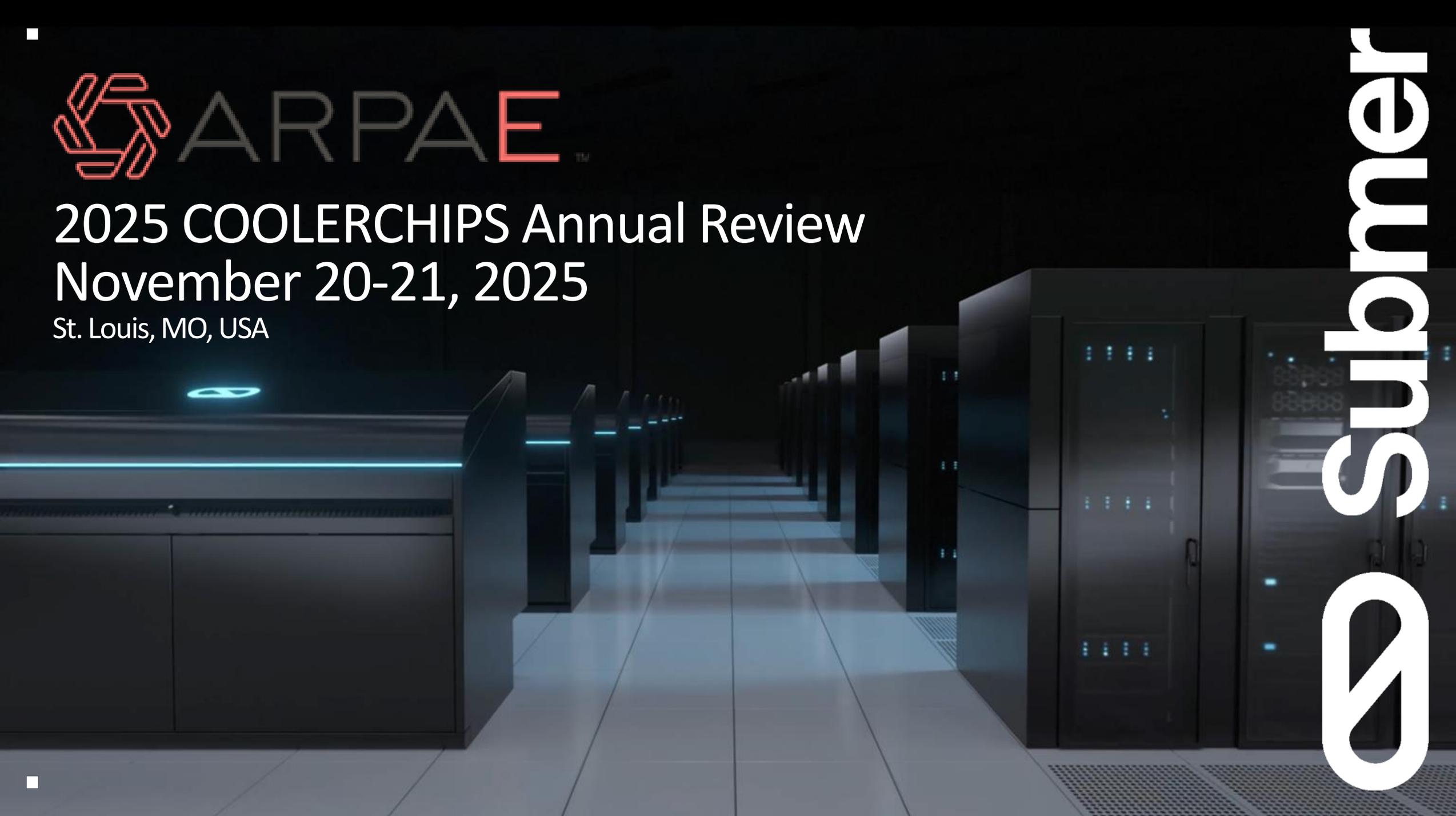# 2025 COOLERCHIPS Annual Review
November 20-21, 2025
St. Louis, MO, USA

02.

Requirements for next-generation HPC/AI-acceleration hardware

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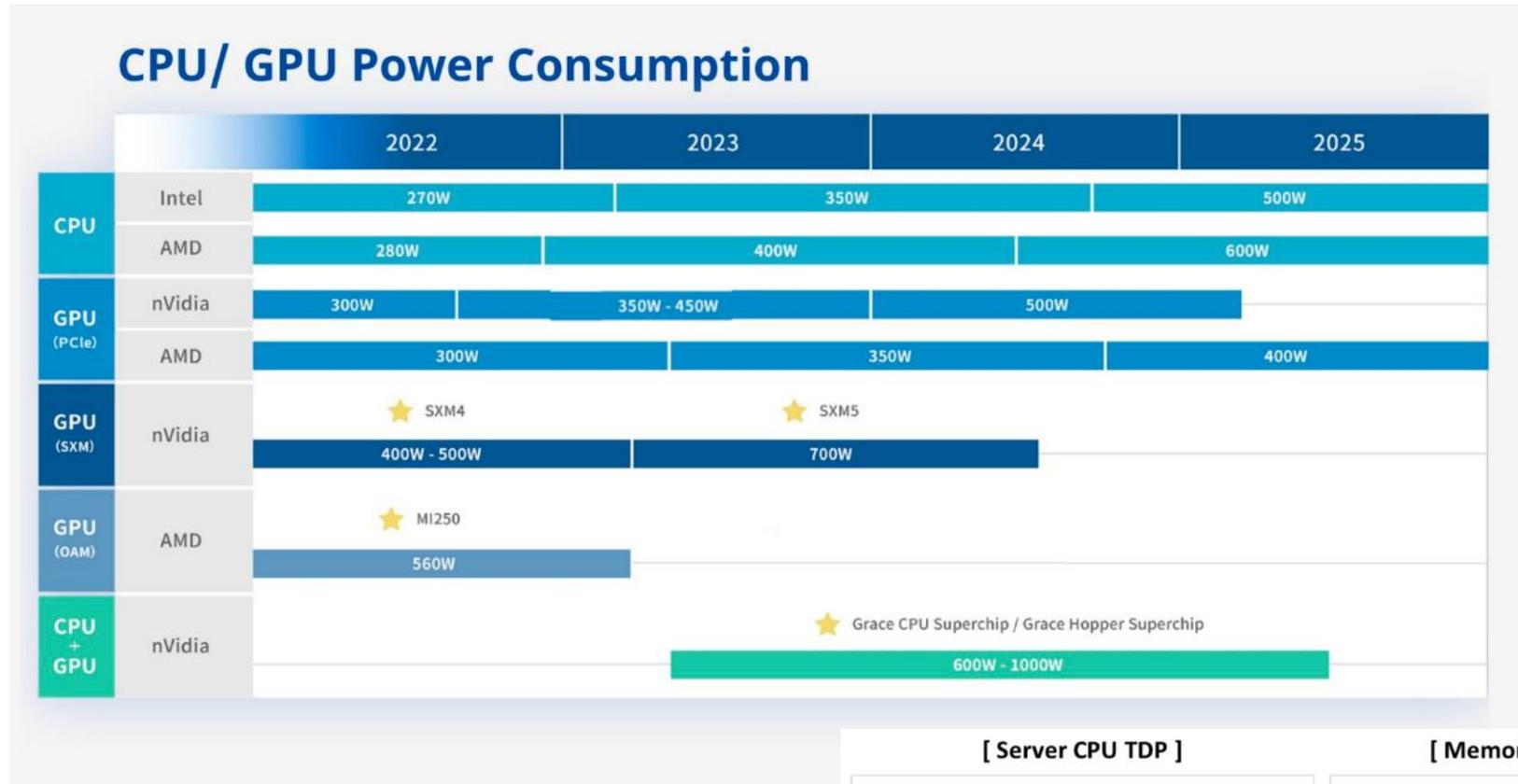Increasing Chip TDPs:
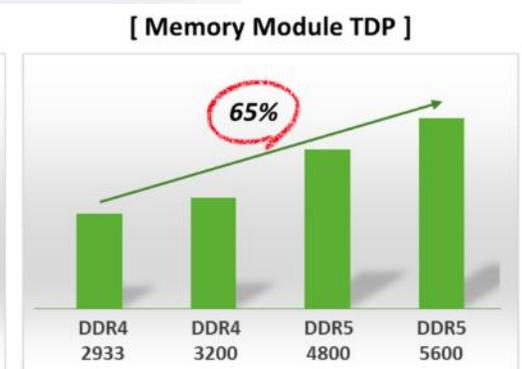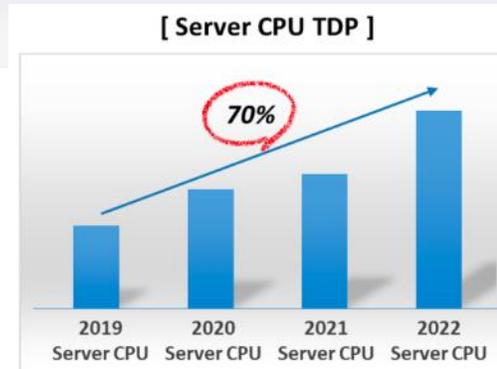
Increasing Chip TDPs

CPU/ GPU Power Consumption

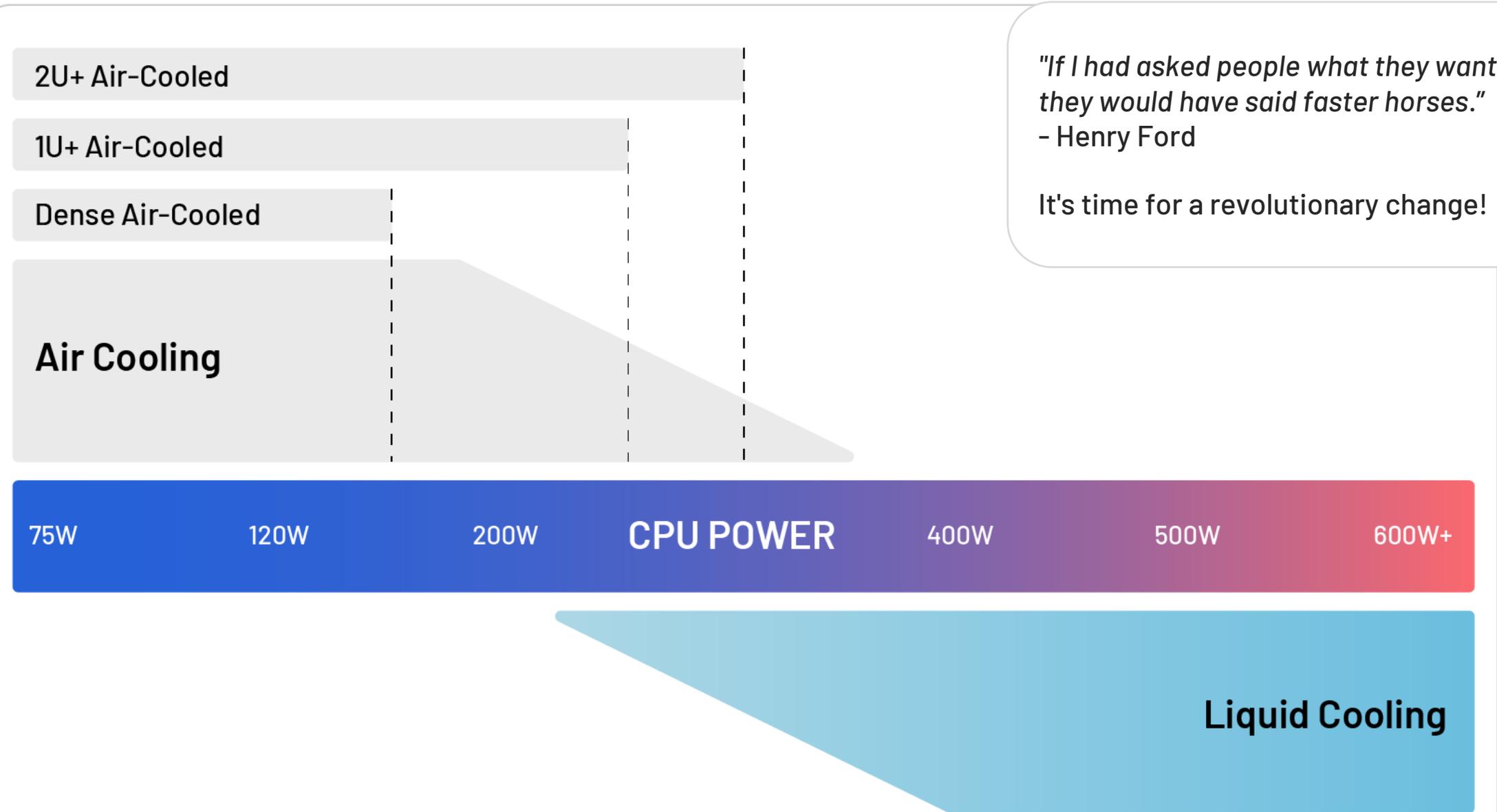|		2022	2023	2024	2025
CPU	Intel	270W	350W		500W
	AMD	280W	400W		600W
GPU (PCIe)	nVidia	300W	350W - 450W	500W	
	AMD	300W	350W		400W
GPU (SXM)	nVidia	⭐ SXM4 400W - 500W	⭐ SXM5 700W		
GPU (OAM)	AMD	⭐ MI250 560W			
CPU + GPU	nVidia		⭐ Grace CPU Superchip / Grace Hopper Superchip 600W - 1000W		

- **CPUs & GPUs are heating up, as well as other components**

- **3 main silicon manufacturers are following the same trend**

[Server CPU TDP]

70%

2019 Server CPU | 2020 Server CPU | 2021 Server CPU | 2022 Server CPU

[Memory Module TDP]

65%

DDR4 2933 | DDR4 3200 | DDR5 4800 | DDR5 5600

Limitations of Air Cooling

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2U+ Air-Cooled

1U+ Air-Cooled

Dense Air-Cooled

Air Cooling

"If I had asked people what they wanted, they would have said faster horses."
– Henry Ford

It's time for a revolutionary change!
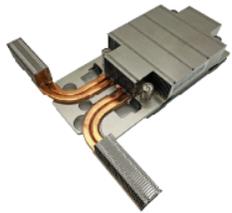
| 75W | 120W | 200W | CPU POWER | 400W | 500W | 600W+ |

Liquid Cooling

Limitations of Air Cooling

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Air Cooling

Traditional Heat Sink can be supplemented with heat pipes, drop-in compatible.

Enhanced Volume Air Cooling adds hardware, requiring area outside the board.

Liquid Cooling

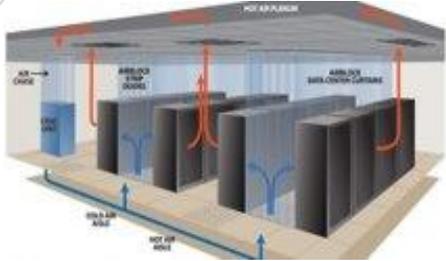Immersion offers 100% heat capture with liquid in direct contact with equipment.

Direct Liquid Cooling (DLC) offers roughly 60% heat capture.

| Down to 1.3 / 1.2 | PUE | Down to 1.03 |

Overview of Main Cooling Technologies

Air-to-Air

Cannot cope with current (let alone future) IT hardware cooling needs

Low power density – large & expensive buildings

Lower air temperatures required

Excessive power and/or water consumption

Heavy use of HVAC systems

Direct Liquid Cooling (DLC)

Whole solution coming from the server vendor - least disruptive transition from air

High heat dissipation capacity

Complexity compromises reliability

Risk of leakage into the IT HW

Cooling DIMMs and other components present a challenge

Requires custom solutions and can lead to vendor lock-in

Requires significant air cooling

Time-consuming servicing

Single-Phase Immersion Cooling

New operating procedures, somewhat disruptive

High heat dissipation capacity

Simple & reliable

Future-proofs facilities – fast adoption of new technologies

Same immersion infrastructure support multiple server generations

No server vendor lock-in

Most competitive TCO

Biodegradable fluid

Less noisy environment

Two-Phase Immersion Cooling

New, disruptive

High heat dissipation capacity

Presents health risk – toxic "forever" chemicals

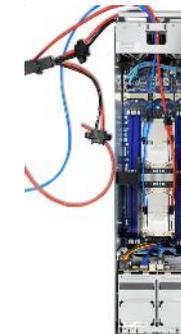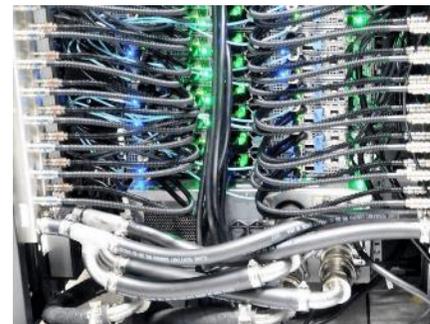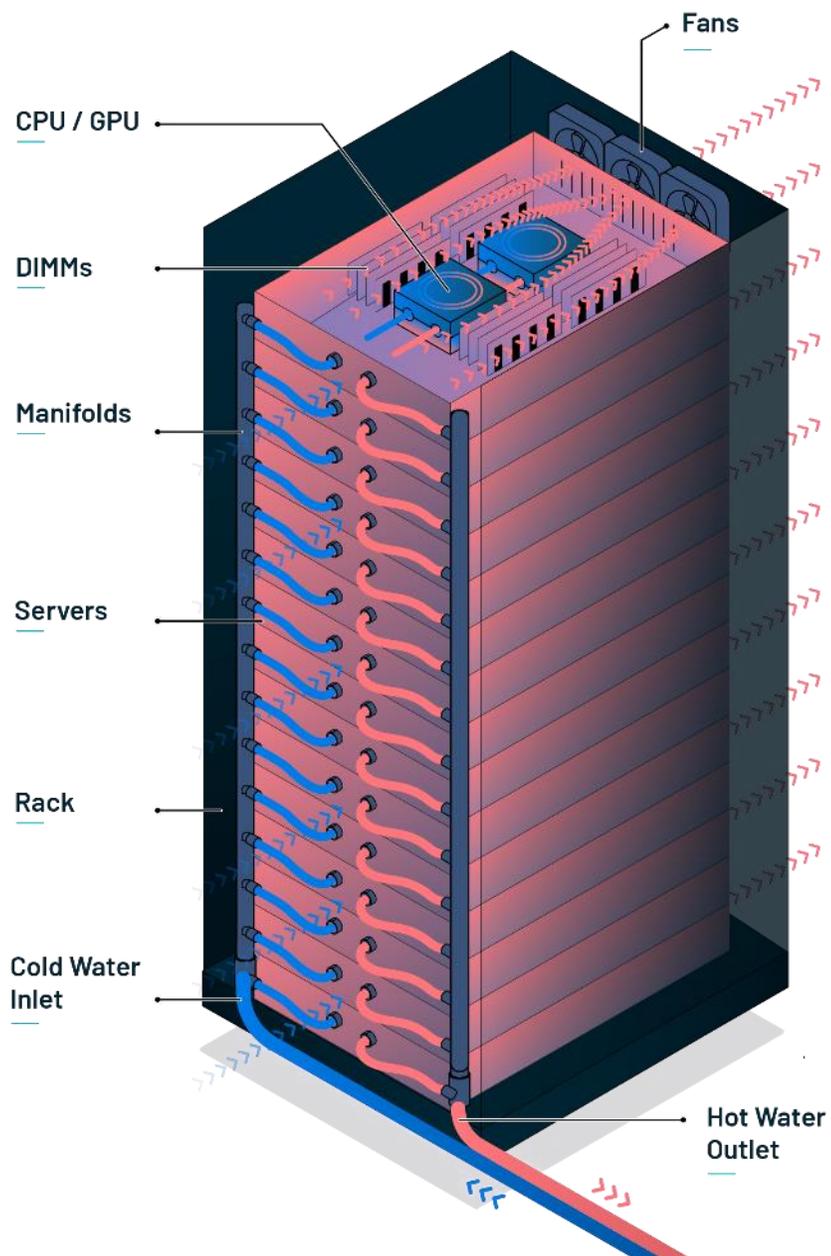Requires overengineered tanks & complex filtration systems

Fluid evaporation means complex servicing

Expensive fluid (~$90/kg)

Environmentally dangerous

Regulation restrictions

Direct Liquid Cooling (DLC)

Pros & Cons

- Perceived as the least disruptive transition from air

- High-complexity and risk of leaks

- Huge amounts of copper required

- Can lead to vendor lock-in

- Challenge of cooling large quantity of DIMMs and other components

- Cost of cooling built into the most abundant and expensive component in the DC: the compute

DLC vs Single-Phase Immersion Cooling

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|	Perception	Reality
Direct Liquid Cooling (DLC)	Familiar Innovative Straightforward Easy to implement Widely accepted Good TCO	Complex Compromised reliability Risk of leaks Complex and time-consuming operation Supported by OEMs/ODMs Cooling cost on servers - refreshed every 3-5 years + vendor lock-in
Immersion Cooling	Disruptive Messy operation Expensive Not supported by OEMs/ODMs Less power density (tank)	Simple and reliable New operating procedures Cooling cost on the infrastructure Immersion-born SKUs & growing support Future-proof datacenters

Two-Phase Immersion Cooling
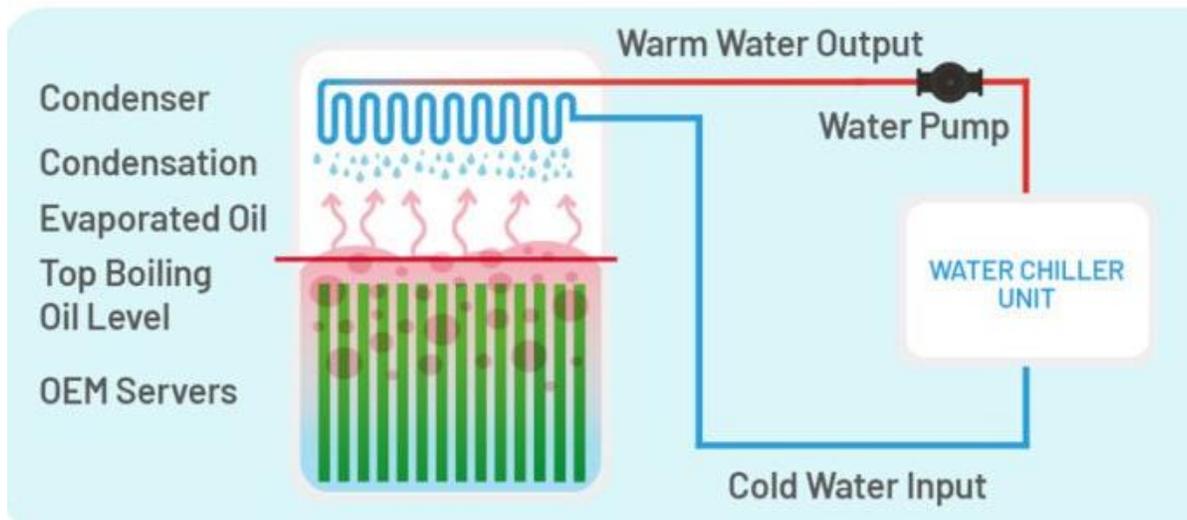
Pros & Cons

- High heat dissipation capacity

- Complex systems

- Health risk - chemical toxicity challenges

- Environmentally dangerous – PFAS (forever chemical)

- Now considered toxic – 3M to cease manufacturing
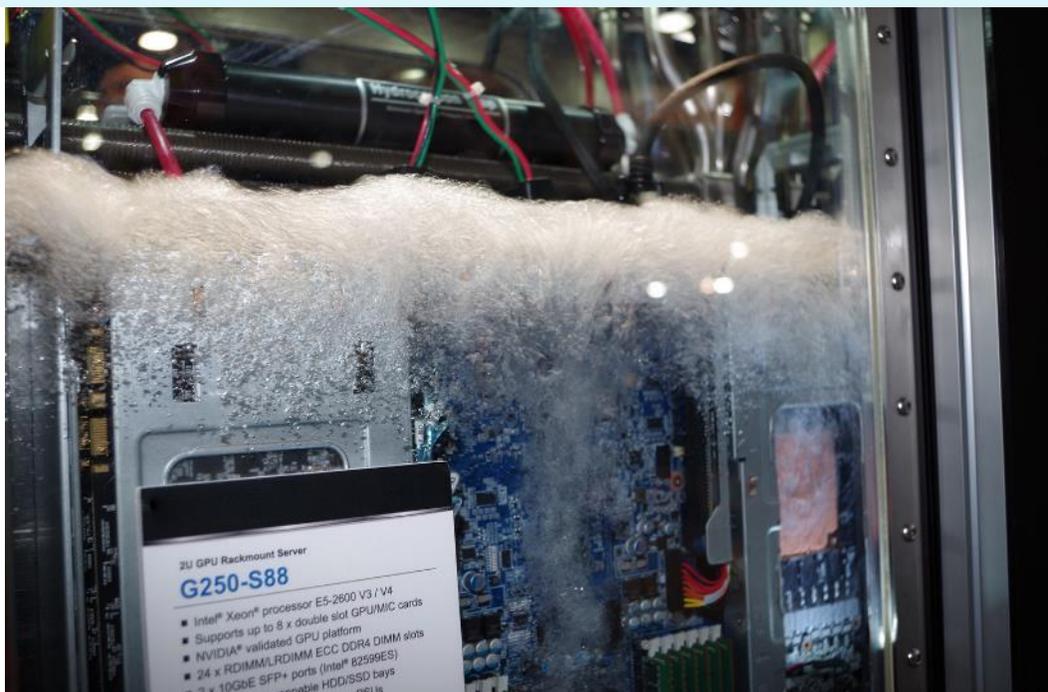
June 2, 2023, 1:00 PM

3M Heads to Trial in 'Existential' $143 Billion PFAS Litigation

Jef Feeley
Bloomberg News

Ryan Beene
Bloomberg News

- First PFAS case to go before a jury is set to kick off June 5
- Litigation risk has made 3M stock 'uninvestible,' analyst says

3M Co. faces an existential threat from lawsuits over allegedly cancer-linked "forever chemicals" that have leached into municipal water supplies, with the company's liability possibly hitting $143 billion for cleanup alone.

The first trial out of some 4,000 lawsuits against 3M, many by state and local governments, over pollution caused by per- and polyfluoroalkyl substances, or PFAS, is set to start June 5 in federal court in Charleston, South Carolina. PFAS have been used for decades in products ranging from nonstick pans to cosmetics, but they don't break down naturally and can settle in soil, water or human bodies.

Topics

Settlements

Chemical Product Safety

Cosmetic Product Safety

Punitive Damages

PFAS

Companies

3M Co
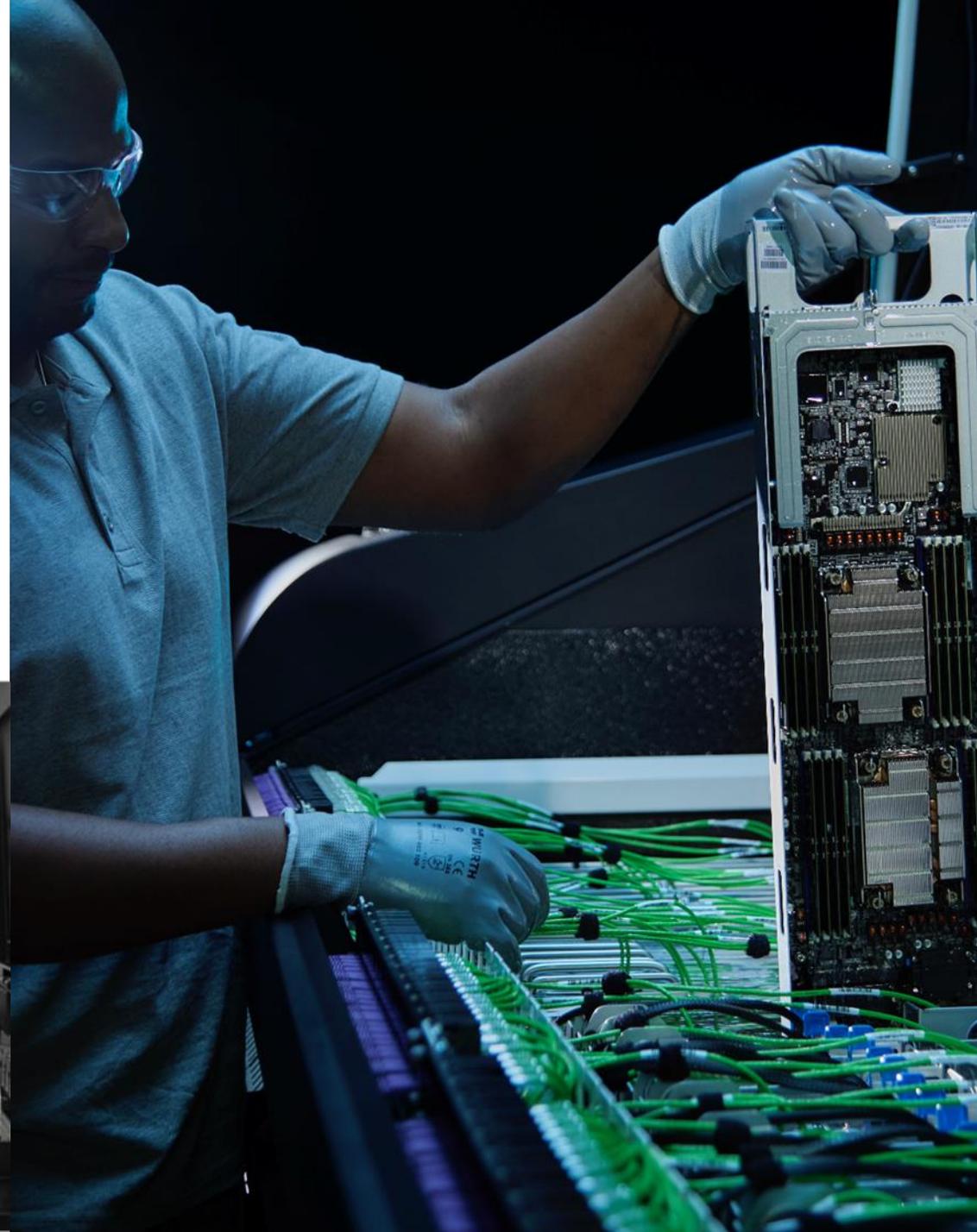
DowDuPont Inc

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Immersion Overview

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High Density Meets Simplicity

Single-Phase Immersion Cooling

CDU

Servers

Smart Coolant

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Pod
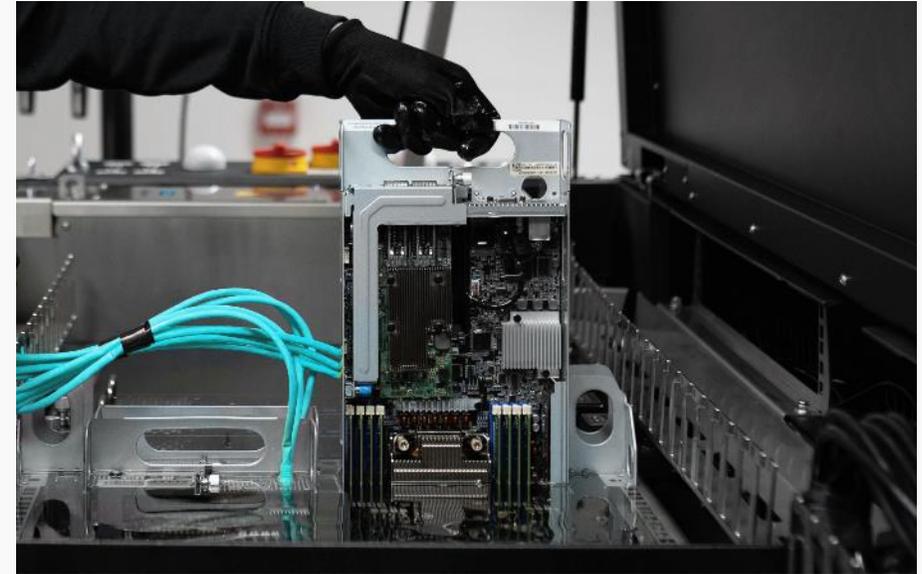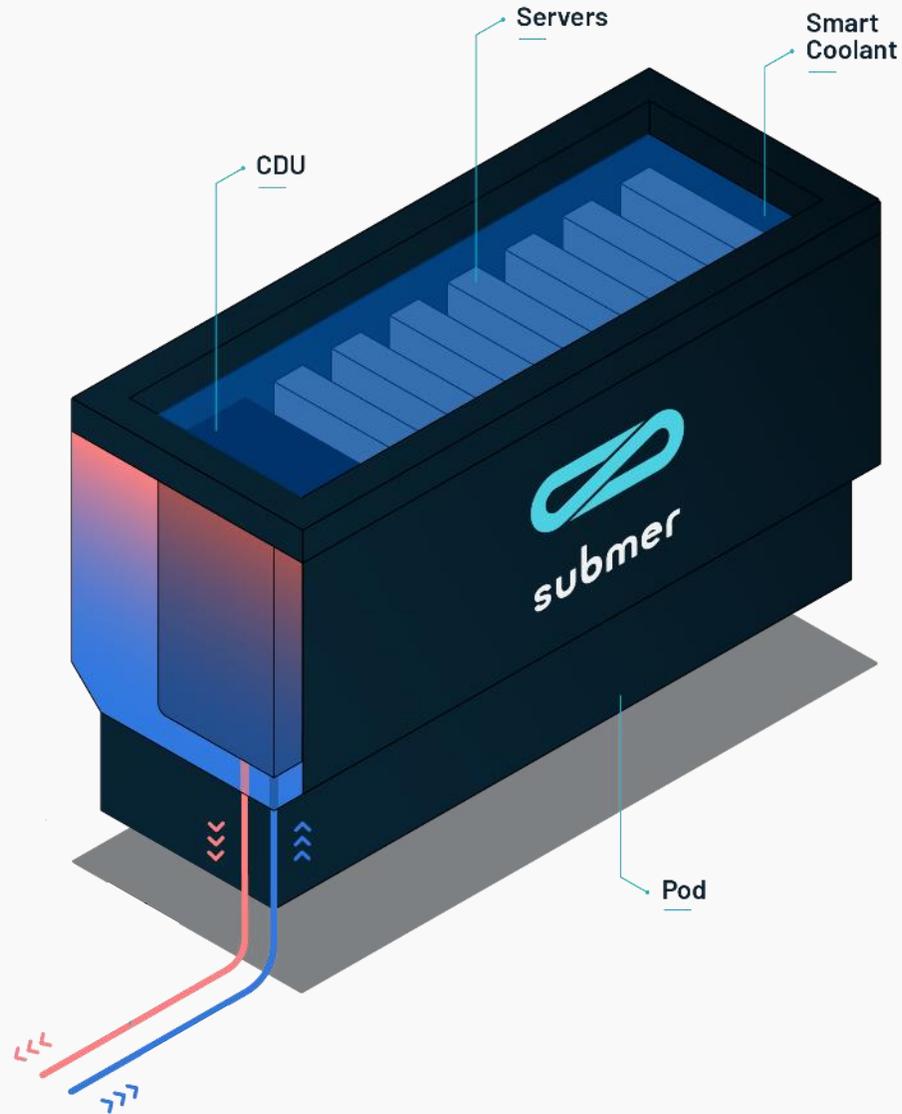
Features:

- High heat dissipation capacity

- Simple & reliable

- Future-proof facilities – fast adoption of new technologies

- Competitive TCO – Same immersion infrastructure supports multi-vendor generational HW refreshes

SmartPod EXO: How does it work?

SmartPod EXO

submer

**Enduring Performance
to Rely On**

SmartPod EXO: Key Features

Setting new standards in performance, our immersion cooling solution ensures your datacenter is future-proof and climate-resilient.

SmartPod EXO

Reliable Performance

High availability (5x9s)*
Concurrent maintainability*
Dissipate up to 361kW **

Climate Resiliency

Heat reuse & free cooling optimized
Opportunity to completely eradicate direct water usage

Smooth & Predictable Daily IT Operations

Modular cable management
Ready for standard 19" patch panels & accessories
PDUs in dry zone

(*) Requires a SmartPod EXO Twin Tank, together with external ATS and UPS and specific operating conditions.

(**) Requires a SmartPod EXO Unitank and specific operating conditions.

SmartPod EXO: Easy & Predictable Daily IT Operations

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Operations That Make Sense

Independent access for IT at the front and power distribution at the back for seamless operation.

Capillarity Prevention

Patch panels between wet & dry zones prevent capillarity.

Standard cables in dry zone and immersion-ready cables in wet zone only, for both power and network.

PDUs in Rear Dry Zone

PDUs can be serviced without interacting with the wet zone.

SmartPod EXO: Main Components

Front Dry Zone (3)

Configurable with standard 19" accessories, and suitable for switches and networking cabling.

Protects the equipment and provides access to the communication ports without removing any panels.

Integration Kit (4)

Pipe sections connecting the CDUs and the tanks for the immersion fluid to circulate within the closed loop.

Rear Dry Zone (5)

Holds standard high-power PDUs, with configurable accessories for power distribution cabling.
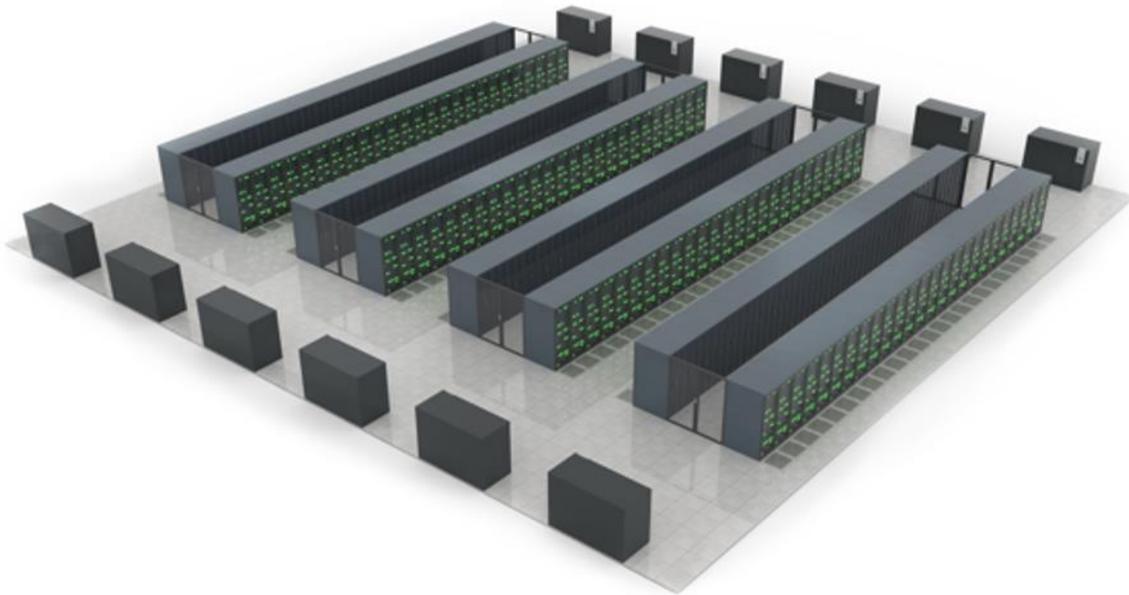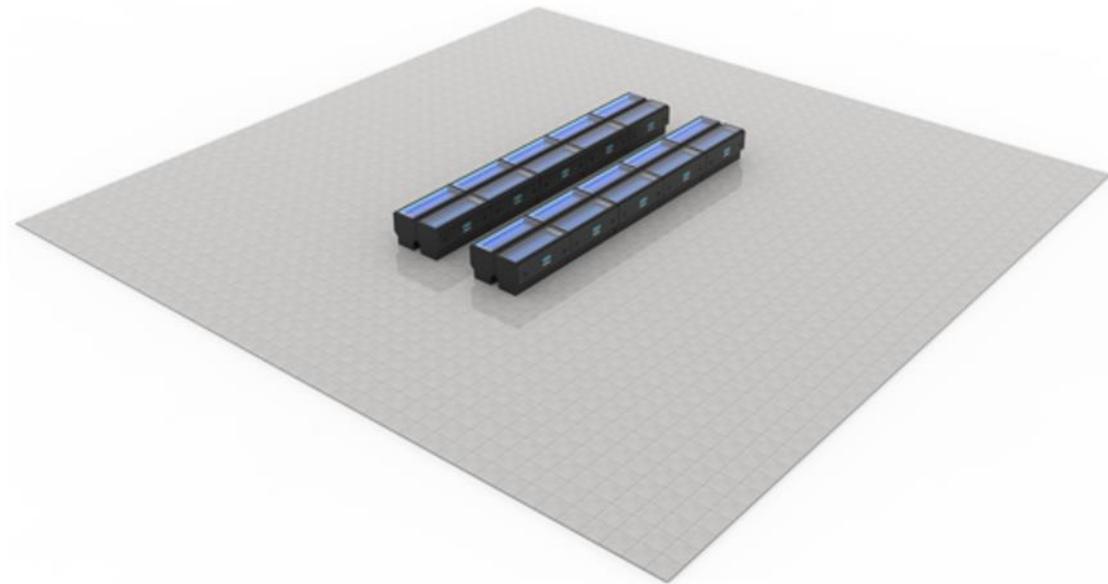
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Immersion Advantages

—

Ultra-dense using <u>less space, less power, and 99% water savings</u>

200 regular air-cooled racks

20 SmartPods

CPU Clock Rates – Air vs Immersion

•**SpeedStep Technology**:
- Designed to balance performance with power efficiency.
- Dynamically adjusts CPU frequency based on current tasks.
- Helps extend battery life in laptops and reduce thermal output.

•**Turbo Boost (100% Turbo Rate)**:
- Allows the CPU to operate at higher than base clock speeds.
- Engages when demanding tasks are running, provided thermal and power conditions allow.
- Offers maximum performance but consumes more power and generates more heat.

Key Takeaways:

•**Performance vs. Efficiency**: SpeedStep prioritizes energy efficiency, making real-time adjustments, while running at 100% turbo rate prioritizes maximum performance.

•**Use Cases**:
- **SpeedStep**: Ideal for everyday tasks like browsing, emailing, or light productivity work.
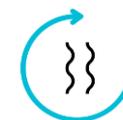- **Turbo Rate**: Best for intensive tasks such as gaming, video editing, or complex computations.
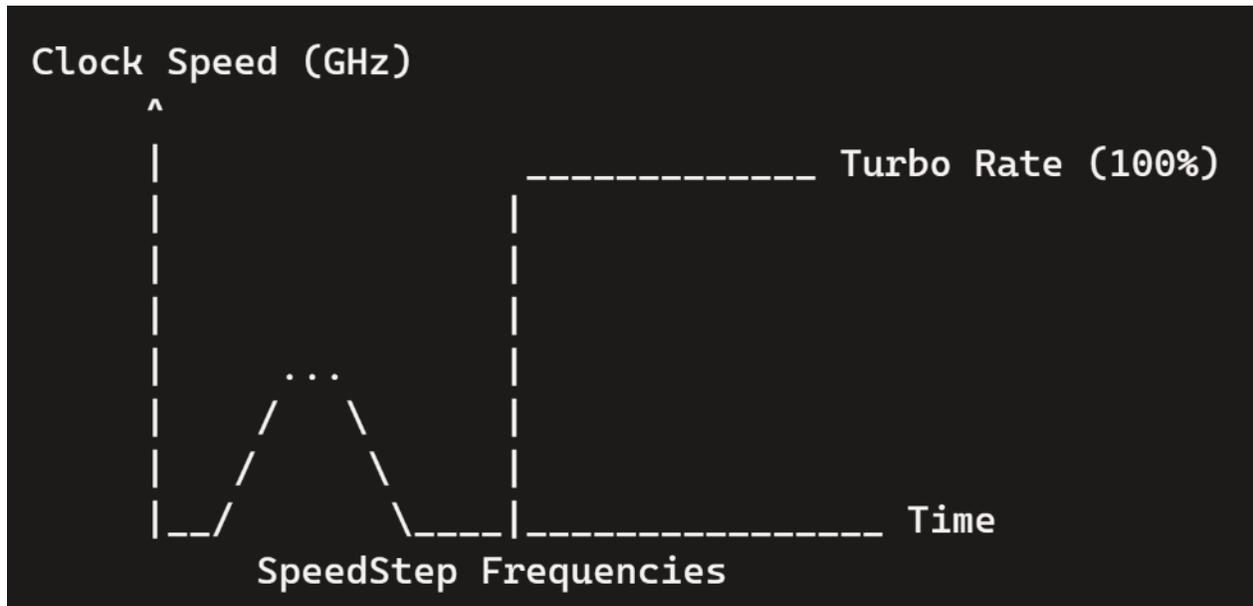
Thermal Consistency
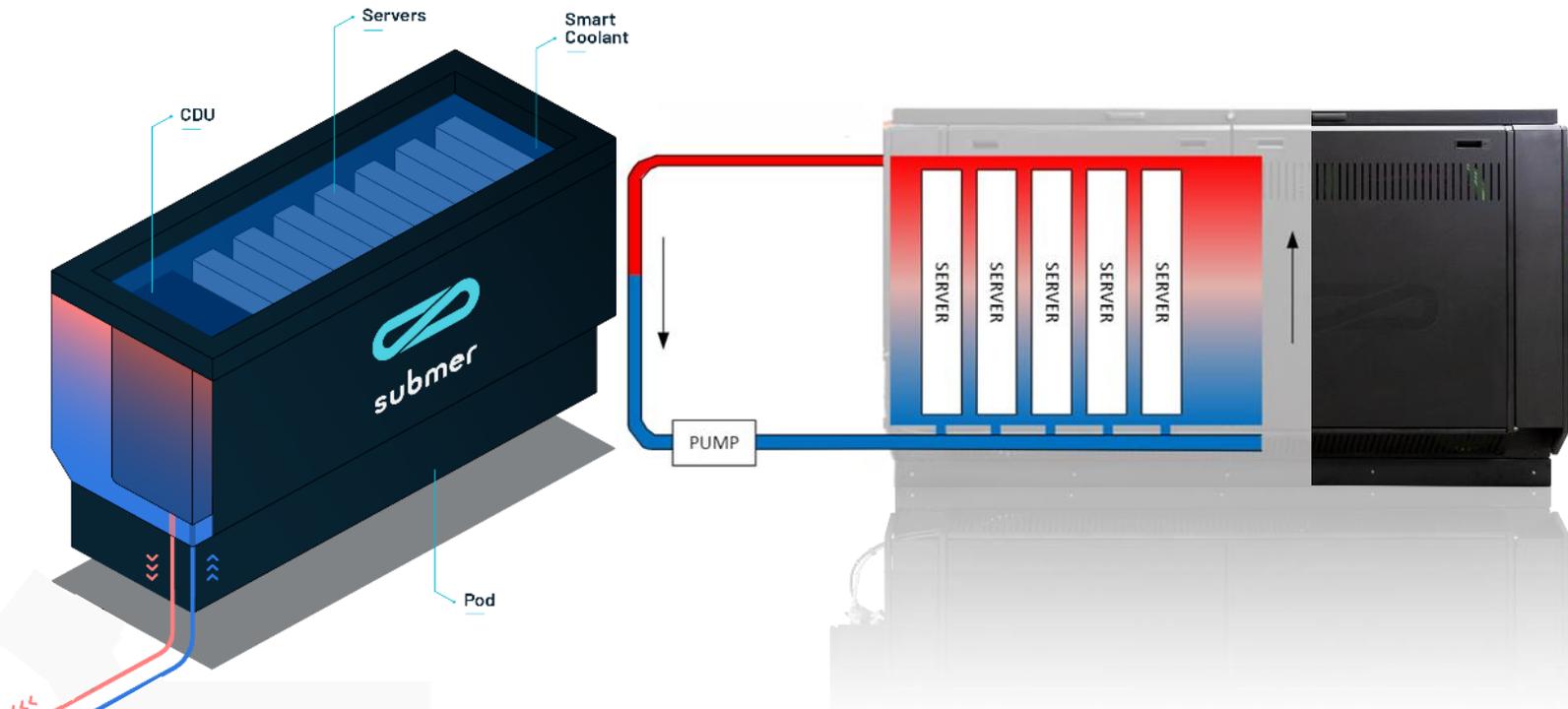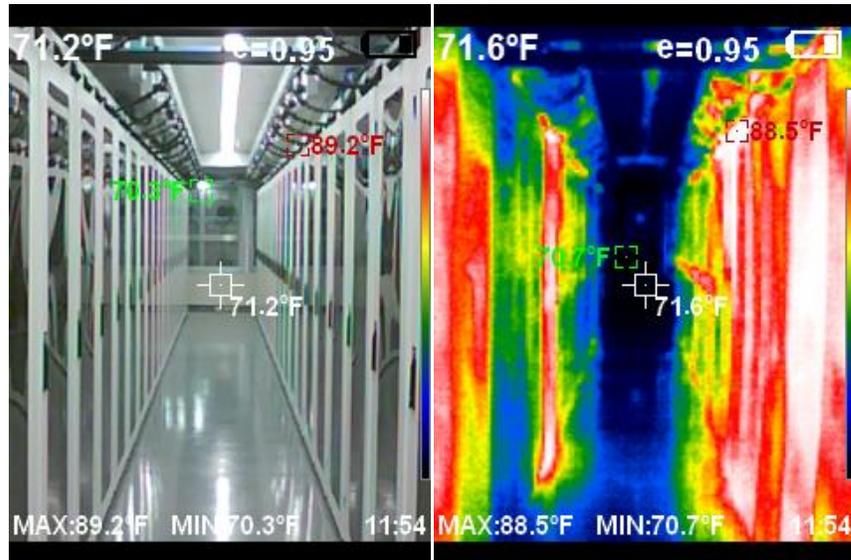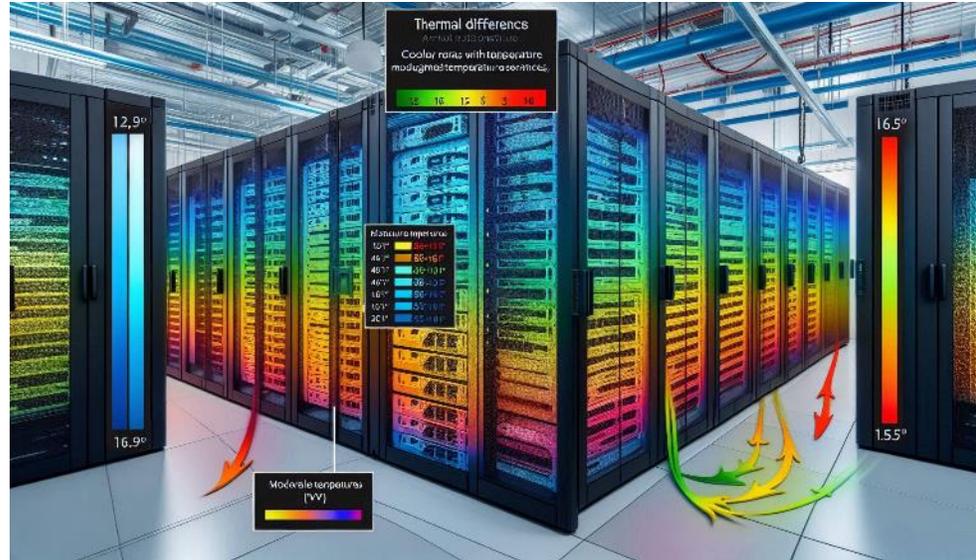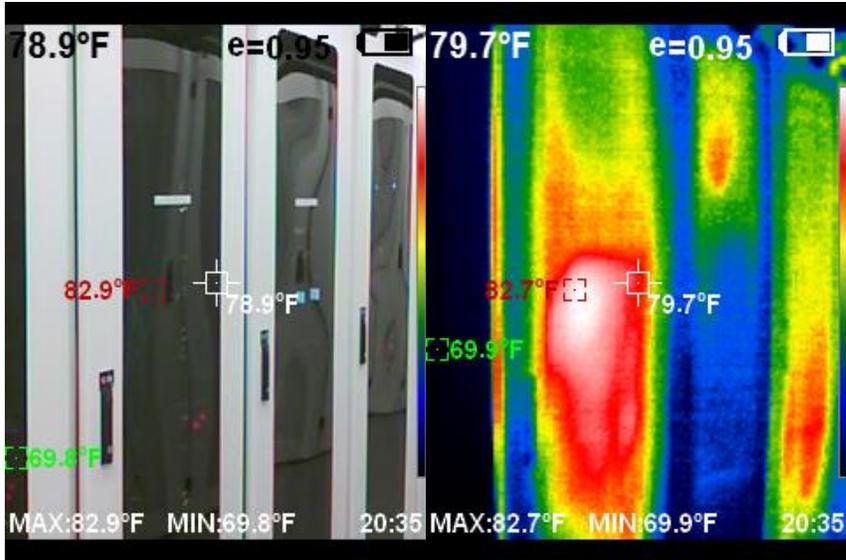
Heat Reuse Opportunities

Projects vary depending on:

DC location

Water temperature range

Local regulations

Heat applications

Why Is Heat Reuse Important?

Biproduct of DC operations

Practically 100% of electricity consumption in data centers is transformed to heat.

Resource Efficiency & Offset of Fossil Fuels

Heat reuse captures thermal energy from data centers, displacing electricity generation and water consumption.

Allows for increased use of free cooling throughout the year.

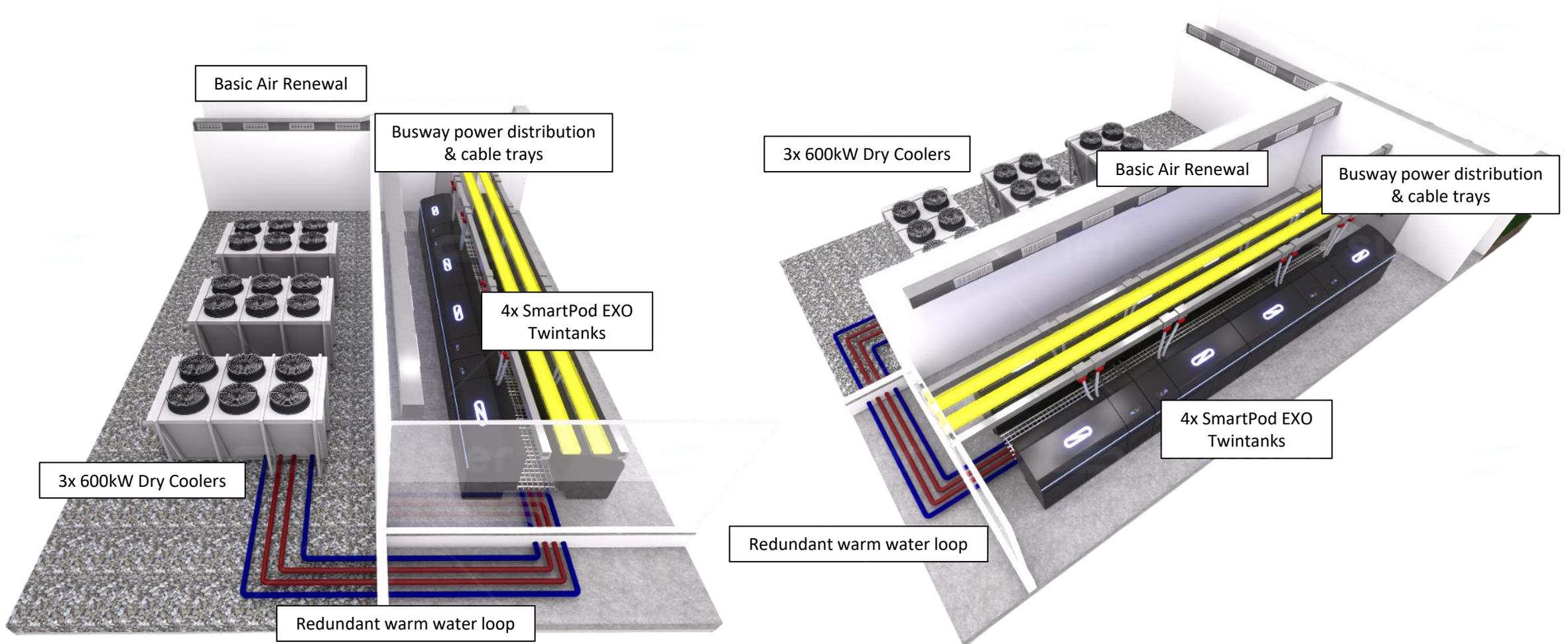**Integration with the Community**

Heat reuse can be central in improving DC reputation and strengthening relationships with local communities.

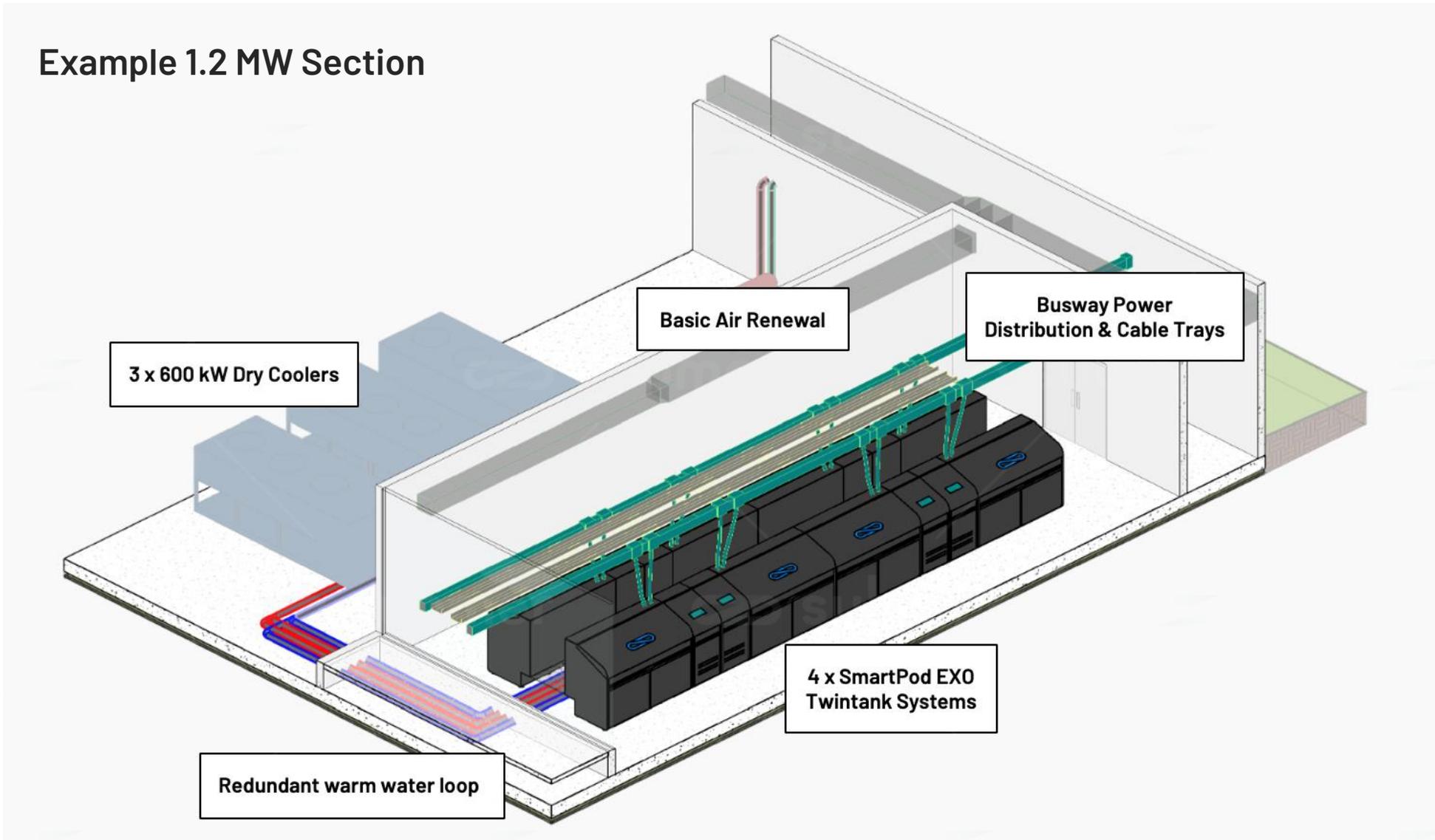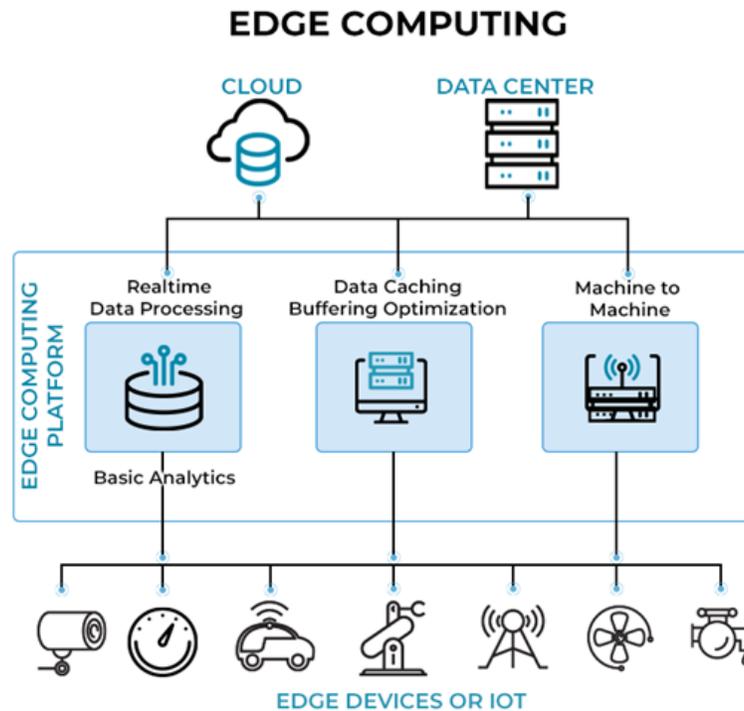Energy is a precious resource that must be shared and used efficiently!

SmartPod EXO: Dry Cooling – Deployment Example

Example 1.2 MW Section

Basic Air Renewal

Busway power distribution & cable trays

4x SmartPod EXO Twintanks

3x 600kW Dry Coolers

Redundant warm water loop

3x 600kW Dry Coolers

Basic Air Renewal

Busway power distribution & cable trays

4x SmartPod EXO Twintanks

Redundant warm water loop

SmartPod EXO: Dry Cooling – Deployment Example

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Example 1.2 MW Section

3 x 600 kW Dry Coolers

Basic Air Renewal

Busway Power Distribution & Cable Trays

4 x SmartPod EXO Twintank Systems

Redundant warm water loop

PoC – Immersion Cooling Facility

TECH ROOM B (UPS)

A

B

EDGE COMPUTING

CLOUD

DATA CENTER

EDGE COMPUTING PLATFORM

Realtime Data Processing

Data Caching Buffering Optimization

Machine to Machine

Basic Analytics

EDGE DEVICES OR IOT
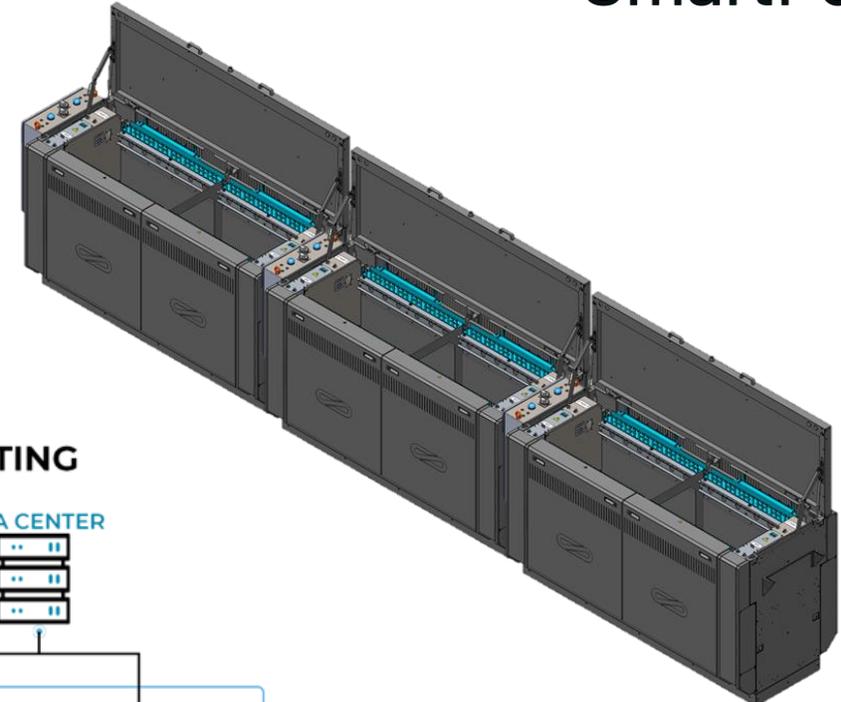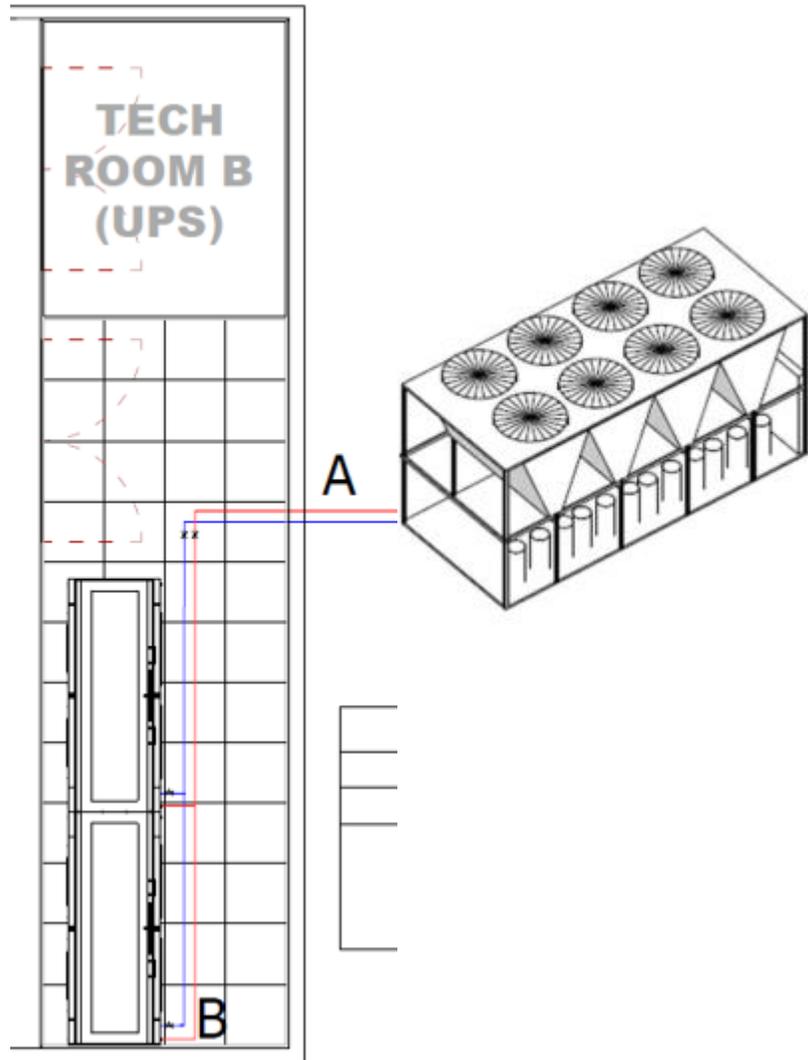
Using Immersion Cooling at High Temps
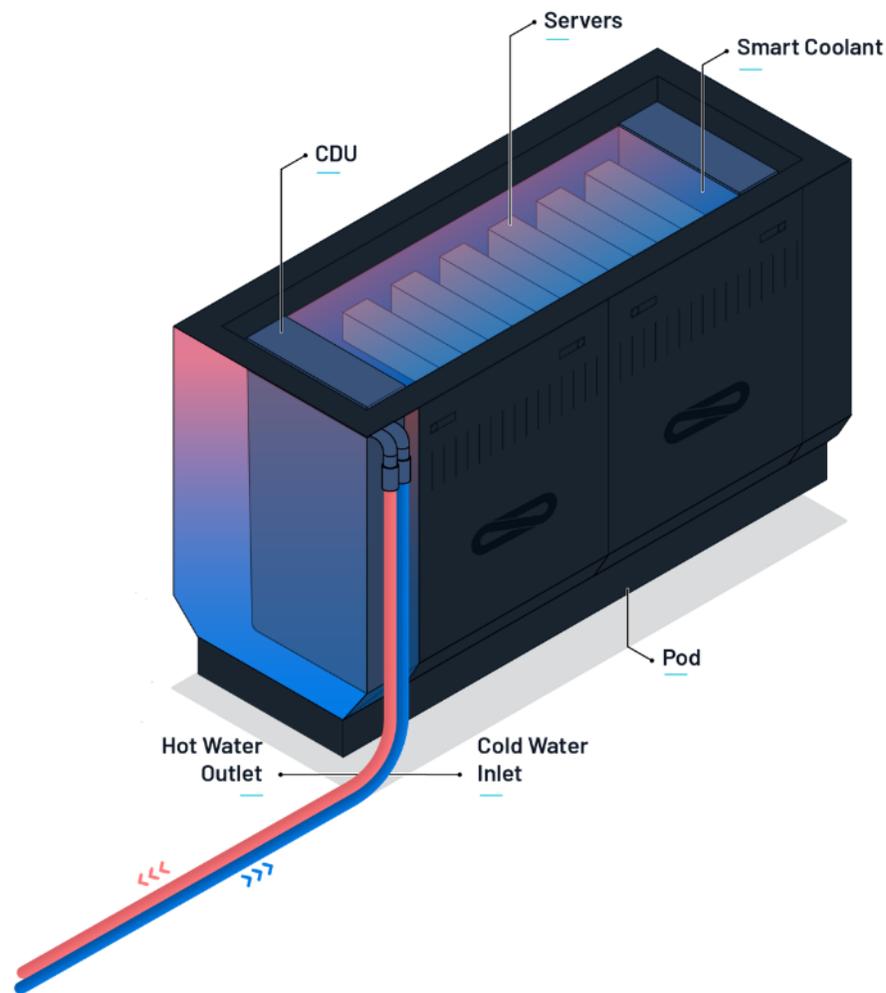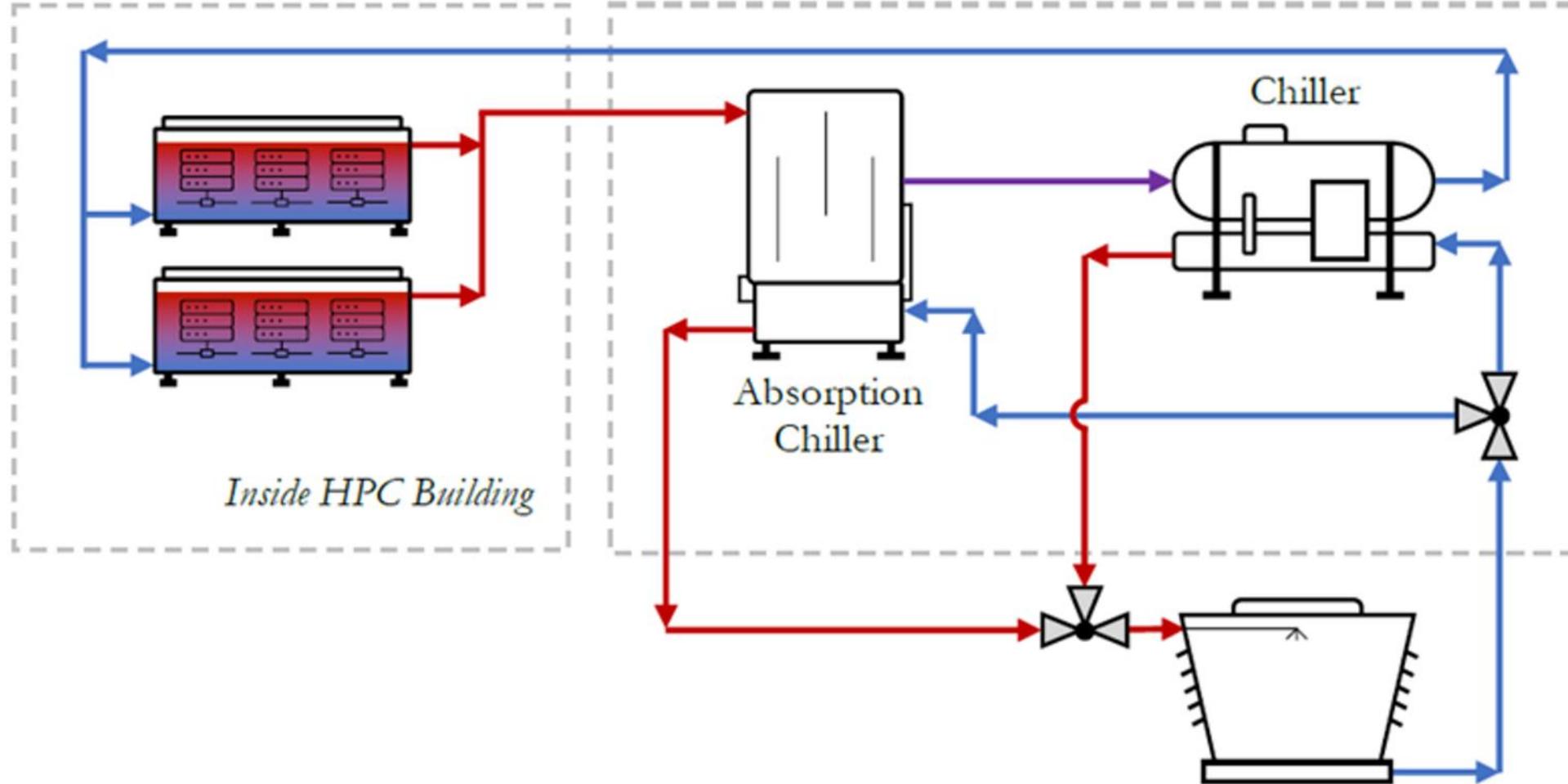
- Outlet of up to 150ºF (65ºC)

- Minimal losses in transfer from fluid to water (90%+) – 10x better transfer than with air cooling

- Leverage free cooling throughout most of the year – lower OpEx for DC operators

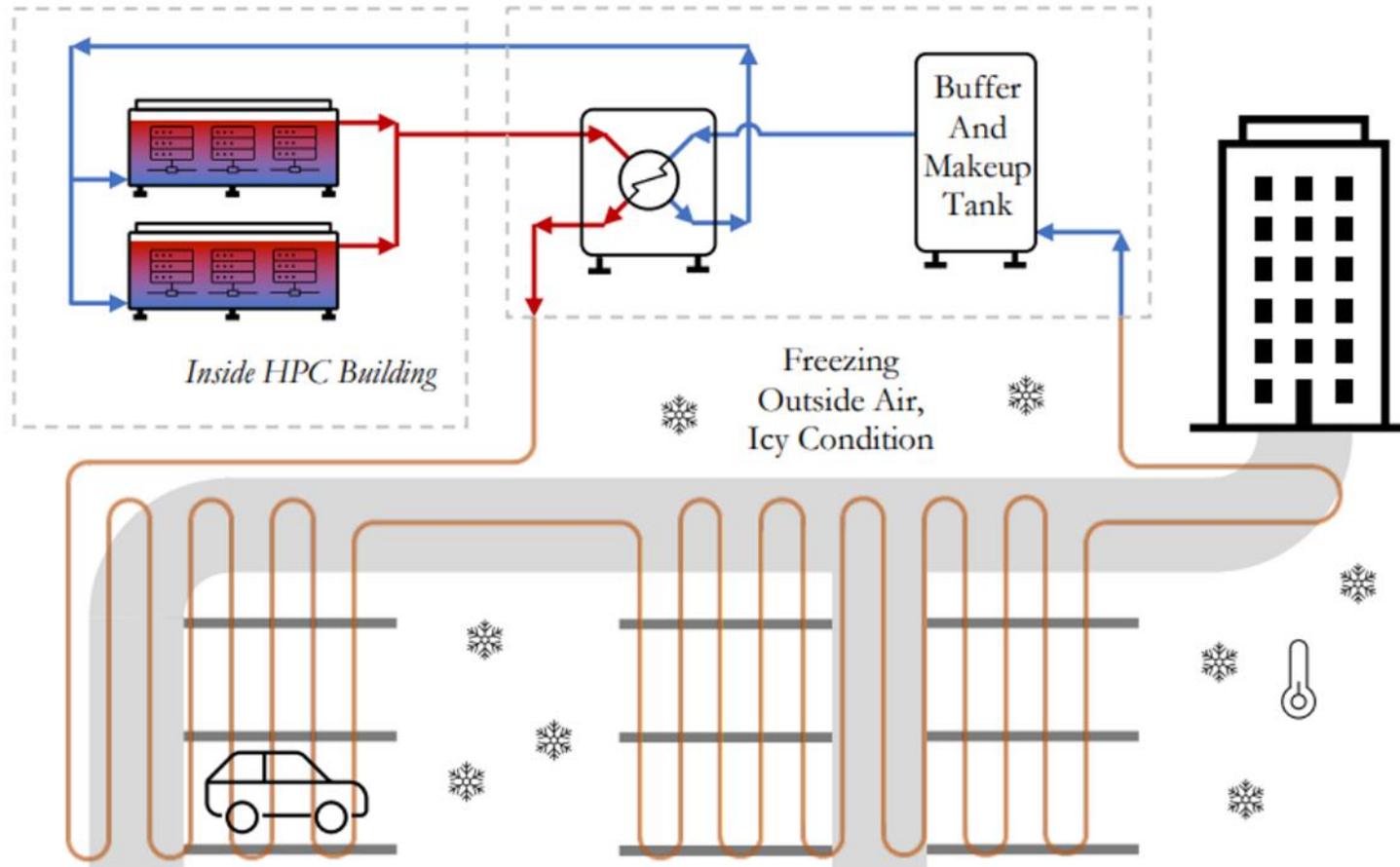- IT hardware is protected – failure rate 1/8th vs air

Hot Climate Application

Figure 41, Diagram showing the waste heat from immersion cooling pods, as input to an absorption chiller, to precool the process water before entering a chiller.
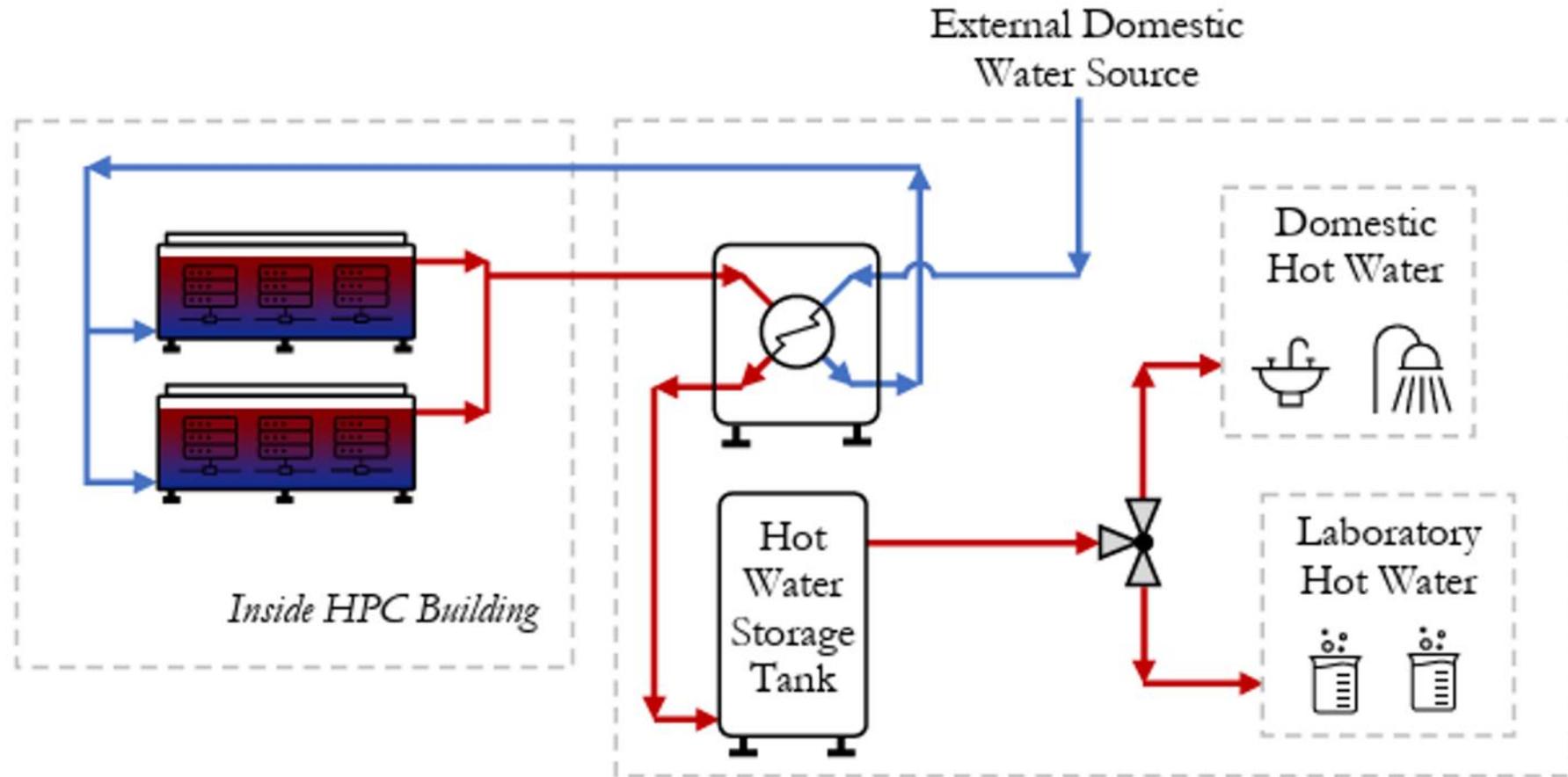
Winter Application

Figure 40, Diagram of Immersion cooling heat reuse ice melt applications.

The National Renewable Energy Laboratory in Golden Co. has implemented an ice melt loop to help combat ice buildup, contributing to slippery conditions (Geet, 2022). The loop uses waste heat from their data center.

Year-round application – in the lab

Figure 39, Diagram of Immersion cooling heat reuse for lab and domestic hot water use.
In all scenarios, a heat exchanger is utilized to isolate the waste heat from the application end use.

How Submer Solutions Address Industry Challenges

Business

Complexity of Cooling Options

What's the most compelling from a TCO perspective?

Market is flooded with liquid cooling providers (vendor lock-in).

Consider location, equipment, IT layout, etc.

TCO as Main Driver

Compelling TCO from chip to infrastructure

Cooling infrastructure that will outlast several IT generations

Easy & predictable daily IT operations

Performance

Density

Have we exceeded Moore's Law?

CPUs at 200-400W and GPUs moving to 1200-1400W

Air cooling is no longer adequate

Proven Technology Runway

Intel and Submer Illuminate the Path to Immersion Cooling for 1000W TDP

Sustainability

Climate Resiliency

Global warming has exceeded 1 ^0C since pre-industrial times

Temperatures are rising and water resources are shrinking, leading to increasingly restricted site selection

Ipcc.ch

Free Cooling

Ability to efficiently operate at higher ambient temperatures

Less water consumption since free cooling is enabled

Less demanding infrastructure leads to reduced emissions

How Submer Solutions Address Industry Challenges

Business

Power & Space Constrains

Power supply limitations and rising electricity costs

Expected exponential growth, therefore reduced footprint is essential

Efficient Use of Resources

Reduced PUE / TUE

Free up space in an existing data hall

Move power from cooling to compute

PUE: Power Usage Effectiveness
TUE: Total-power Usage Effectiveness

Performance

Flexibility

Increasingly hot components

General compute & distributed heat flux workloads

Increasingly hot DIMMs, FPGAs, & many other components

Hardware and Workload Agnostic

100% IT components covered and properly cooled

Future-proofed datacenter for any IT hardware and workloads

Sustainability

Regulations

Net-zero carbon emissions by 2050

IPCC goals

The Paris Agreement

Datacenters reporting on key areas

Improves 5/6 Key Areas

1. GHG emissions
2. Water management
3. Circularity
4. Energy efficiency
5. Renewable energy
6. Design/siting/building optimization

09.

How we can be of help?

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Q & A