RE-ENTRY OF LIQUID COOLING IN THE DATACENTER

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Agenda

- What is driving the new interest in liquid cooling in the datacenter environment?
- Relationship between applications and high energy density
- High density IT-equipment and implications for the datacenter
- Liquid Cooling Technology Overview
- Liquid Cooling - Market Size and Growth
- Preparation for adoption
- Sustainability

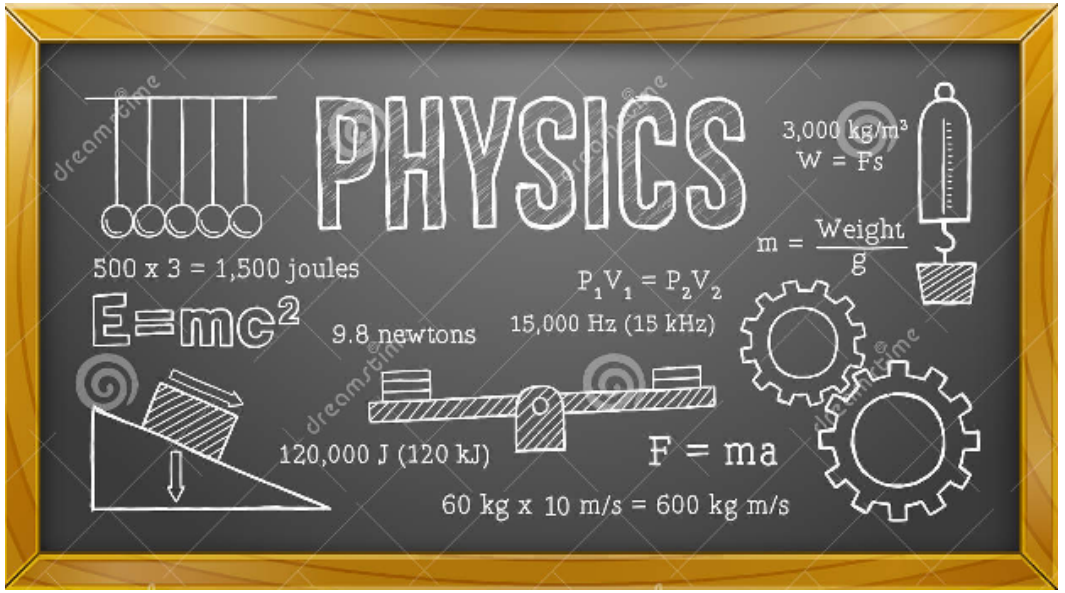
Driving force behind the new interest in liquid cooling

First a step back….

Electrical consumption of a server translates 100% to heat

(YES! except for the few mW that can leave the server via network cables)

Example: server consumes 1 kW and emits 1 kWth of heat



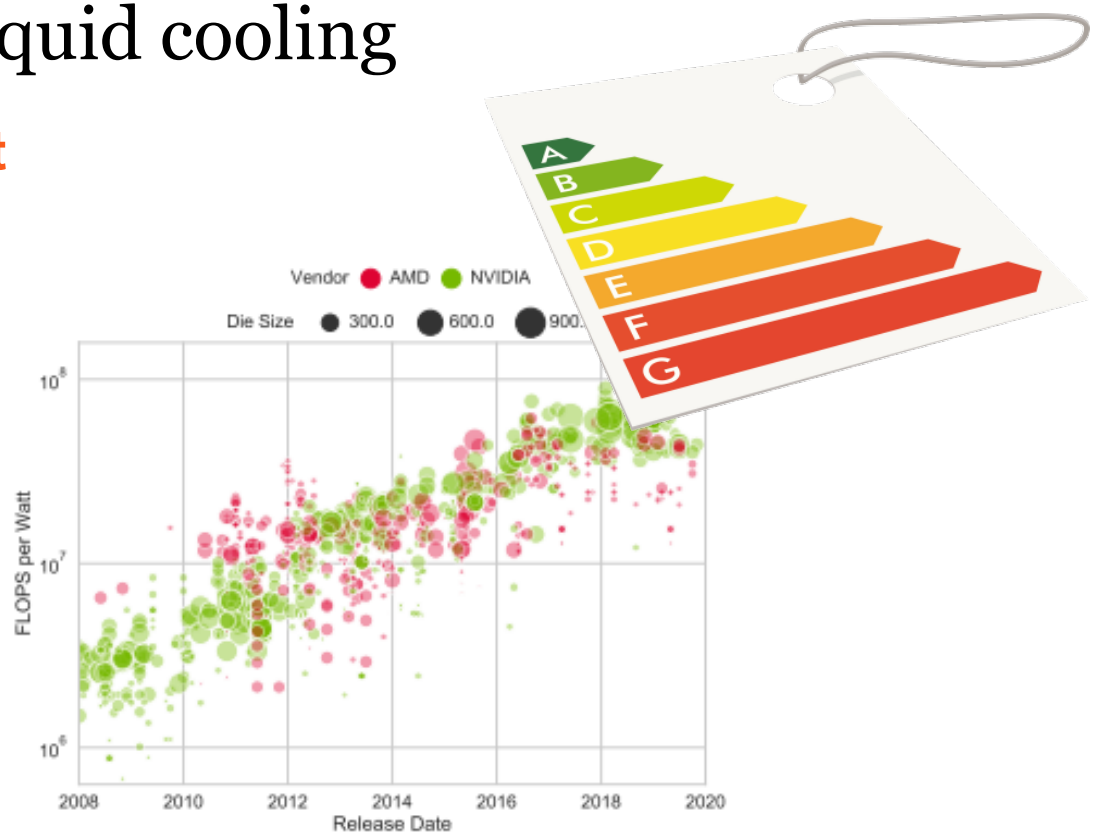
Law of conservation of energy: *Energy cannot be lost but can only be transferred to another form*!

Driving force behind the new interest in liquid cooling

But servers are becoming more energy efficient, aren't they?

That's certainly true, but we're talking about the relationship of computing power versus energy consumption (flops / watts)

Additionally, the demand for higher computing power is still increasing, causing total energy consumption to grow faster than ever before in datacenters



Why?

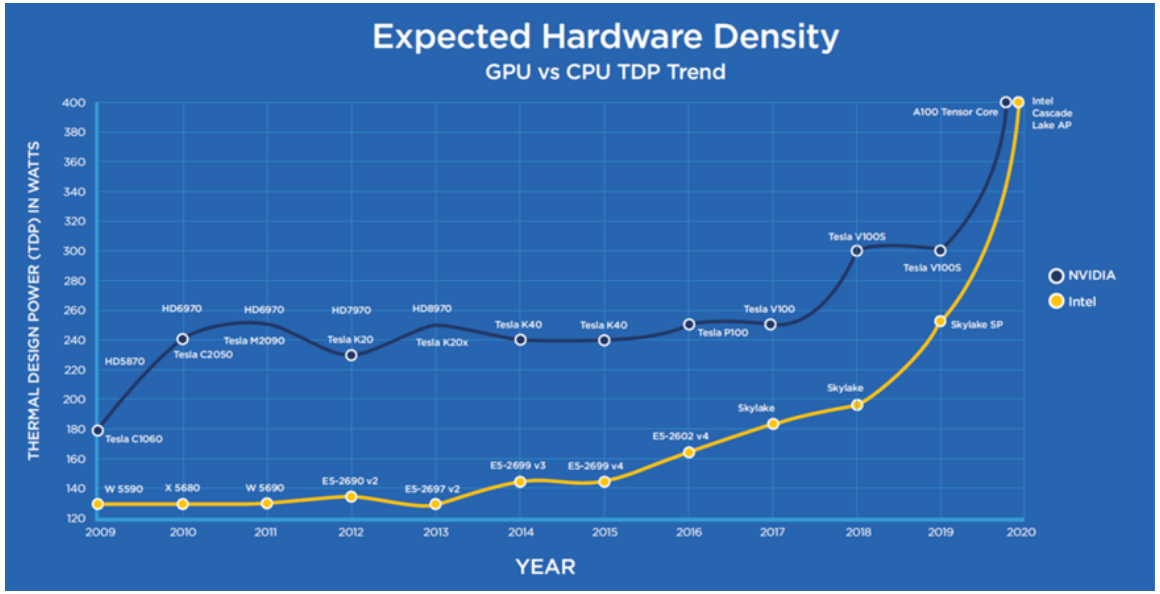
- IoT (Internet of Things)
- Media and Entertainment
- Manufacturing – simulation and testing
- Smart City
- Data Infrastructure for Autonomous Vehicles
- AI for Big Data
- Healthcare
- Finance-Trade automation Fraud detection

Driving force behind the new interest in liquid cooling

New demand for liquid cooling

Due to the new generation of Chips, there is now a technical necessity that has arisen

Trend for watts per processors has stepped up



Market Drivers

High power Chips

CPU and GPU server components increasing in power resulting in higher Thermal Design Power beyond air cooling capability

Low Latency

Interdependency of components bringing them closer together = compaction of components making it difficult to cool with air

AI & HPC

Adoption beyond science labs. HPC going into mainstream adoption including cloud based HPC, Finance, Online Gaming, Media & Entertainment

Environment/Efficiency

Reduced power consumption eliminating fans and compressors. No Noise

Harsh environments

Sealed systems deployed in uncontrolled environments without airflow

Implications for the Data Center

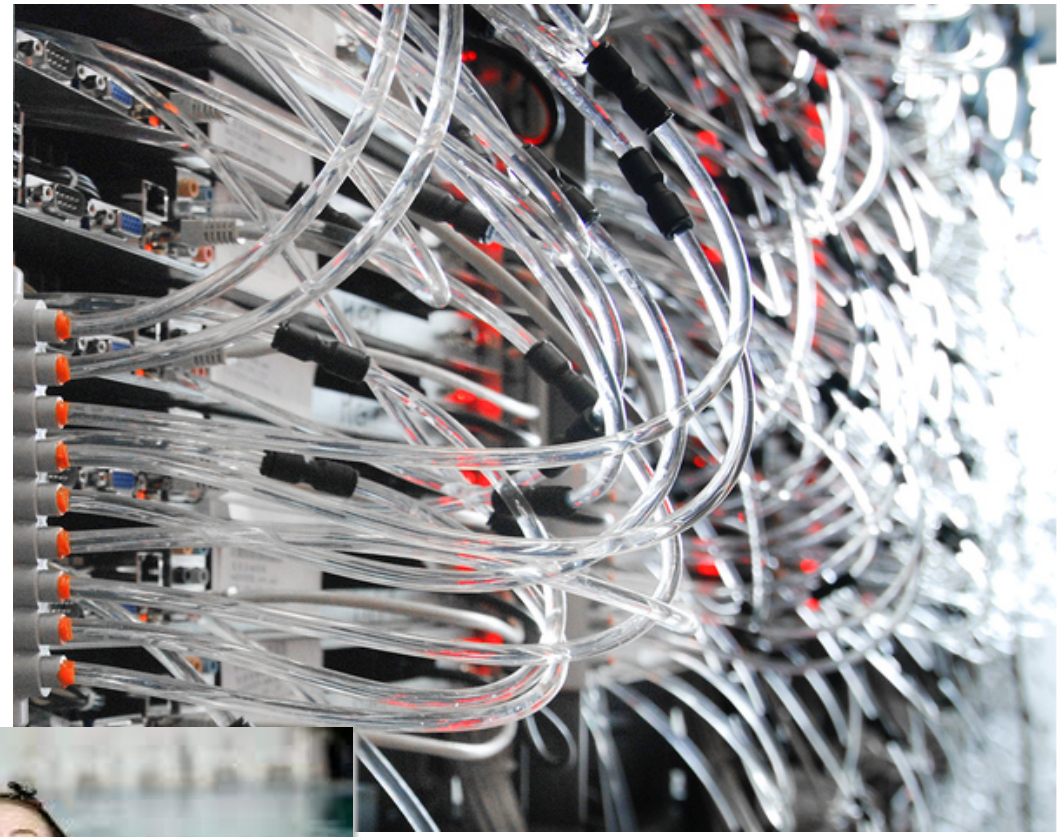
Liquid cooling is not new, is it?

There have been servers and even entire datacenters with liquid cooling for years. (OVH is a good example)

We all want lower costs.

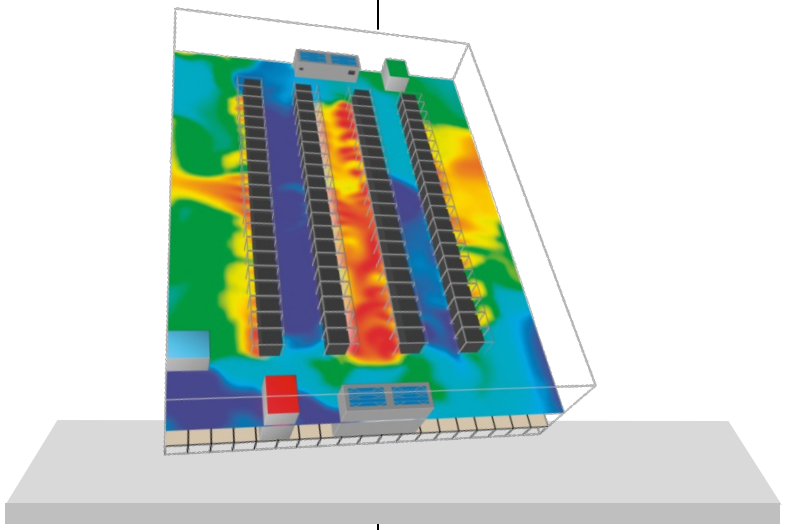
This is not an easy task, certainly not in a Colo datacenter (shared datacenter). Colo DCs have customers with variety of server hardware

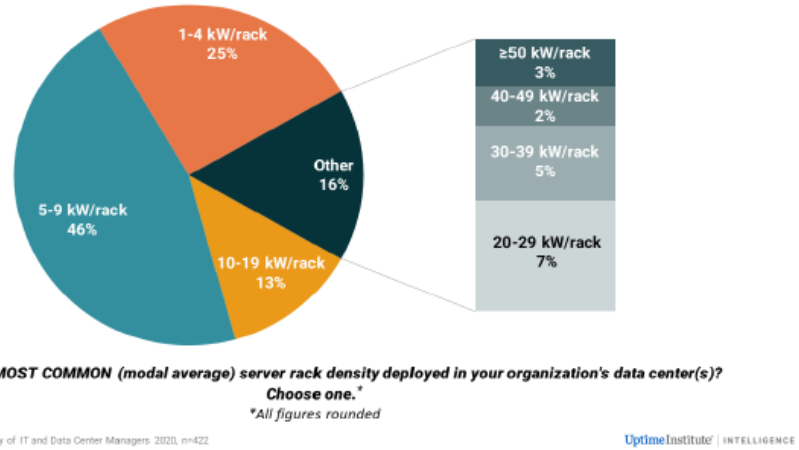
Initial costs of Liquid cooling are high compared to air cooling and earning back on energy costs is not easy



Fear of water near equipment

Implications for the Data Center





*What is the MOST COMMON (modal average) server rack density deployed in your organization's data center(s)? Choose one.**

**All figures rounded*

Source: Uptime Institute Global Survey of IT and Data Center Managers 2020, n=422

Uptime Institute | INTELLIGENCE

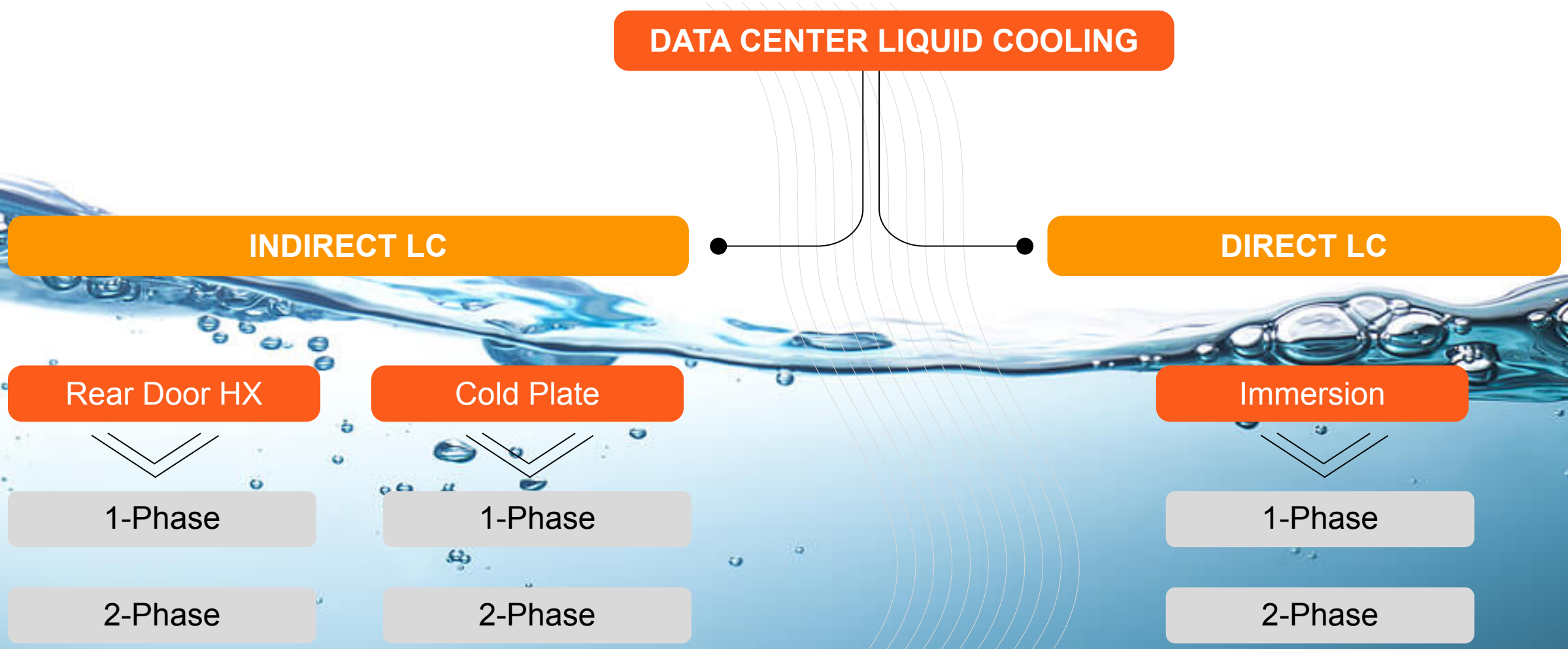
Challenges

- Managing airflow with dynamic loads (Hot Spots)
- Reduced inlet temperature for High Density IT Equipment
- High return temperatures from High Density IT Equipment
- Managing Energy efficiency and sustainability goals

Solutions

- Deploy cooling in close proximity to heat source
- Air flow management; containment, in-row, in-rack
- Direct to chip liquid cooling - cold plate
- Immersion cooling

Liquid Cooling Technology Overview



Liquid Cooling Technology Overview

DATA CENTER LIQUID COOLING

INDIRECT LC

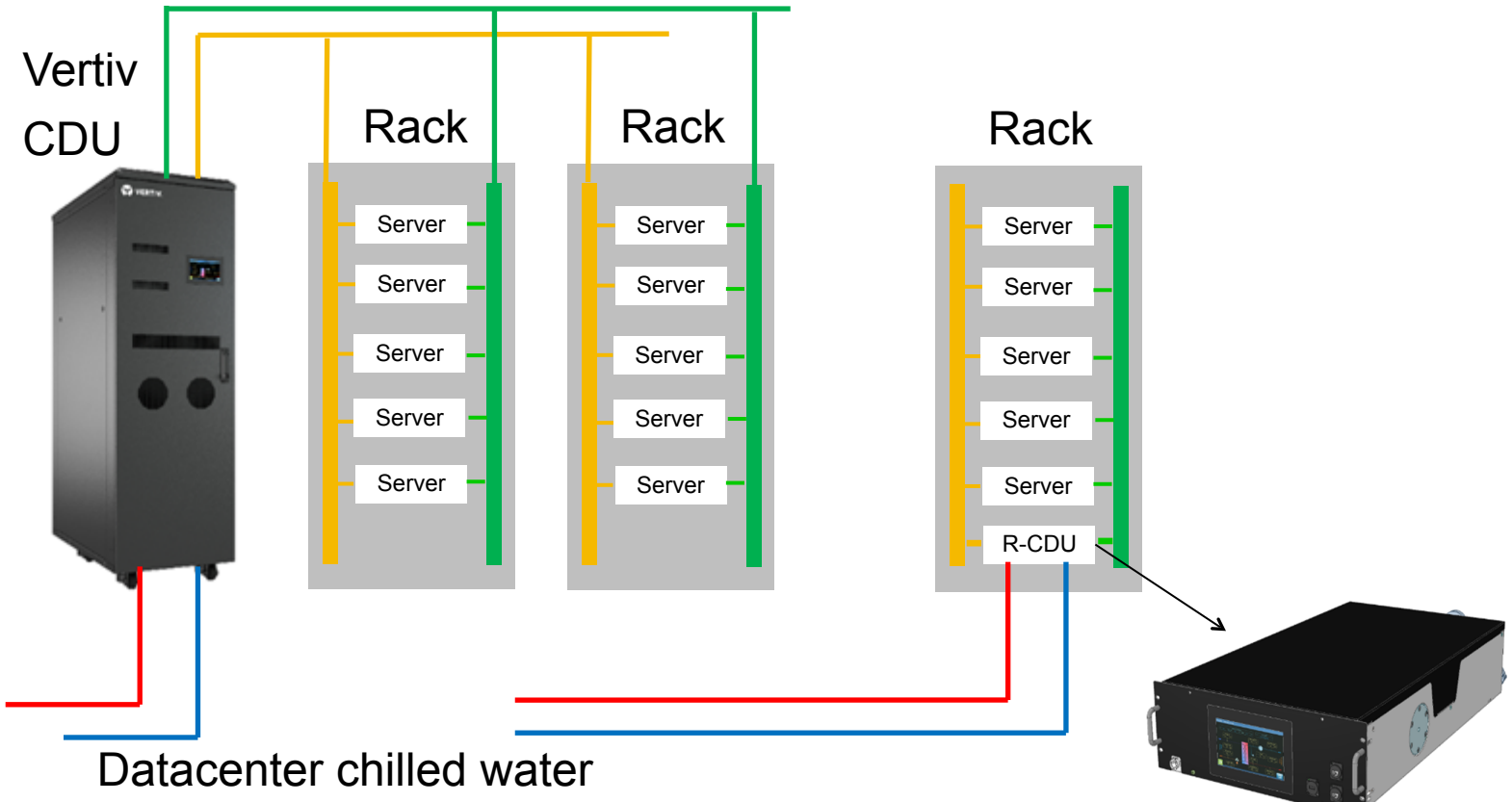
- Rear Door HX
- Cold Plate

DIRECT LC

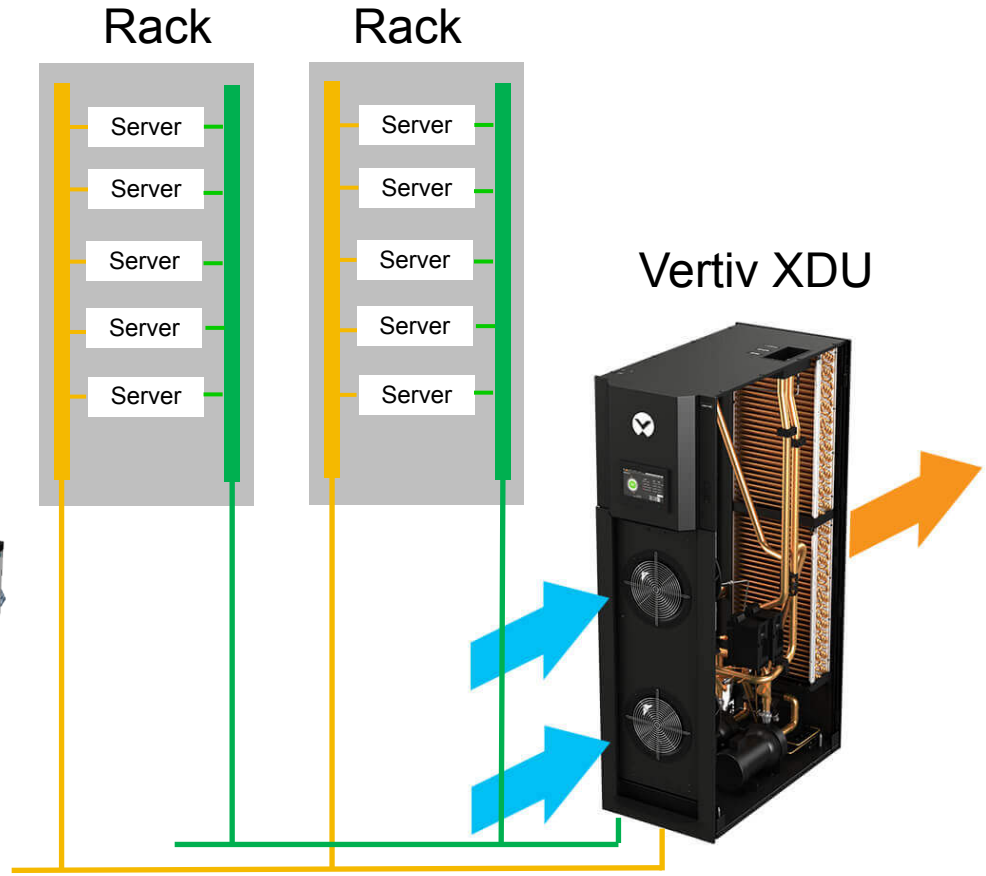
- Immersion

Datacenter facility side for liquid cooling

Chilled water liquid - - liquid

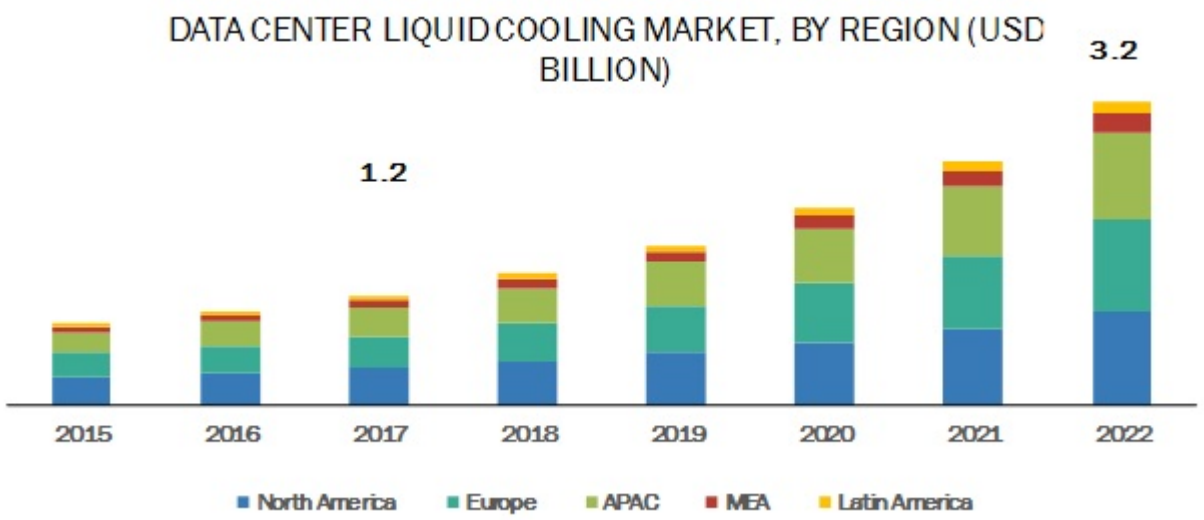


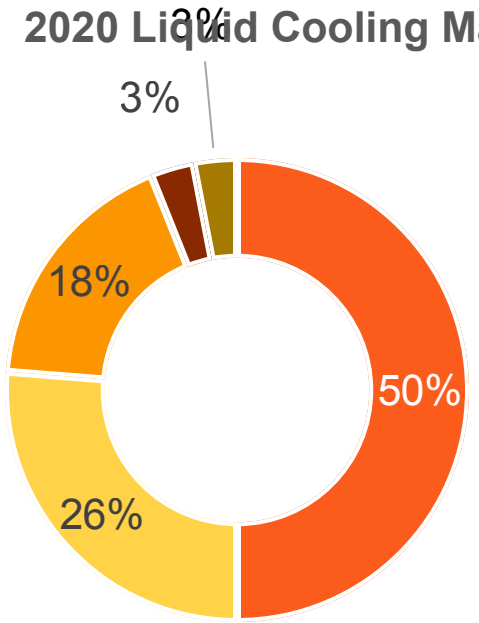
Chilled water liquid - - air



Liquid Cooling –Market Size & Growth

Market Size & Growth





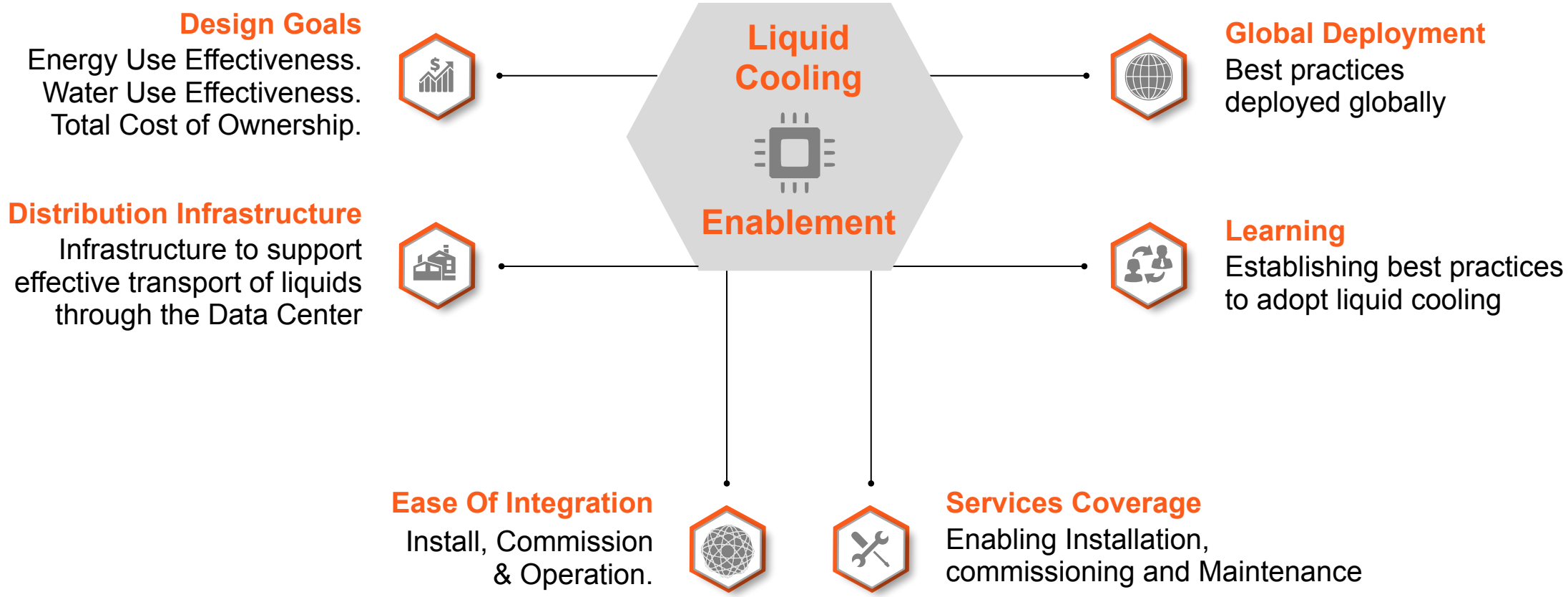
5 Year CAGR
Liquid Cooling 16-28%

- 1 P Direct to Chip
- 1P Immersion Tank
- 1P Immersion Chasis
- 2P Direct to Chip
- 2P Immersion Tank

- Major server OEMs offer SKUs supporting Direct to Chip Liquid Cooling
- Intel recently announced a focus on immersion cooling

Liquid Cooling Technologies - Preparing for Adoption

Strategies for Effective Design, Build, Deployment and Maintenance



Industry enablement to deploy liquid cooling at scale to support growth in high density

Vertiv Covers the Complete Liquid Cooling Eco System

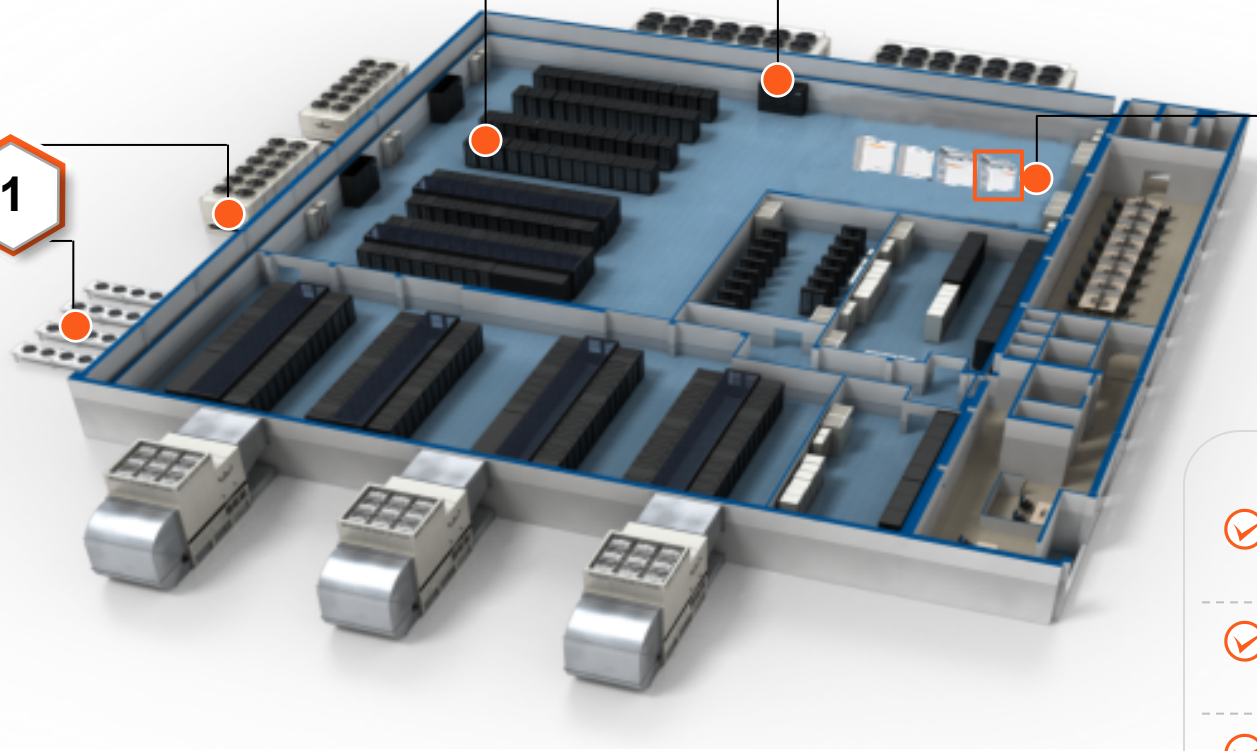
Covering the needs for Liquid Cooled IT

Coolant Distribution Unit 2

Centralized & Rack mounted CDU's to distribute and manage liquid to servers for Direct to Chip Cooling

Indoor Chiller 3

Drop in Chiller to replace DSE units to leverage the efficiency of the Vertiv EconoPhase technology and Flexibility to move from air to liquid using existing infrastructure



Heat Rejection 1

Fluid Cooler & Chillers to reject heat outdoors

Immersion 4

Immersion Racks to support server compaction and IT that can no longer be cooled with air or direct to chip

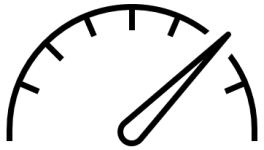
Key components

- **Coolant Distribution Units** (maintain liquid integrity)
- **Heat Rejection** (Operate in high ambient temperatures)
- **Liquid Loop** (Secondary loop to rack and cold plate)

Thermal Sustainability Trends and Innovations

Increased Water Temperatures and ΔT

- Server Operating Temperatures
- Direct to Chip Liquid Cooling
- Immersion Liquid Cooling



Variable Speed Compressor Technology

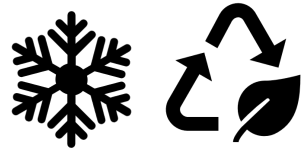
- Utilized During Part Load
- Energy Efficient
- Reduce Operational Costs

Freecooling Technologies use will increase

- Higher Server Temperatures
- Utilize Air Economizer
- Global Regulation Changes

Non-raised floor

- Alternatives Include Containment
- Change to Building Height
- Reduced First Cost



Environmentally Friendly Refrigerant for chillers

- Reduce Greenhouse Gases
- New Chiller Designs
- Green Refrigerant Selections

Space optimized layouts outdoor package

- Minimize Tech Space Incursion
- Packaged Designs
- Reduce Footprint

LIQUID COOLING	THERMAL CONTROL	HEAT REJECTION	ENCLOSURE COOLING	NEXT GENERATION CHILLERS	PACKAGED SYSTEMS

Sustainability in High Density

Sustainability Metrics

PUE:

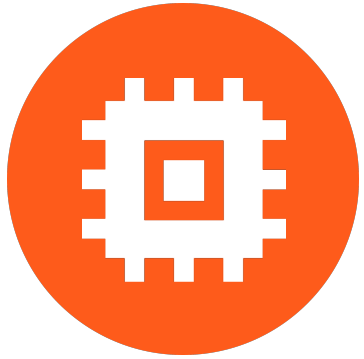
$$\frac{\textit{Total Energy Consumption}}{\textit{IT Energy Consumption}}$$

WUE:

$$\frac{\textit{Annual water use}}{\textit{IT Energy Consumption}}$$

ERE:

$$\frac{\textit{Cooling} + \textit{Power} + \textit{Lighting} + \textit{IT Reus}}{\textit{IT Energy Consumption}}$$



Direct to Chip

- Reduction in fan power
- Component cooling at source
- 70%+ Heat to liquid

pPUE

- Highest liquid temperatures
- Use of dry coolers in most climates
- Reduces water use

pWUE

- Use of high return water temperatures
- Pre-heating for boiler or electricity supply
- District or domestic heating

Immersion

- Eliminates server fans
- Component cooling at source
- 100% Heat to liquid

pPUE

- High liquid temperatures
- Increased potential for dry coolers
- Reduces water use

pWUE

Additional benefits

- ✓ Facility footprint reduction (Power distribution)
- ✓ Reduced need for cold aisle (Immersion)
- ✓ Easier to manage dynamic loads
- ✓ Support for high density applications
- ✓ Reduction of energy consumption in low density
- ✓ Flexible for Edge or Modular DC deployments
- ✓ Increased use of free cooling
- ✓ Heat reuse potential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