

Expanding the Horizons of Data Center Infrastructure to Liquid Cooling and Beyond

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nVent Overview

\$3B+

nVent 2024 sales, up 12%
reported YoY

~600M

of nVent sales in **Data
Center business**

33%

of nVent sales in
Infrastructure vertical

- **High growth** electrical company
- Consists of 2 segments:
 - **Systems Protection**
 - **Electrical Connections**

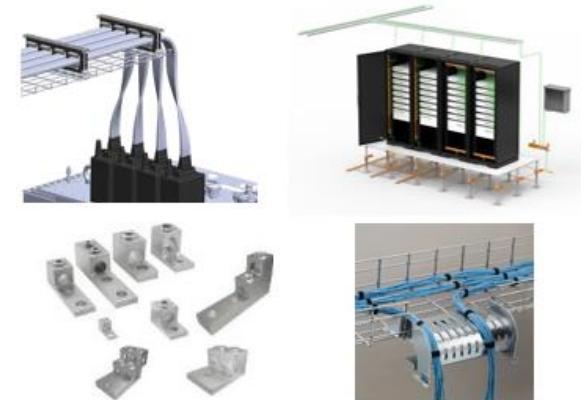
Systems Protection

Enclosures, cooling and power solutions that protect electronics and data across mission-critical applications.



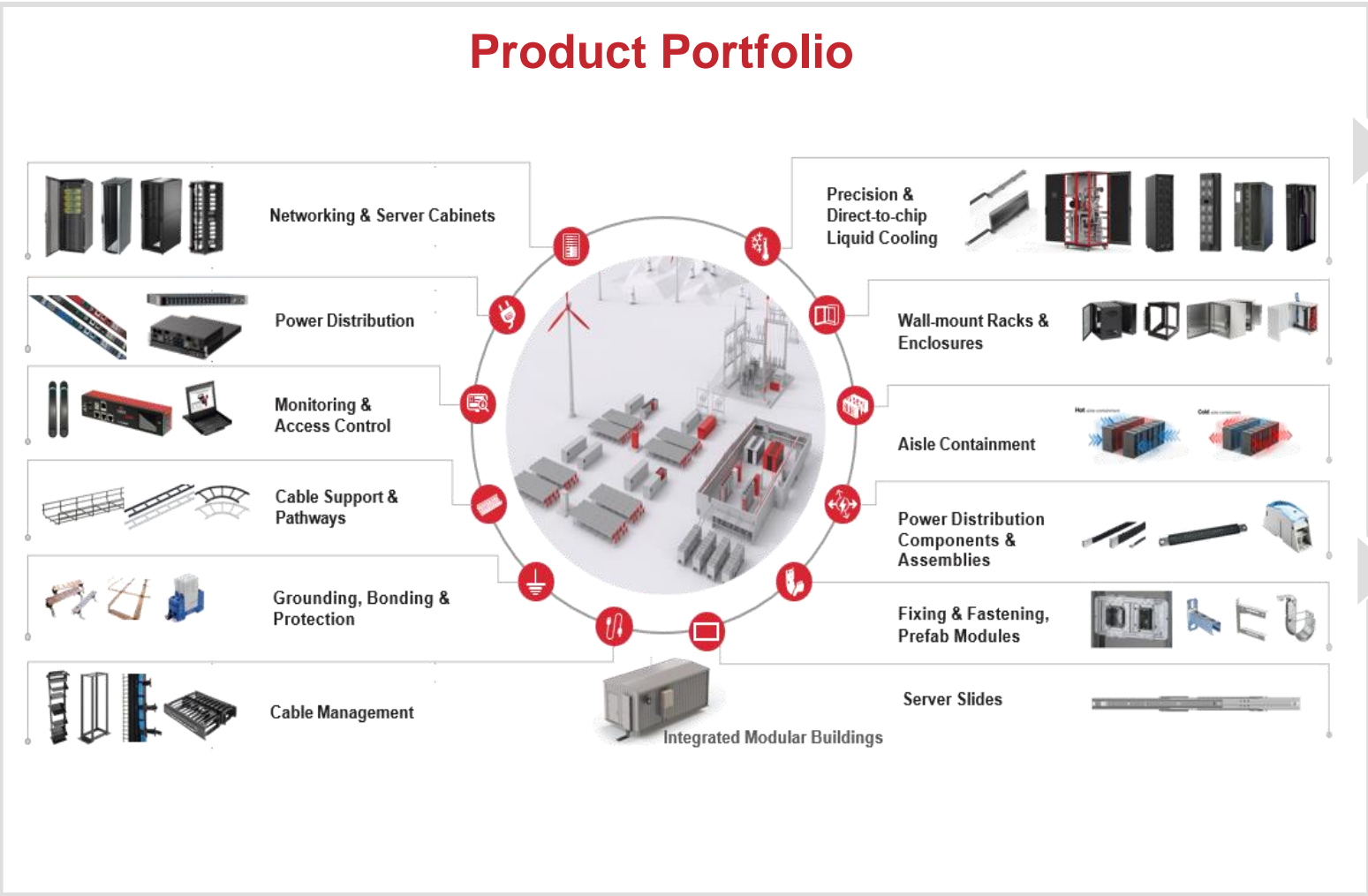
Electrical Connections

Resilient, quality solutions designed that simplify installation while improving productivity and end-user safety.

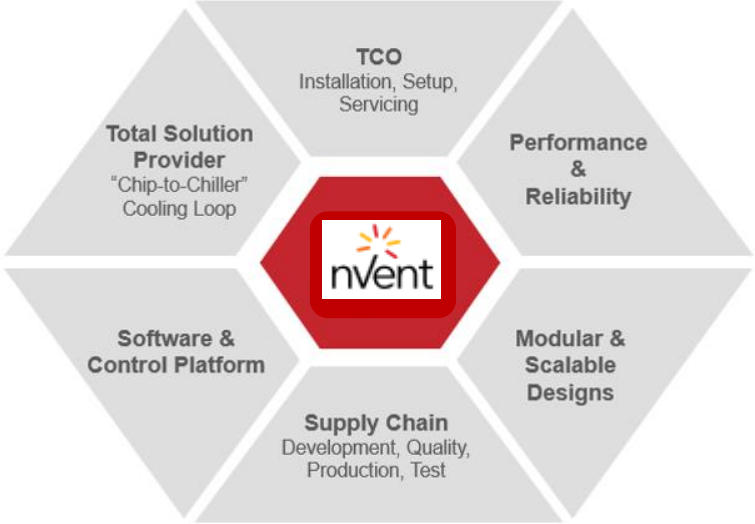


Transforming nVent to a more focused, higher growth electrical connection and protection company

nVent Data Solutions Product Portfolio



Value Proposition



Where We Win | Customer Needs:

- Our extensive portfolio offers **configurable solutions**, making us a **versatile partner in collaborative design**.
- Deep **technical expertise**, robust **supply chain management**, **advanced manufacturing** capabilities
- Our **global presence** ensures **local support** and scalability, allowing us to **meet diverse needs** effectively.

Infrastructure solution provider for IT/Networking and Data Center applications

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Challenges of **rising demand** of cooling needs



The World Around Us is Electrifying

3X ELECTRICITY DEMAND by 2050



Electrification

- Electric vehicles projected to be 35% of cars sold by 2030
- Data Centers are growing year over year.



Energy Transition

Renewables projected to be 80% of power generation by 2050

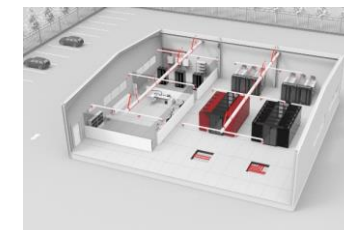
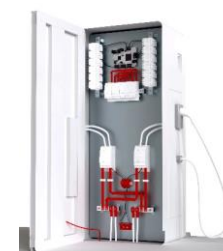
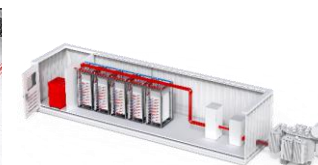
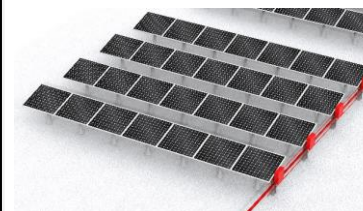
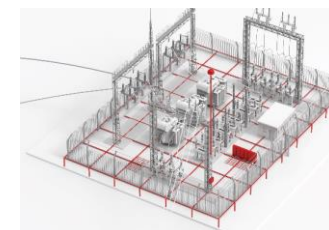
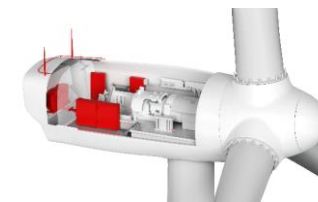


Aging Infrastructure

>45 yrs in Europe*
>35 yrs in USA*



Driving the need for modernizing our electrical infrastructure



Tremendous opportunity for innovation in **sustainability and electrification**

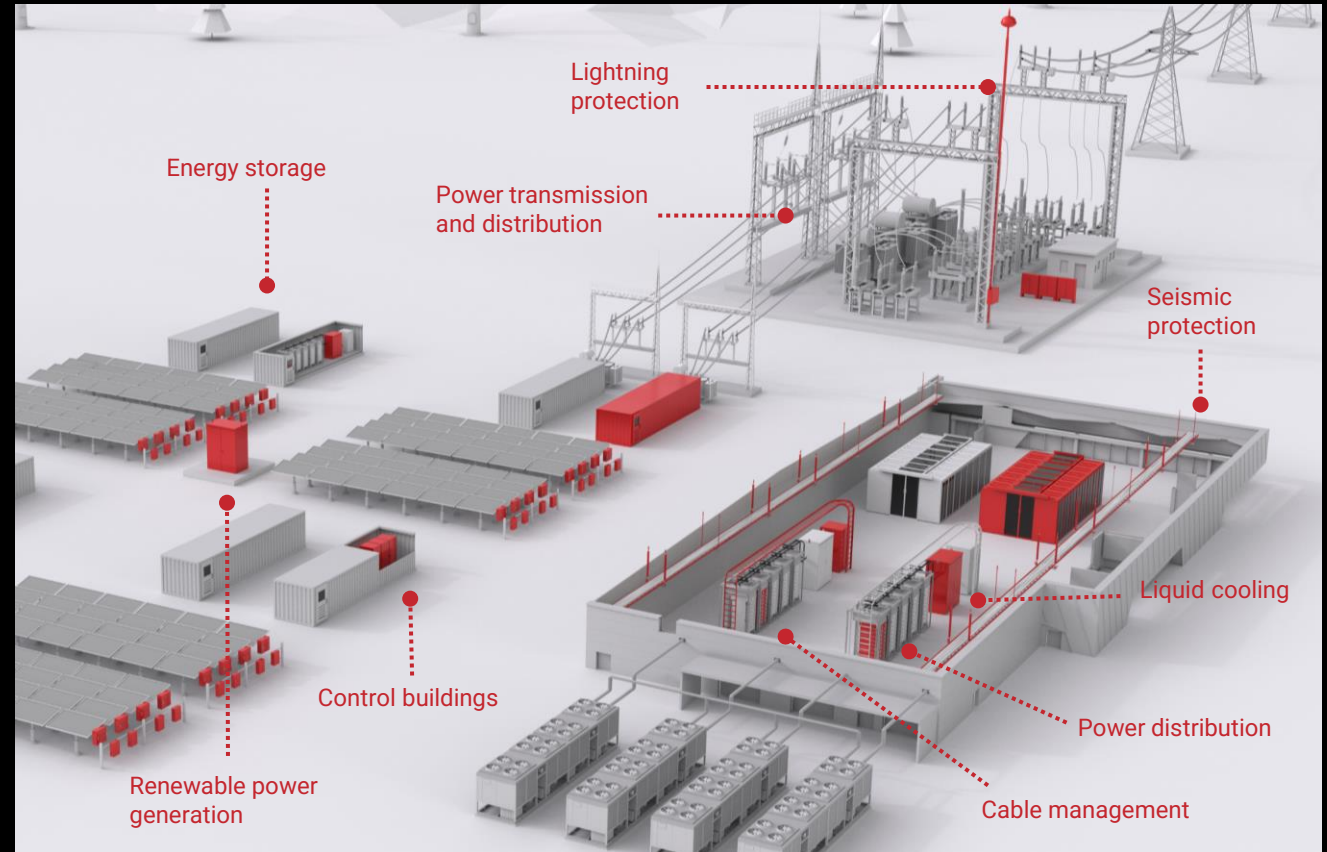
Data Centers: Need power inside and outside

A data center is a facility composed of networked computers, storage systems and computing infrastructure used to assemble, process, store and disseminate large amounts of data.

WHITE SPACE: IT equipment, servers, storage, network gear, racks, Cooling Distribution Units, power distribution systems

GRAY SPACE: Back-end equipment, switch gears, uninterruptible power supplies, generators, network pathways

SUPPORT INFRASTRUCTURE: Power generation infrastructure, water supply, chillers, CRAC units



Opportunities to optimize system for **efficiency** and **reduced environmental impact**

Projected Trends



Data Centers are Heating Up And Consuming More Electricity and Water

US DOE: Data centers consumed about 4.4% of total U.S. electricity in 2023 and are expected to consume approximately 6.7 to 12% of total U.S. electricity by 2028. Usage tripled in a decade and are expected to double by 2028.

CBRE:

North American
data center
inventory up 24%
YoY in 1Q24

Google:

Global data
center electricity
consumption
represents 1-
1.3% global
electricity
demand

Goldman:

A ChatGPT query
requires 2.9 watt-
hours of
electricity vs. 0.3
for a Google
search

ING Group:

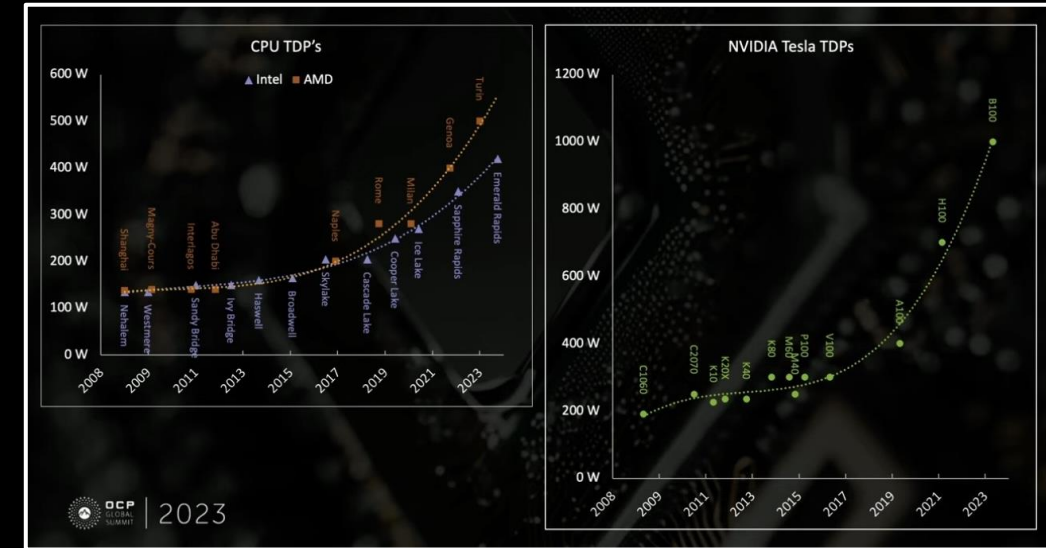
A mid-sized data
center uses as
much water per
day as 100,000
homes

Artificial Intelligence (AI) is Driving a Paradigm Shift in Cooling in Data Centers

- Rapid adoption of AI, specifically Gen-AI (ChatGPT, Gemini, Meta AI, Claude etc.), in last two years
- Gen-AI consumes a lot of energy because of the vast amount of data it trains on, complexity of the models and high volume of user requests
- AI requires GPU-powered racks: more power → more heat

Rubin Ultra NVL576 Rack
to be 600kW

(in 2027)



Here are the major points NVIDIA founder and CEO Jensen Huang covered in his keynote:

- **We're at a \$1 trillion computing inflection point.** AI computing demand is accelerating rapidly, driven by the rise of reasoning AI and agentic AI. The scale and complexity of AI workloads are transforming data center investments worldwide.
- **NVIDIA Blackwell is in full production, delivering 2x the performance of A100.** The Blackwell architecture significantly enhances model training and inference, enabling more efficient and scalable AI applications. It marks the evolution of the NVIDIA Blackwell AI factory platform, Blackwell Ultra, which is set to transform the semiconductor landscape this year.
- **NVIDIA will follow an aggressive path in the buildout of AI infrastructure. Each year will bring new GPUs, CPUs and accelerators, computing advancements, including the upcoming NVIDIA Vera Rubin architecture, designed to drive performance and efficiency improvements in AI data centers.**
- **AI infrastructure, including photonics and optimized storage, is set to revolutionize the industry.** Advanced networking and storage solutions will improve AI scalability, efficiency and energy consumption in large-scale data centers.
- **Physical AI for industrial applications is a \$50 trillion opportunity.** AI-powered robotics and automation are set to transform manufacturing, logistics, healthcare and other industries, with the NVIDIA Isaac and Cosmos platforms leading the way.

Requirements of AI and sustainability are driving a **cooling paradigm shift**

Available Cooling Solutions:

Liquid Cooling is a **Game Changer**



Liquid Cooling at a Glance

What is Liquid Cooling?

Using chilled liquid to capture and transport heat away from IT equipment:

- Liquid has a much greater heat transfer capacity than air
- Liquid can be brought closer to the source of heat (chip)
- Increases capacity, improves efficiency
- Achieves required temperature parameters and reduces energy consumption of cooling systems

Energy Efficiency

50% Energy savings with liquid cooling versus conventional mechanical cooling*

Liquid Cooling Business Opportunity

~5-10%

of Data Centers liquid cooled today

4X

Growth for liquid cooling compared to air (40% vs 9% growth, Dell'Oro)

AI Adoption

Driving demand for data center liquid cooling

Note: Analysis is based on nVent internal estimates.

*When using multiple cooling technologies, including direct-to-chip liquid cooling. Source: Science Direct, 2022.

Key Sustainability KPIs for Data Centers

1. PUE – Power Usage Effectiveness

- Equals Total Utility Power / IT Power
- The lower the better

2. DCiE – Data Center infrastructure Efficiency

- Equals IT Power / Total Utility Power (inverse of PUE)
- The higher the better

3. WUE – Water Usage Effectiveness



Scalability



Sustainability



Cost Savings



PUE	DCiE
3.0	33%
2.5	40%
2.0	50%
1.5	67%
1.2	83%

Choice of Cooling Solution

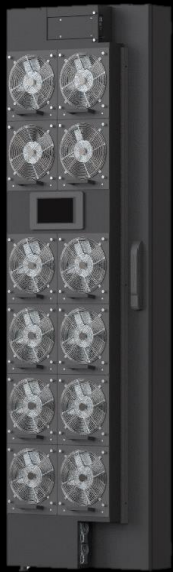
Types of Products for cooling IT Racks

Liquid Available in FWS	Yes	No	Yes
Liquid Needed in TCS	No	Yes	Yes
Cooling Solution type	Air to Liquid	Liquid to Air	Liquid to Liquid
Product Type	Rear Door HX, In Row HX	Rack Mount LTA, In- Row LTA (Sidecar)	CDU (In-Rack or In-Row)

Hyperscalers, Colo providers have a choice to make

Types of Liquid Cooling

1. Air-to-Liquid



2. Liquid-to-Air



3. Liquid to Liquid



4. Immersion



Hardware diversity and variable thermal output necessitates a
flexible and adaptive cooling strategy

Air-Liquid Cooling Systems

Rear Door Heat Exchanger (RDHx)

Cools IT equipment within the rack using air and cools the hot air with chilled liquid from facility

Requires facility liquid cooling lines

50-100 kW

Practical range per rack



Liquid-To-Air Cooling Distribution Systems

Liquid-to-Air Heat Rejection Unit (HRU)

Brings liquid cooling to IT equipment in an air-cooled data center by circulating chilled liquid within rack

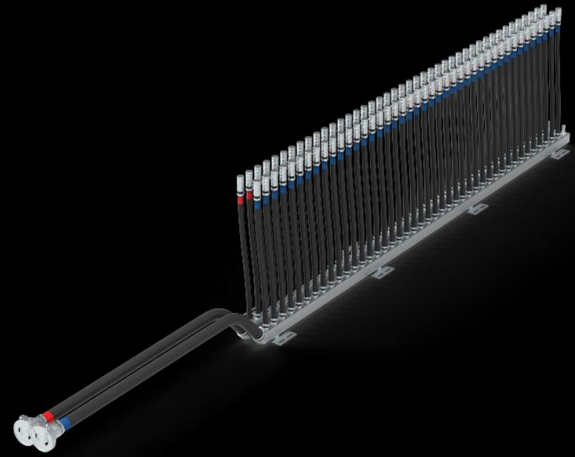
Does not require facility liquid cooling infrastructure

50-100 kW

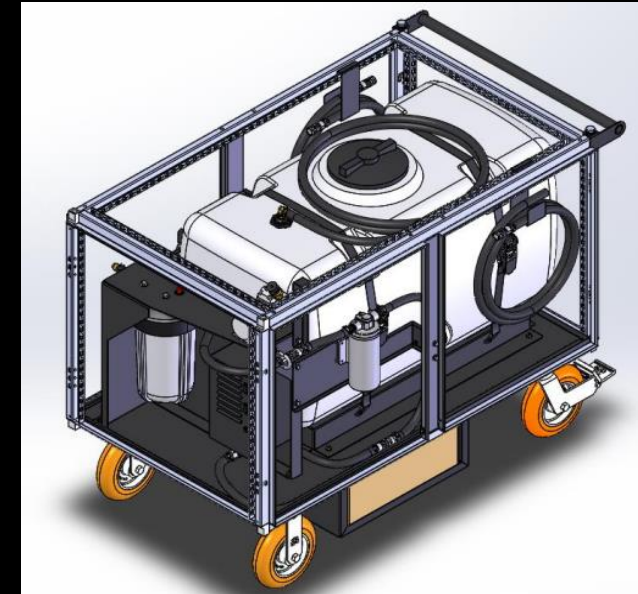
Practical range per rack



*Liquid-to-Air Heat
Rejection Unit*



Rack Manifold



Fill and Drain Tool

Liquid-to-Liquid Cooling Distribution Systems

Liquid-to-Liquid Cooling

Cools IT equipment with a heat sink placed directly on board

Must be carefully engineered due to proximity to IT systems

50-200kW

Practical range per In-Rack

300+ kW

Practical range per In-Row



Immersion Cooling Systems

4. Immersion Cooling

Servers immersed in cooled dielectric liquid

Cools and shields from dust and humidity

30 - 100 kW

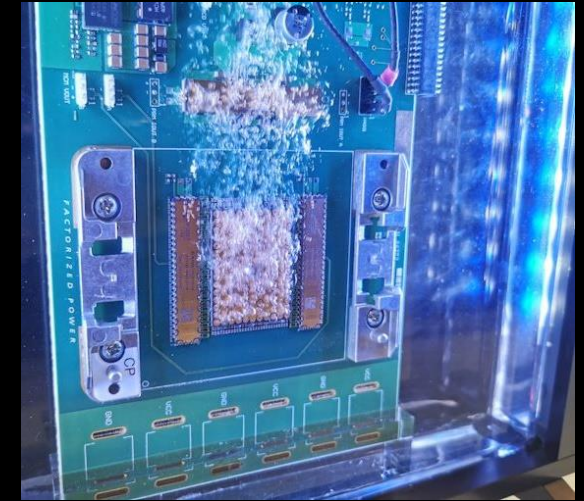
Practical range per tank (single phase)

>500 kW

Practical range per tank (two phase)



Single-phase immersion cooling



Two-phase immersion cooling

The Beyond: **ESG Impact** of adoption of this technology



The Coolant Distribution Unit (CDU): Heart and Brain of Liquid Cooling Systems

CDU Benefits

- Precisely **pumps liquid** at the desired operating conditions through the cooling system (Heart)
- Advanced **control algorithms** adjust various parameters for optimal performance (Brain)
- **Enables higher rack density**, reduces energy consumption and decreases total cost of ownership
- Gain benefits of liquid cooling while **using less water** because liquid is a closed loop



Critical component for a unified cooling infrastructure that is flexible, modular and can accommodate any liquid cooling method

Sustainability is Good for Business and Good for the Planet

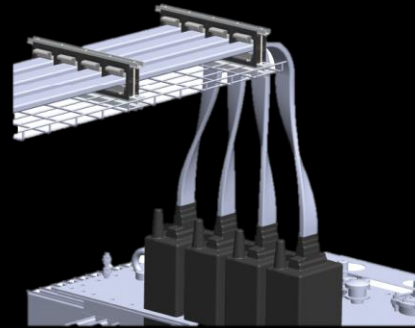
Product Examples



Liquid Cooling for Data Centers *Energy efficiency*

Good for business: Enables the use of AI and ML technology

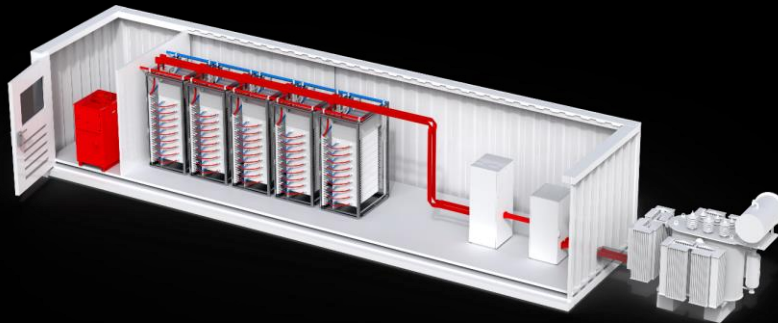
Good for the planet: Improves data center power use effectiveness



Space-Efficient Power Connections *Resiliency and protection*

Good for business: Easy to use, forms reliable power connections

Good for the planet: Enables more reliable and space-efficient renewable energy systems



Battery Energy Storage Systems for Renewable Energy *Eco-friendly*

Good for business: Provides backup power for critical processes

Good for the planet: Enables renewable energy, improved cooling technologies can create more energy efficient battery systems

Electrification Creates Opportunities for Sustainability

Enables the rapid scaling of **sustainable electrical infrastructure**:



Energy Efficiency:

Our solutions improve energy efficiency for our customers.



Lifespan and Serviceability:

Our solutions extend the lifespan of our customers' systems, reducing waste and lowering cost.



Resiliency and Protection:

Our solutions add resiliency to critical systems by helping keep them safe from natural and human-made disruptions.



Safety:

Our solutions improve end-user safety and help our customers enhance the safety of their operations.



Customer Productivity:

Our solutions reduce labor cost in design and installation, improve utilization and reduce total cost of ownership.



Eco-Friendly:

We support customers' sustainability goals by developing environmentally friendly products and solutions.

Closing Thoughts

- The AI revolution is driving a paradigm shift in cooling needed in data centers
- Liquid cooling is a more sustainable way of cooling
- For liquid cooling to scale, the solutions need to demonstrate high reliability
- Advanced control algorithms can help enhance cooling efficiencies
- Opportunities for reusing waste heat from data centers. Ex: decarbonize the food chain
- **Become an advocate for Green Data Centers!**



NVIDIA-Blackwell-ultra

<https://nvidianews.nvidia.com/news/nvidia-blackwell-ultra-ai-factory-platform-paves-way-for-age-of-ai-reasoning>

Thank you for your kind attention !

