“Innovative & Sustainable Liquid Cooling Technology for Data Centers”

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Training Partner of Tecnoviq Learning Academy

(BICSI Authorized Design Training Provider)

BICSI Certified Courses:

DD102, DC102, PM102 & OSP102

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With more than 30 years of experience in ICT & DC industry.

Experience in ICT network & wireless infrastructure, smart IoT & security, spray liquid cooling technology and data center.
Certified Trainer for ICT and Data Centre from BICSI Learning Academy

Honorary Master of Engineering (Hon. MEng) from Global University of Science & Technology.

BICSI Credentials

- Registered Communications Distribution Designer (RCDD®),
- Data Center Design Consultant (DCDC®)
- Registered Telecommunications Project Manager (RTPM®)
- Outside Plant Designer (OSP™)

(Facilitator for BICSI Courses: DD102, DC102 & OSP102)

DCPro Credentials

- Data Centre Practitioner (DCP®)
- Data Centre Specialist (DCS®) in Design Engineering

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Company Profile

Incorporated in year 1990, with over 32 years of history, Market leader in providing information & communications technology (ICT) solutions.

Design, build and implement cutting edge ICT, smart cities & security & IoT solutions for our customers.

Specialize in data centre infrastructure solutions, energy efficiency, innovative & sustainable liquid cooling technology.

With our technology partners, we provide a full solution for your needs as an one stop service provider for all your business needs.

Vision

To become
The Platform of the Future

Values

Teamwork, Integrity,
Commitment and Safety

ISO9001: Quality Management System
ISO14001: Environmental Management System
ISO45001: Occupational Health & Safety System
ISO 22301: Business Continuity Management System
BizSAFE STAR: Building Safety and Health
ConQuas21: Quality Construction Finishes

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Next Generation Cooling For 2022 & Beyond

1. Market Trends
2. Types of Air Cooling Technologies
3. Types of Liquid Cooling Technologies
4. Comparisons & Considerations
5. Benefits & Summary

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Market Trends

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Market Demands

01 *Increase Demand of Cloud and Edge Computing*

- Increase in internet traffics such as AI, Machine Learning, Robotics, Realtime Data, Video Image Processing, Gaming, Blockchian & IOT.

02 *Migration to Cloud and Edge Compute*

- Shrinking IT budgets, higher demands on Compute. Limited power, space and CAPEX available. Limited manpower resources to support.
- Enterprises are also moving & migrating into cloud or edge computing

03 *Growth of Hyperscale Data Centers*

- Emerging Cloud & Edge Computing technologies. An alternative for Cloud & infrastructure.

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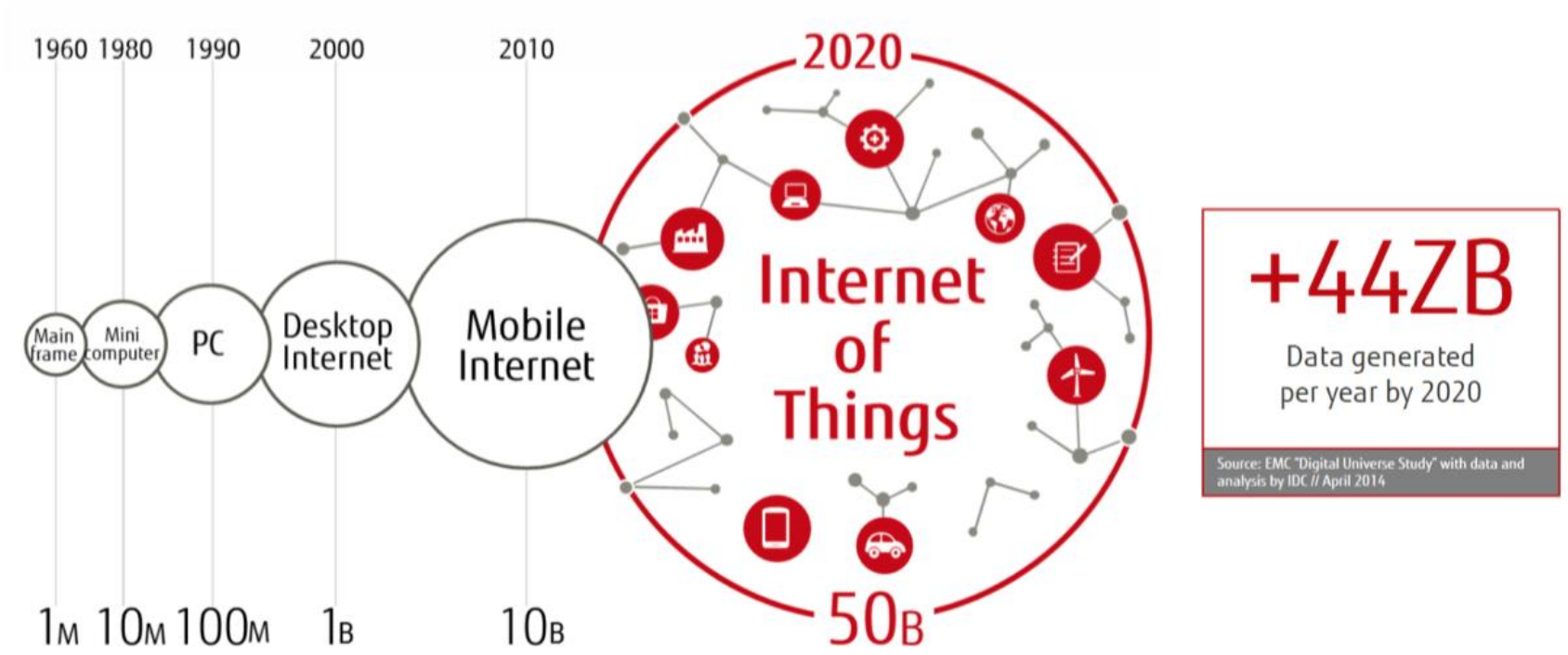
INTERNET TRAFFICS

Explosive Growth for Information



1. Over-The-Top (OTT) Data (Internet & mobile APP)
2. Internet of Things (IoT) Data (Sensors, data collection, video image processing, gaming, Blockchain, AI & ML)
3. Digital & Online Data (Cashless & credit card transactions)

Source: OCP Summit 2018 – Alibaba Infrastructure Services

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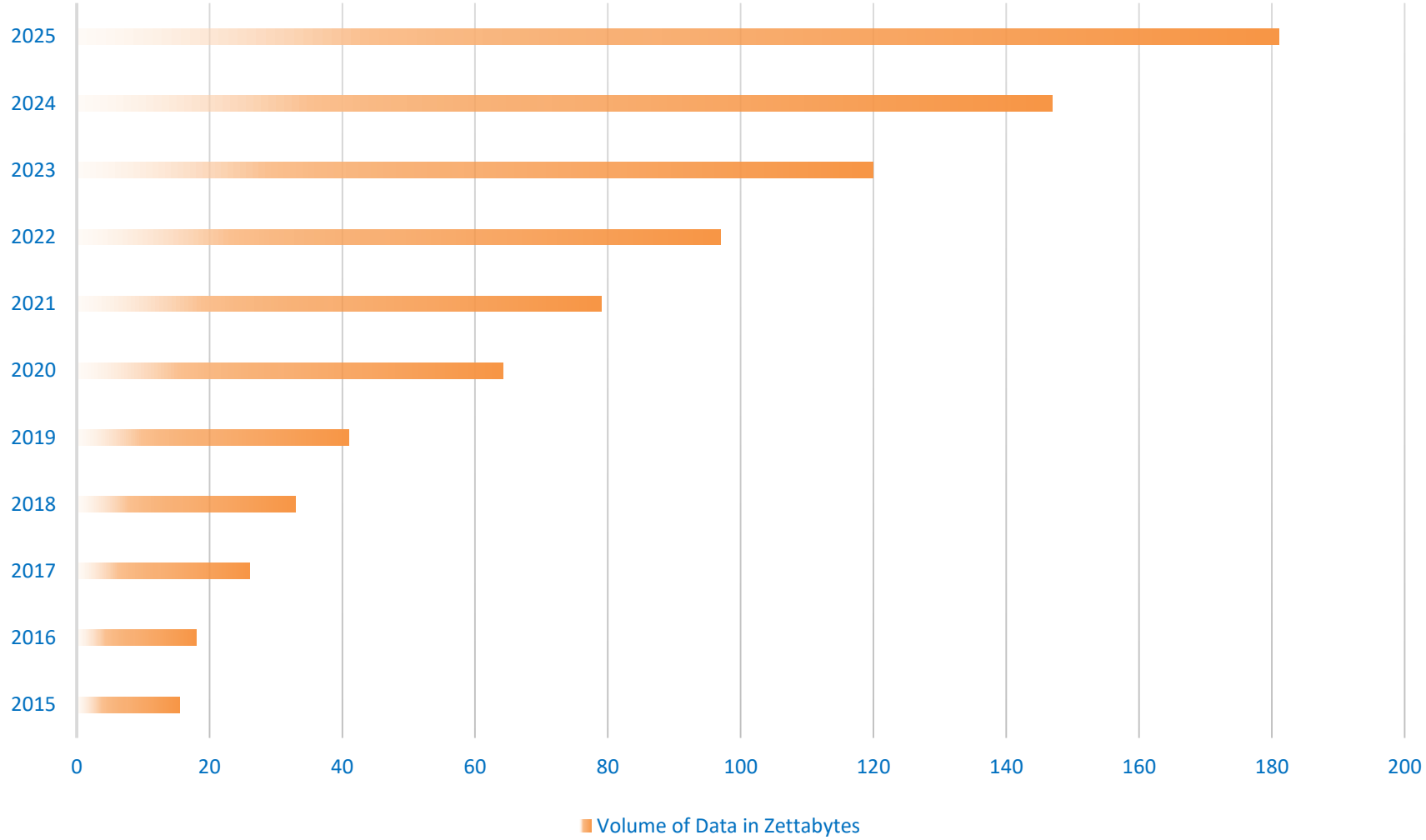
Estimated Volume of Data Consumed Worldwide in Zettabytes by 2025



97 Zettabytes in 2022

181 Zettabytes by 2025

Source: Satistia

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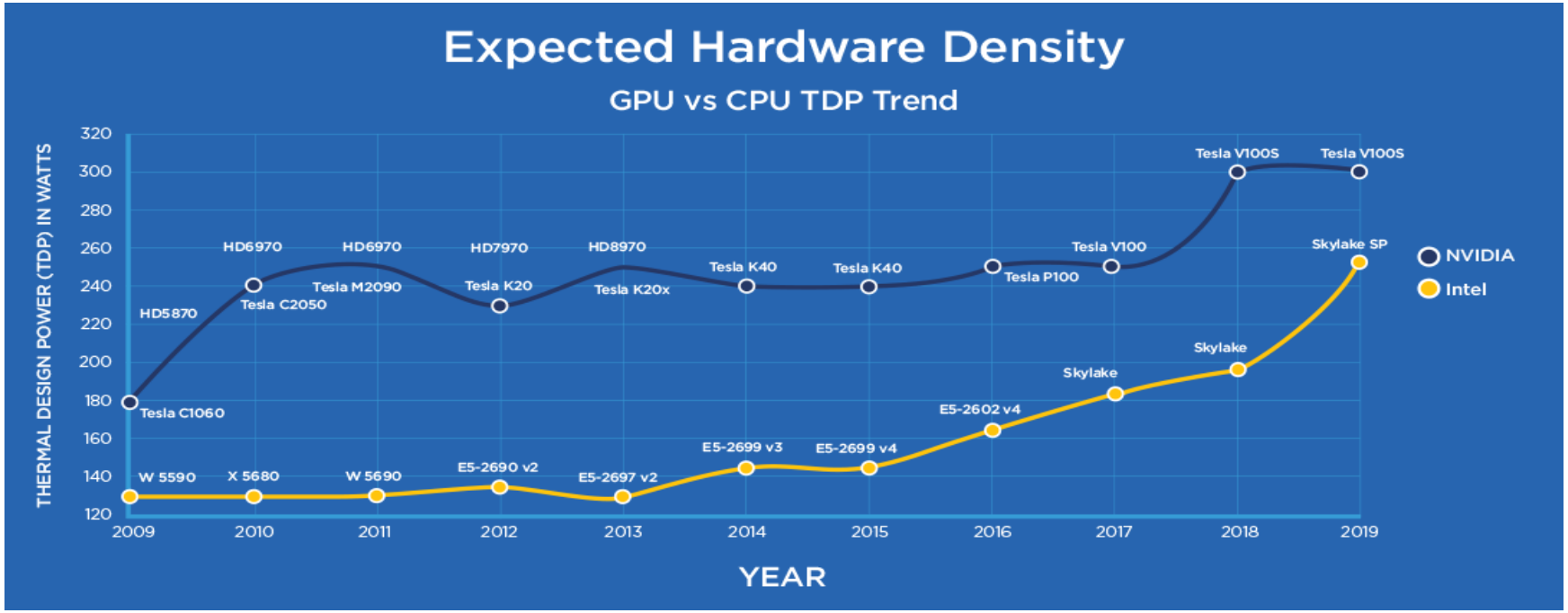
GPU & CPU Thermal Design Power (TDP) Trend



***Higher power chipsets are very commonplace now, we're seeing 500W or 600W GPUs, and CPUs reaching 800W to 1,000W.**

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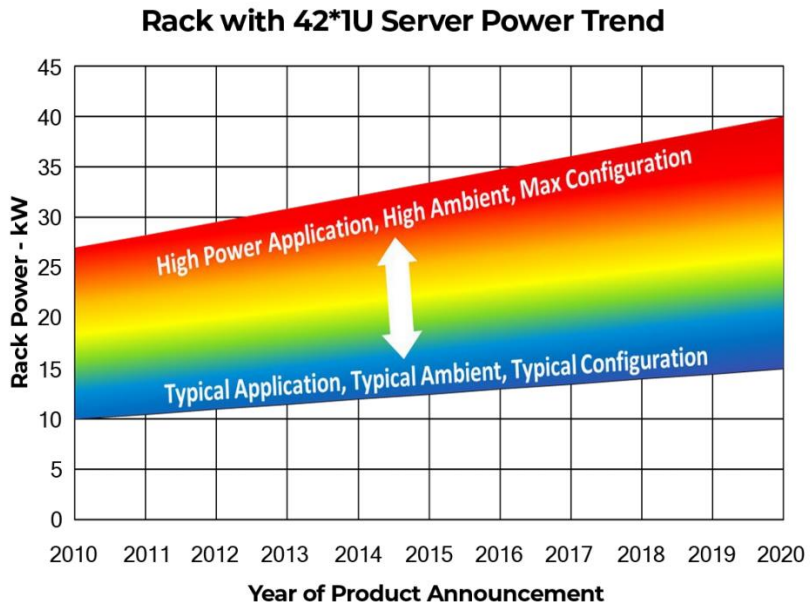
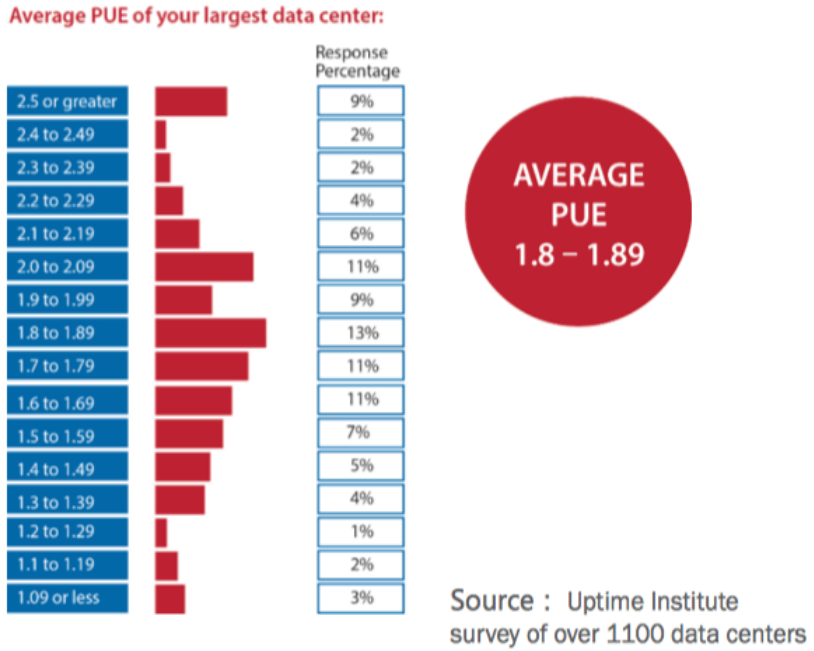
CHALLENGES

Balancing CAPEX and OPEX for Energy Efficiency and Profits





Datacom Equipment Power Trends and Cooling Applications – ASHARE

***Increasing of computing power, rack power density & transceiver bandwidth.**
***Air-Cooling cannot meet the heat dissipation demand any more**

***Data Center based on Tier standard.**
***Reserve of future spaces, partial power usage & underutilized capacity.**

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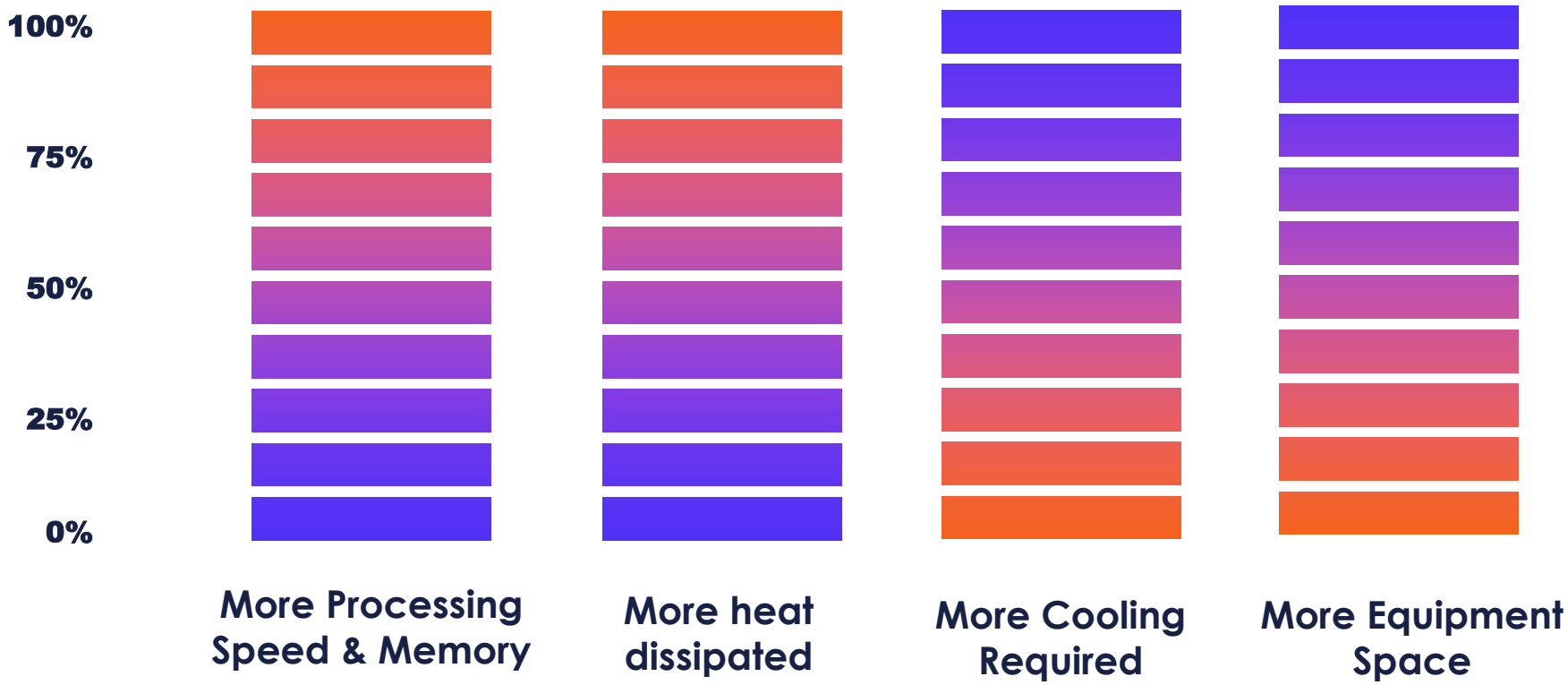
IMPLICATIONS



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The challenges faced by Data Center and Cloud Provider:-

Power capacity is constrained by the space required within the servers.

Power Density is increasing – exceeds 40KW/Rack soon.

Conventional forced air-cooling & fans from servers are inefficient.

Brute force thinking and methods to decrease the cooling temperature is expensive.

Conventional data center design needs to change to host compute resources leading - high amount of CAPEX.

Water Technology

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Water Technology

COOLING CAPACITY

Water has 1500X Cooling Capacity than AIR.

THERMAL CONDUCTIVITY

Water is 25X better at transferring HEAT than Air.

TRANSPORT ENERGY

Water requires 10X less Energy to move HEAT than AIR.

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Maximum Rack Power in KW

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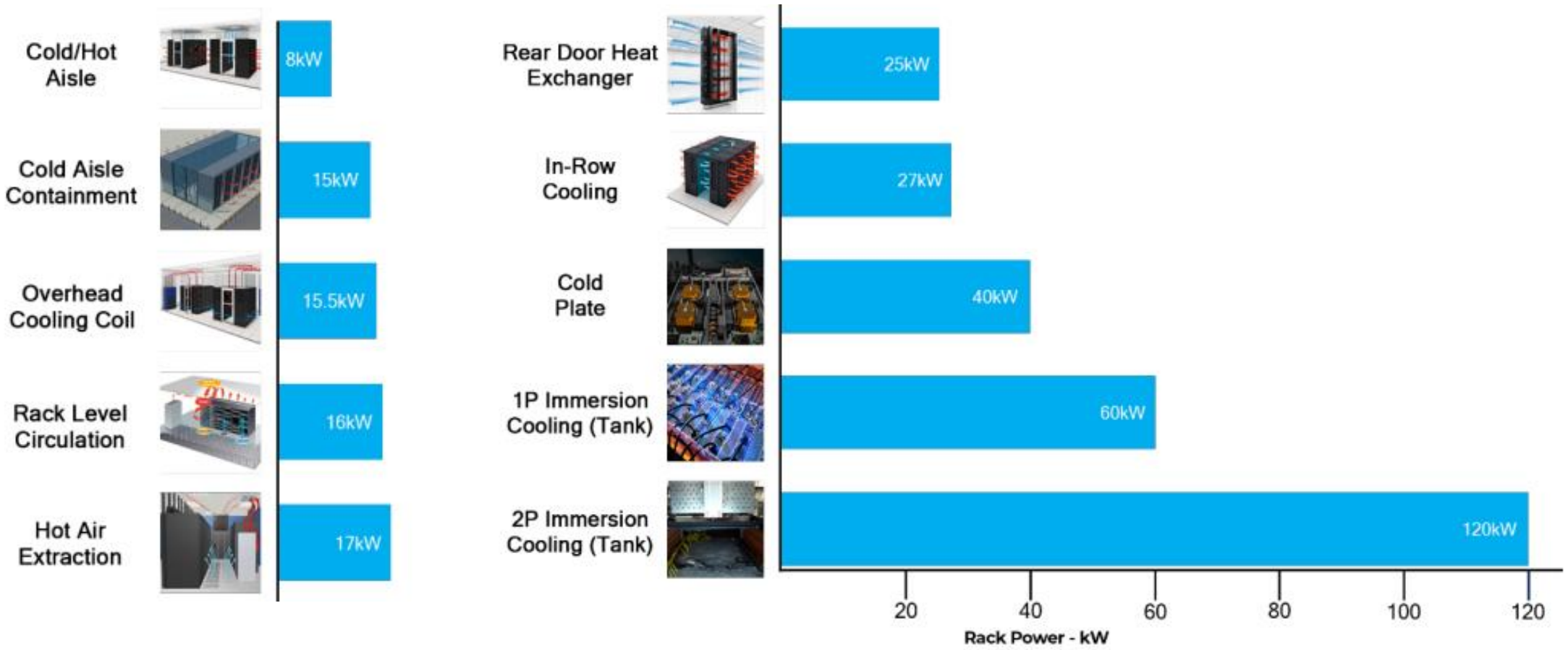
Maximum Rack Power in kW



Maximum Rack/Tank Power (KW) currently deployed by the real-world data centers using different facility-level cooling approaches

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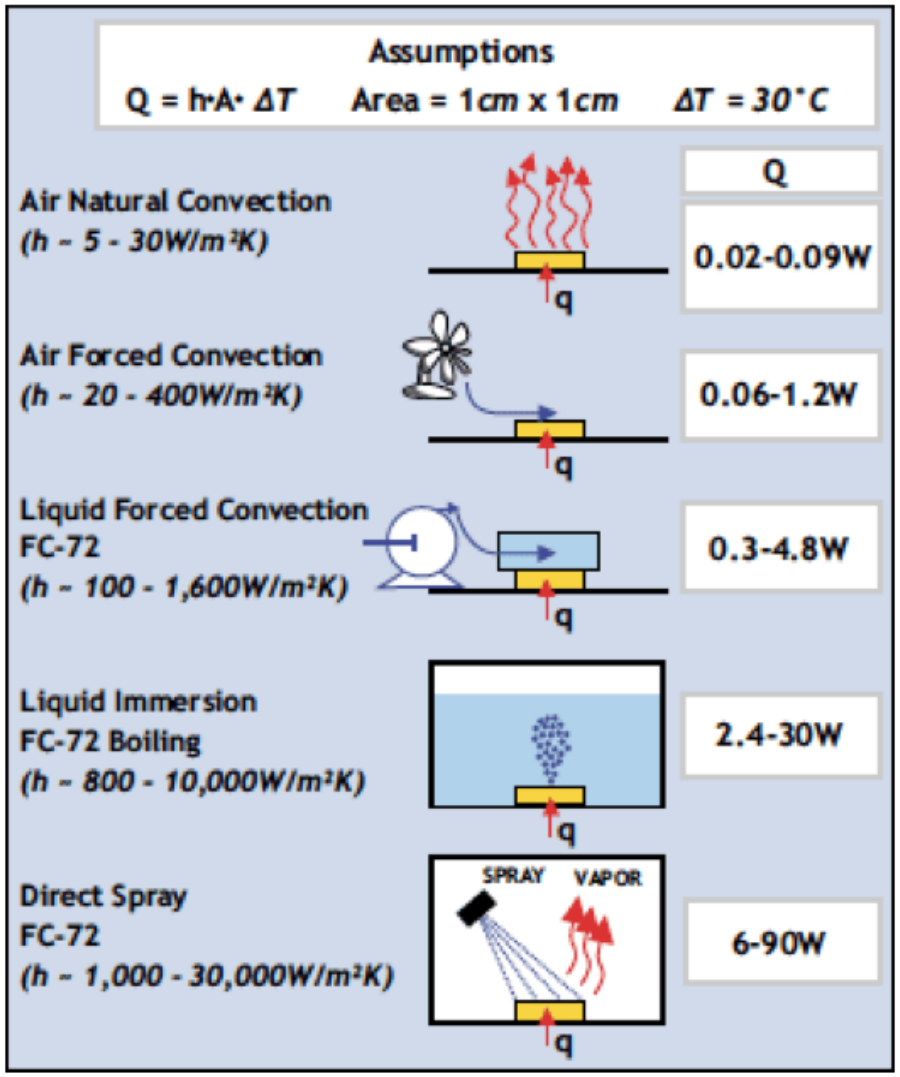
Air & Water Cooling Technology

Liquid cooling is more effective than air cooling. The evaporative cooling is even more effective than liquid cooling.

At 1 atmospheric pressure and 30℃:

- ❑ *Specific heat capacity of air = 1.01 kJ/kg℃*
- ❑ *Specific heat of capacity of water = 4.19 kJ/kg℃*
- ❑ *Latent heat of vaporization of water = 2260 kJ/kg*



3M Fluorinert Electronic Liquid FC-72 : A non-conductive, thermally and chemically stable liquid ideal for many direct contact single and two phase low temperature heat transfer applications (Boiling Point: 56degreeC).

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Innovative & Sustainable Liquid Cooling Technology

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Data Center Liquid Cooling Technologies

Indirect Liquid Cooling

(Cold Plate/Direct-On-Chip)

Direct Liquid Cooling

(Immersion/Spray)

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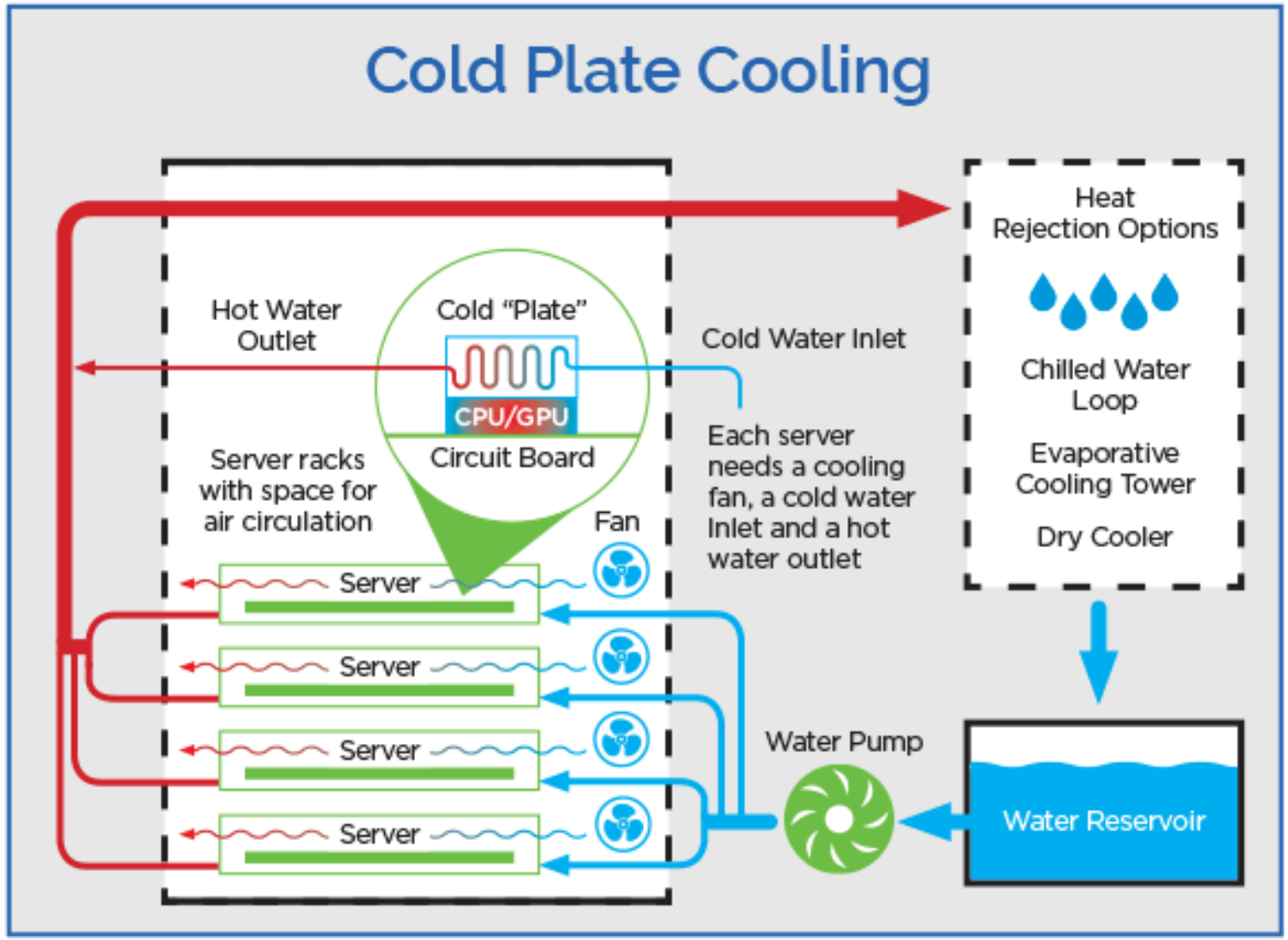
Direct-On-Chip Liquid Cooling



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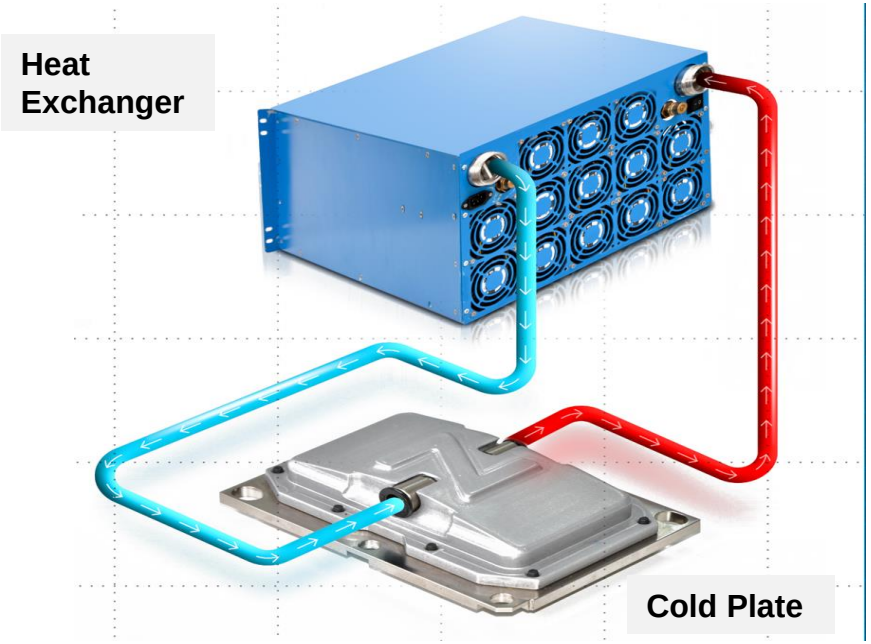
Direct to Chip (D2C) Liquid Cooling

1-Phase D2C



2-Phase D2C

- Captures between 60% and 80% of server heat from the CPUs & GPUs.
- Removes heat within servers using liquid in the cold plate in direct contact with the CPUs & GPUs.
- Can be either single-phase or 2-phase cooling.

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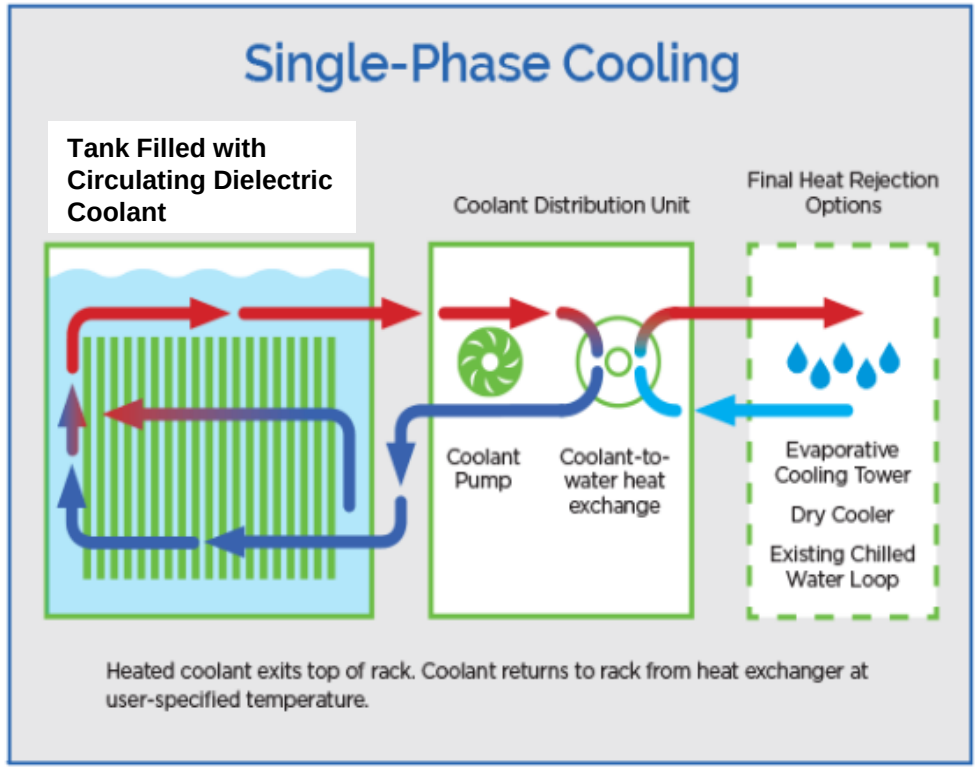
Immersion Liquid Cooling



1-Phase Immersion Cooling

- ❑ Remove heat by convection.
- ❑ Eliminates all pressure, fumes, vapors, and corrosion due to state transition from liquid to gas in 2-Phase cooling.
- ❑ Using an unsealed tank.

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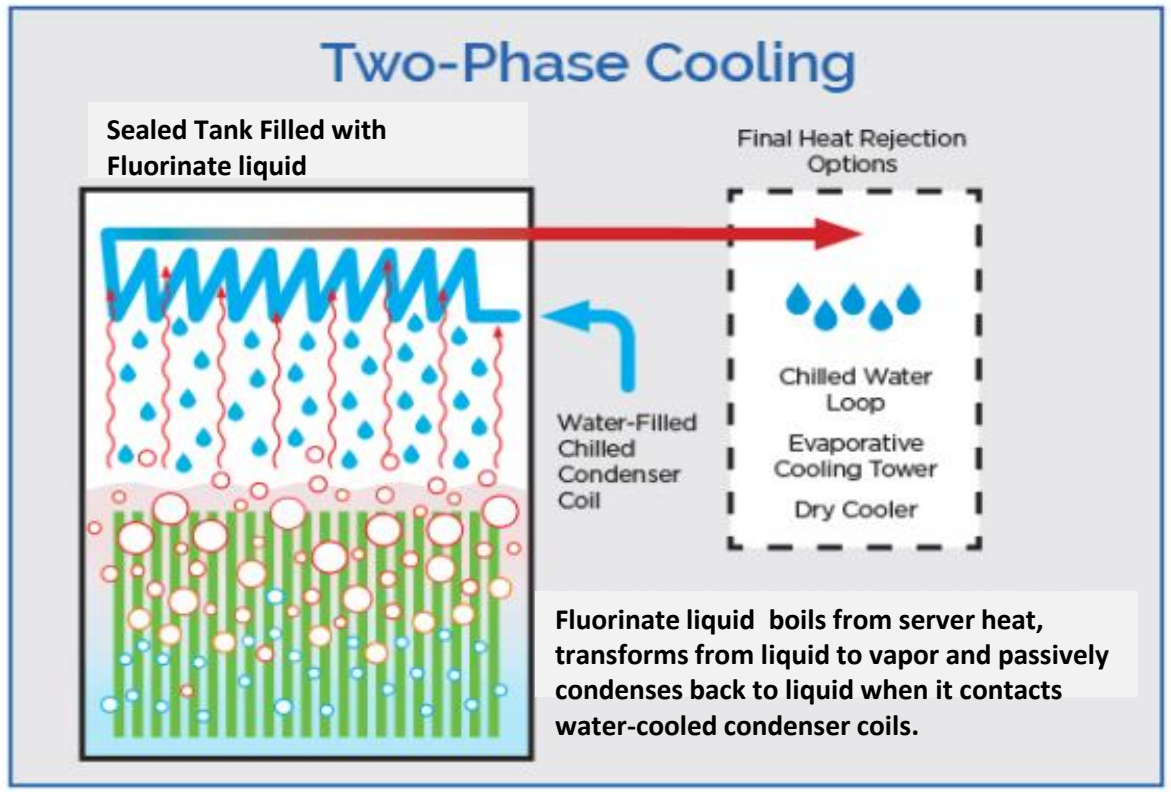
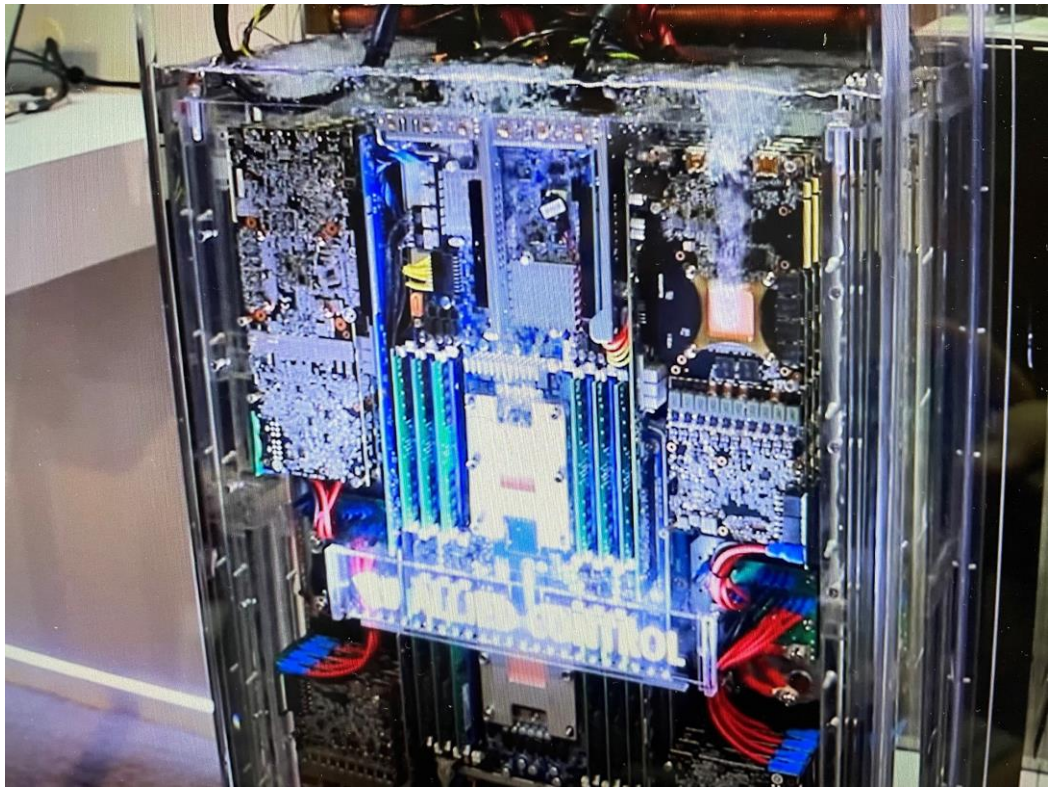
Immersion Liquid Cooling





2-Phase Immersion Cooling

- ❑ By convection & evaporation (boiling) of fluid to remove heat
- ❑ Clean, environmentally friendly and non-flammable.
- ❑ No pumps and jets are required. .
- ❑ Requires a sealed tank to contain the vapors.

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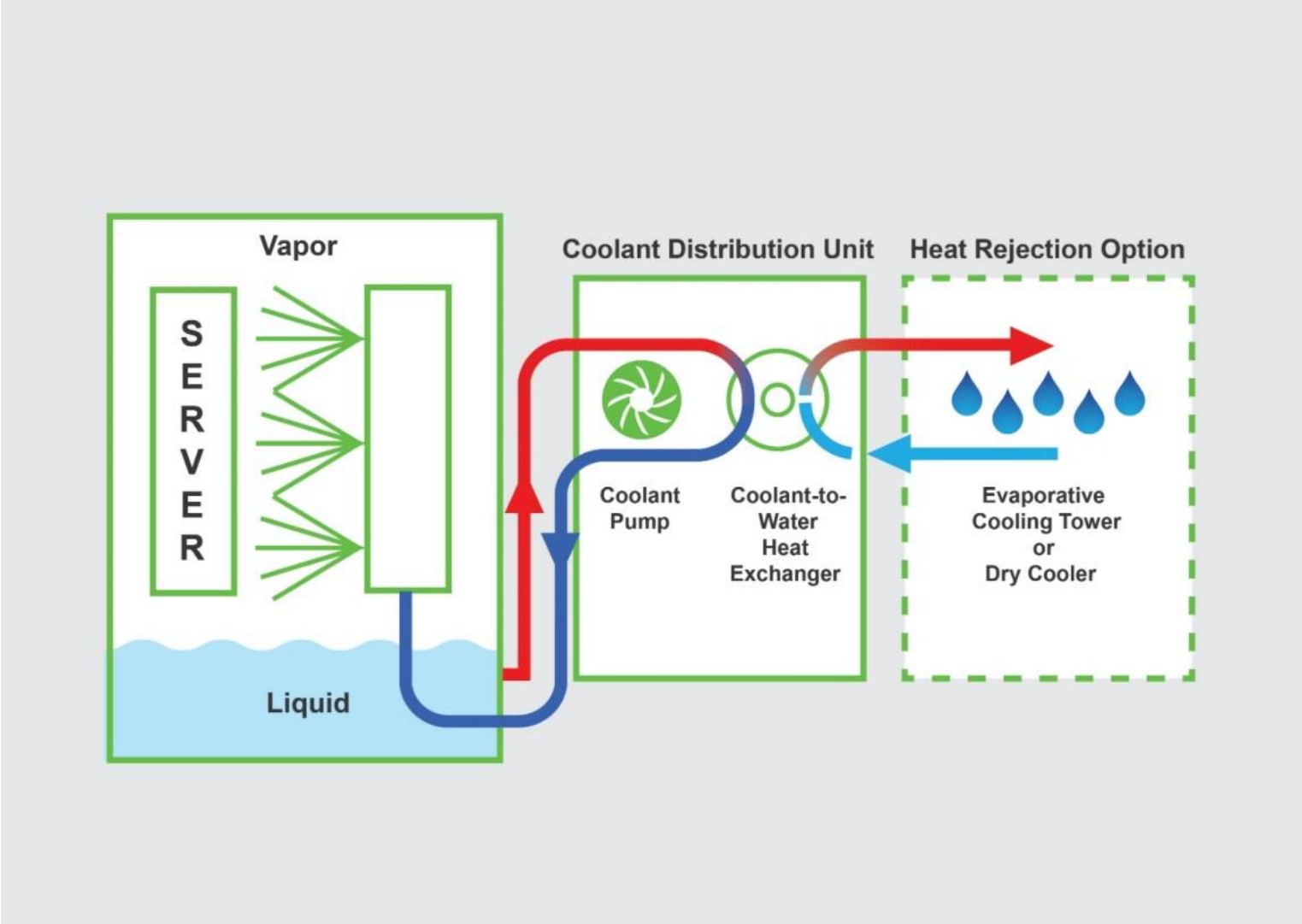
Spray Cooling Technology



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Spray Cooling Technology – How it works?

- Spray Cooling technology using single-phase cooling process which fluid remove the heat through convection;

- Spray Cooling technology using two-phase cooling process which fluid boils and condenses; thereby, changing its state of matter from liquid to vapor and back again.

- The dielectric fluid is sprayed directly on electronic devices or motherboard to cool the server through atomization. The heat from CPU/GPU chips/electronic components will be absorbed by the liquid through convention or vaporization.

- The heat exchanger ejects heat at 40 to 45℃ through free air or water cooling in the dry cooler or water cooling tower.

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Spray Cooling Technology – What is the liquid used?

- *The fluid used is called fluorochemicals eg. 3M NOVEC or any other compatible fluid. Another name is called Engineered Fluid.*

- *The dielectric fluids used are Perfluorocarbons (PFC), Perfluoropolyether (PFPE), Hydrofluoroeter (HFE), and Fluoroketone (FK). These fluidshave high dielectric strength so that they can be in contact with a larger amount of electronics.*

- *The fluids are environmentally friendly, low viscosity, non-combustible, non-flammable, and non-toxic.*

- *Perfluorocarbons have been used in electronic cooling for more than 40 years.*

Spray Cooling Technology – What are the benefits?

- *Eliminates oxidation and corrosion of electrical contacts due to lower operating temperatures.*
- *Mitigates exposure to electrostatic discharge, and sensitivity impairment to ambient particulate, humidity, or temperature conditions.*
- *Lessening environmental contamination like dust, debris, and particulates.*
- *The liquid is a cleaning agent which will also help to maintain the electronic parts in the most pristine conditions.*

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Edge Chassis

Innovative & Sustainable Spray Cooling Technology

Descriptions

- Customized according to customer's requirement
- IP67 rated, fully sealed chassis

Capacity

- 1 server per chassis
- Up to 15 - 20 Chassis per rack
- Up to 45 - 60 KW per rack

Deployment Scenarios

- Edge data centers
- Micro-Data Centers
- Containment data centers.

Specifications

- Fits any 19inch rack mounted 1U server
- Single or dual nodes per server
- Customization
  - Up to 2U servers
  - Up to 8 GPU
  - Up to 3.5kW per chassis

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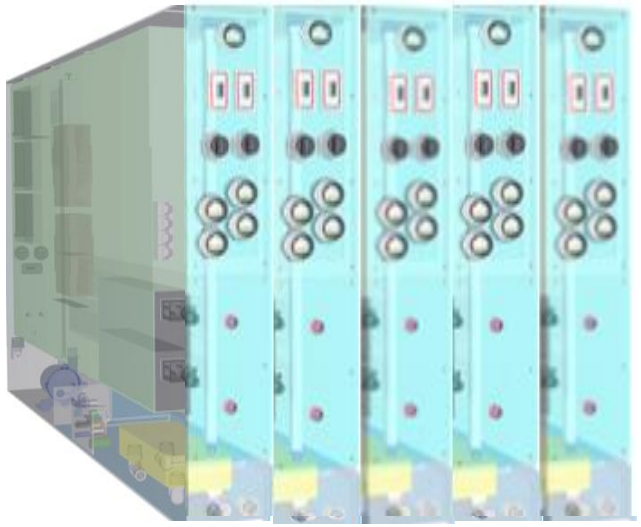
Edge Chassis - Deployment Scenarios

Edge & Micro-Data Centers

Single Chassis
3kW/chassis
Single or Dual Nodes



Full Rack (45RU)
5 to 20 servers/rack
15 – 60 kW/rack

Single Chassis

Single Rack

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Heat Rejection Configurations

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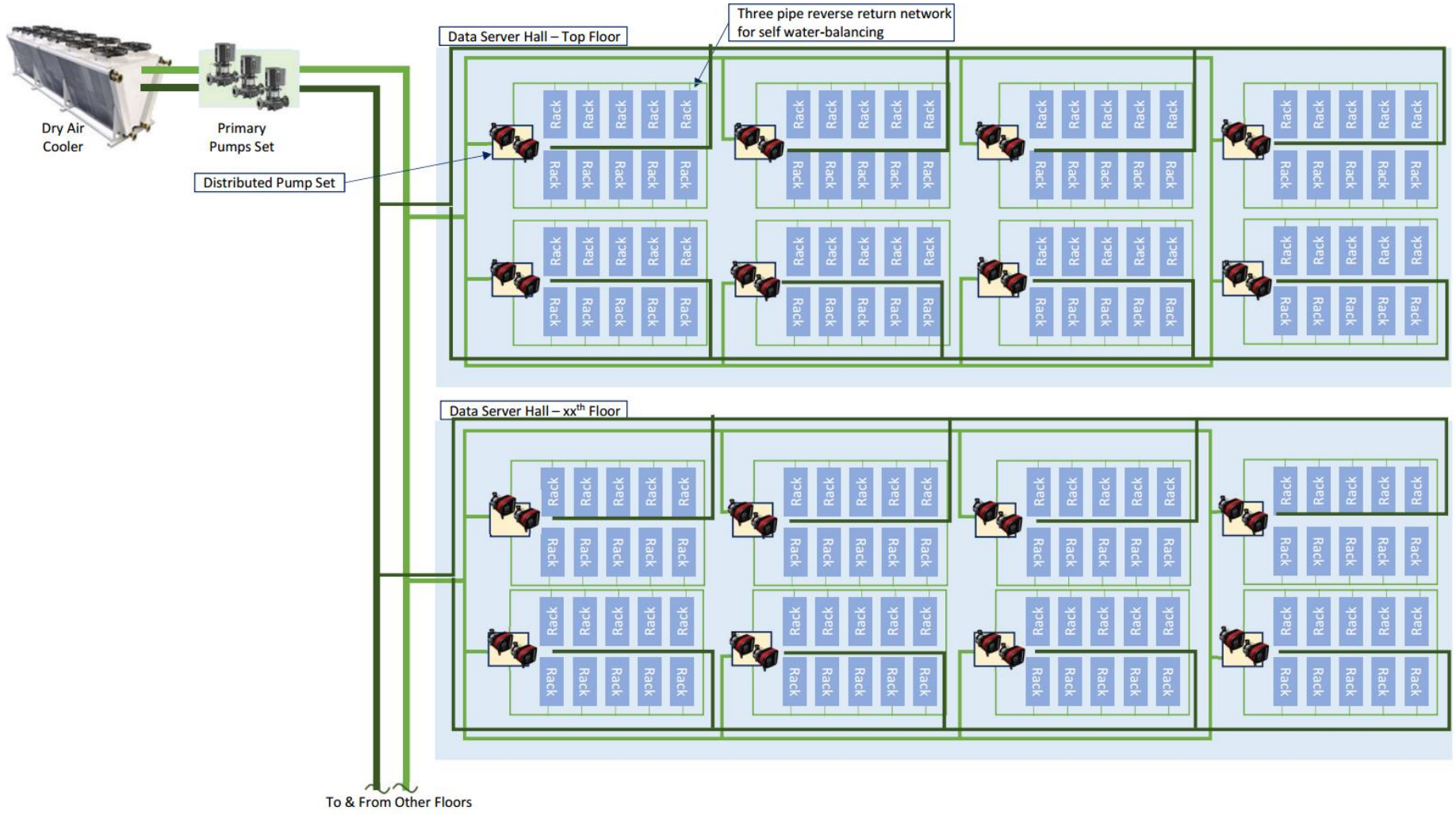
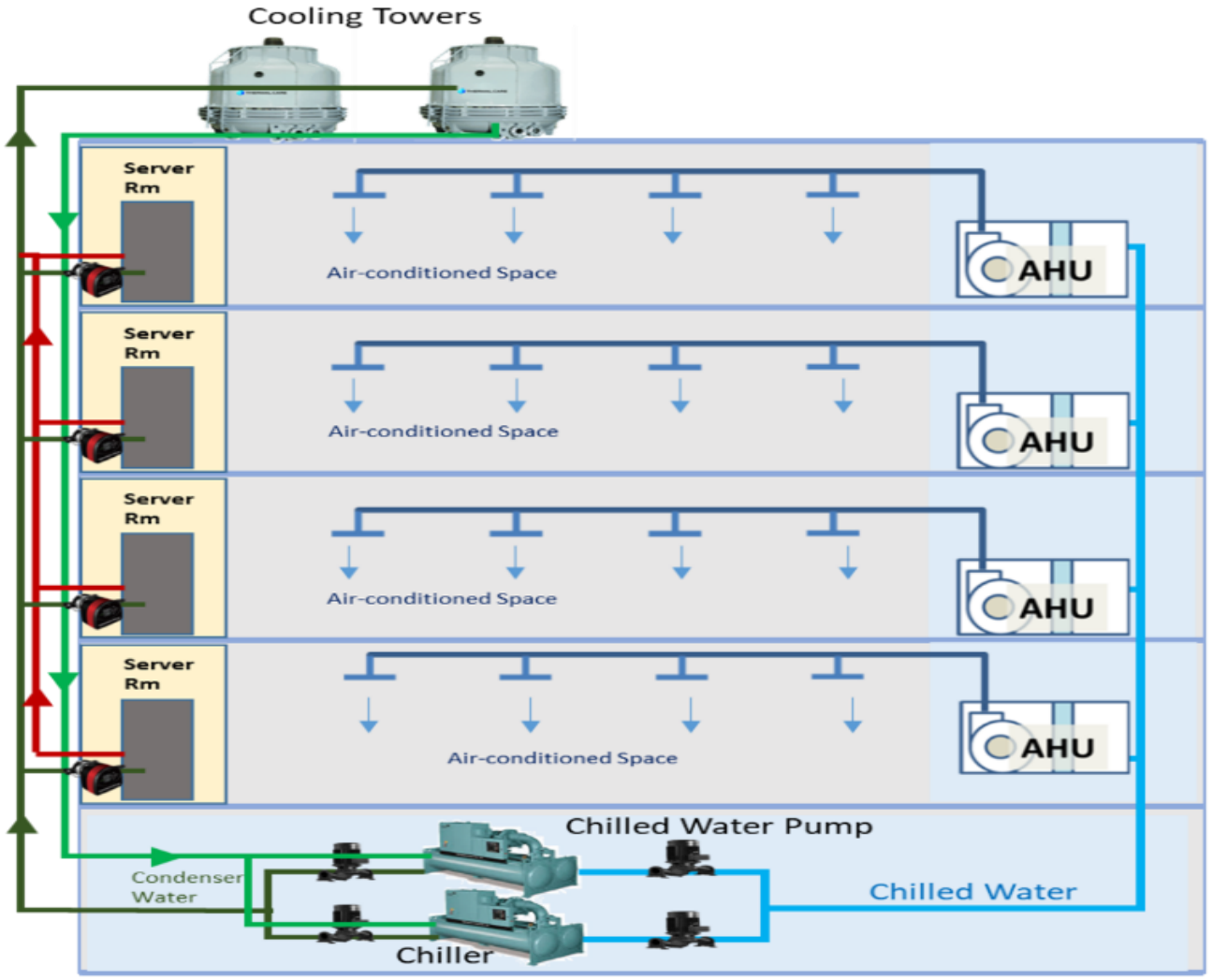
Distributed Heat Rejection System



Typical Liquid Cooling Implementation in Central Chilled Water Air-conditioning System



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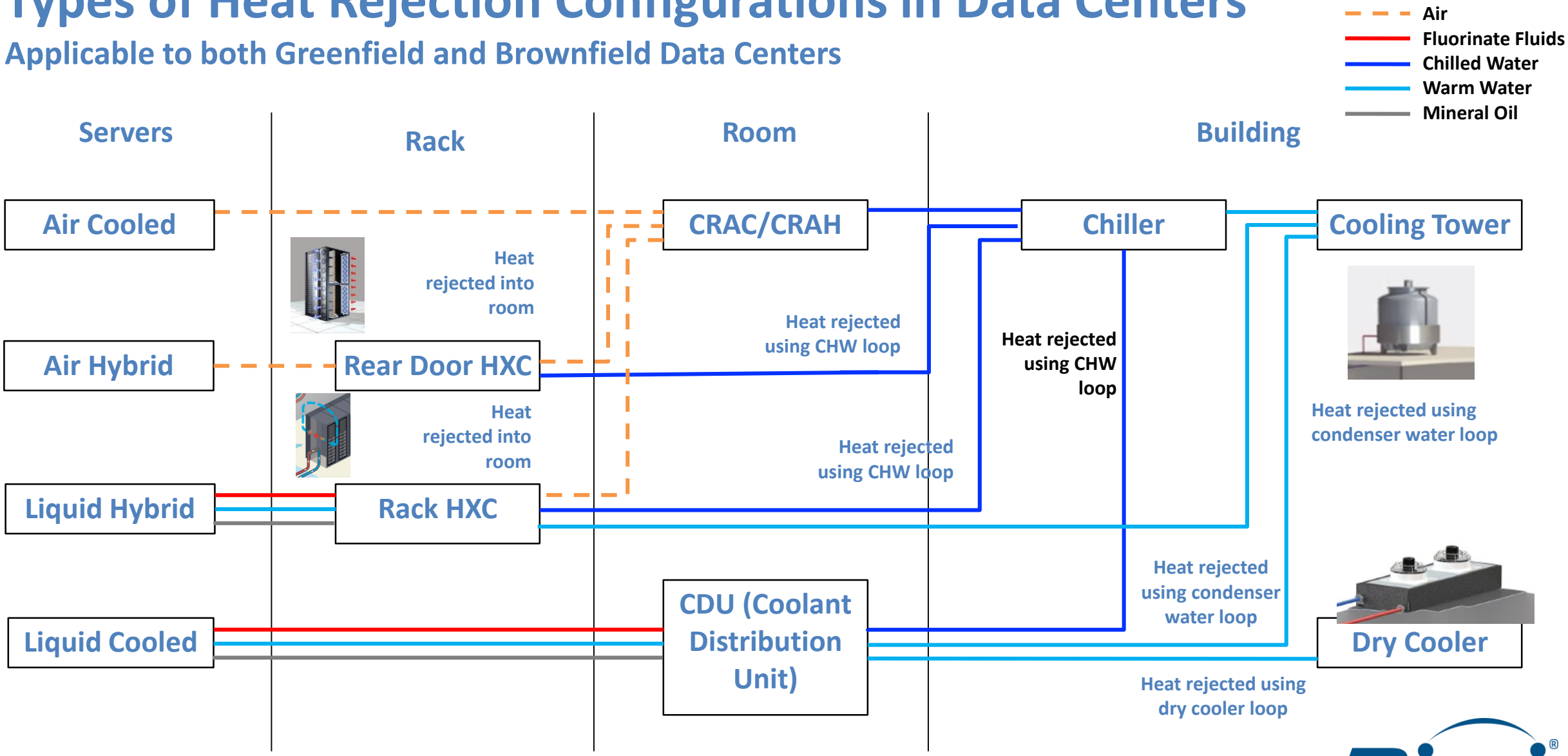
Types of Heat Rejection Configurations in Data Centers

Applicable to both Greenfield and Brownfield Data Centers



Select the suitable Setup or Combination of Setups that Best Fits the Site Conditions

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Comparison of Liquid Cooling Technologies

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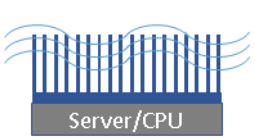
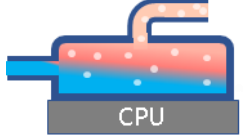
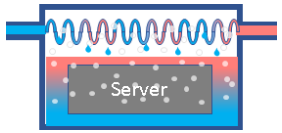
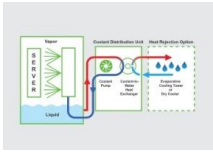
Comparison Analysis









Baseline (Air Cooled)	Air Cooled	Cold Plate	Immersion	Spray	Against Baseline
Cooling Capacity	0	▲	▲▲	▲▲▲	**Highest cooling capacity, 1500x than air**
Maintenance	0	▼▼	▼▼▼	▼	**No specialized equipment**
Reliability	0	▼	▲	▲	**100% component coverage**
Cooling Efficiency	0	▲	▲▲	▲▲▲	**Higher cooling efficiency, minimal power use**
Heat Recovery	0	▲	▲▲	▲▲	**Ease of waste heat recovery**
Noise	0	▲	▲▲	▲▲	**Noiseless**
Corrosion	0	0	▲▲	▲▲	**Not expose to atmosphere, supports harsh environments, extend life of server**
Fire Protection (built-in)	0	▼	▲▲	▲▲	**Inert environment, hermetically sealed chassis**
Space	0	▼	▼▼▼	▲	**Space saving, 2x to 4x capacity**
Weight	0	▼	▼▼▼	▼	**Up to 90% weight savings**
CAPEX – M&E	0	▼	▼▼	▼	**Small CAPEX, No Chiller, Pipes & Pumps**
CAPEX – Whitespace	0	▼	▼▼	▲▲	**Slab floor, dry sprinkler, low weight, no FM200**
Capex – Chassis	0	▼	▼▼▼	▼	**Marginal chassis costs, reusable**
OPEX	0	▲	▲▲	▲▲▲	**Lower operating costs, energy savings**

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Conversion of Air Cooling to Liquid Cooling System

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Conversion of Air Cooling to Liquid Cooling System

Remove or Downsize

- Chillers & CRAHs/CRACs.
- Hot/Cold Containments.

Adding or Existing

- Changes for pumps & piping
- Existing Water Cooling Tower or Dry Coolers.
- Liquid Cooling Technology.
- Cooling management (Monitor & control).

Changes

- Customer and operators required to change process or use specialize equipment.
- Reducing global warming and future Carbon Tax
- More efficient use of energy.

Considerations

Things to consider when adopting liquid cooling

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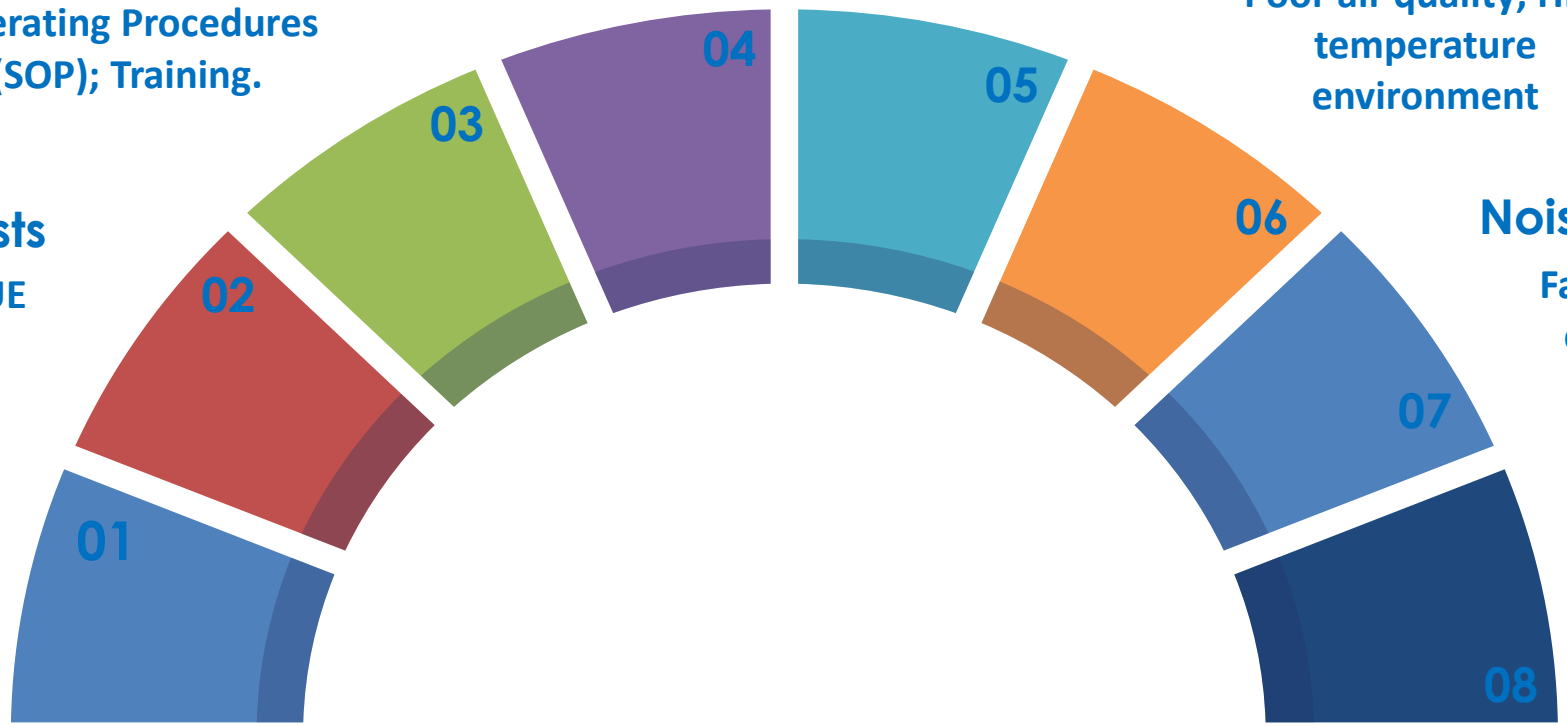
CONSIDERATIONS



Capital Costs
Type of technology selected; Technology refresh.

Energy Costs
Impact to PUE

Serviceability
Impact to Standard Operating Procedures (SOP); Training.

Rack Density
How much more to compute; Power limits.

Water Usage
Impact to WUE; Especially in drought prone areas.

Harsh Environment
Poor air quality; High temperature environment

Noise pollution
Fan noise; air circulation

White Space
Layouts and edge location where air cooling is not possible.

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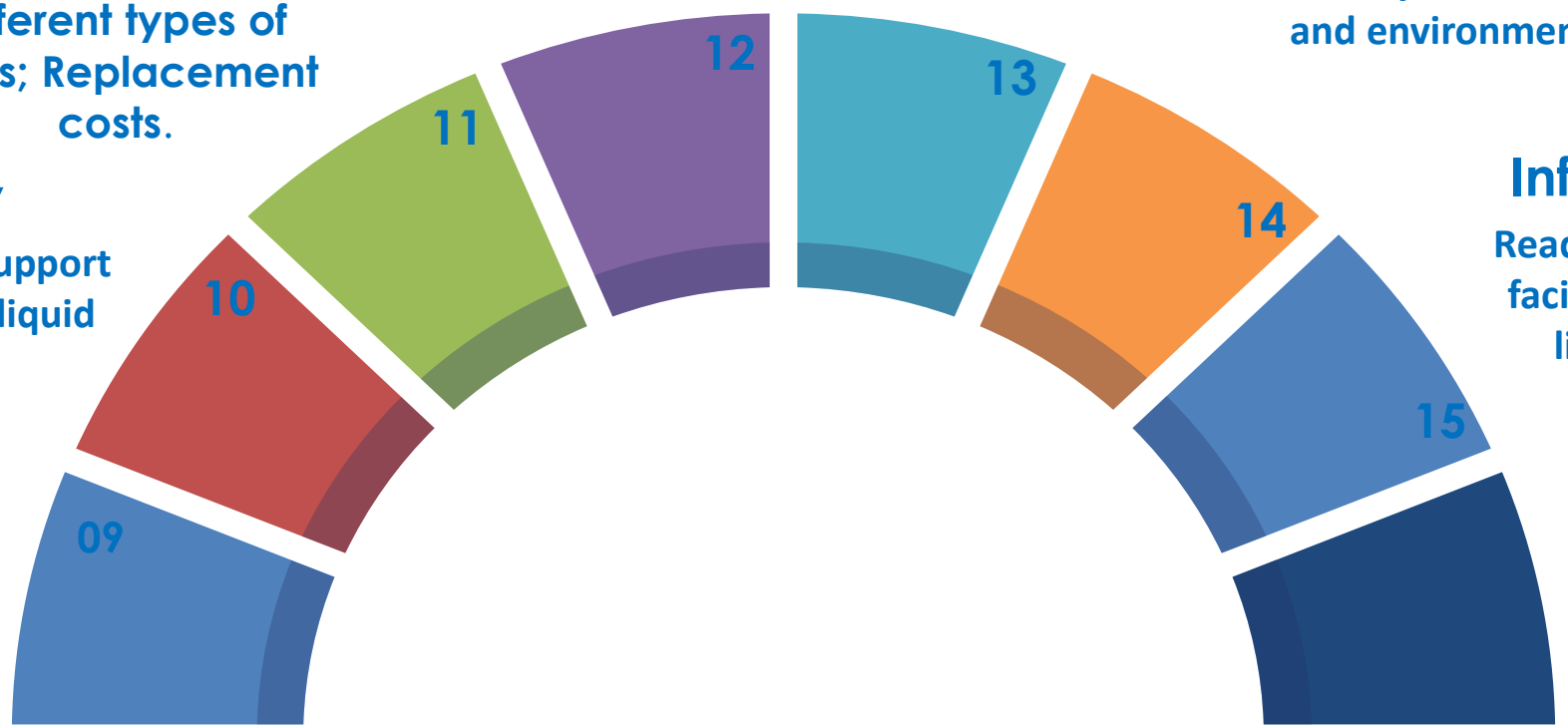
CONSIDERATIONS



Retrofitting
Mixed use of liquid cooling technologies.

Scalability
Ability to scale & support infrastructure for liquid cooling.

Fluid Types
Trade off using different types of fluids; Replacement costs.

Material compatibility
Long term impact of fluid on components.

Environmental
Ozone Depletion Potential (ODP); Global Warming Potential (GWP).

Health and Safety
Toxicity to humans and environment.

Infrastructure
Readiness of existing facilities to support liquid cooling.

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Key Benefits & Summary

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Key Benefits

Return On Investments

ROI < 1 year. CAPEX and OPEX are slashed, return on investments (ROI's) are accelerated, and real estate assets are maximized.

Density

It can achieve 2X to 4X servers density. 100% utilization of rack & DC space.

Scalability

Easy retrofit & meet fluctuation demands.

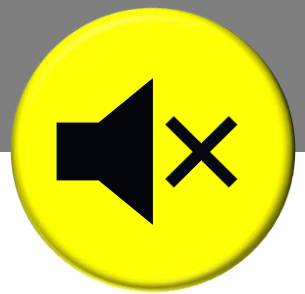
Key Benefits

Efficiency

Significant reduction in total energy consumed. Achieves partial PUE as low as a constant 1.03

Reduce Noise

Reduce vibration; Remove & relieve employees from the disruption of the screaming server fans.



Savings

Reducing OPEX cost & savings in cooling CAPEX; Overall reduction of TCO.

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Key Benefits

Hot Spot

Eliminate hot spots in the racks and the data centers & the need for expensive CFD consultants .

Performance

Facilitating peak performance for higher powered and overclocked processors.

Green

Global Warming; Reduction of CO2 (3 Tons per KW per year).

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Summary

Liquid Cooling is commercially suitable in the tropical countries for:

- ❑ **Hyperscale Computing.**
- ❑ **Cloud Computing.**
- ❑ **Edge Computing.**

Supports scalable deployments to:

- ❑ **Micro-Data Centers.**
- ❑ **Standalone Edge Computing on a Lamp Post or in the Telecommunication Towers.**
- ❑ **Hybrid Cloud or Computing.**

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