop design and is in a geographic region with an extreme climate (outside temperatures that exceed 100°F in the summer and below freezing in winter), the organization required cooling units capable of operating with zero water usage.

These results confirmed that the VectorCool chiller could meet the provider's requirements for reliability, scalability, and energy efficiency. The testing also reinforced Airsys' ability to deliver rapid deployment, global support, and innovative cooling technologies tailored to hyperscale GPU environments.

The operator views Airsys as a strategic partner capable of matching the speed, flexibility, and technical sophistication required in modern AI driven data center operations.

For more information

Airsys has delivered precision air control systems for more than 30 years, with solutions spanning edge and telecom environments through hyperscal data centers. Our 245,000+ sq ft manufacturing facility in Woodruff, SC, along with strategically located global facilities, ensures fast component distribution to end users. A growing network of server and infrastructure OEM partners further supports rapid delivery, service fulfillment, and warranty response. Visit our website or contact sales to learn more about Airsys precision heat pump and environmental control solutions.

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