Evolution of Data Centre Cooling

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AGENDA

The eras of data centre cooling

Challenges in the Middle East

Typical data centre analysis

Scenario 1: Lift air temperatures
Scenario 2: Chilled Water
Scenario 3: Free Cooling in high ambient regions

Low PUEs through smart control

A backdrop of global megatrends

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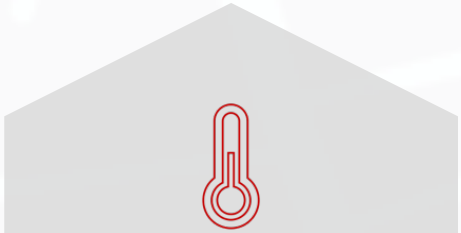

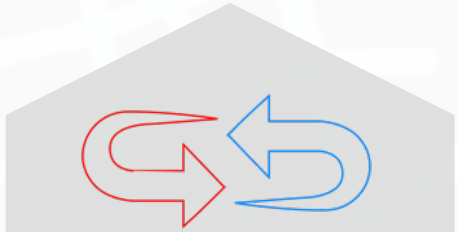

The Eras of Data Centre Cooling

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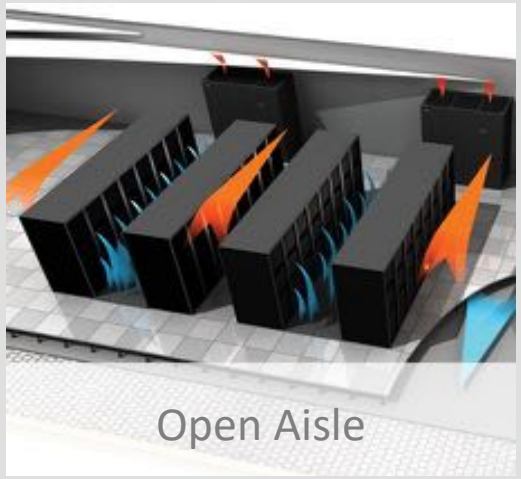
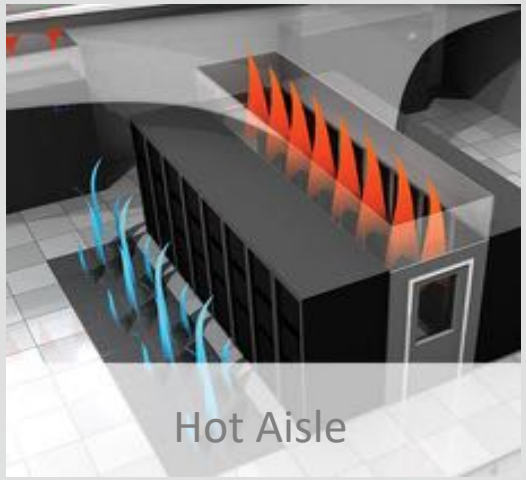
Air Management

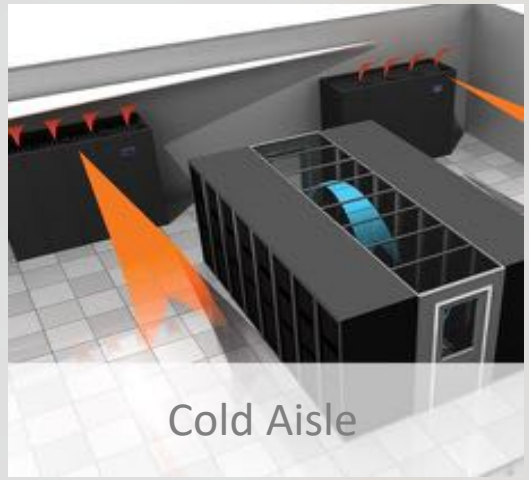
Aisle Containment



Open Aisle



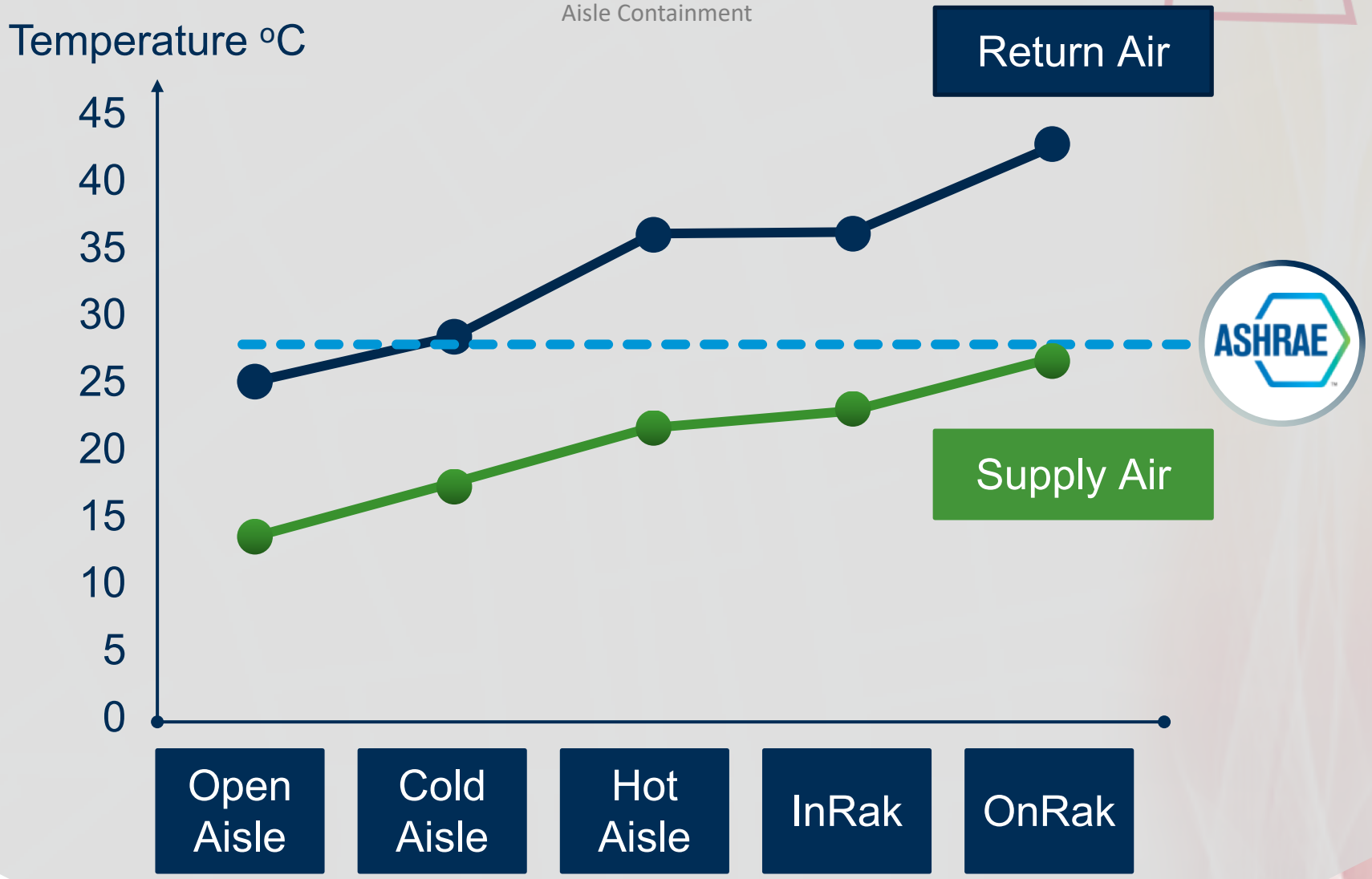
Hot Aisle

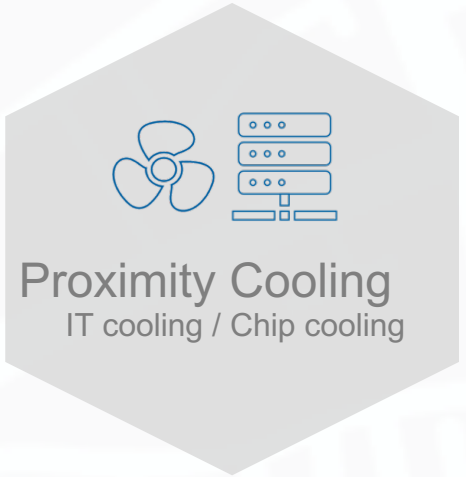


Cold Aisle

InRak Hot Aisle

OnRak Hot Aisle


Temperature °C
45
40
35
30
25
20
15
10
5
0
Return Air
Supply Air
ASHRAE
Open Aisle
Cold Aisle
Hot Aisle
InRak
OnRak



The Eras of Data Centre Cooling

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Methods of cooling have evolved along with server density / application

Higher Temps

In line with ASHRAE recommendations

Proximity Cooling

IT cooling / Chip cooling

4kW

CoLo / Enterprise

Room Cooling / Open Architecture

10kW

Edge

In-Row Cooling

20kW

HPC

Back-Door Cooling

30kW

Blockchain / Cryptocurrency Mining

Direct-Chip Cooling

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The Eras of Data Centre Cooling

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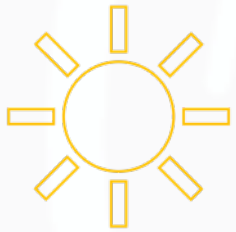

High ambient

Low rainfall / water scarcity

Energy efficiency key

Conservative temperature management

Challenges in the Middle East

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100-200kW

Mostly DX, some dual fluid

20°C set-point

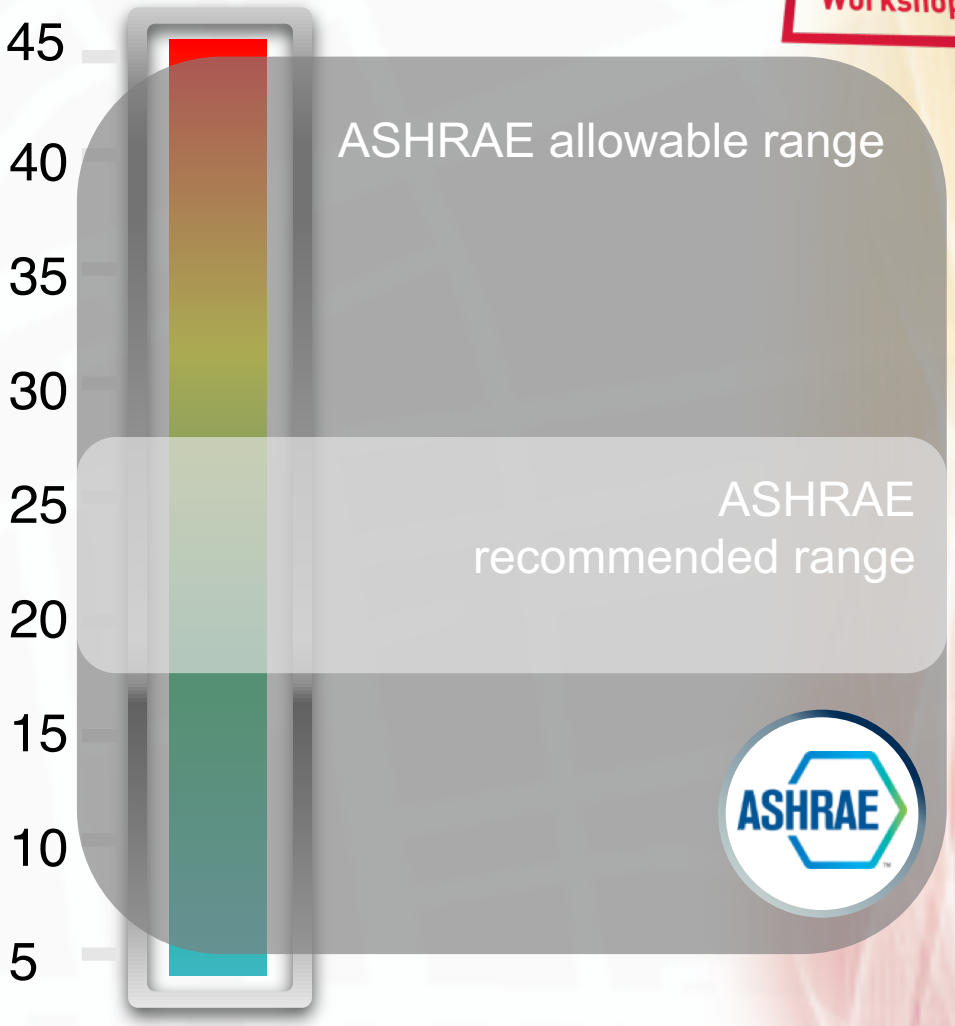
Open architecture with raised floor

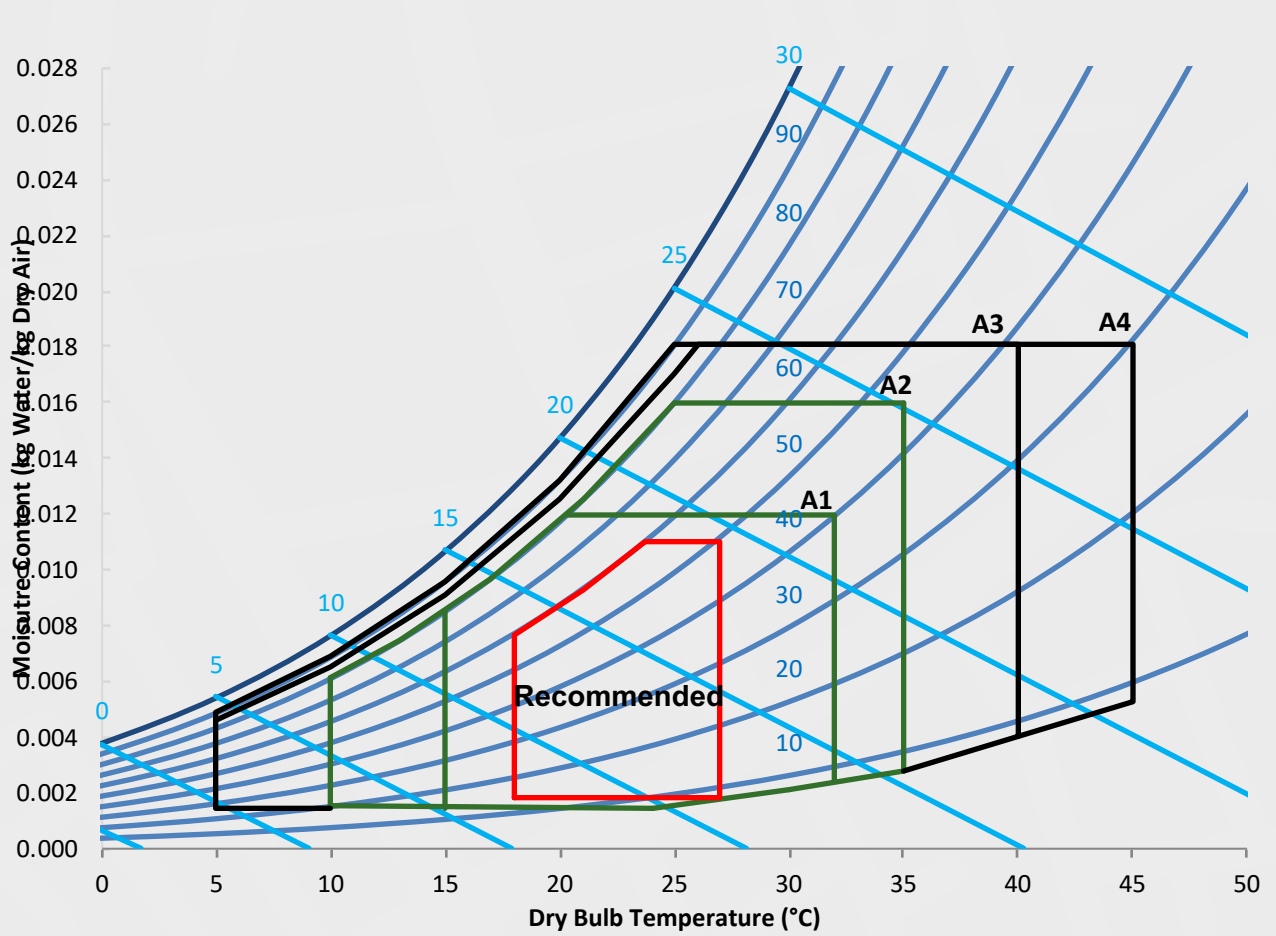
Typical Data Centre

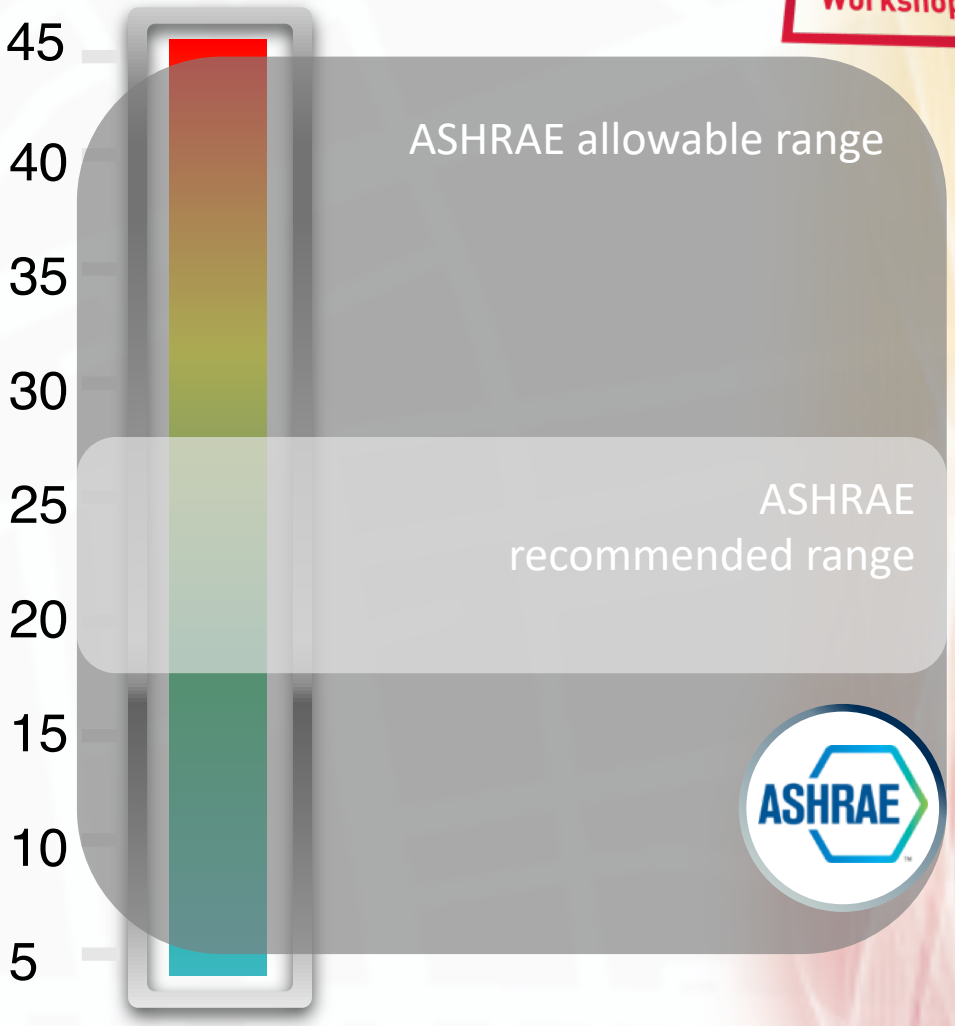
OPTIMISATION OF AIR TEMPERATURES

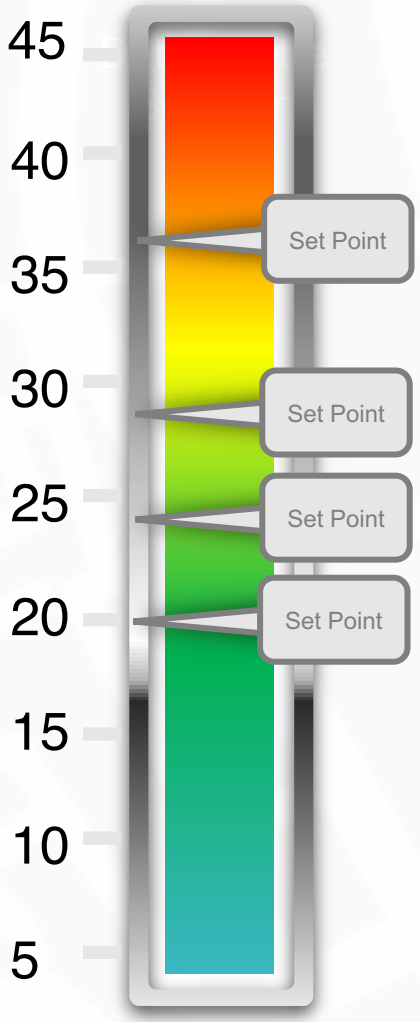
What temperature should you operate data centres at?

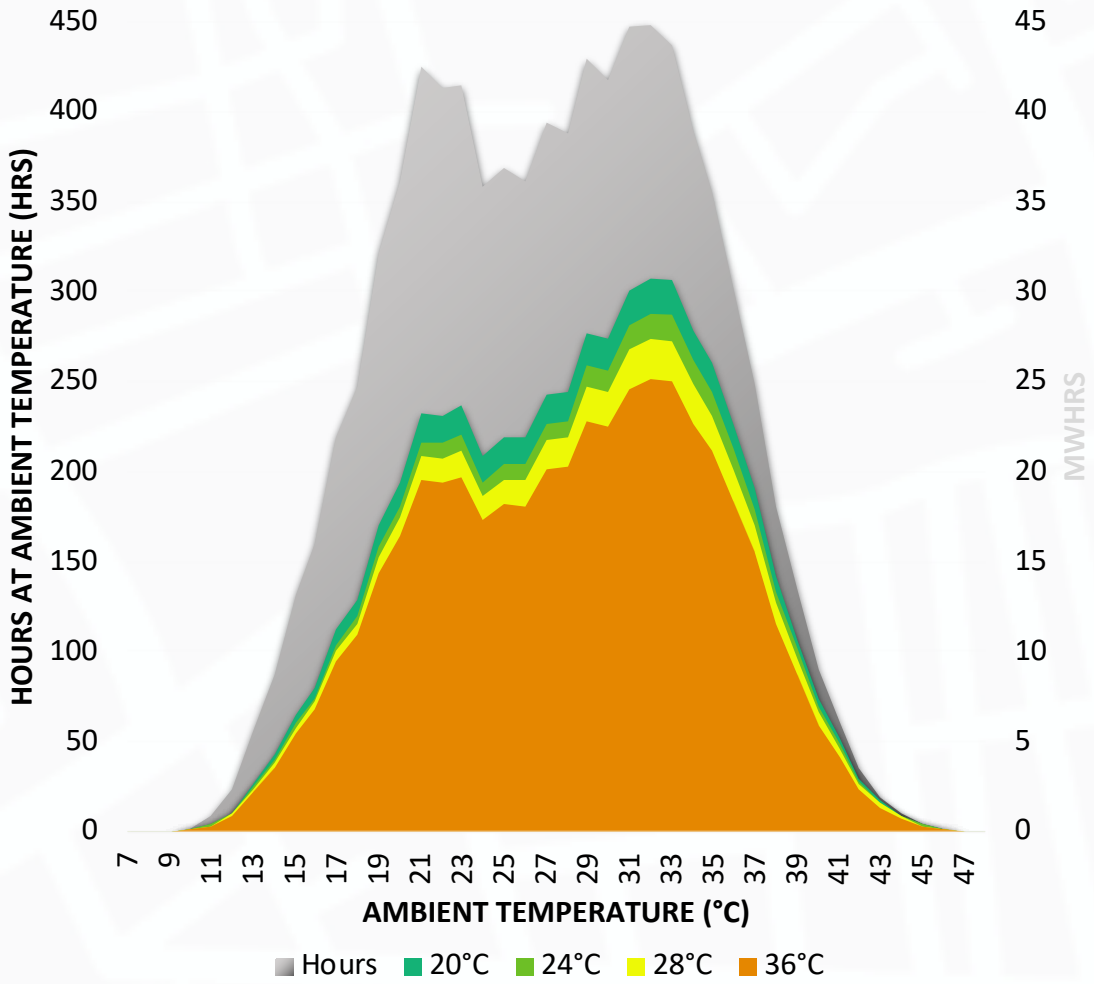
- The American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE) publishes guidelines for temperature and humidity operating ranges of IT equipment.
- The ASHRAE guidelines cover server inlet air temperatures, not air conditioning temperatures.
- The “allowable” range provides IT equipment manufacturers and data centre designers with a simple way to define product specification limits.
- ASHRAE stresses that data centre operators should plan to keep IT equipment conditions within the recommended range as much as practical.
- We will look at several scenarios whereby increasing the air-return temperatures can provide efficiency benefits to a typical Data Centre.




Moisture Content (kg Water/kg Dry Air)
0.028
0.026
0.024
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0
5
10
15
20
25
30
35
40
45
50
Dry Bulb Temperature (°C)
30
90
80
25
70
A3
A4
60
A2
20
50
A1
40
15
30
10
20
Recommended
10
5
0

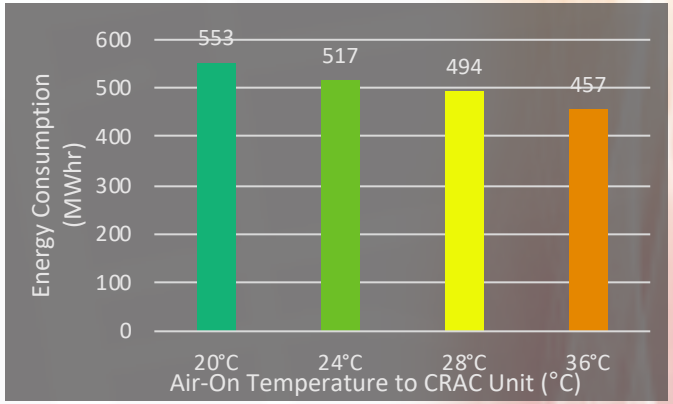

45
40
35
30
25
20
15
10
5
ASHRAE allowable range
ASHRAE
recommended range
ASHRAE





Raising the Air-On temperatures to the CRAC unit reduces energy consumption.

Graph shows energy consumption at Air-On temperatures ranging from 20 to 36°C.



Based on a 200kW IT, 5 x CRAC AC unit

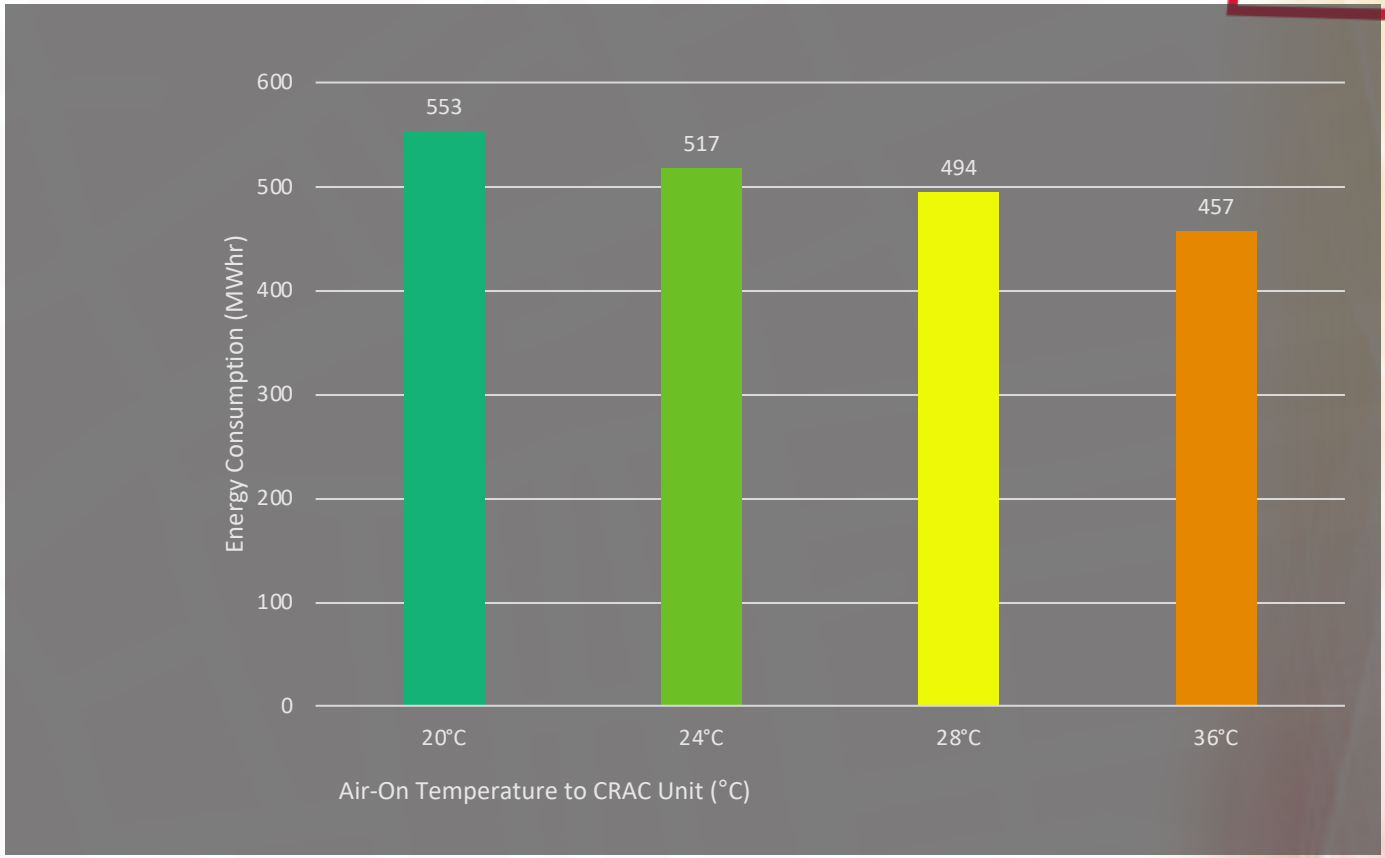
AED 210,140

AED 196,460

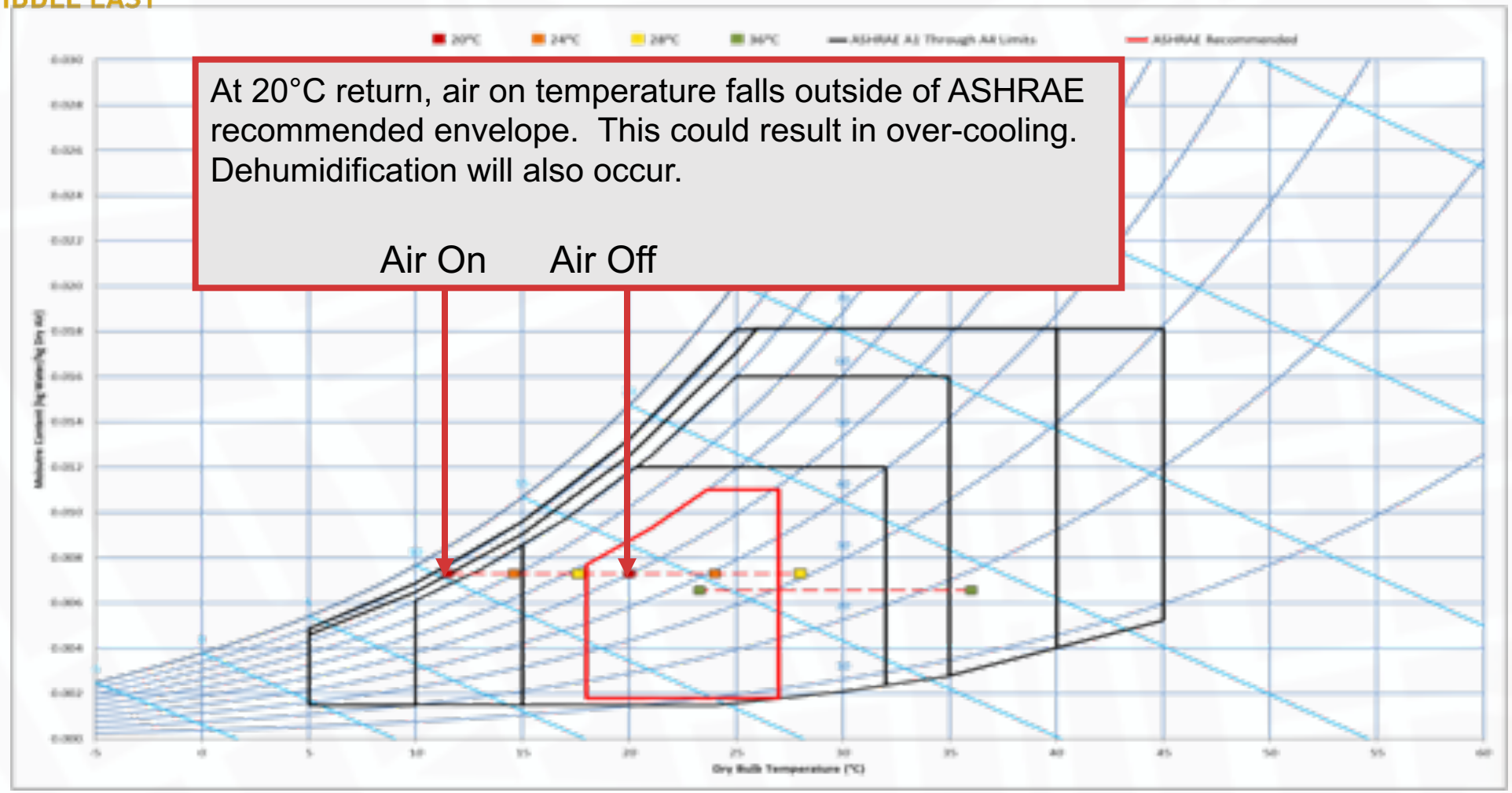
AED 187,720

AED 173,660

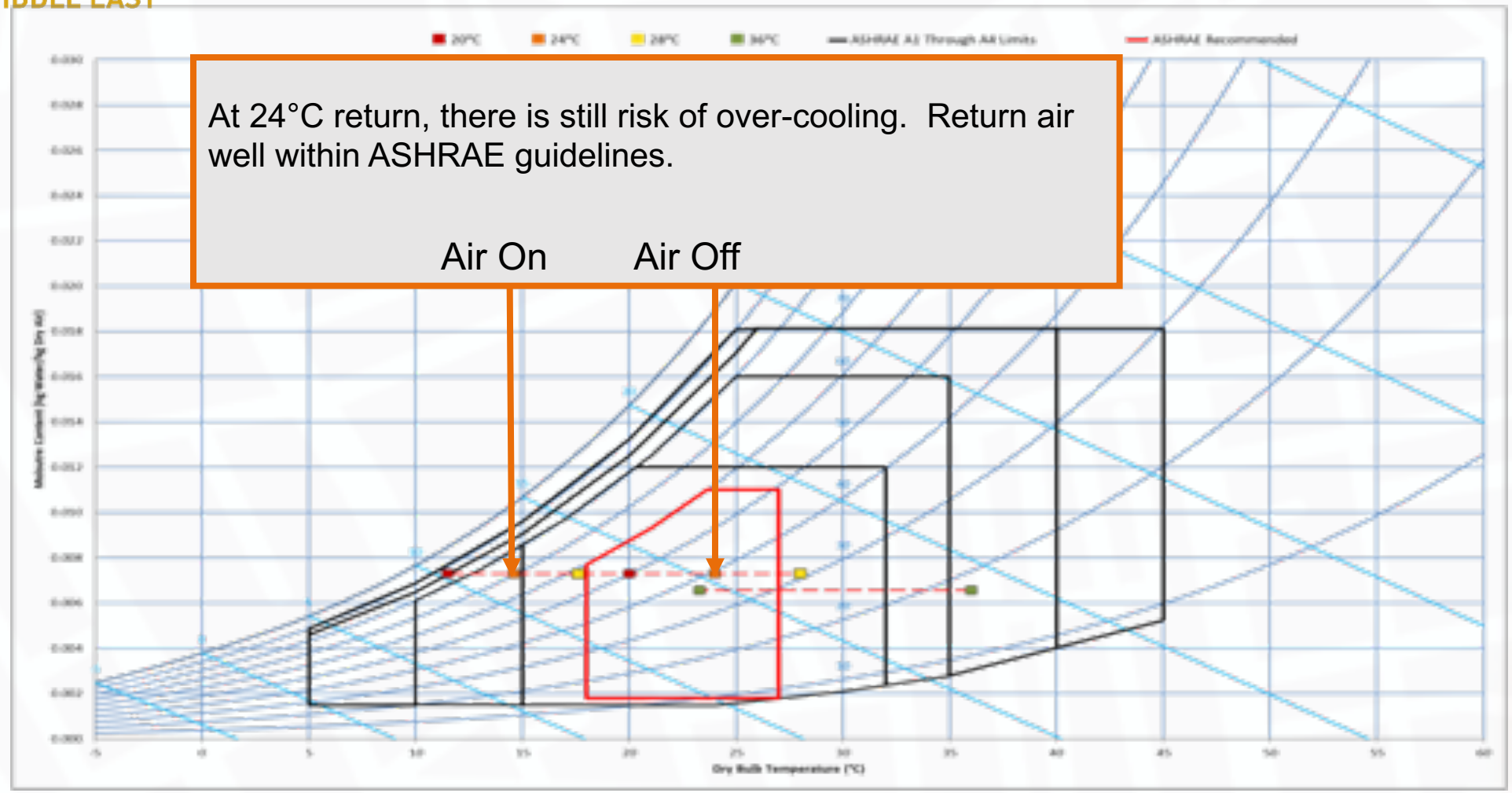
AED 36,480 / $10,000 / year



Based on DEWA slab tariff of 38 fils/kWh at Band R (6001 kWh/month and above)



DX Air Temperatures and ASHRAE Guidelines



DX Air Temperatures and ASHRAE Guidelines

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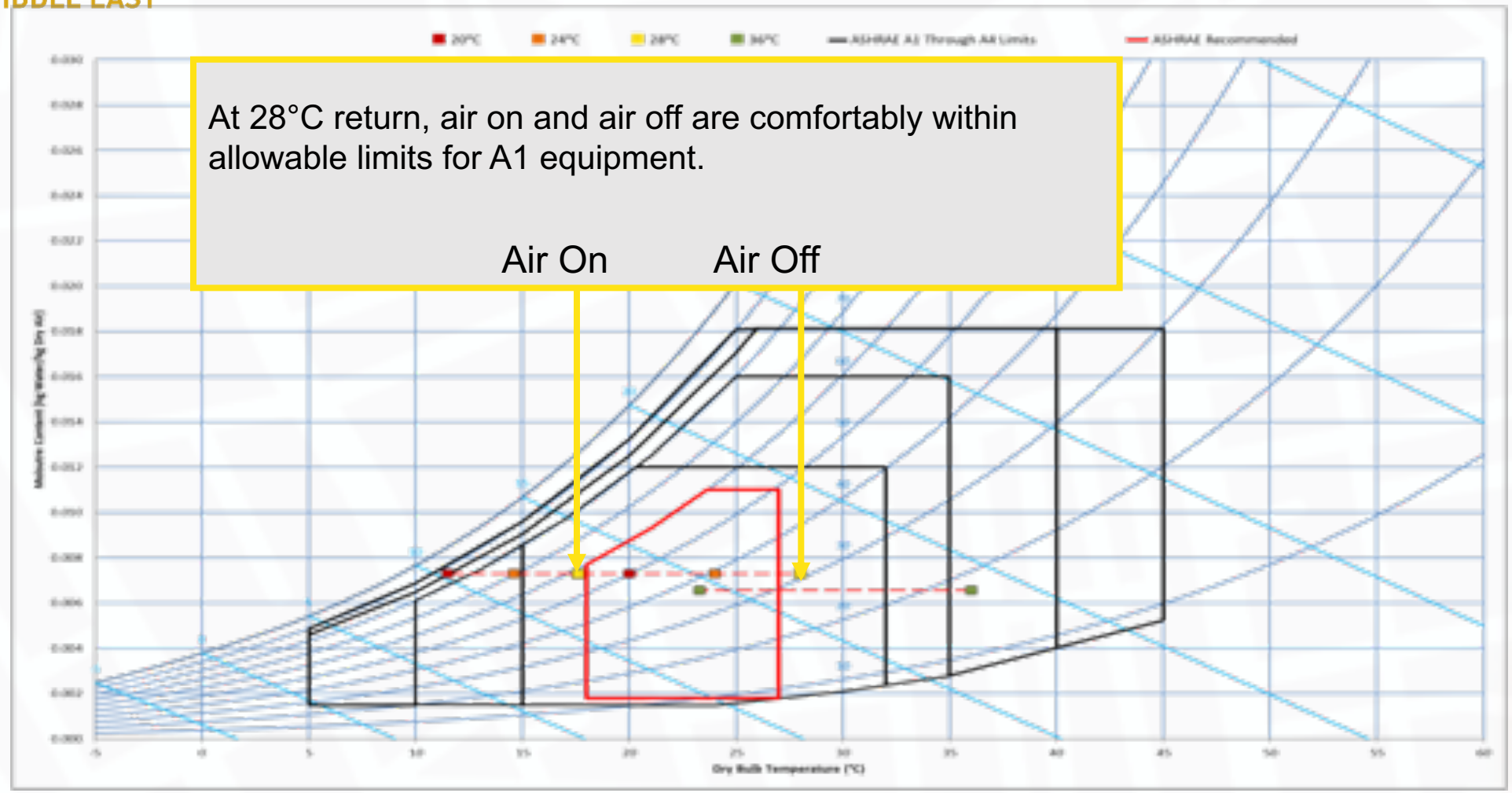
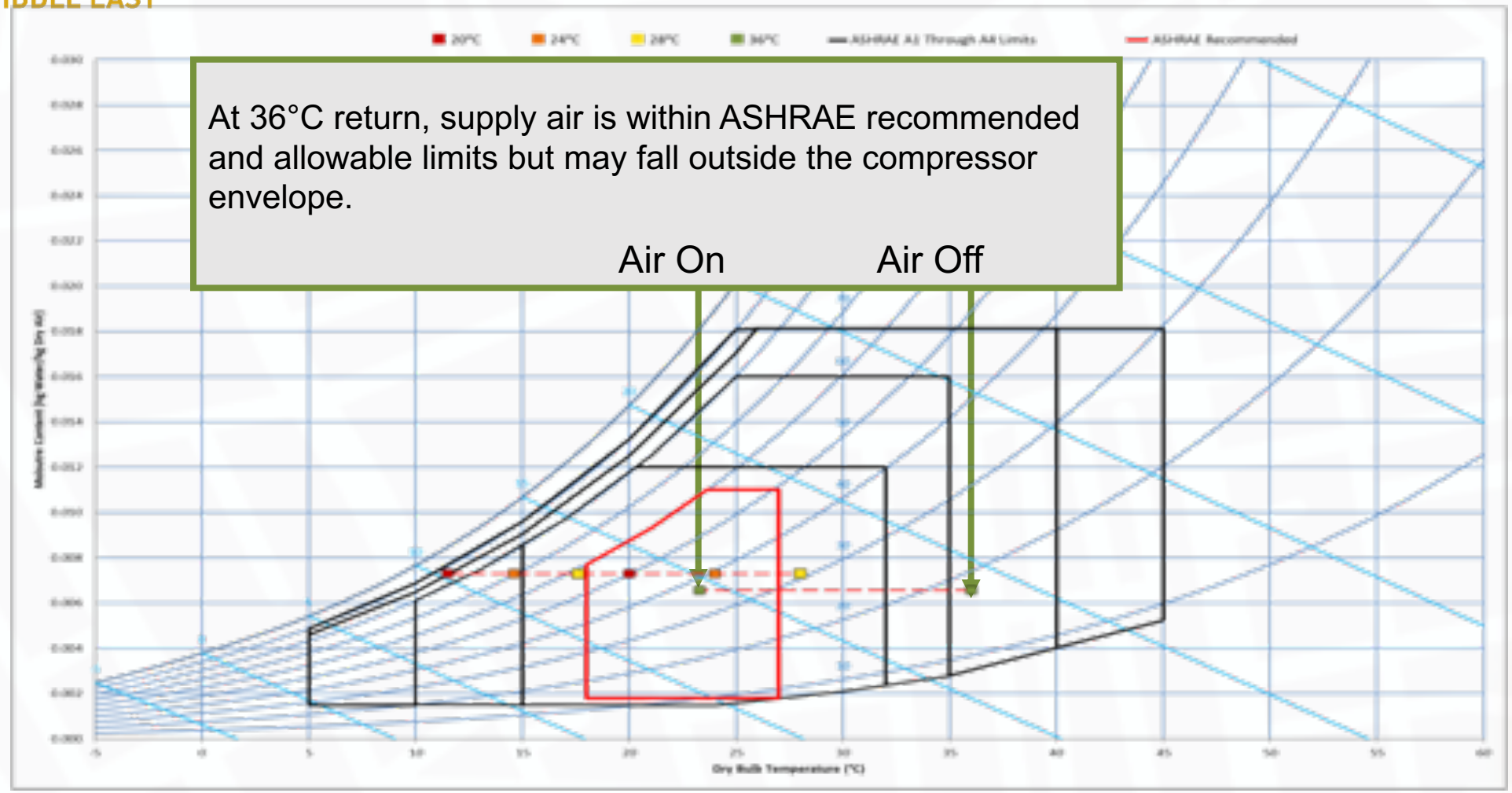


DX Air Temperatures and ASHRAE Guidelines



DX Air Temperatures and ASHRAE Guidelines

Conclusion

With DX systems control is on return air temperatures, meaning supply air temperature can be unstable, particularly at part load

Increasing air temperatures can save energy, keep facilities within ASHRAE recommended limits and also avoid overcooling of servers

At higher air temperatures, air management in the form of ducting / aisle containment will improve efficiency

We would recommend transitioning towards a 28°C return in typical data centres based in this region

For our 200kW example this would result in an annual energy cost saving of AED 22,420 ($6,104)

CHILLED WATER SYSTEMS

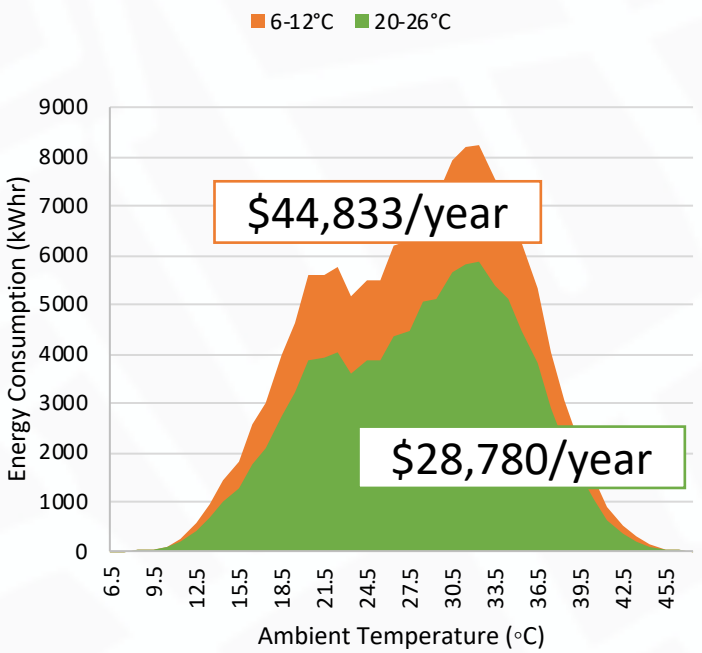
Chilled Water Systems

Pros	Cons
No refrigerant in building	Extra capital equipment (chillers, pumps) and larger pipework
Supply air temperature control	Lower cooling efficiency than DX
Free Cooling	More complex to maintain / operate
Longer pipe runs	
Closer control (modulation of flow)	

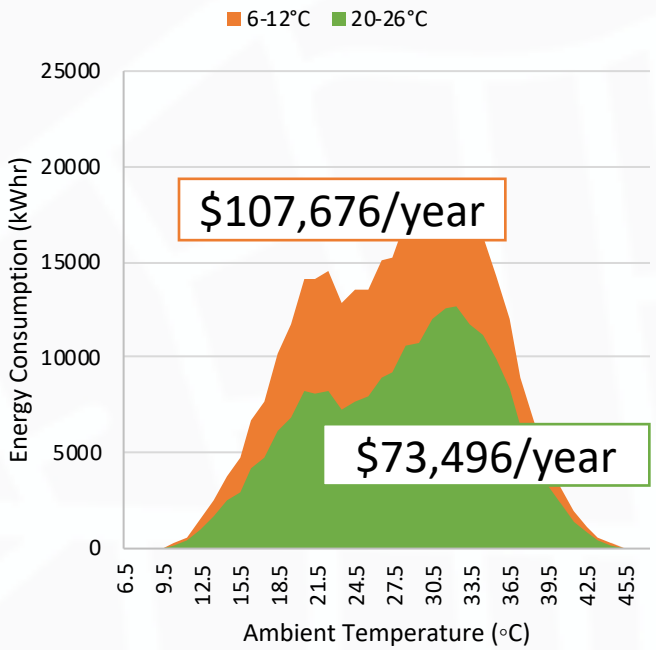
Chilled Water Systems

- We ran an energy programme on three scenarios to see if a CW system offered benefits over DX
- The Graphs below show the Chilled Water units selected for 6/12°C and 20/26°C.

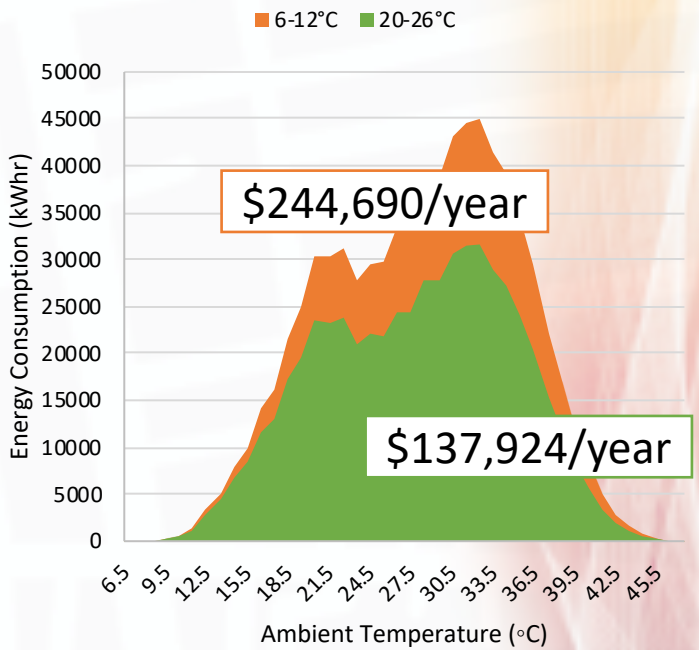
200kW

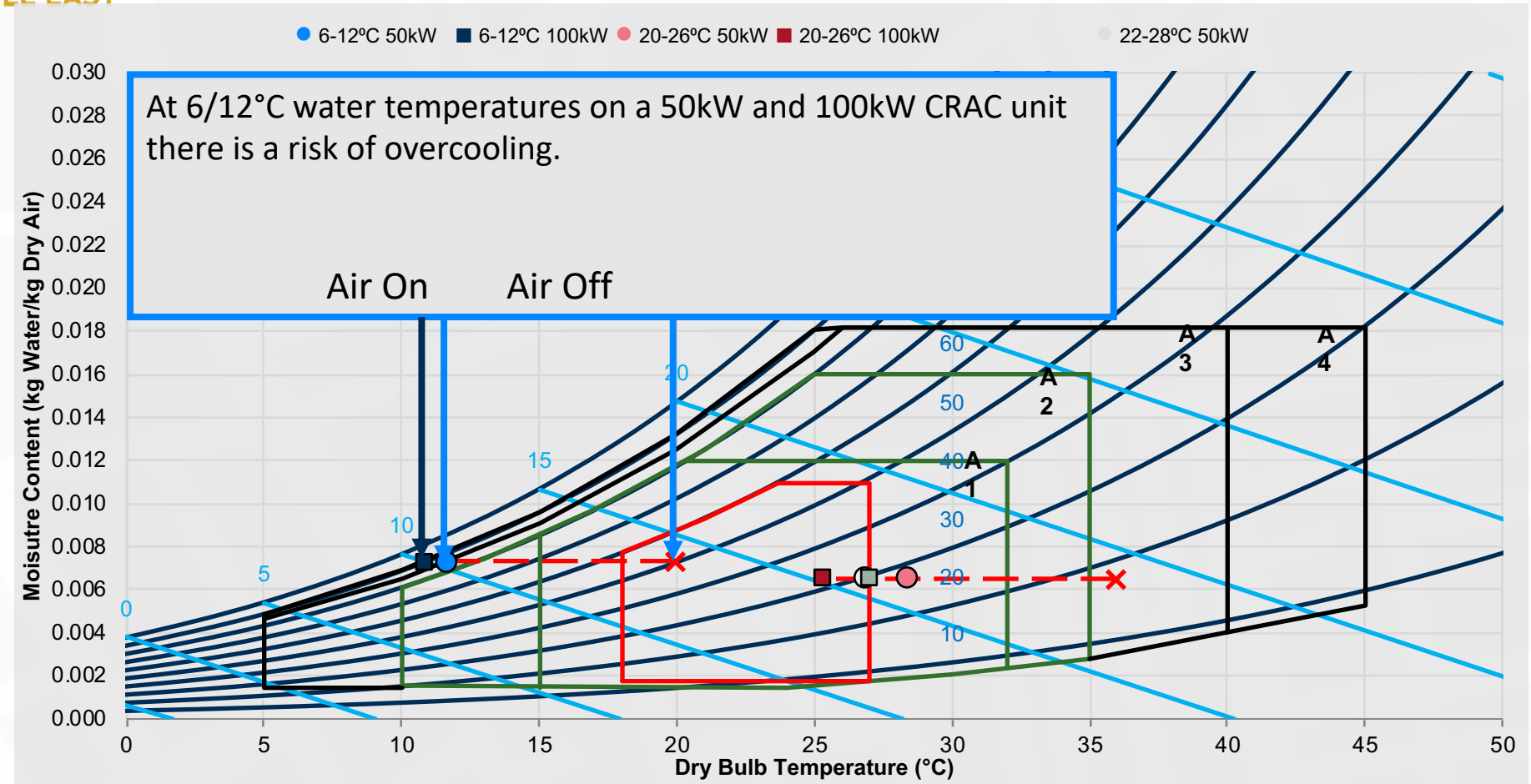


500kW

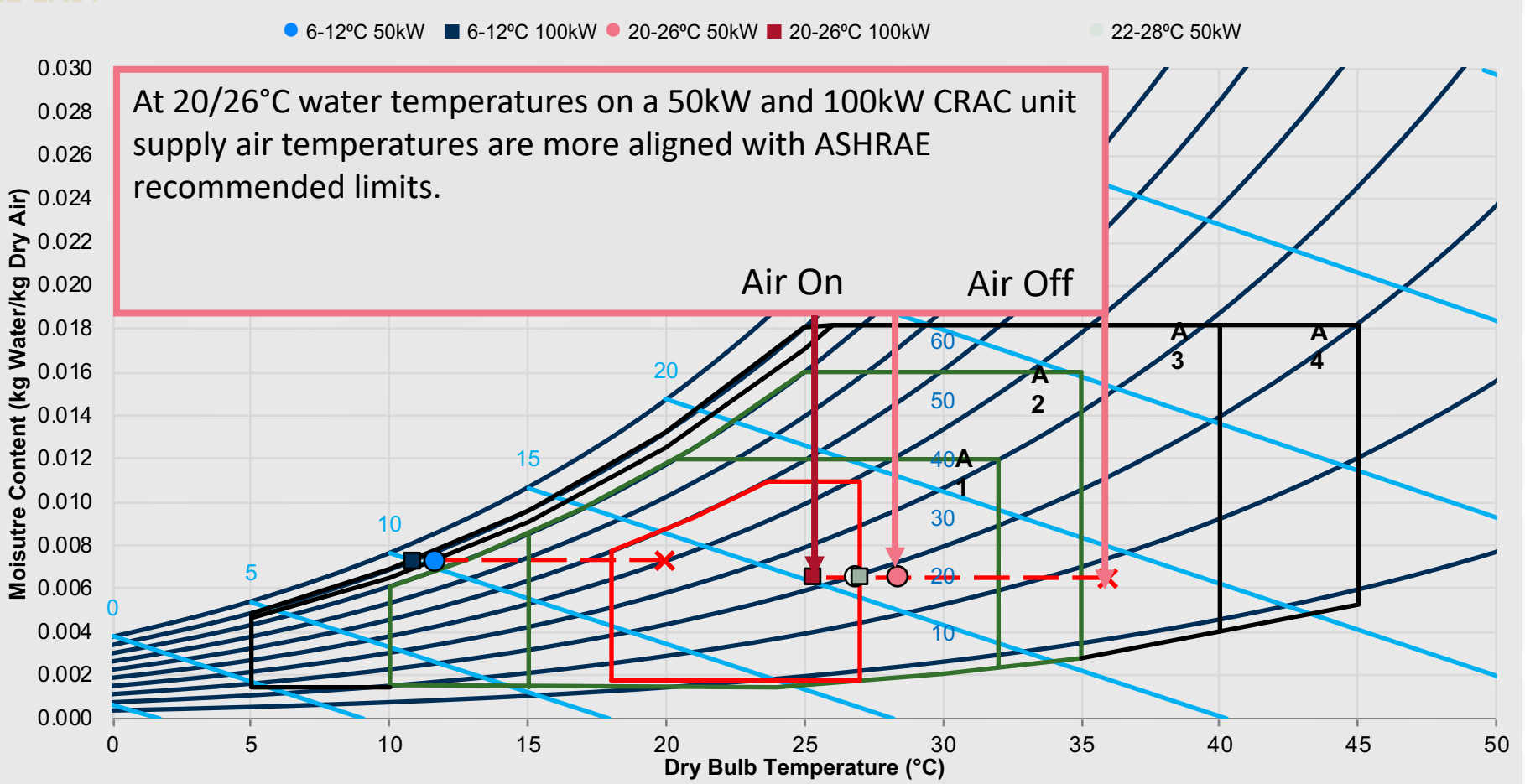


1000kW

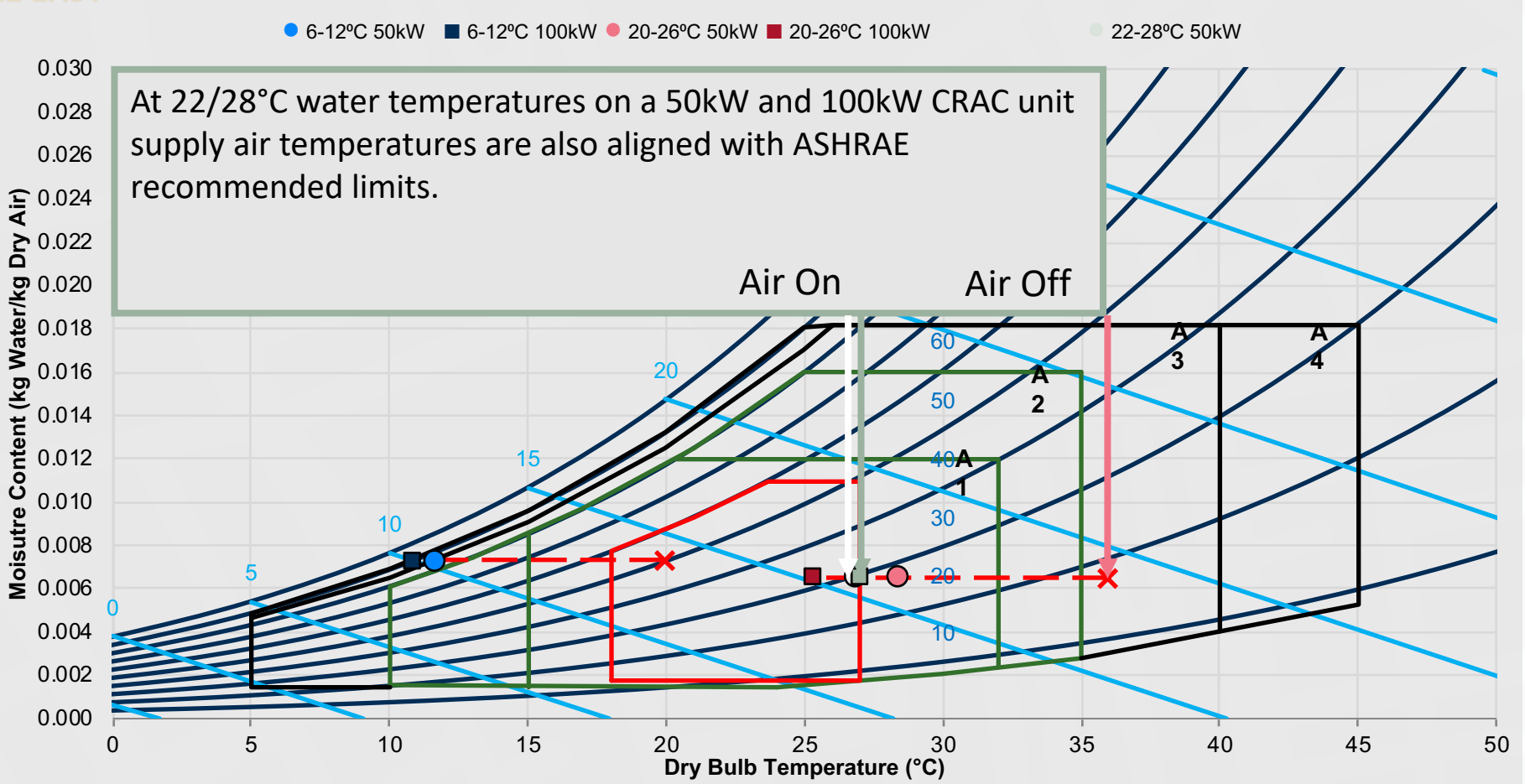




Chilled Water Systems



Chilled Water Systems



Chilled Water Systems

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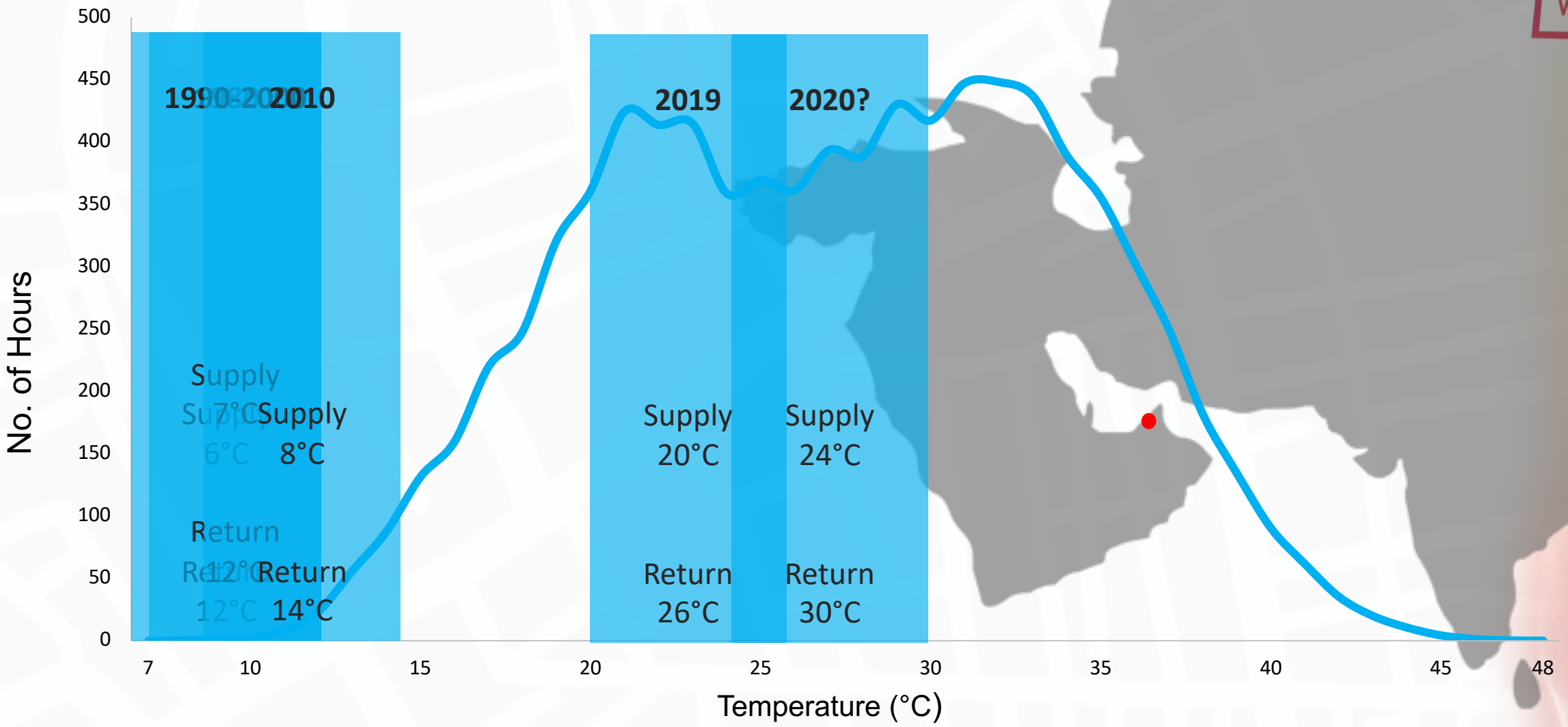
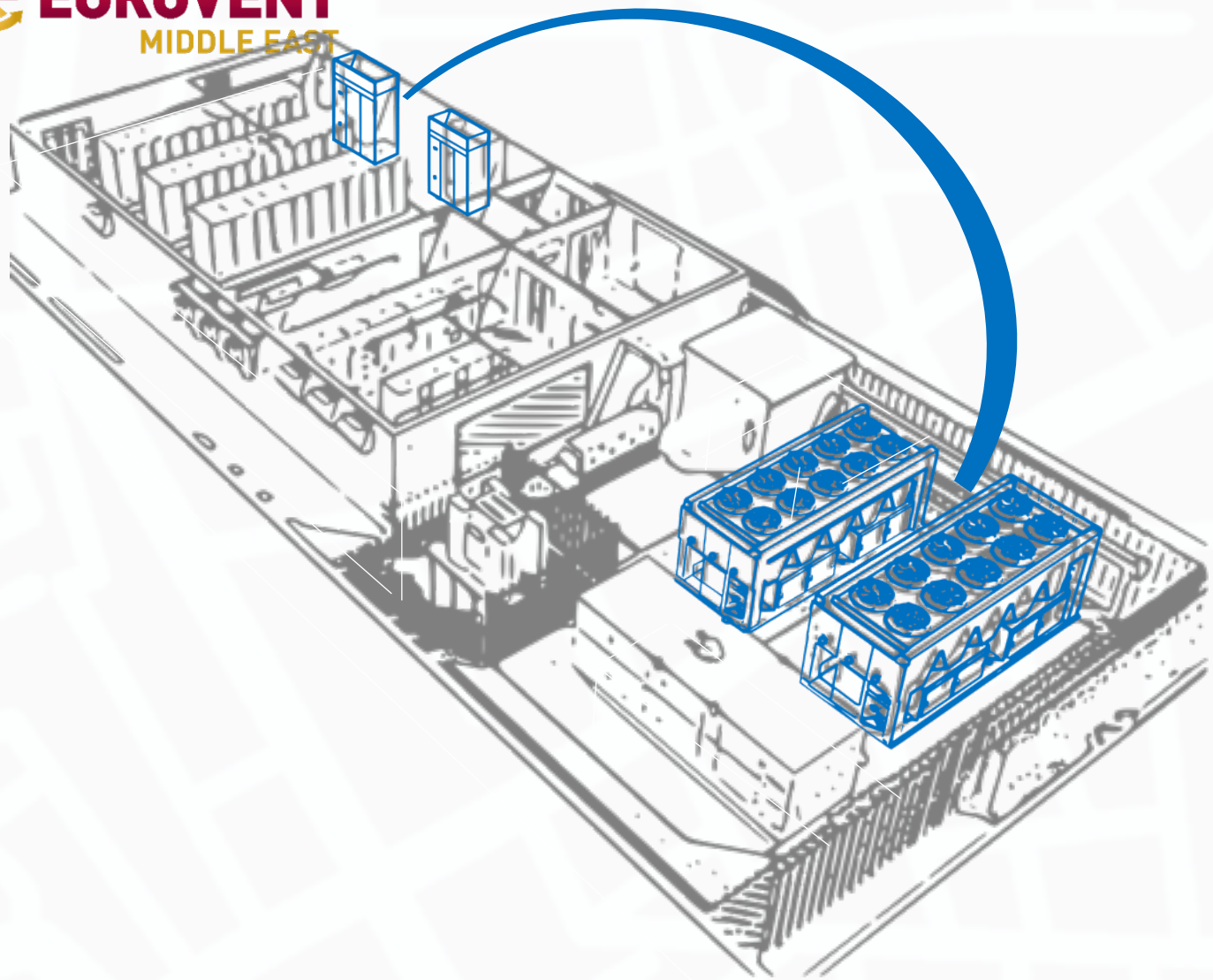


The evolution of chilled water temperatures

Intelligent Cooling



The key to optimised HVAC is the harmonisation of the equipment with the environment.

A combination of unit controls and building controls can ensure HVAC systems run effectively at their most efficient operating settings

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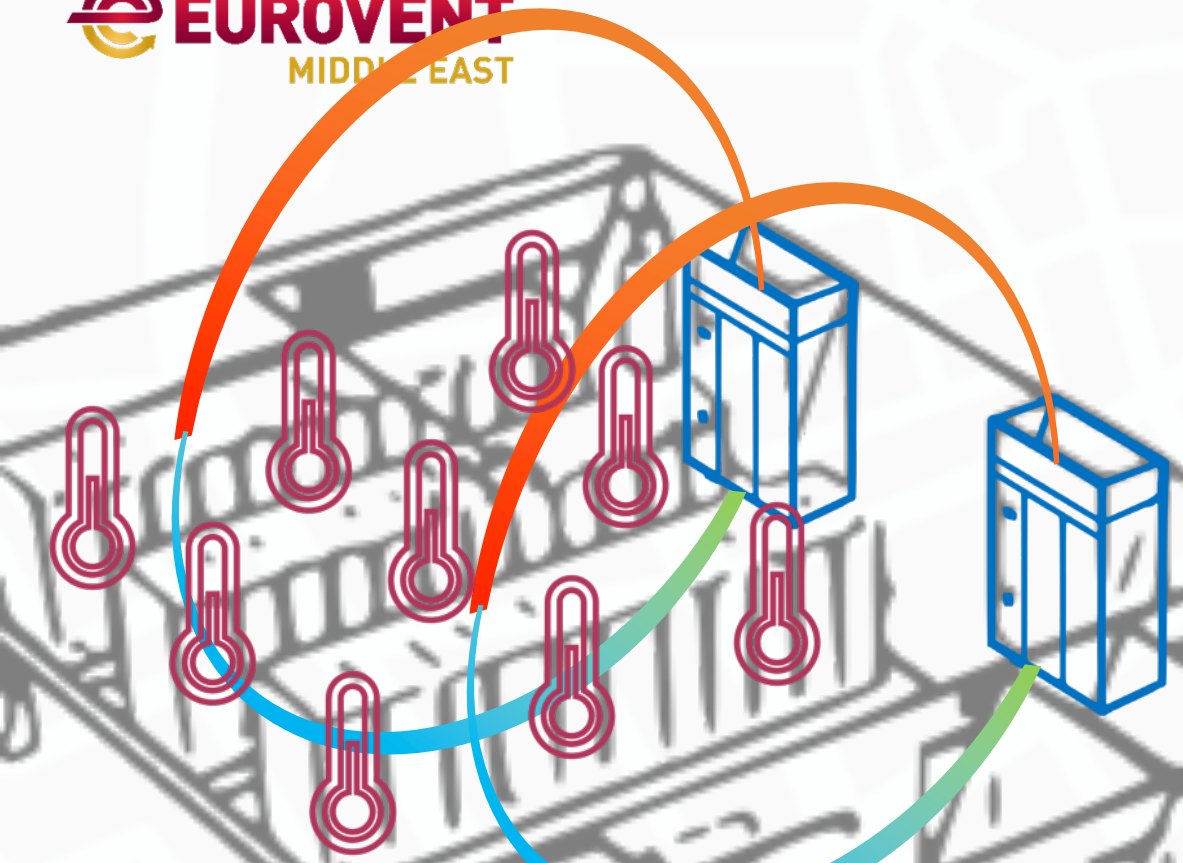
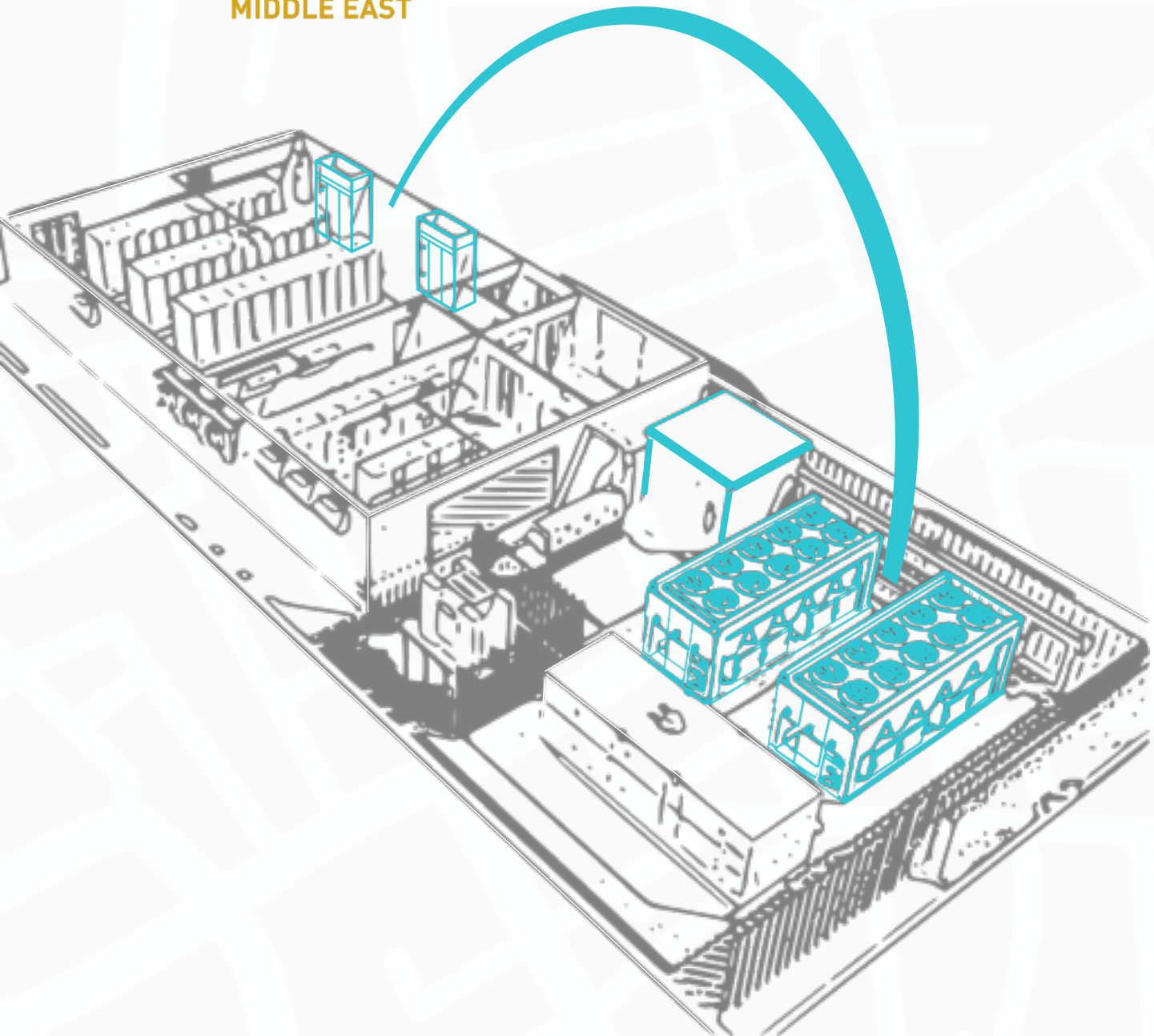


Supply Air Stabilisation

Using a specialised HVAC Building Management System it is possible to monitor conditions at rack level.

This allows the return air setpoint to be dynamically adjusted to meet the desired rack temperature, therefore optimising the CRACs.



CW Optimisation

Maintaining a chilled water valve setpoint of 90% open

Pump modulation

Chiller sequencing

Dynamic CW setpoint

Key Takeaways

The continued digitisation of our everyday lives is increasing the demand for cloud and edge computing

As the data centre industry grows, so to does its demand on the planet's natural resources, including power and water.

As cooling systems and techniques evolve there is an opportunity for data centre operators in this region to conserve resources and save money.

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