

**SPG
DRY
COOLING**



Member of



SPG DRY COOLING
We cool the world's critical industries

260 GW
INSTALLED CAPACITY

140 YEARS LEGACY

30+ PATENTS



+2000

EMPLOYEES WITHIN PAHARPUR
COOLING TOWERS

MARKETS



POWER
GENERATION



DATA
CENTERS



OIL &
GAS



INDUSTRY



HVAC &
DISTRICT COOLING



GREEN ENERGY & LOW CARBON
HYDROGEN, NUCLEAR, SOLAR, GEOTHERMAL, BIOMASS

650

DRY COOLING EXPERTS

22 OFFICES & 10 MANUFACTURING PLANTS



MEMBER OF



Global leader in dry cooling technology

Trusted worldwide with the largest installed base of more than 200GW



Under Paharpur group, we propose a complete range of heat rejection solution



NEW

Field Erected
Plug & Play



ACHE



Hypercooler



Field Erected Cooling Tower



Air Cooler



Hybrid (adiabatic) Cooler



Package Cooling Tower

Dry

Wet

Air Cooled Heat Exchanger is an all-around solution mostly dedicated to oil & gas plants

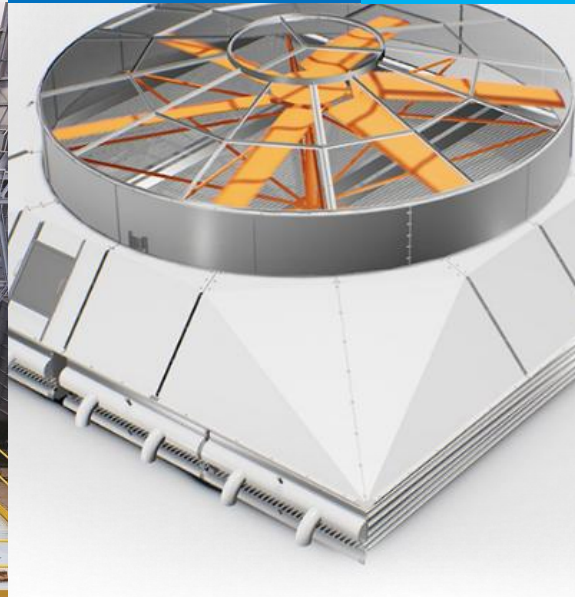


Dry Cooling

Field Erected

>100

Global
References



From **10 MW** and beyond

Flexible configurations
HTRI certified

They allow the direct cooling by air of various process mediums.

Hypercooler is an efficient and compact dry cooler dedicated to hyperscale data centers



Dry Cooling

Field Erected

NEW

From **10 MW** and beyond

**Compact, energy
efficient and silent**

Also available with spraying system

Dry and Adiabatic Coolers



Adiabatic cooling

Factory Assembled

From **0.2 MW** To **20 MW**

**The right choice for
plug&play solutions**

Reduce **energy** consumption by up to **40%** or
reduce **water** usage by up to **80%**. Available
with Cu/Al or SS/Al coils

Under SPGDC flagship, we are the world leaders in **Air Cooled Condensers**



>1000

Global
References

From **5 MW** and beyond

**The sustainable
solution for a
water-smart future.**

Dry cooling solutions can decrease total
water consumption by more than 95%

Dry Cooling

Field Erected

Cooling Towers remain the most efficient solution when water is available



>1000

Global
References

From **5 MW** and beyond

**Fully integrated
manufacturing**

Different types and configurations available
for each specific need

Wet Cooling

Field Erected

Packaged Cooling Towers



>1000

Global
References



Wet Cooling

Factory Assembled

Most Efficient / Cost Effective Cooling Solution

CTI Certified

Different types and configurations available for each specific need

Data centres require high amounts of
power and cooling



Technology is **changing quickly** and so are the cooling needs

From MWs to 1000 MW data center capacity



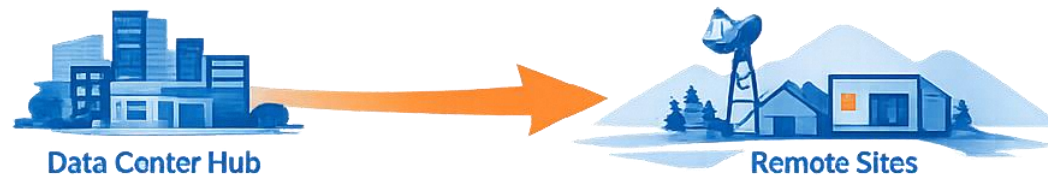
From Air Cooling to Direct to chip / Immersion cooling



From kW rack to MW



From Centralized to Remote Locations



Liquid Cooling enables higher cooling temperatures



LIQUID COOLING IN A DATA CENTER

Heat is absorbed at the chips, carried by liquid to a CDU, rejected by a chiller, and released to the outside by a dry cooler.

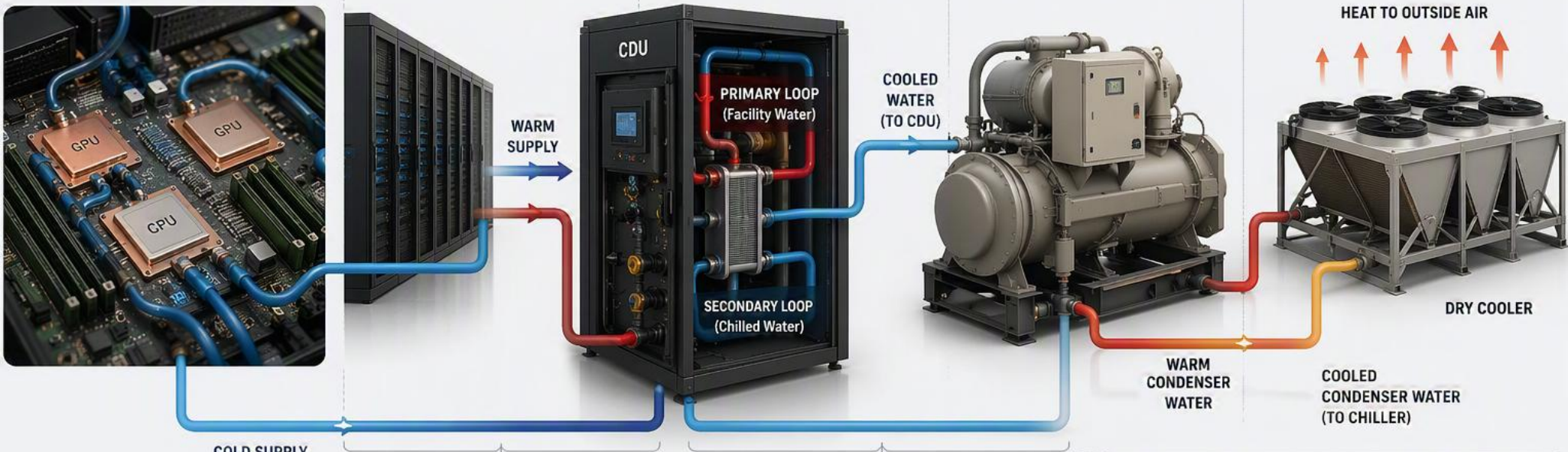
1 HEAT ABSORBED AT THE CHIPS
Coolant flows through cold plates attached to high-power chips (CPUs, GPUs, accelerators) and absorbs heat.

2 WARM LIQUID TO CDU
The warmed liquid leaves the servers and goes to the Coolant Distribution Unit (CDU).

3 HEAT REMOVED IN THE CDU
Inside the CDU, a heat exchanger transfers heat from the primary (facility) loop to the secondary (chilled water) loop.

4 COOLED BY WATER CHILLER
The chiller removes heat from the secondary loop, cooling the water and rejecting the heat to the condenser water loop.

5 HEAT REJECTED BY DRY COOLER
The dry cooler uses outside air to reject the heat from the condenser water, returning it cooler to the chiller.

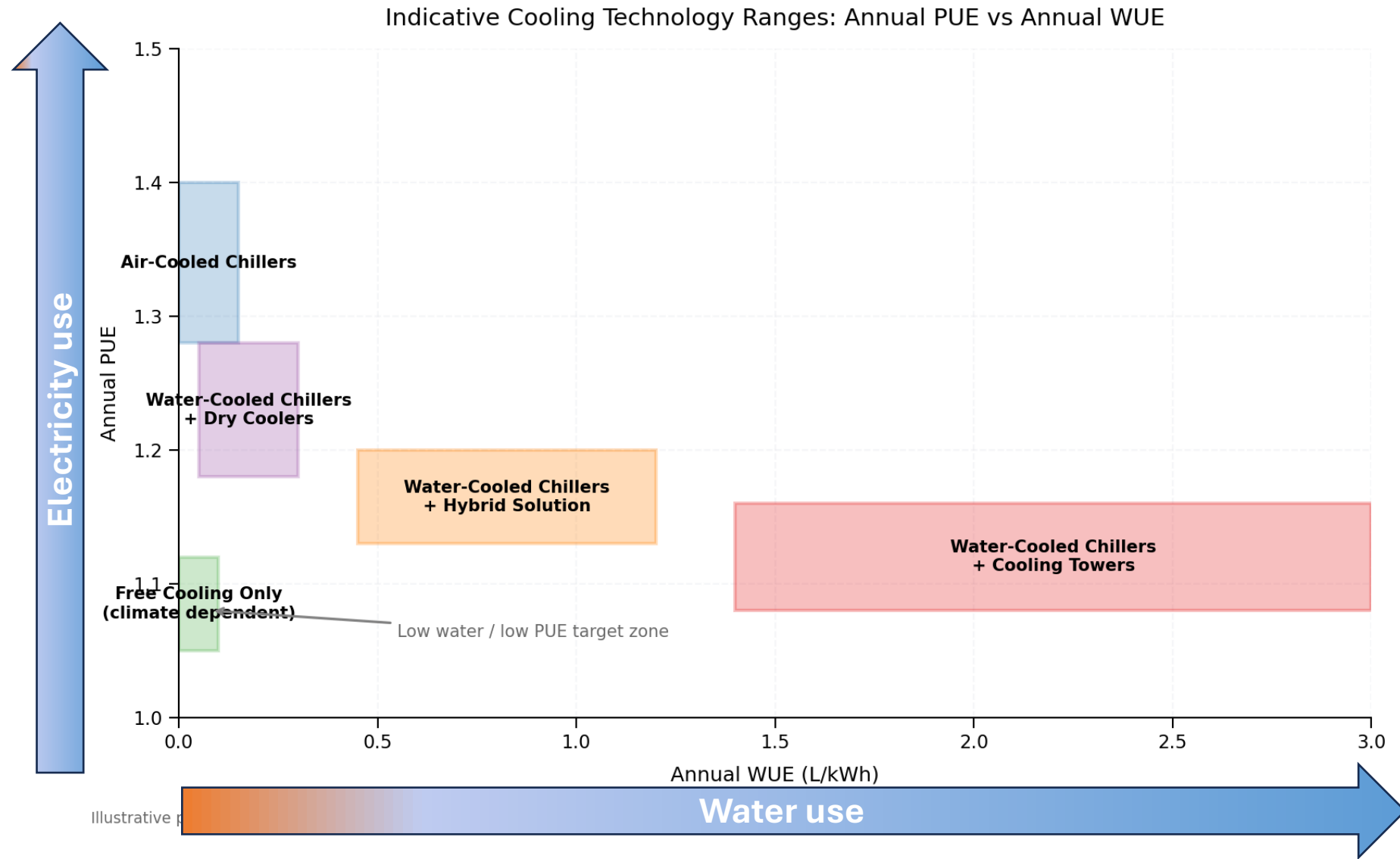


PRIMARY (FACILITY) LOOP
Closed loop inside the data center

SECONDARY (CHILLED WATER) LOOP
Closed loop between CDU and chiller

- COLD / COOLED LIQUID
- WARM / HOT LIQUID
- WARM CONDENSER WATER
- COOLED CONDENSER WATER

Most efficient cooling goes without mechanical cooling (chiller)

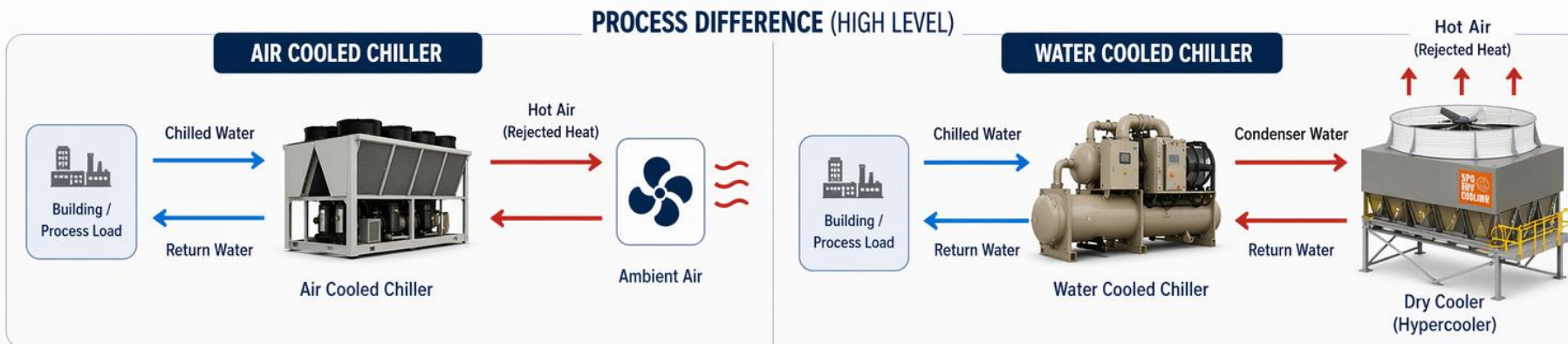




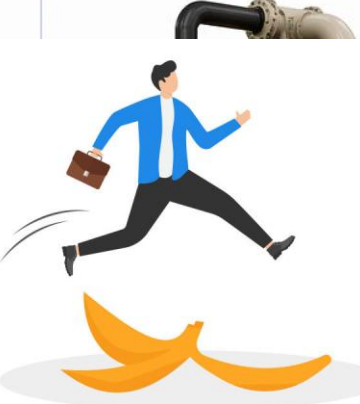
How does it work with chillers?

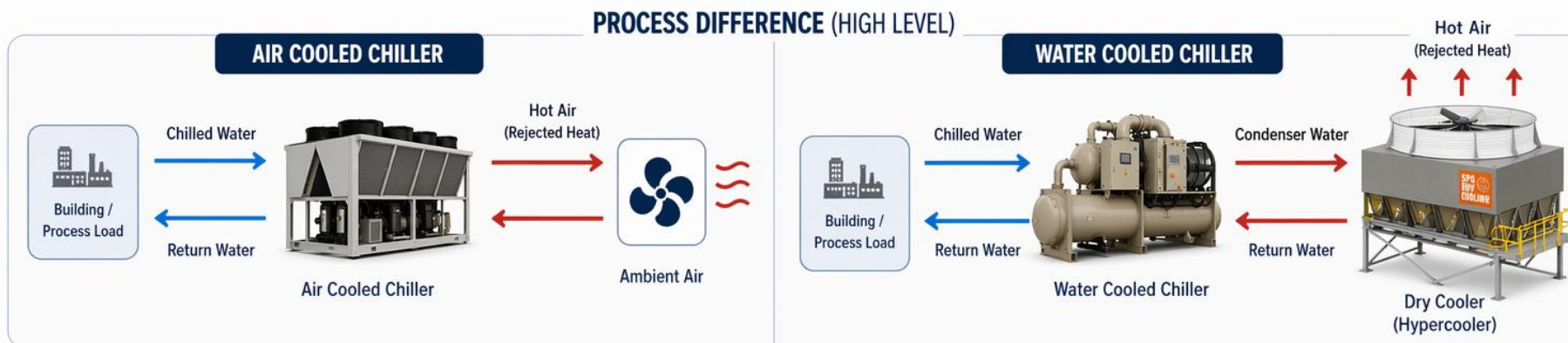
Water cooled chillers + dry coolers are more efficient than air cooled chillers

AIR COOLED CHILLERS			WATER COOLED CHILLERS		
	 GOOD Higher energy use, especially in hot climates.	 EFFICIENCY	 EXCELLENT More efficient, lower operating costs.		Rejects heat to a water loop through a water-cooled condenser and requires a dry cooler (hypercooler) for heat rejection.
	 LARGER FOOTPRINT Requires more space for installation and airflow clearance.	 SPACE	 COMPACT Smaller footprint, ideal for space constrained sites.		
	 NO WATER USE No water required for heat rejection.	 WATER USE	 NO WATER USE No water required for heat rejection.		

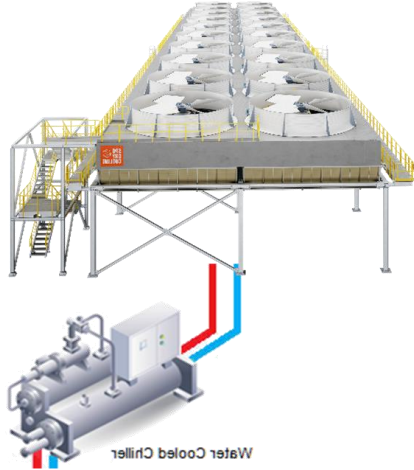


Water cooled chillers and dry coolers are more efficient than air cooled chillers

AIR COOLED CHILLERS			WATER COOLED CHILLERS		
 Rejects heat to ambient air using fans and air-cooled heat exchanger (coils).	 GOOD Higher energy use, especially in hot climates.	 EFFICIENCY	 EXCELLENT More efficient, lower operating costs.	 Water Cooled Chillers do not waste water (if dry cooled)	
	 LARGER FOOTPRINT Requires more space for installation and airflow clearance.	 SPACE	 COMPACT Smaller footprint, ideal for space constrained sites		
	 NO WATER USE No water required for heat rejection.	 WATER USE	 NO WATER USE No water required for heat rejection.		

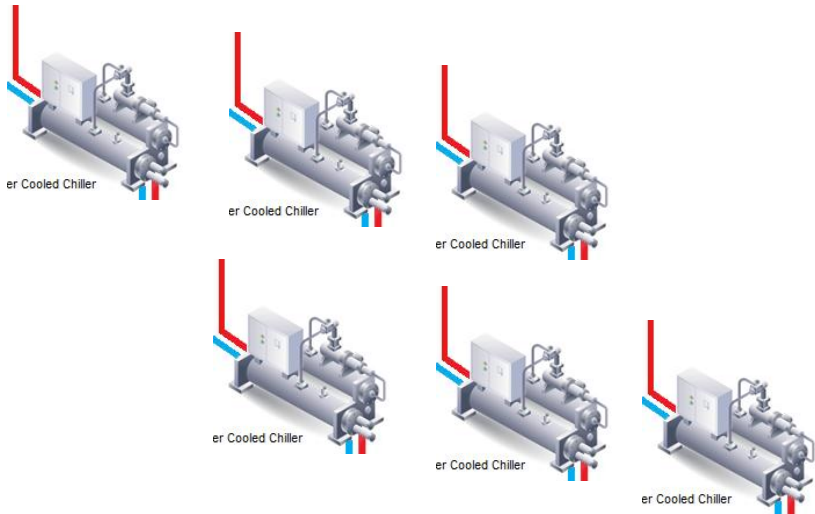
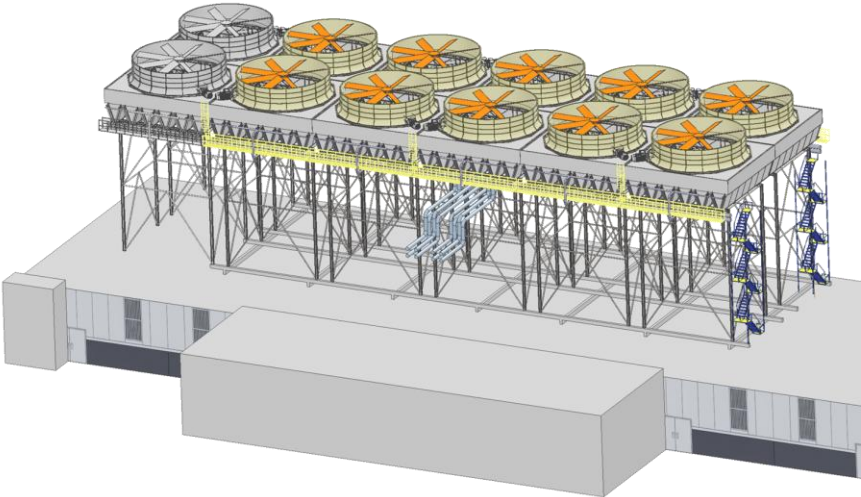


More efficient and scalable than air-cooled chillers



Criteria	Air-Cooled Chiller (ACC)	Water-Cooled Chiller + Dry Cooler
 Footprint	● Very high	● Low (-50%)
 Noise	● Very high	● Medium (-5-7 dB)
 Power Consumption	● Very high	● Low (-50%)
 Maintenance	● Extremely high (100x more fans)	● Medium (WCC system)

More efficient and scalable than air-cooled chillers: space

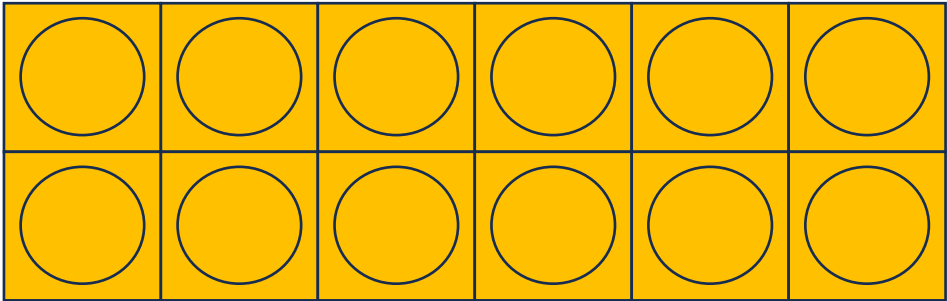


VS

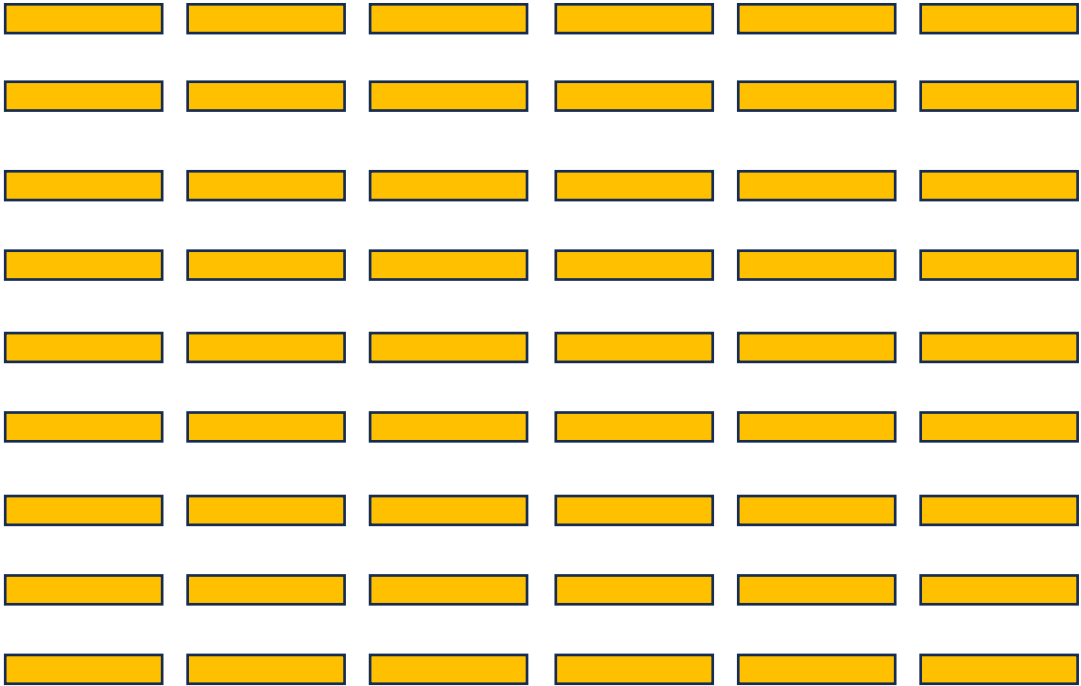


x 40-60

More efficient and scalable than air-cooled chillers: space



VS



x 40-60

More efficient and scalable than air-cooled chillers: space



			
WCC+Dry Cooler		Air Cooled Chiller	
Design Conditions			
Air Inlet Temperature	°C		39
Total Tons of Dissipation (per roof)	MW		74
Chilled water supply	°C		27
Chilled water return	°C		19

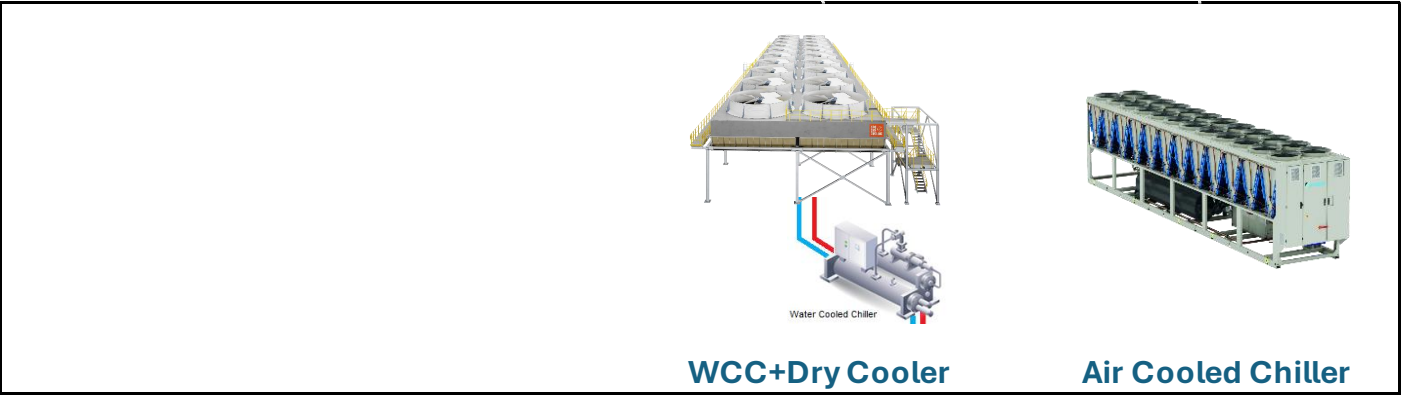
2x lesser footprint and
100x less fans

Quantity required				
Capacity per Chiller	MW	12		1.3
Number of chillers required		6		56
Dry Coolers required (n+1)		12		0

Footprint		Per unit	Total	Per unit	Total
Dry Coolers with WCC underneath	m2	140	1,681		
Air Cooled Chillers (spacing between units	m2			63	3,510

Maintenance		Per unit	Total	Per unit	Total
Number of fans		1	12	20	1120

More efficient and scalable than air-cooled chillers: noise and power consumption



5-7dB quieter and **10-50%** reduction in annual power consumption **without consuming a single drop of water**

Noise	Per unit dB	Total dB	Per unit dB	Total dB
Dry Coolers	100	111	-	-
WCC	95	103	-	-
ACCH	-	-	100	117
Total		111		117

Annual Power Consumption (est'd)	Total (MWh)	Total w/o free cooling (MWh)	Total with free cooling (MWh)
Dry Coolers	7,921		
WCC	28,996	-	-
ACCH	-	73,299	42,030
Total	36,917	73,299	42,030



Evaporative vs Dry Cooling

Dry and evaporative cooling are very distinct

1 PRINCIPLE

HOW HEAT IS REJECTED

No contact between air and fluid.

Heat is transferred through a coil and fins (heat exchanger surface) to the air.

KEY POINT:

Air and fluid stay in separate circuits.
No evaporation occurs.
Higher leaving water temperature

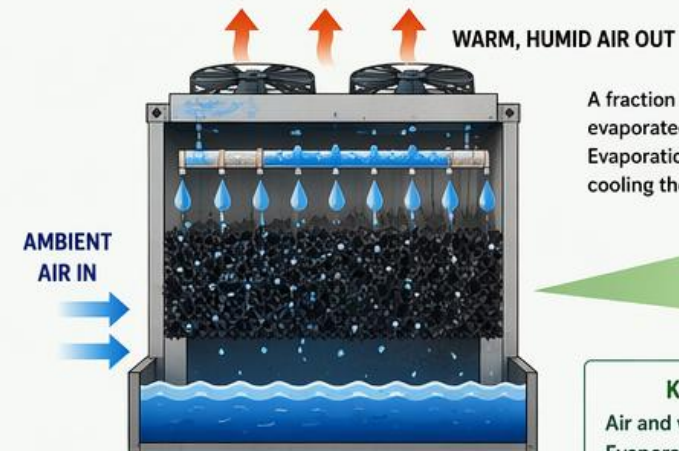
DRY COOLING – HYPERCOOLER (No contact between air and fluid)



VS

EVAPORATIVE (WET) COOLING

(Air evaporates some droplets to cool down the fluid)



KEY POINT:

Air and water are in contact.
Evaporation cools the water.

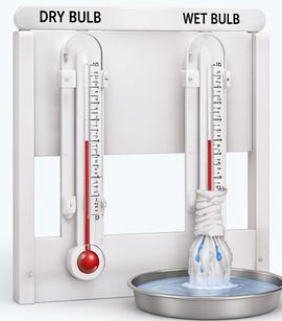
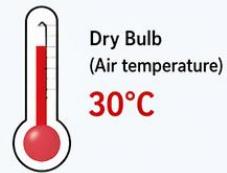
Evaporative cooling works on wet bulb = the evaporation potential of the air

WHAT IS WET BULB TEMPERATURE?

The lowest temperature air can reach by evaporation of water.

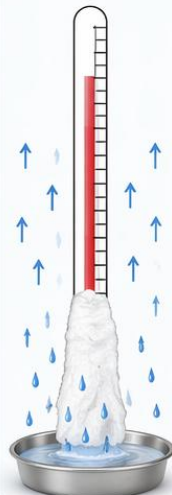
1 STARTING POINT

Air at a certain temperature and humidity.



2 EVAPORATION OCCURS

Water evaporates from the wet cloth into the air.

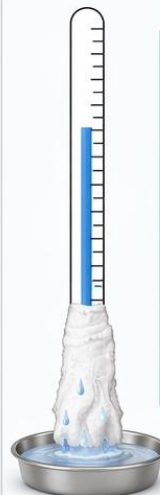


During evaporation:

- Water changes from liquid to vapor
- Energy (heat) is taken from the air and the water
- Air temperature drops

3 EQUILIBRIUM REACHED

Evaporation continues until a balance is reached.

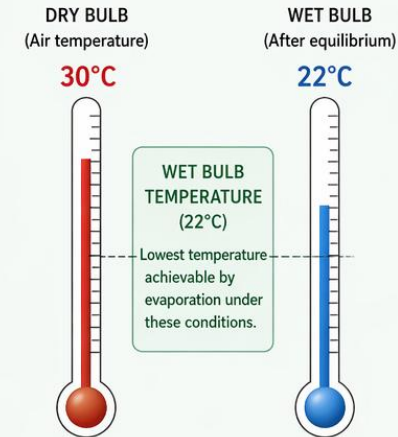


At this point:

- The air is saturated at the wet bulb temperature
- No more net evaporation
- The wet bulb temperature remains constant

RESULT

The wet bulb temperature is always equal to or lower than the dry bulb temperature.



WHAT AFFECTS THE WET BULB TEMPERATURE?



HUMIDITY

Higher humidity → less evaporation
→ wet bulb closer to dry bulb



AIR MOVEMENT

More airflow → more evaporation
→ lower wet bulb temperature



AIR TEMPERATURE

Higher air temperature (with same humidity) → higher wet bulb

i When air is 100% saturated, no evaporation occurs and WET BULB = DRY BULB.

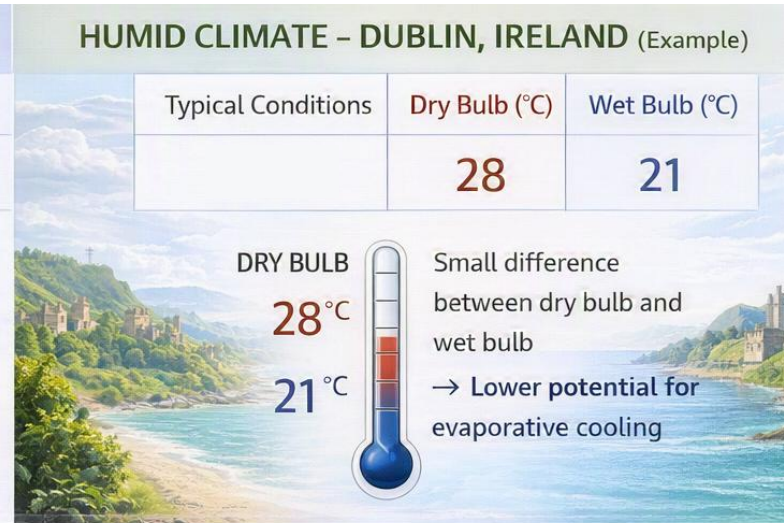
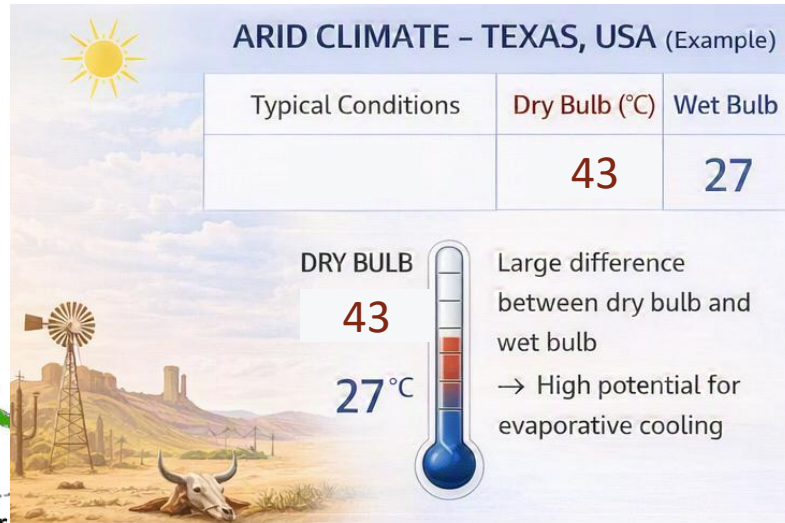


KEY TAKEAWAY

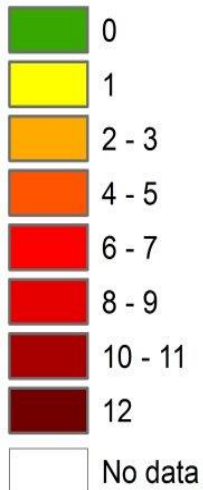
Wet bulb temperature represents the cooling potential of evaporation.

It is a key indicator for the performance of evaporative (wet) cooling systems.

Potential for wet/dry cooling greatly varies depending on location



Number
water scarcity > 100%



Evaporative cooling enables lower water temperature but evaporates a few % of the circulated water



Combining dry and evaporative cooling is the key for some locations
(can get your water temp lower by another 5°C)

How can dry and wet work together? Use water wisely

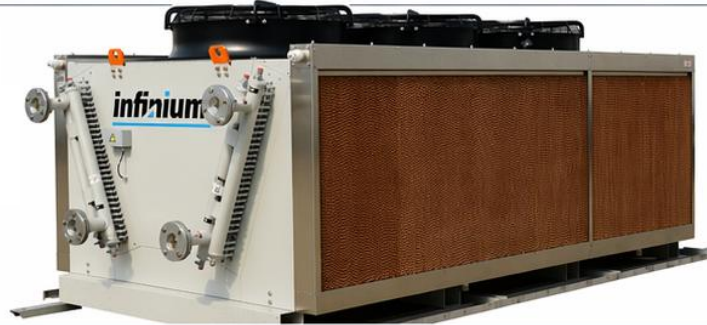
1 DRY COOLER WITH SPRAY

Air is pre-cooled with sprays until it gets closer to wet bulb



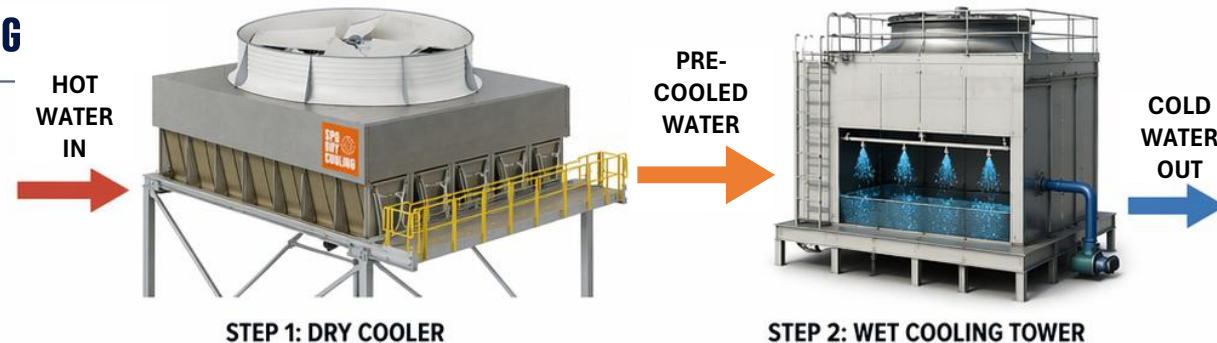
2 DRY COOLER WITH PADS

Air is pre-cooled with pads until it gets closer to wet bulb



3 SERIES COOLING

Two-stage process: air is pre-cooled in a dry cooler, then further cooled in a wet cooling tower.





What is your
favorite **dry**
cooler?

Available dry coolers and their shortfalls



FLAT AIR COOLED HEAT EXCHANGER (ACHE)



VS

PACKAGED AIR COOLER



Up to 1-2 MW per unit

Up to 2-4 MW per unit

! KEY PAIN POINTS



COMPACTNESS

Very large footprint.
Requires significant space.



HEAVINESS

Heavy steel structure.
High structural & civil requirements.



INSTALLATION / PACKAGE

Site-built solution.
Long erection time and complex installation.

! KEY PAIN POINTS



POWER CONSUMPTION

High fan power consumption,
especially in high ambient conditions.



SITING REQUIREMENTS

Needs more clearance and access
for maintenance and airflow.



HOT AIR RECIRCULATION

Risk of recirculation in confined
or improperly designed sites,
reducing performance.



NOISE

High noise levels due to fans,
may require mitigation.



SUMMARY

Flat ACHes are robust and suited for large-scale applications but come with challenges in compactness, weight, and installation complexity.

Packaged Air Coolers are compact and easy to deploy but face challenges in power consumption, siting, hot air recirculation, and noise.

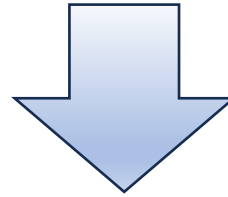
Hypercooler: Efficient. Compact. Water-Free.



Package Cooler



ACHE



Up to 10
MW per
cell



How to solve hyperscalers challenges altogether?

Energy Efficiency



Large fans move air
much more efficiently
and quietly than small
ones:

Up to **30%** reduction in auxiliary
losses and **4-8 dB(A)** lower

How to solve hyperscalers challenges altogether?

Maintenance



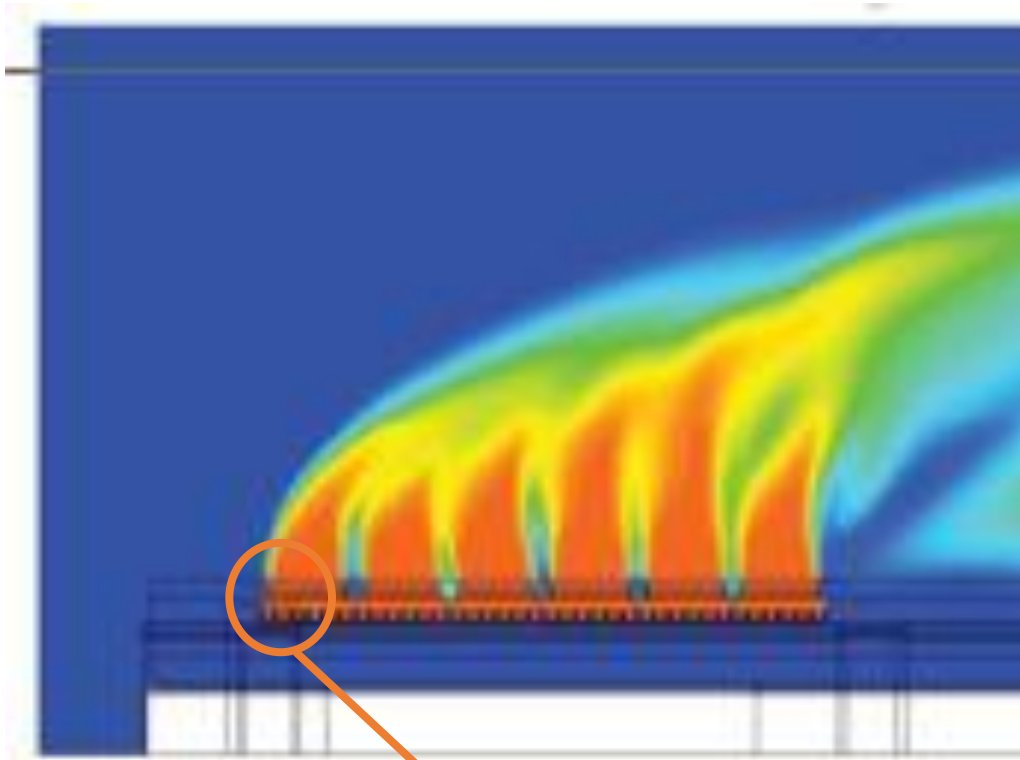
One large axial fan covers the duty of 100 small EC fans

How to solve hyperscalers challenges altogether?

Hot Air Recirculation

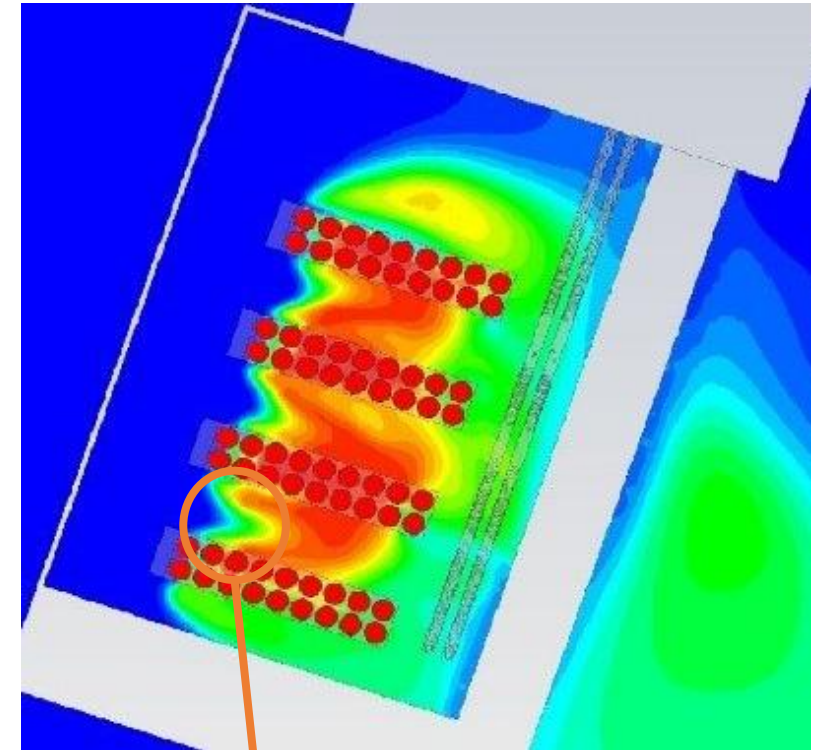


Hypercooler



No recirculation between individual units

Package Dry Cooler (or chiller)



Hot air from a neighbouring unit can be ingested in the next one

How to solve hyperscalers challenges altogether?

Footprint



V arrangement
combined with a light
elevated structure
ensures
up to **20-40% smaller**
footprint

Hypercooler is the best-performing dry cooling solution on the market



	Flat Arrangement	Package Dry Cooler	Hypercooler
 Footprint	 High	 High (needs spacing between units)	 Low (-50%)
 Noise	 Medium (+2 dB)	 High (+4 dB)	 Low (= baseline)
 Power Consumption	 Medium (baseline)	 Higher (+20%)	 Low (-30%)
 Maintenance	 Medium	 Very high	 Very low



Modular Chiller Plants

Modular Chiller Plant with Dry Coolers

Water Conservation Built In.

DRY COOLED (AIR COOLED HX)

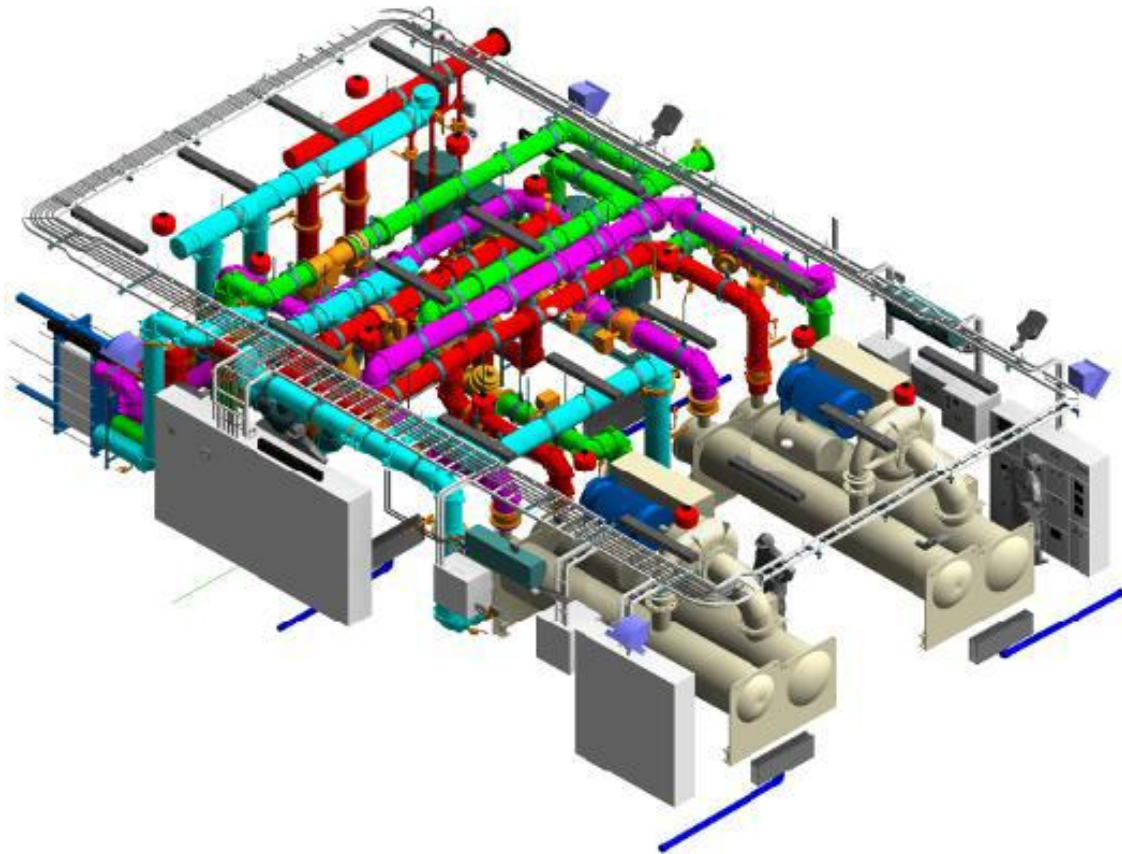
- Zero water use
- Up to 30% auxiliary power reduction
- Noise reduction by 4–8 dB(A)

ADIABATIC ASSIST

- Up to 80% less water vs. cooling towers
- VFD optimization
- Closed-loop operation

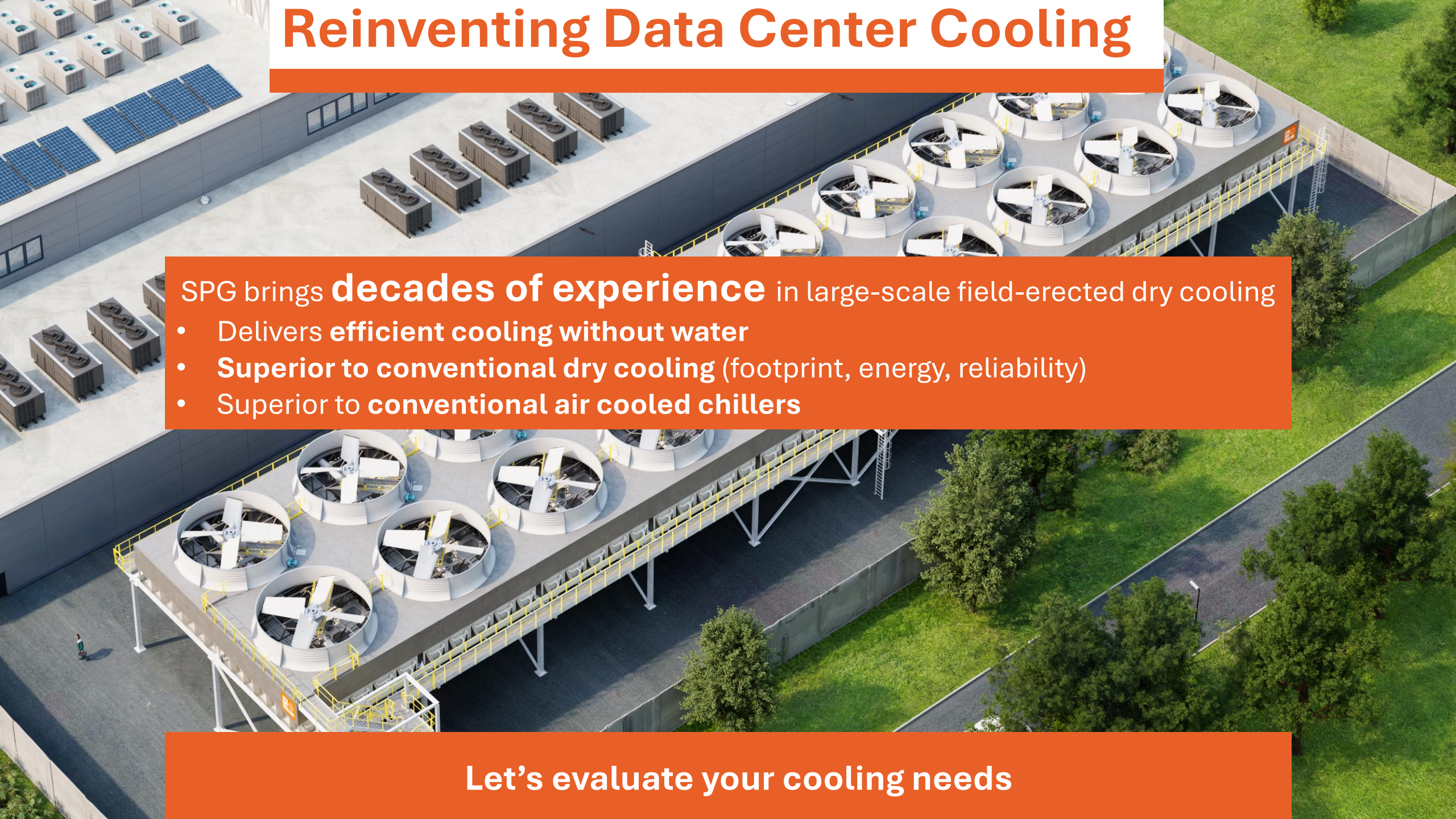


Modular Chiller Plant – Dry or Wet



- 750 – 3,600 ton capacity range
- Designed for high-density, high-performance computing
- Delivers on-demand, precise cooling with high energy efficiency
- Tier III/IV and ASHRAE TC 9.9 compliant
- Factory-tested, plug-and-play installation
- Minimal on-site work
- System can be pre-staged and stored
- 44'L x 14'W x 13.5'H (typical)
- 130,000 lbs per module (typical)

Reinventing Data Center Cooling

An aerial photograph of a modern data center building. The building has a flat roof with several large, rectangular solar panel arrays. Adjacent to the solar panels is a large, elevated platform or rooftop structure. This platform is equipped with a series of large, circular, white cooling fans, each with four blades. The fans are arranged in a grid-like pattern. A yellow safety railing runs along the edge of this platform. The building is surrounded by a green lawn and some trees. The sky is clear and blue.

SPG brings **decades of experience** in large-scale field-erected dry cooling

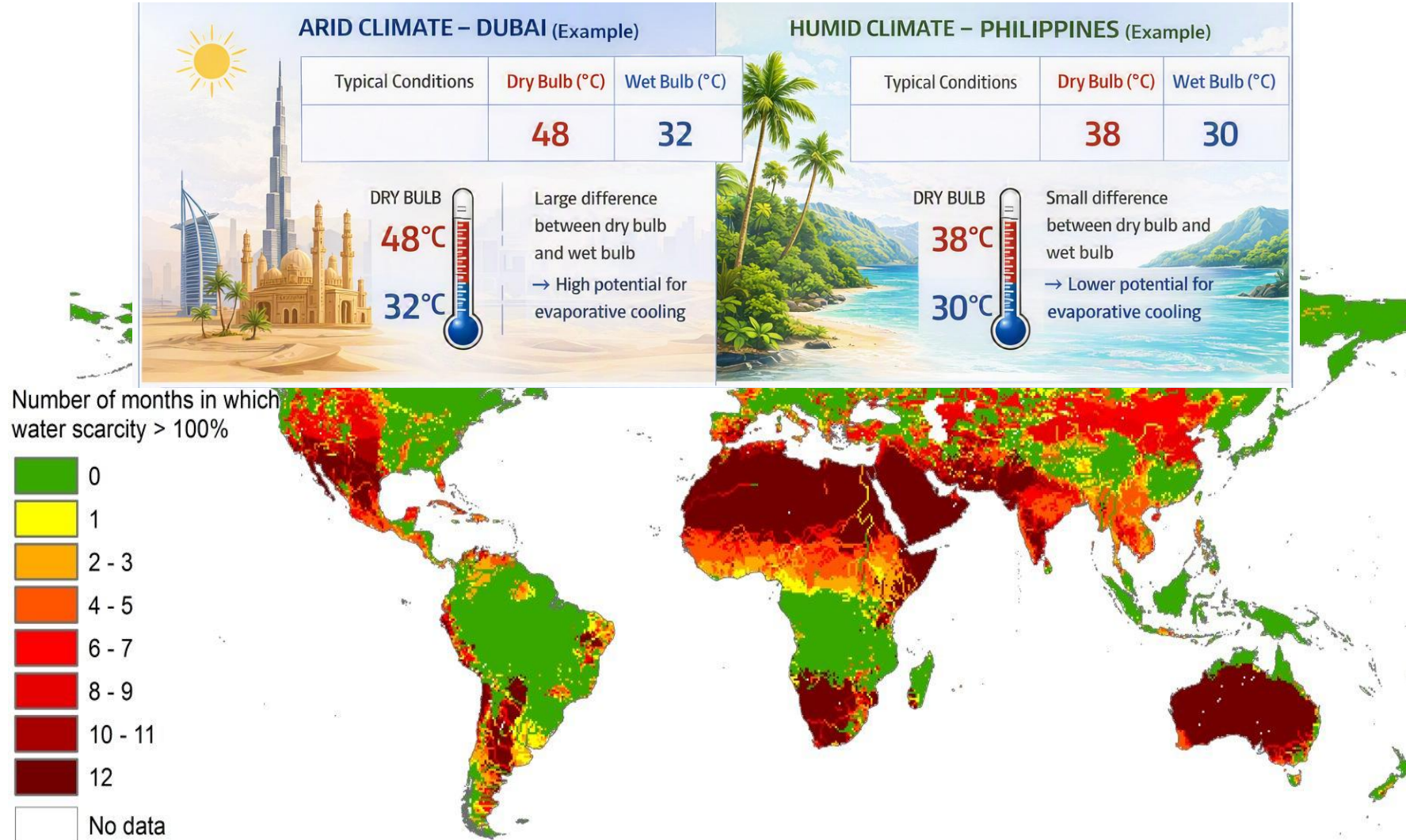
- Delivers **efficient cooling without water**
- **Superior to conventional dry cooling** (footprint, energy, reliability)
- Superior to **conventional air cooled chillers**

Let's evaluate your cooling needs

BACKUP



Middle East needs to cope with very hot climate and water scarcity

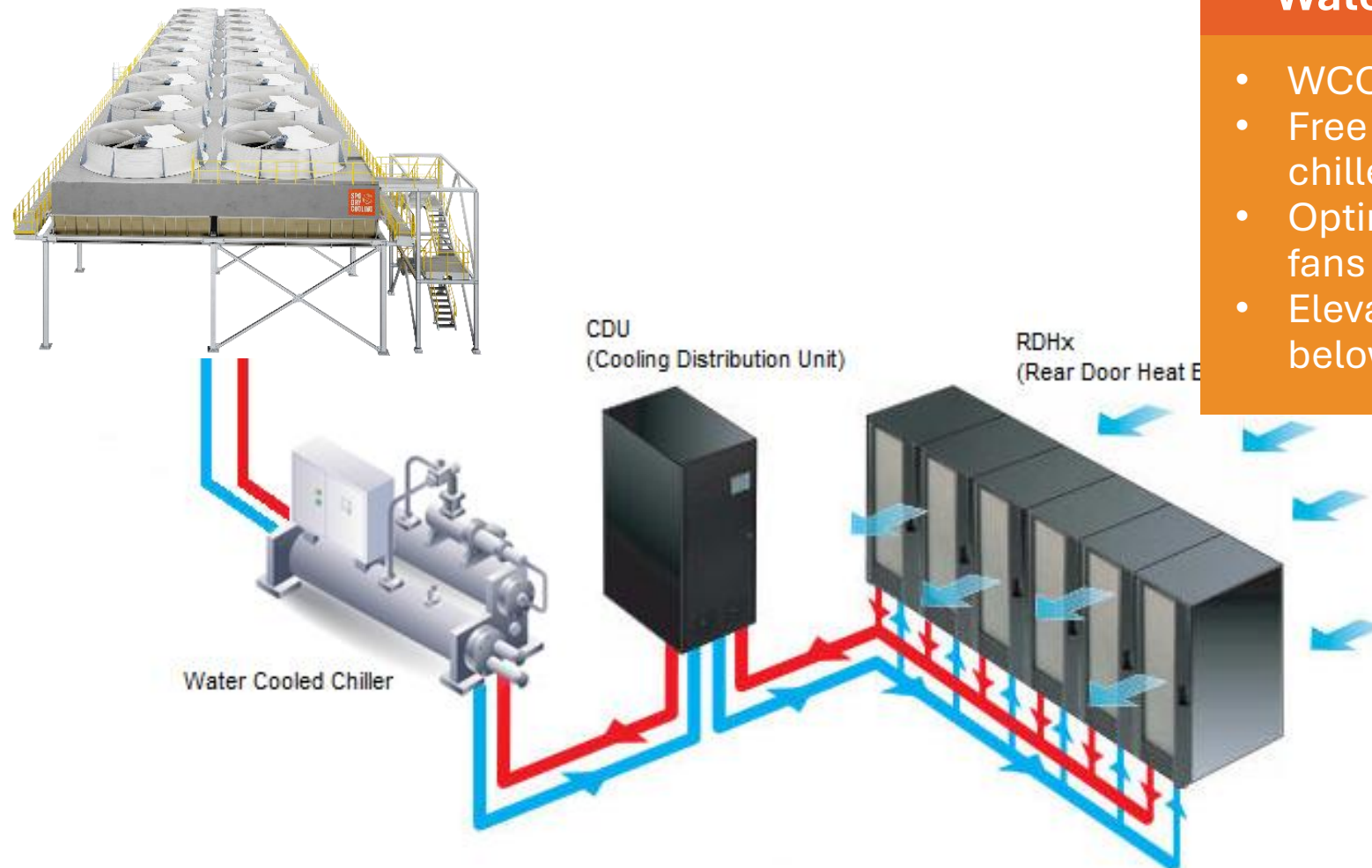


Combined with a water cooled chiller, it enables to drastically reduce PUE & footprint

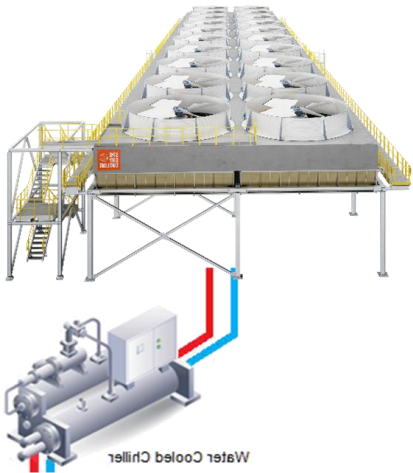


Water Cooled Chiller + Dry Cooler

- WCC yield higher efficiency
- Free cooling simply by bypassing chiller
- Optimized air cooling with large size fans
- Elevated layout creates free space below to install equipment



Combined with a water cooled chiller, it enables to drastically reduce PUE & footprint



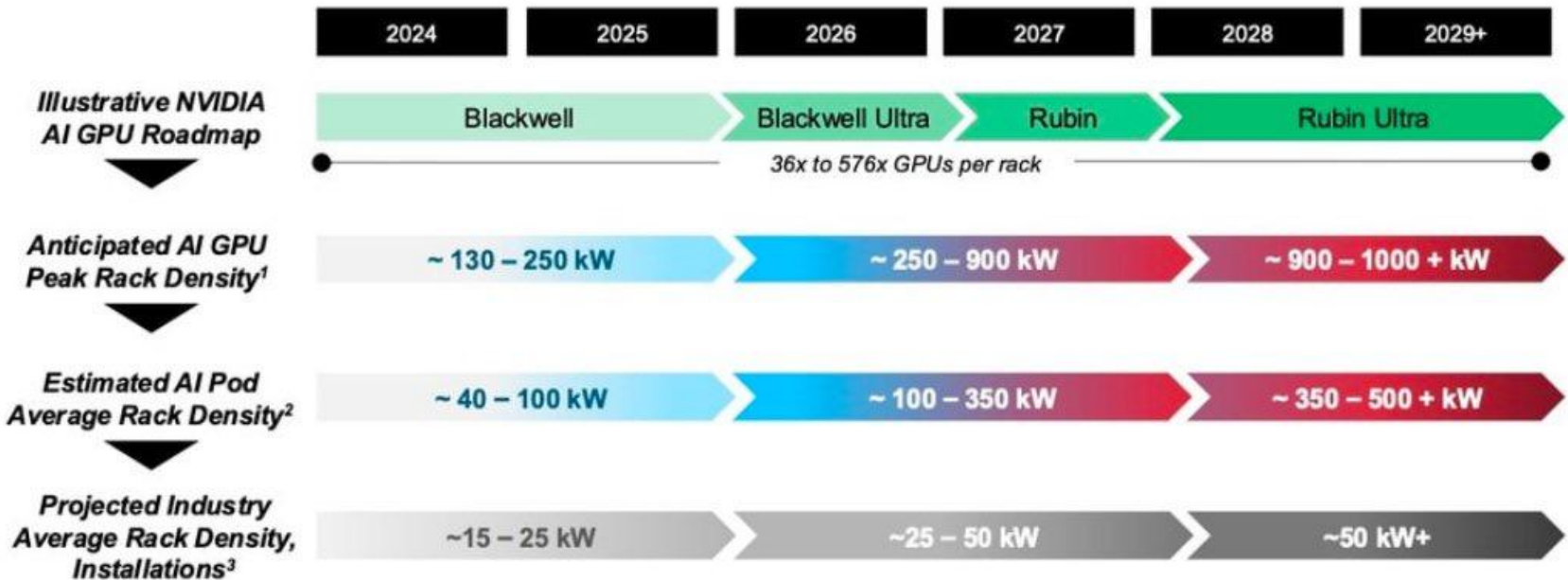
Criteria	Air-Cooled Chiller (ACC)	Water-Cooled Chiller + Dry Cooler
 Footprint	 Very high	 Low (-50%)
 Noise	 Very high	 Medium (-5-7 dB)
 Power Consumption	 Very high	 Low (-50%)
 Maintenance	 Extremely high (100x more fans)	 Medium (WCC system)

Rack Density Evolution



2

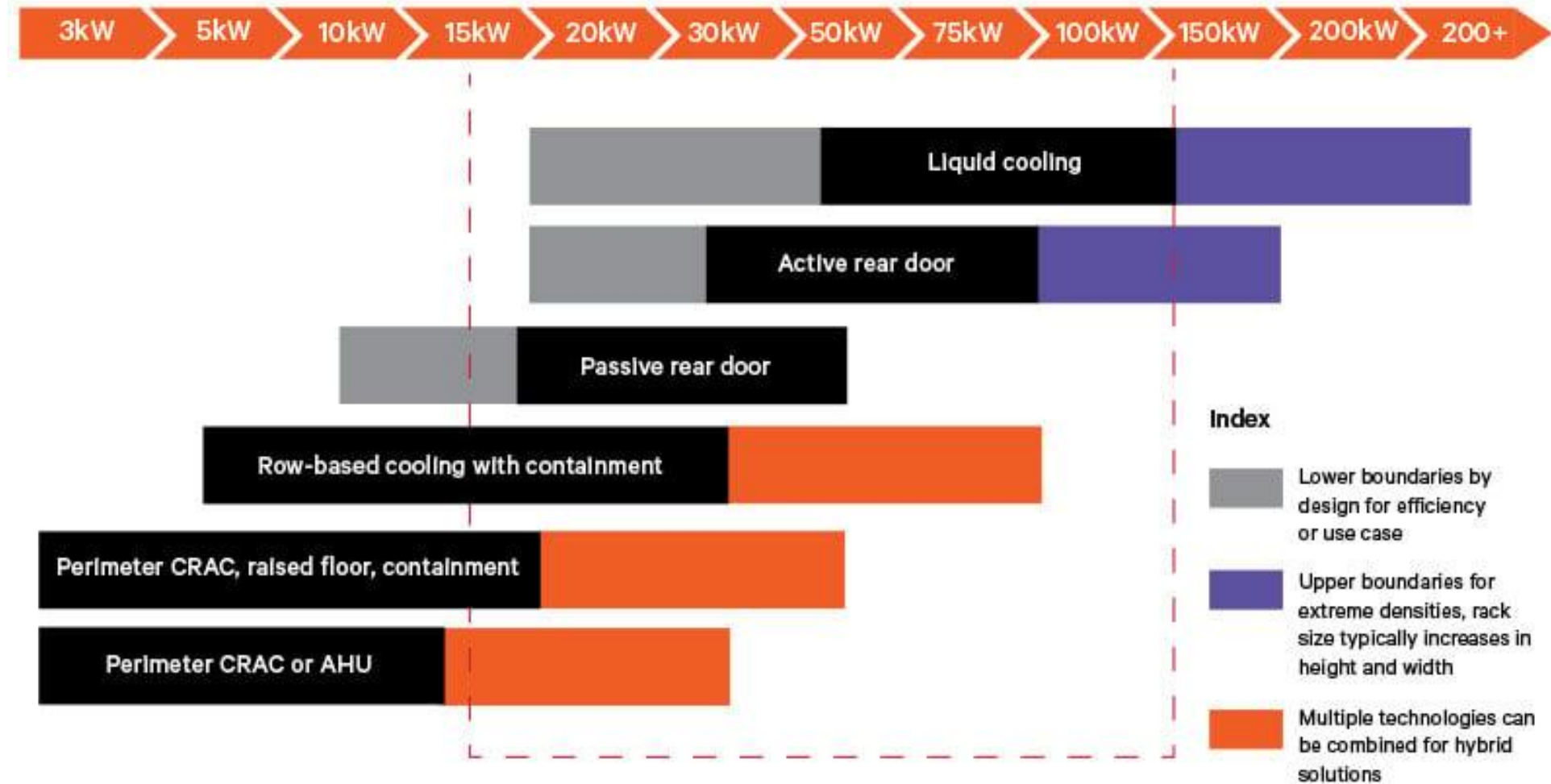
Anticipated increases in extreme and overall industry rack densities



Note: Projections. Rack density varies by application. ¹ Management Estimates; ² Management Estimates, assuming an AI pod consisting of 18 racks (9 per row) including 8 GPU racks at higher peak density and 10 networking racks; ³ Management Estimates; average densities of data center rack installations across Cloud, Colocation and Enterprise/Distributed IT.

Densification roadmaps point to extreme peak rack densities of 1MW+ resulting in estimated new build average rack density increasing across varying workload applications and market segments

Applicability Air vs Liquid Cooling

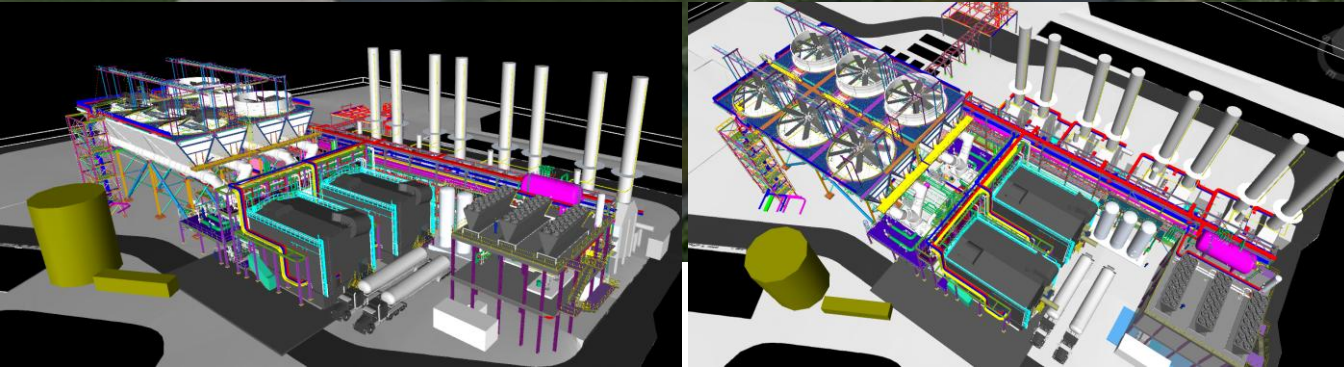




DUB10

Dublin, Ireland

- Data Centers consume more than **20% of Ireland's electricity**
- 3x30MW IT Load and 120 MW of power generation from a **captive power plant**
- Supplying **2x dry cooled W-Style** for Data Center's power supply
- SPGDC equipment selected for **Echelon's first captive power plant**



STT Global Data Centre Bangalore, India

- 18MW IT Load, **5.5 MW cooling capacity**
- Air Coolers specifically **designed for Immersion Cooling**
- Exclusive Service Level Agreement (SLA) with a **2 hours turnaround**



Bazian Turkey

- (ACHE) Air Cooled Heat Exchangers
- Combined Cycle Power Plant auxiliary cooler
- Advanced engineering for high pressure-temperature case
- Compliance with API 661 and ASME Sec VIII Div .3





Herne 6 Project, Siemens Germany 600MW

- Combined cycle Power Plant
- Low Noise Cooling Tower
- Low noise achieved by air inlet and outlet silencers designed by Paharpur
- Unique design with concrete risers