The Future of Room-Based Cooling Systems in AI and High-Density Data Centers

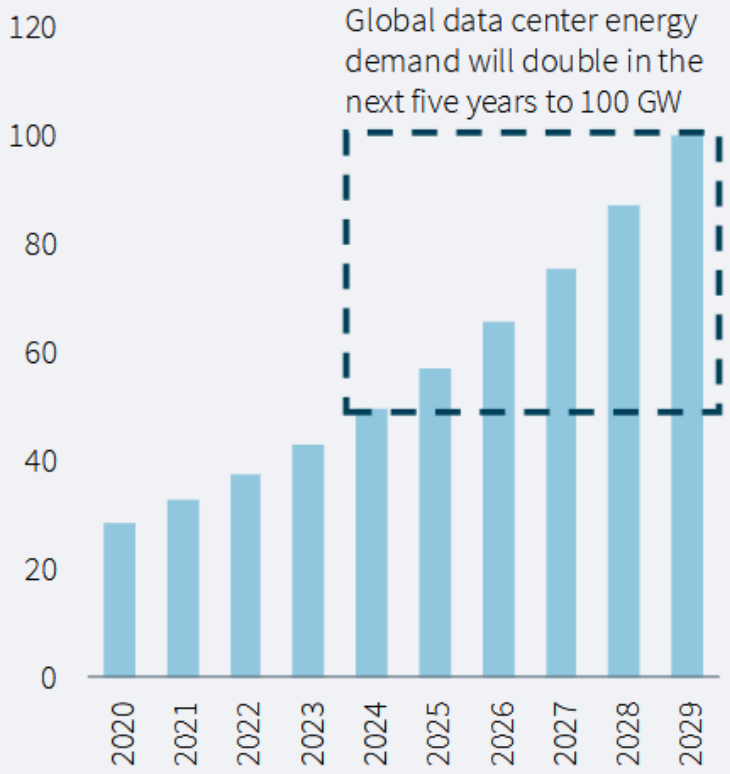
Datacenter Forum, Helsinki

1. High-density trend & liquid cooling demand
2. Current significance of air cooling
3. Future outlook for air-assisted liquid cooling

AI is accelerating DC capacity expansion

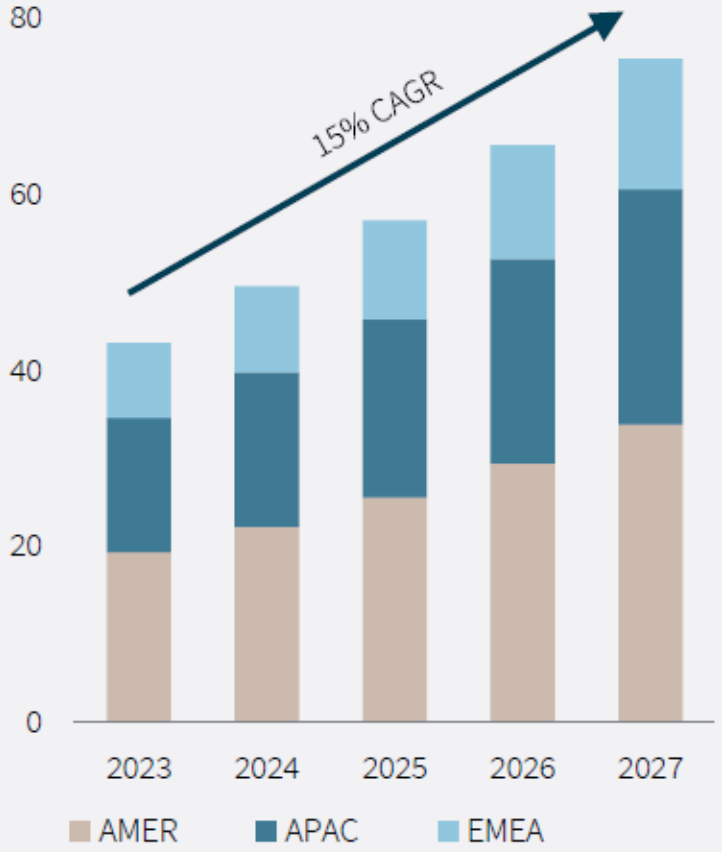
High-density trend & liquid cooling demand

Global data center energy demand (GW)



Sources: JLL Research, Structure Research
Note: Capacity includes hyperscale and colocation.

Global data center capacity (GW)



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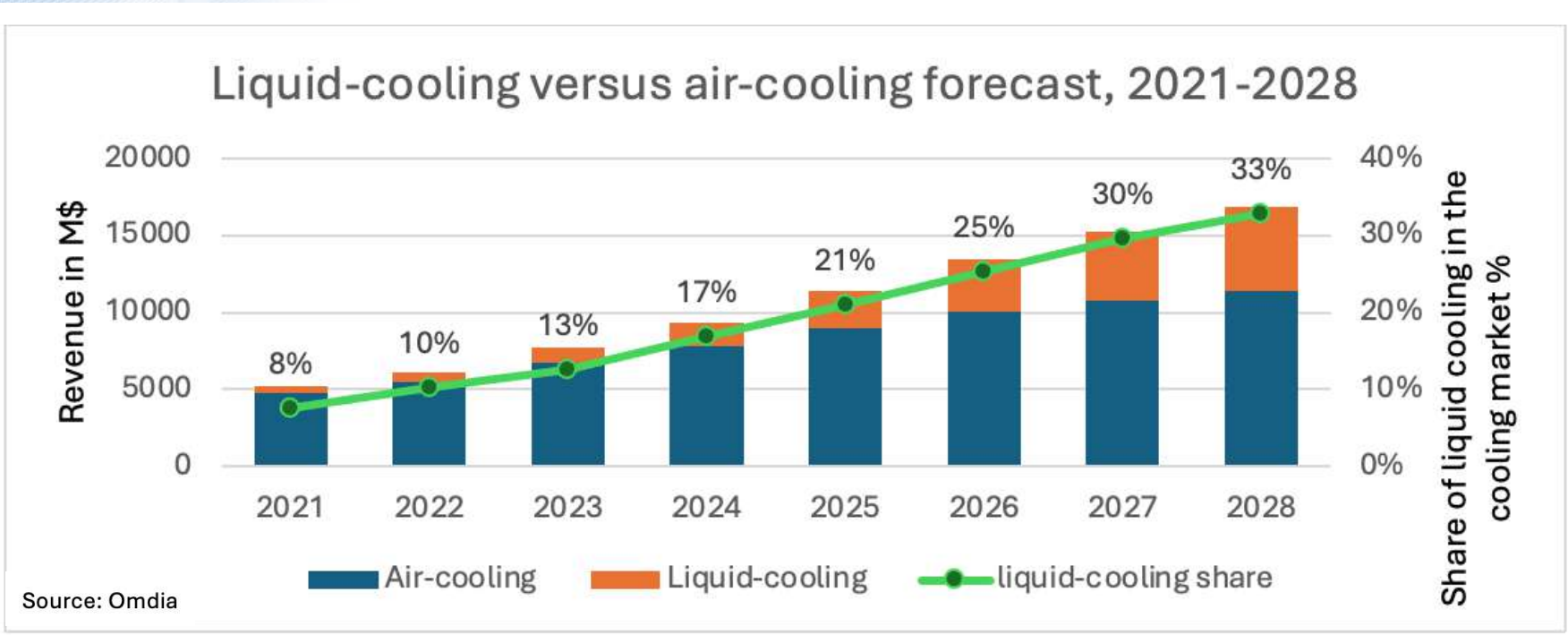
AI is surging demand for liquid cooling

High-density trend & liquid cooling demand

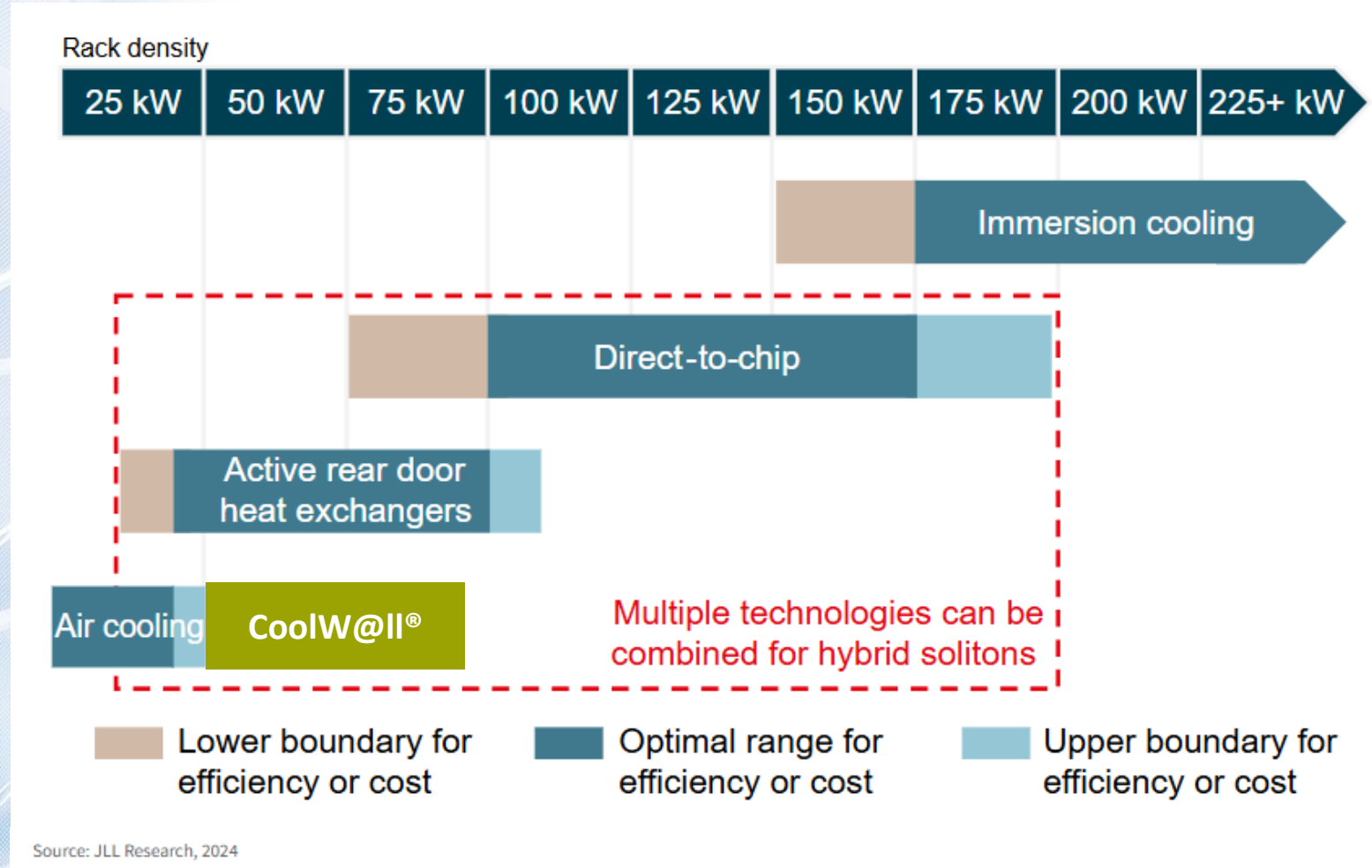
Air cooling - for many decades the only choice



Applicable cooling technologies by rack density

Current significance of air cooling

Air cooling systems are coming to its limits

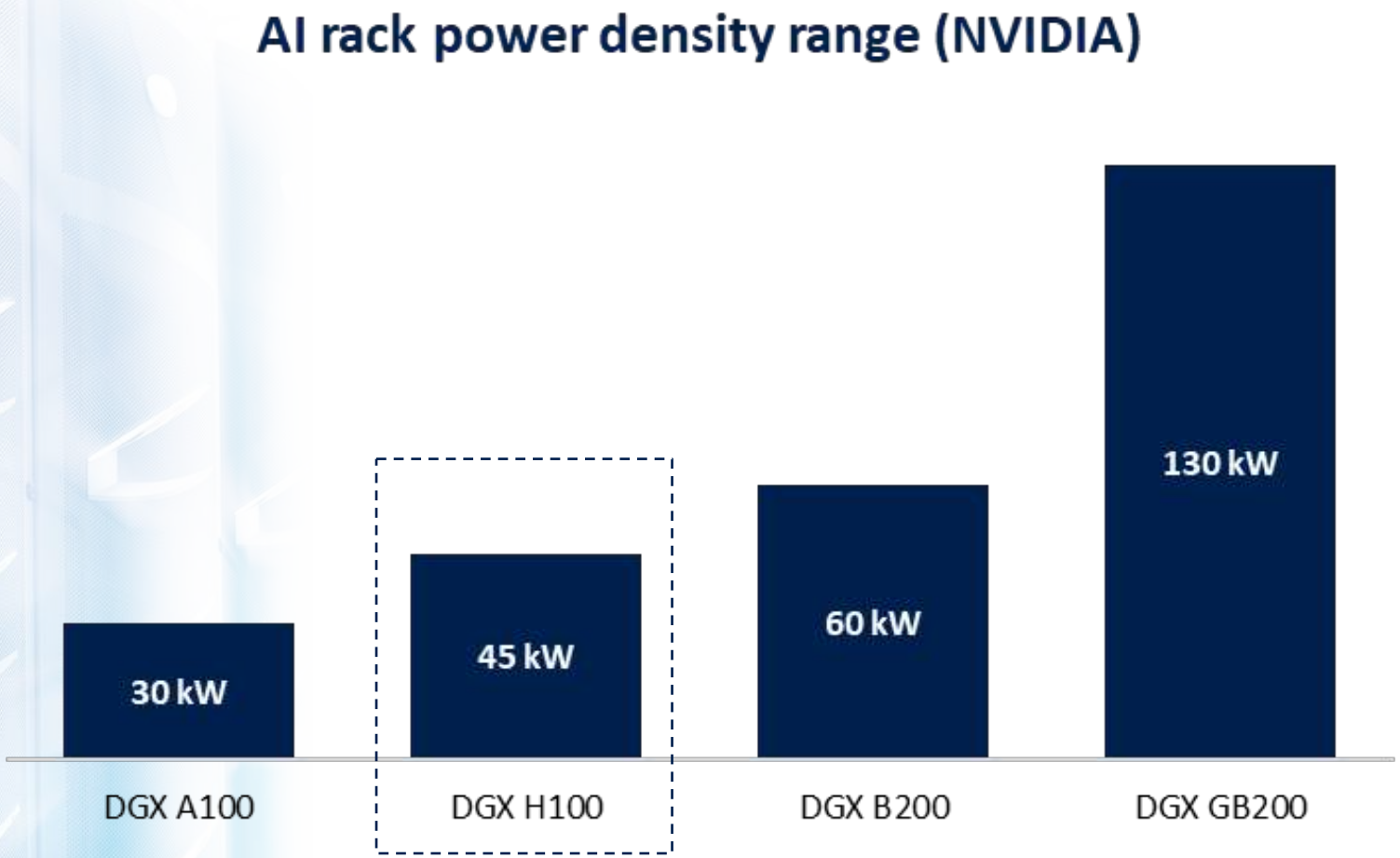


Source: JLL Research, 2024

AI workloads are increasing rack density

Current significance of air cooling

The AI data center market is moving towards greater rack densities



AI workloads are increasing rack density

Current significance of air cooling

NVIDIA DGX H100 – The proven standard for AI infrastructure.

Feature	Specification
Operating Temperature	5° C to 30° C (41° F to 86° F)
Relative Humidity	20% to 80% non-condensing
Airflow	1105 CFM Front-to-Back @ 80% fan PWM
Heat Output	38,557 BTU/hr

Source: NVIDIA

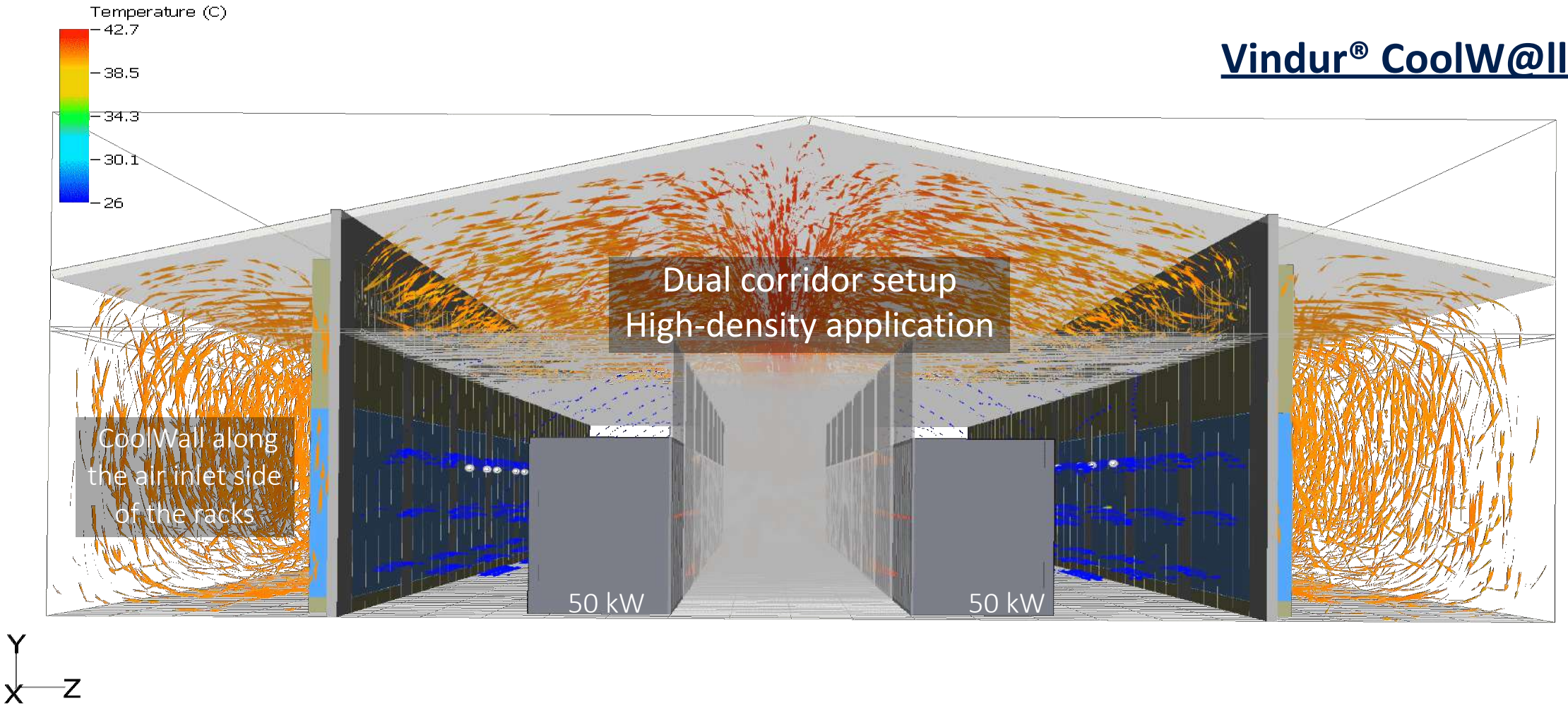
- 8 x H100 Tensor Core GPUs per DGX
- 4 x DGX systems per rack
- Airflow: 7.510 m³/h
- Heat load: 45,2 kW

dT: 18 K

Pushing the boundaries of air cooling to the limits

Current significance of air cooling

Vindur® CoolW@ll®



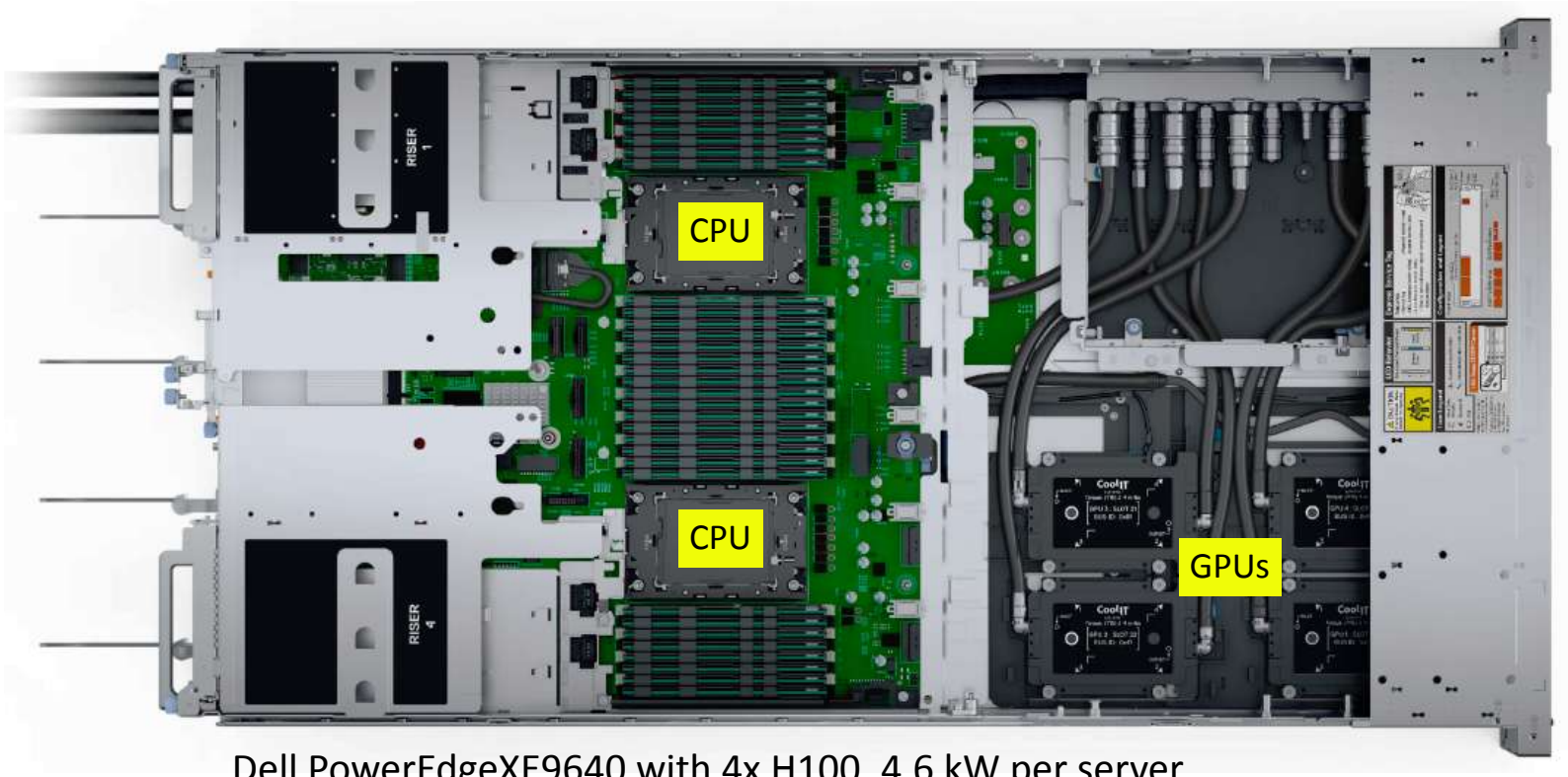
Liquid-cooled servers still rely on air cooling

Future outlook for air-assisted liquid cooling

Direct-to-chip liquid cooling

- CPUs and GPUs are equipped with copper cold plates
- Cold water supply and hot water return circulate and remove the heat load from the CPUs and GPUs.
- Fans are required to collect the heat from non-liquid-cooled parts

15-30 % of the heat load is still dissipated into the room!



Dell PowerEdgeXE9640 with 4x H100, 4,6 kW per server

The future will be HYBRID

Future outlook for air-assisted liquid cooling

Source: NVIDIA

NVIDIA GB200 NVL72 – The next chapter in generative AI.

- 36 Grace Blackwell Superchips in one rack
- Heat load: 132 kW
- Rule of thumb is 70/30:

  130 x 70 % = 91 kW of heat removed by DLC

  130 x 30 % = 39 kW of heat removed by air

- **Liquid cooling is becoming vital for AI DCs**
- **Air Cooling will still play an important role**
- **The future will be HYBRID!**

Rear door heat exchangers as one option for the remaining heat load

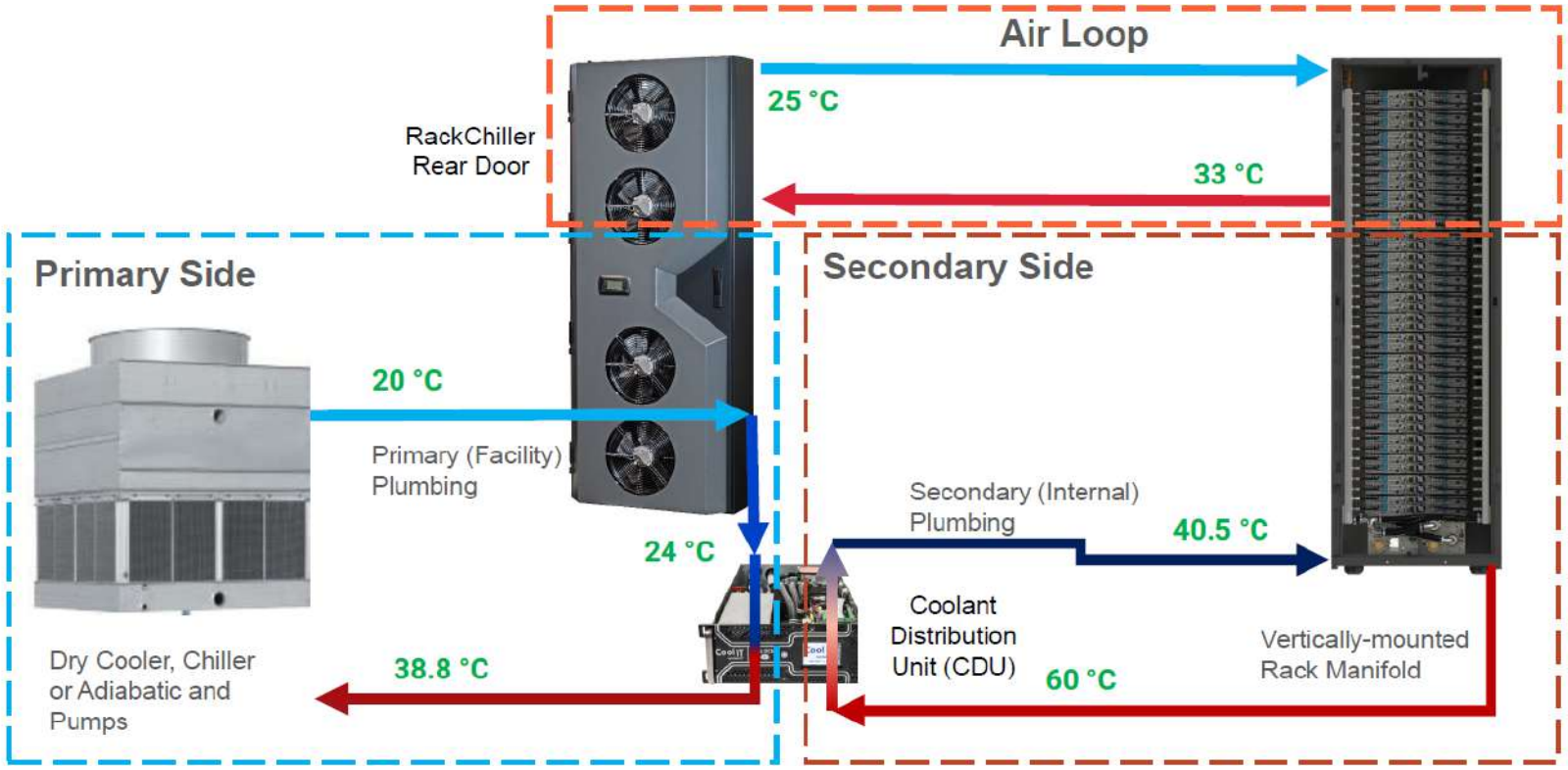
Future outlook for air-assisted liquid cooling

Pros:

- Physical proximity to the heat source => high ratio of real heat transfer to maximal heat transfer

Cons:

- Higher fan power (multiple small fans are less efficient than one large fan)
- Higher CAPEX (multiple units compared to central units)



Source: nVent

CoolWalls (Fan Walls) as one option for the remaining heat load

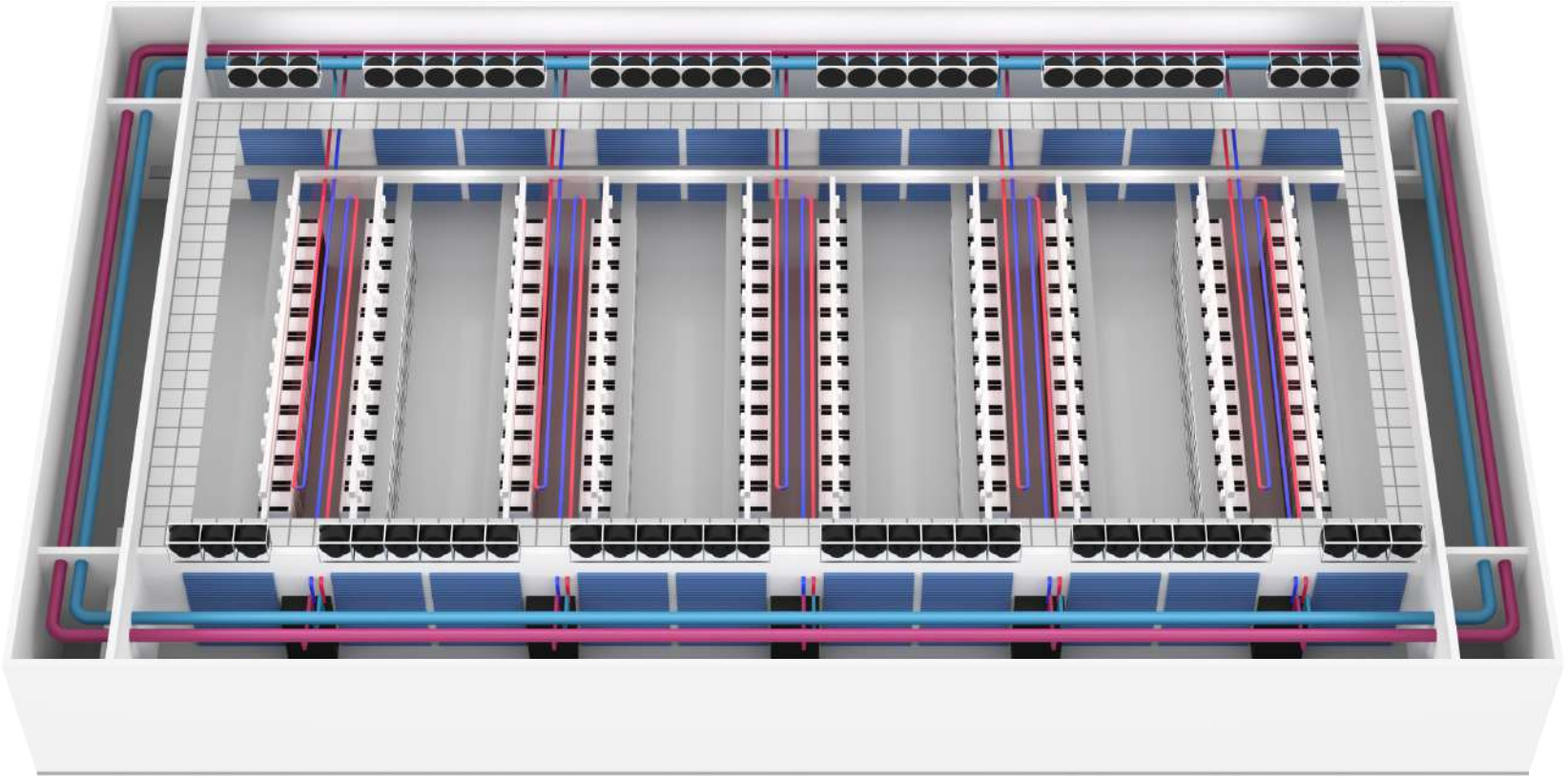
Future outlook for air-assisted liquid cooling

Pros:

- Lower CAPEX with fan walls than with multiple RDHx (including plumbing)
- Clear separation and easier Maintenance as the units are located outside the data hall
- Lower energy consumption

Cons:

- More space is needed as one or two technical corridors are required
- Airtightness must be ensured



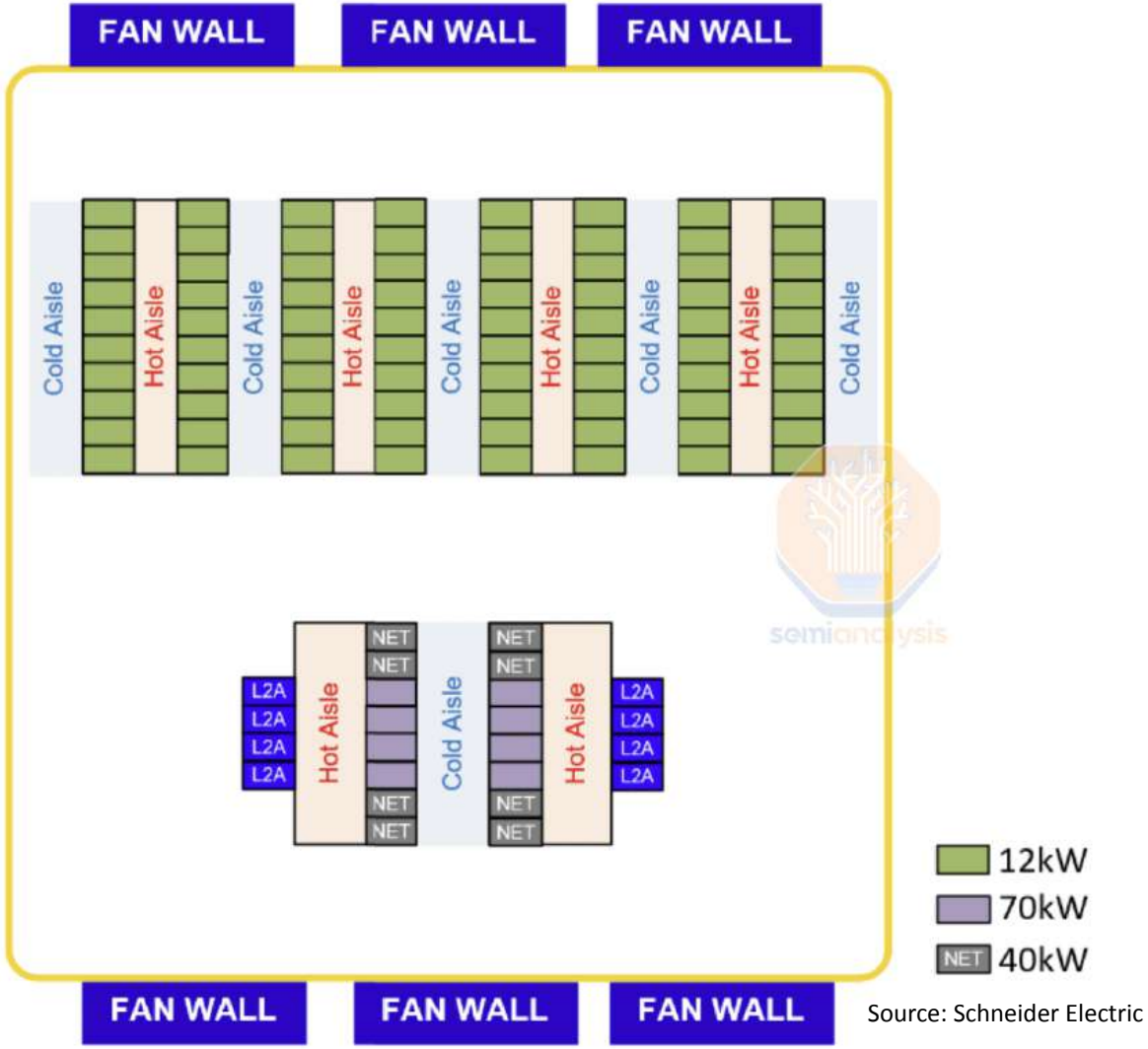
Source: Rittal

CoolWalls (Fan Walls) as one option for the remaining heat load

Future outlook for air-assisted liquid cooling

In a typical data hall of the future:

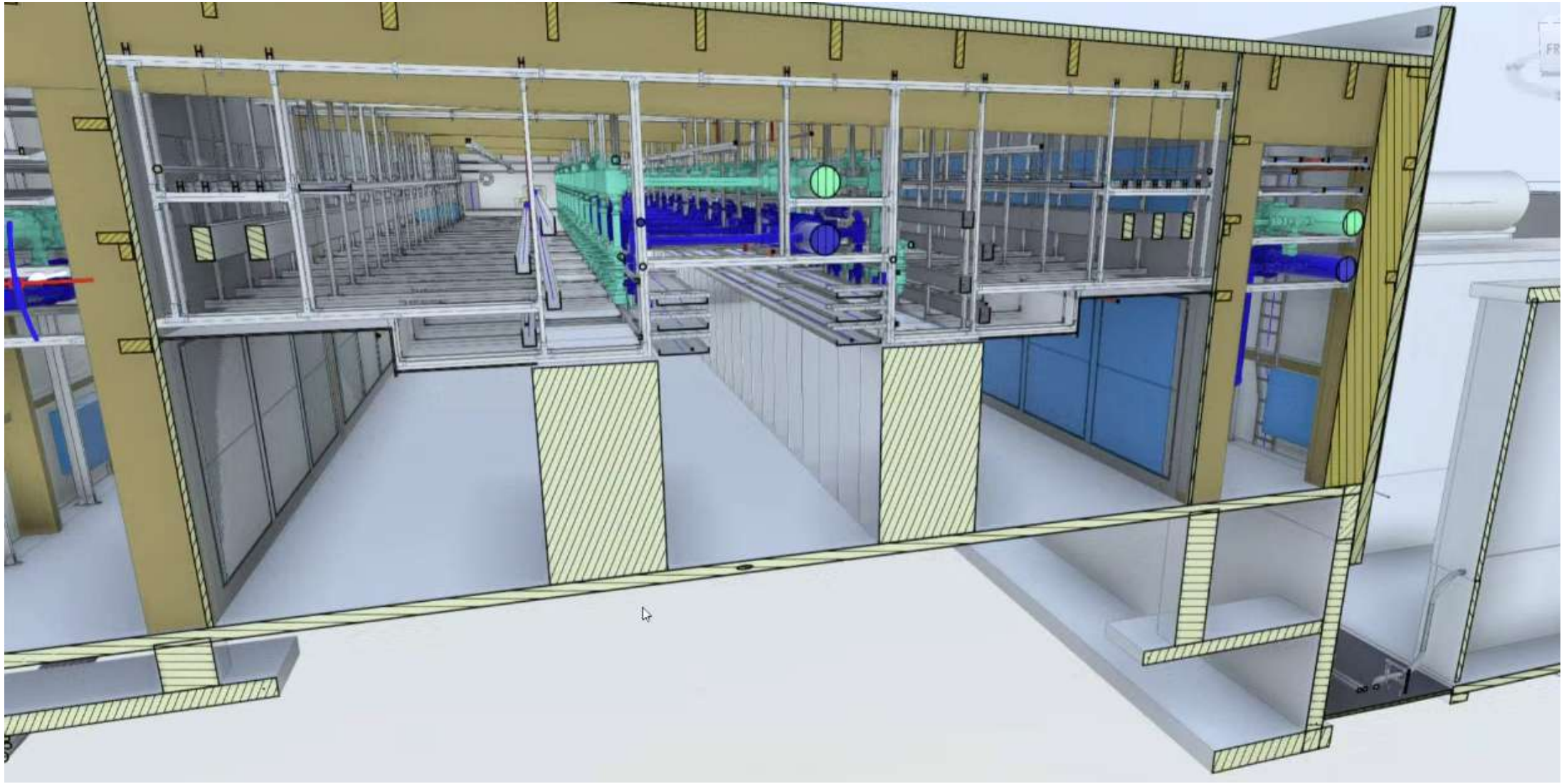
- There will be still ordinary server racks with a lower heat load per rack which will be purely cooled by air
- There will be high-density clusters where the server racks will depend on a mix of direct liquid cooling plus air cooling



Source: Schneider Electric

Hybrid cooling solution consisting of DLC and CoolWall solution

Current significance of air cooling

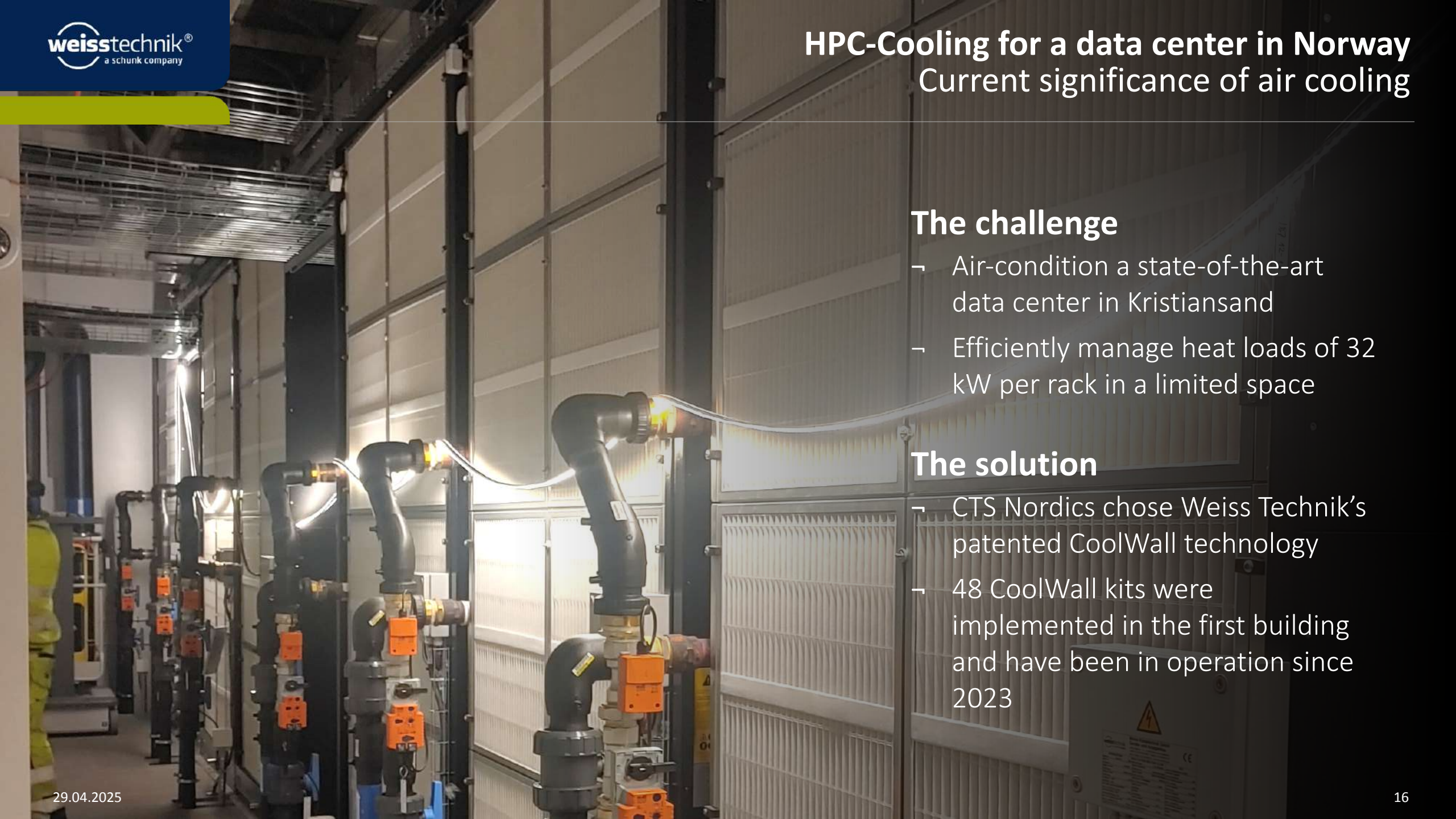


Minimization of the technical corridor

Current significance of air cooling

Source: Vantage

HPC-Cooling for a data center in Norway
Current significance of air cooling



The challenge

- Air-condition a state-of-the-art data center in Kristiansand
- Efficiently manage heat loads of 32 kW per rack in a limited space

The solution

- CTS Nordics chose Weiss Technik's patented CoolWall technology
- 48 CoolWall kits were implemented in the first building and have been in operation since 2023

Best-in-class room-based air cooling

Current significance of air cooling

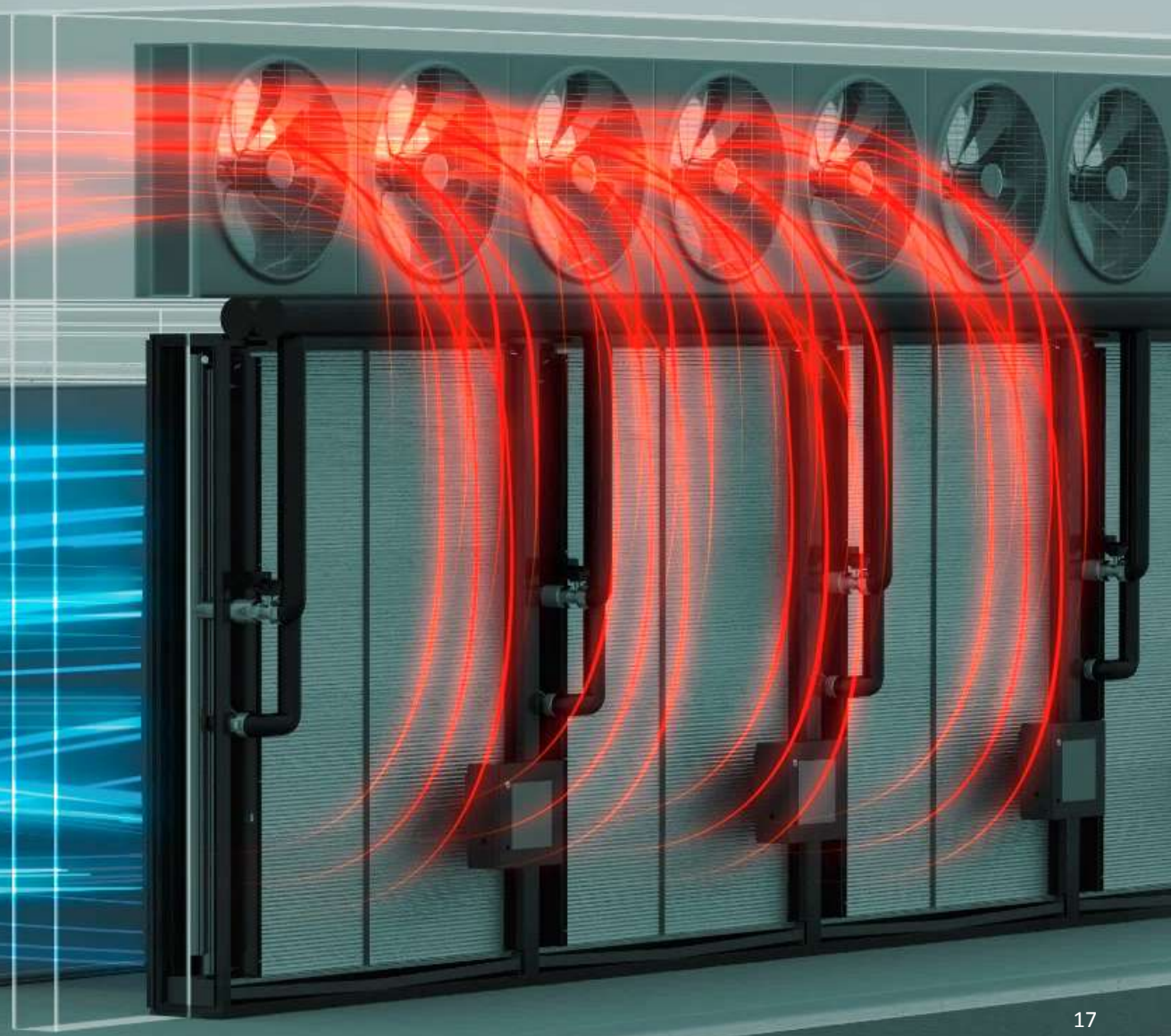
Cooling wall system

Built-in solution that maximizes cooling potential

- ¬ Utilizing almost the entire room height/width
- ¬ Transforming service corridor into a walk-in cooling chamber

  - Enlarged coil and filter surfaces
  - Reduced internal pressure losses
  - Minimized floor space requirement

Highest capacity per footprint and minimal power consumption!



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