

SMARTAISLE™ COLD AISLE CONTAINMENT

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Mechanical Containment

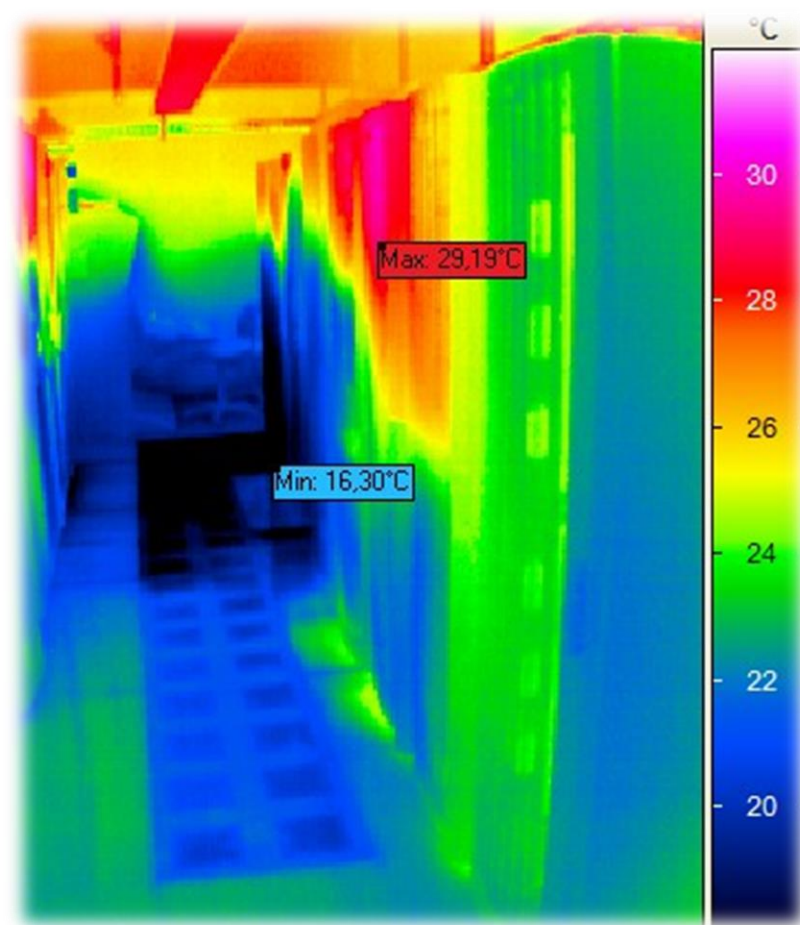
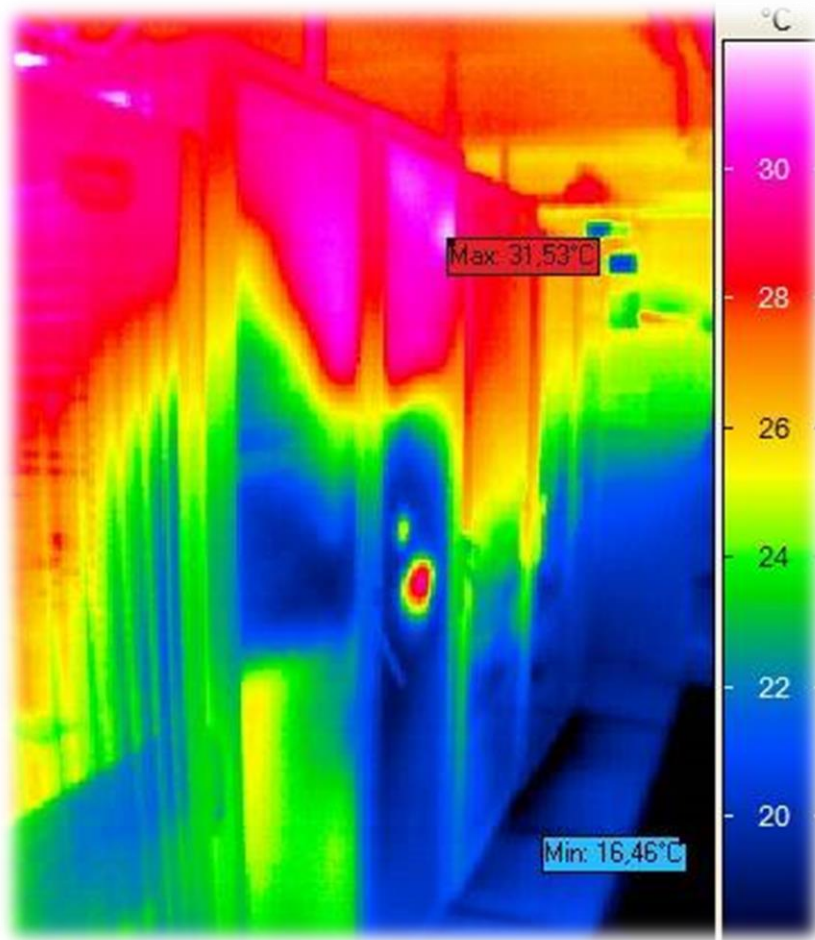
Why Not Just Containment?

Pressure Control in the Raised Floor

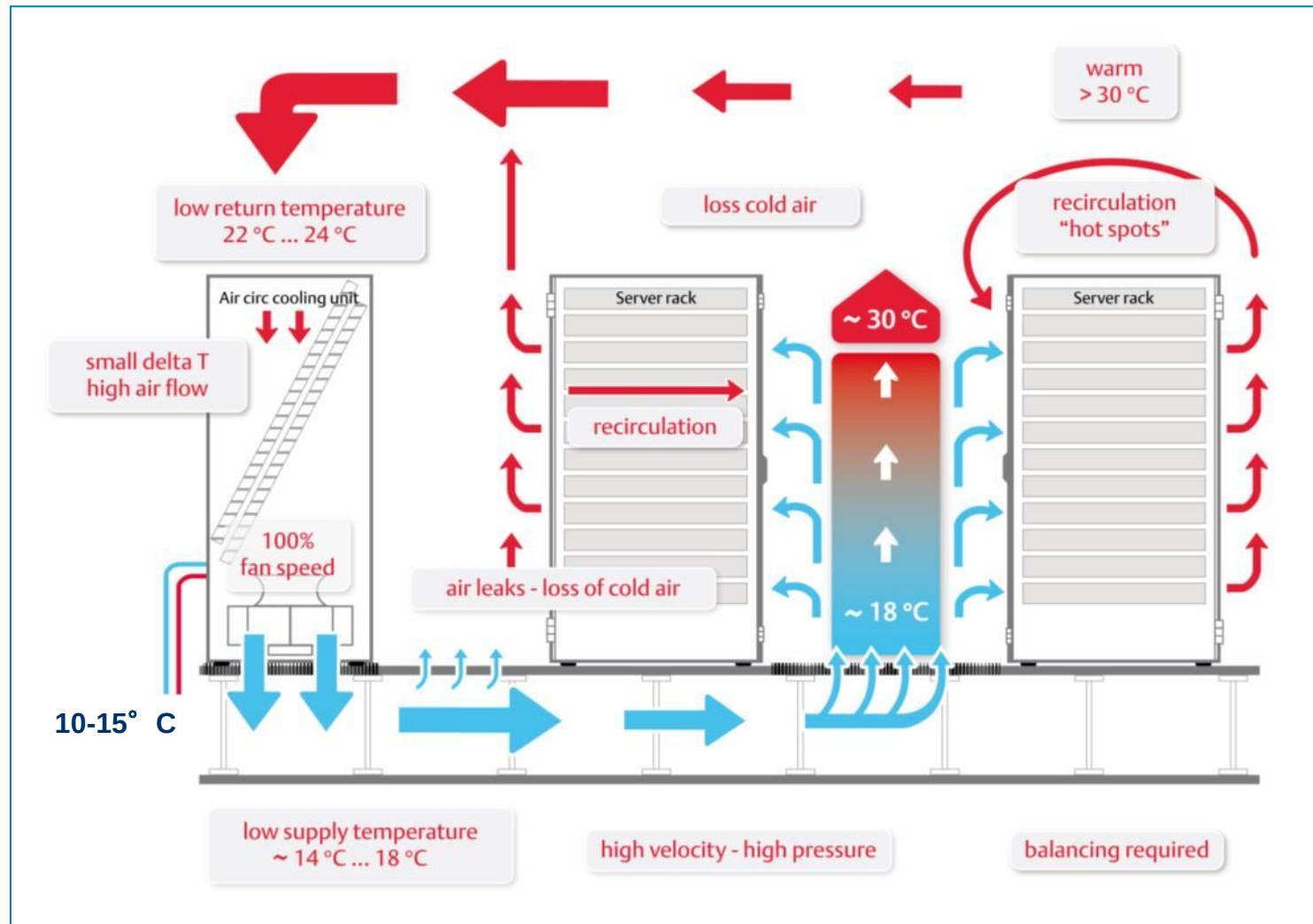
Starting from the Server

Not Only Efficiency

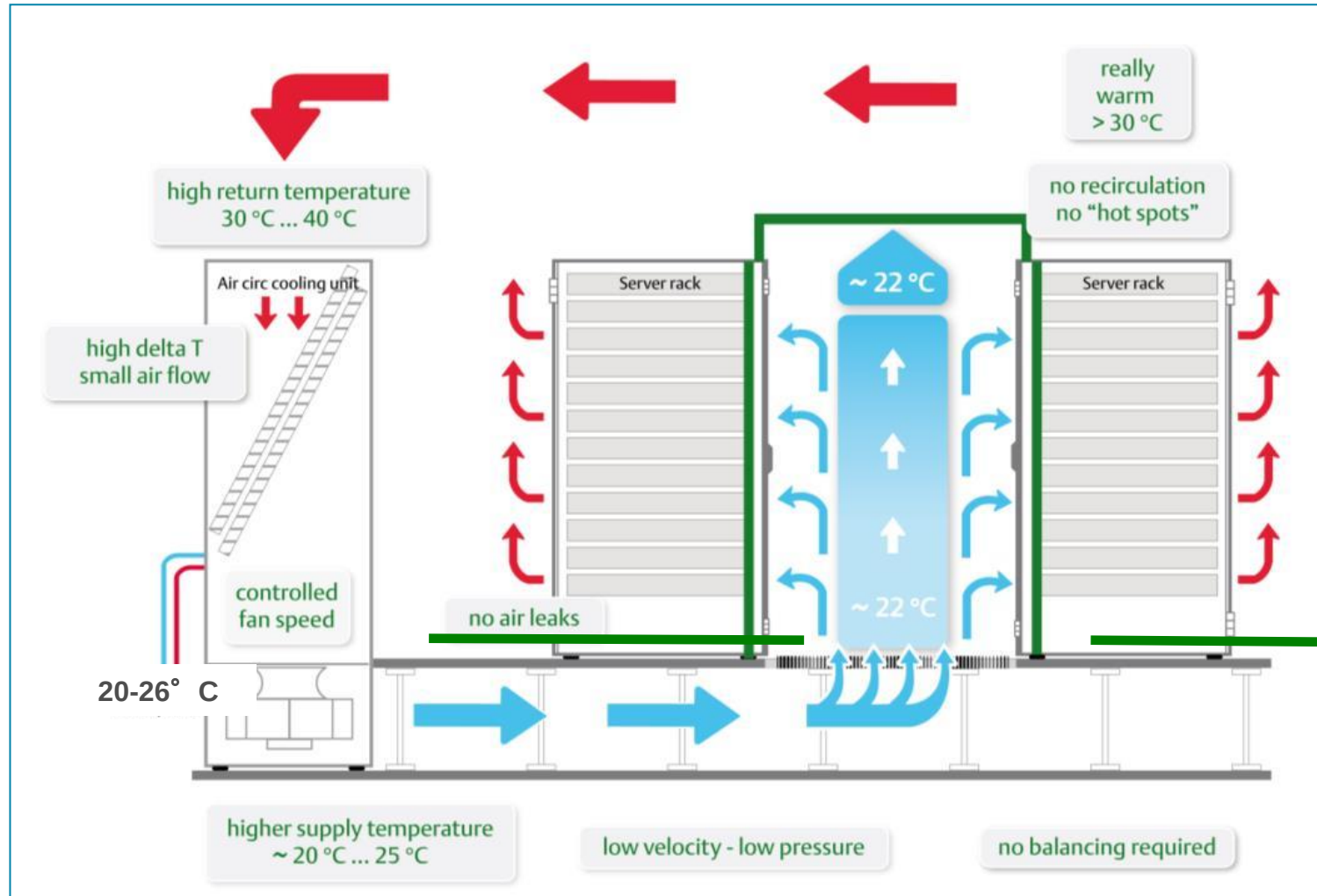
PROBLEMS WITH TRADITIONAL AIR COOLING



TRADITIONAL AIR COOLING TROUBLES



THE FIRST STEP: HOT-COLD SEPARATION



THE FIRST STEP: HOT-COLD SEPARATION

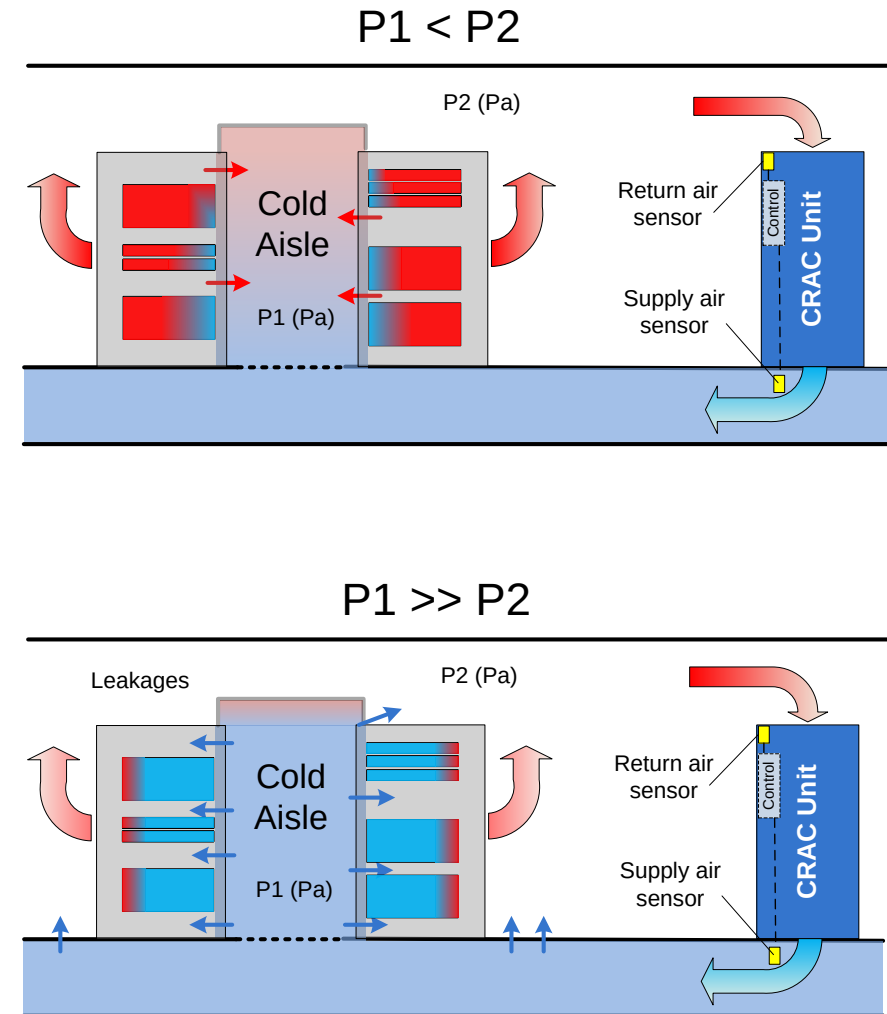
By just applying a proper separation between cold and hot air we can obtain:

- A more **efficient** air distribution
- **Improved temperatures** in front of the servers
- Higher temperatures behind the cooling units (which will then operate with higher evaporating temperatures or water temperatures)
- **Increase the number of freecooling hours**, in case a freecooling system is used

This, however, is just the first step, the key point is how a cooling system can better adapt to an application with containment...

WHY NOT JUST CONTAINMENT?

- Servers are not getting enough air
- Risk of hot air intrusion into the cold aisle
- Over-blowing server fans
- Loss of cold air = low efficiency
- Reducing server fans life-time



THE ANSWER TO CUSTOMERS' NEEDS

Addressing Cooling Needs Only *Real Focus on IT Equipment Needs*



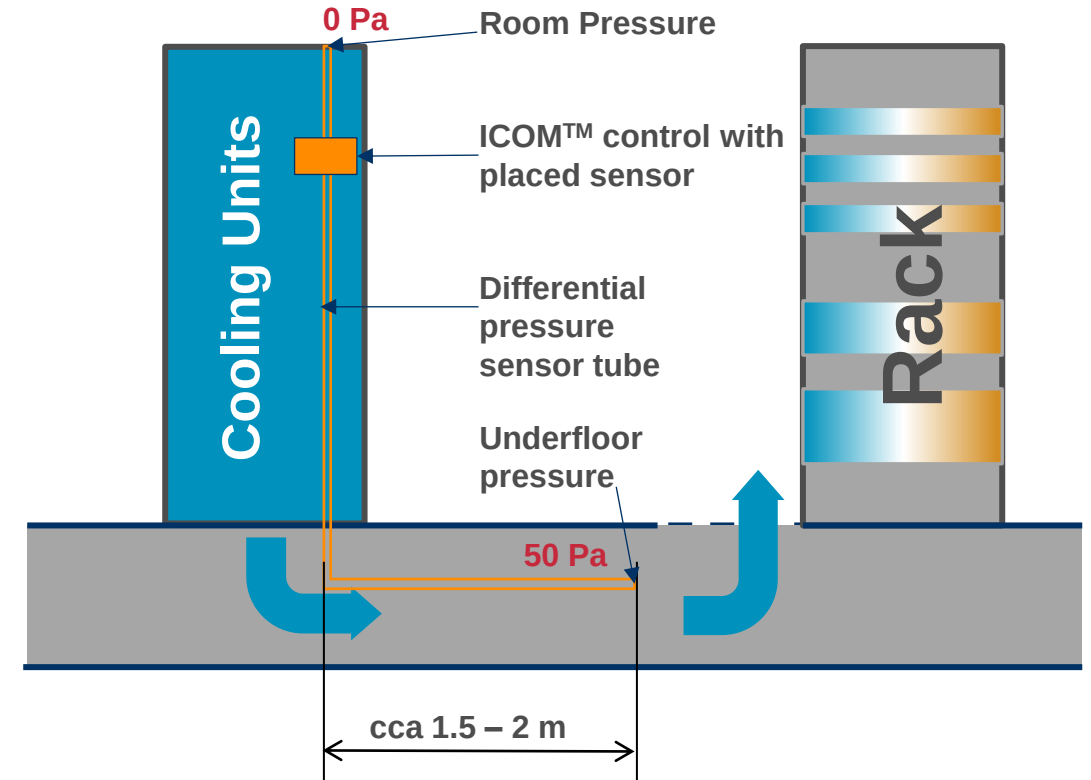
PRESSURE CONTROL IN THE RAISED FLOOR

Type of control to keep a constant pressure in the raised floor

Control based on the differential pressure sensor

2 readings:

- Inside the unit body (room pressure)
- In the raised floor, cca 1.5 m – 2 m distance from the unit (underfloor pressure)



PRESSURE CONTROL IN THE RAISED FLOOR

Each Unit with its own Sensor → More Redundancy

All Units Sharing the readings → Improved Room Coverage

Typical Application:

- **Open architecture:** the sensor will typically work in the range of 50 – 100 Pa
- **Hot / cold aisle containment:** the sensor will typically work in the range of 15 - 20 Pa

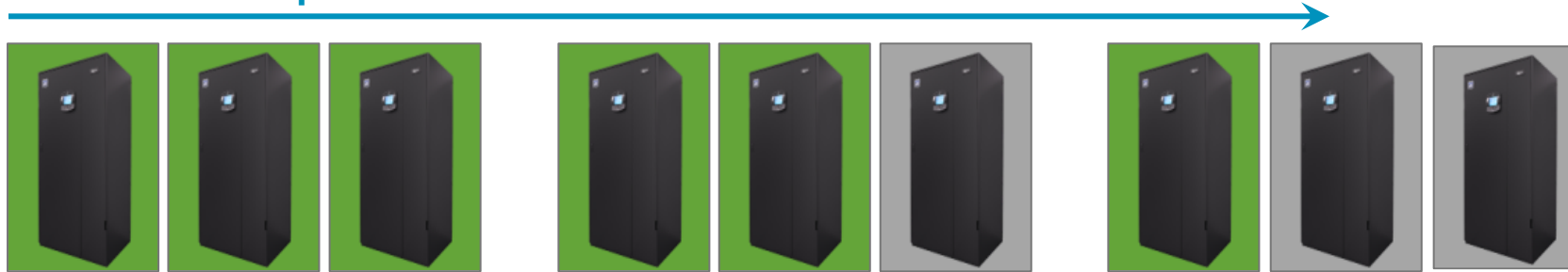
It is thus important that sensors are calibrated according to its application

A CLEVER WAY TO MANAGE THE SYSTEM

Cascade By Pressure

- Always have the right number of units operating
- Work with EC Fans at the most efficient working point as long as possible
- Grant the proper airflow management

Fans running at minimum fan speed
Pressure > set point

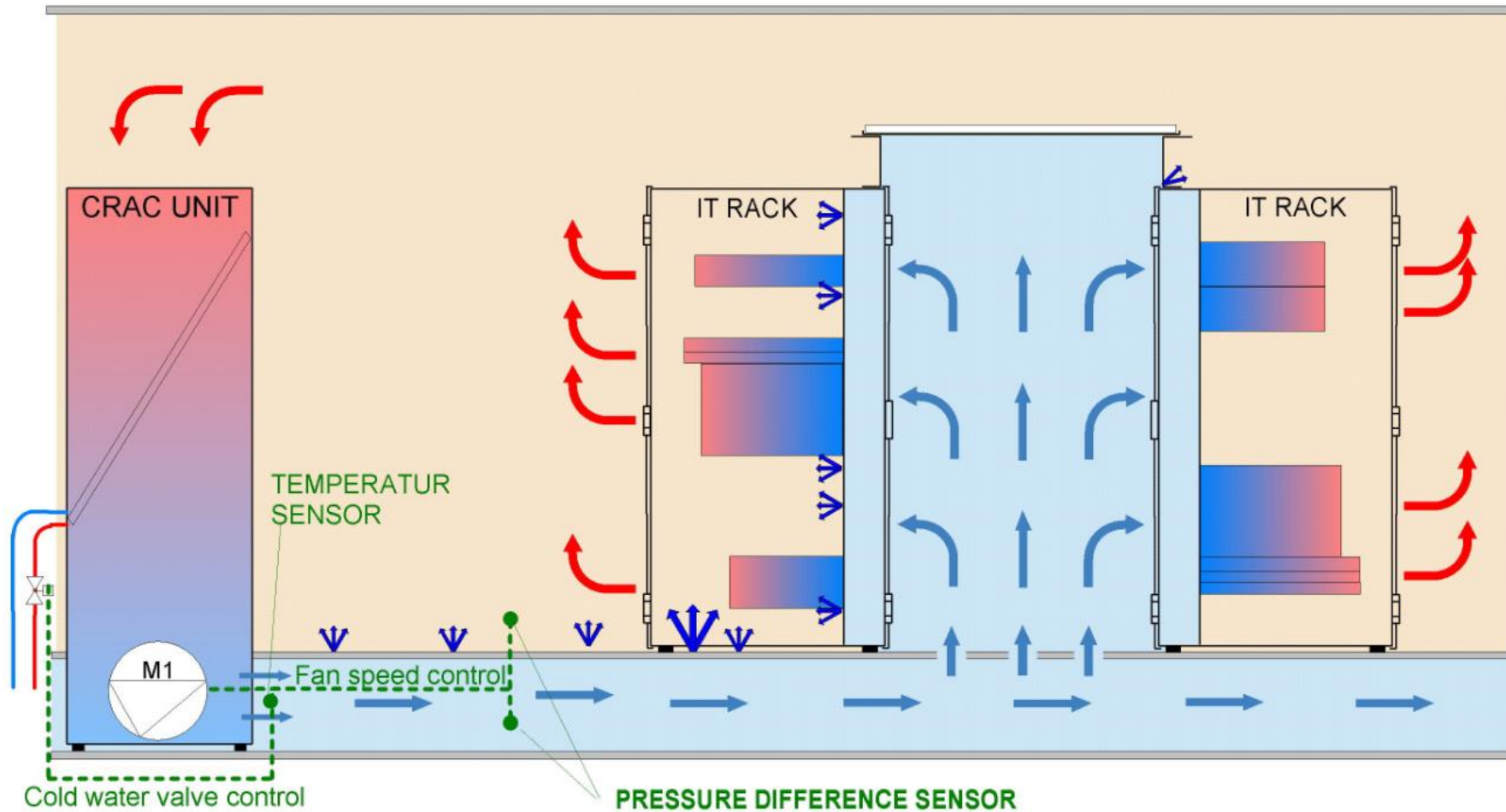


Fans running at minimum fan speed
Pressure < set point

Running units
Stand-by units

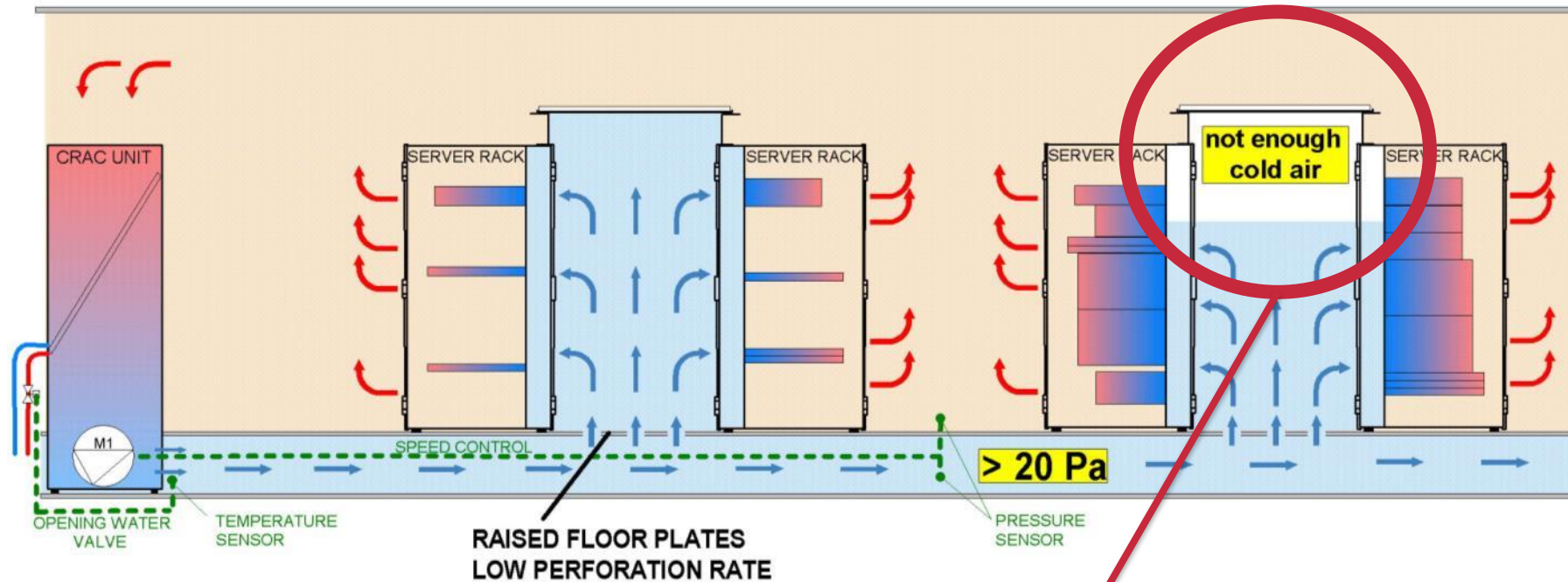
PRESSURE CONTROL LIMITATIONS

A good solution, but with some drawbacks...

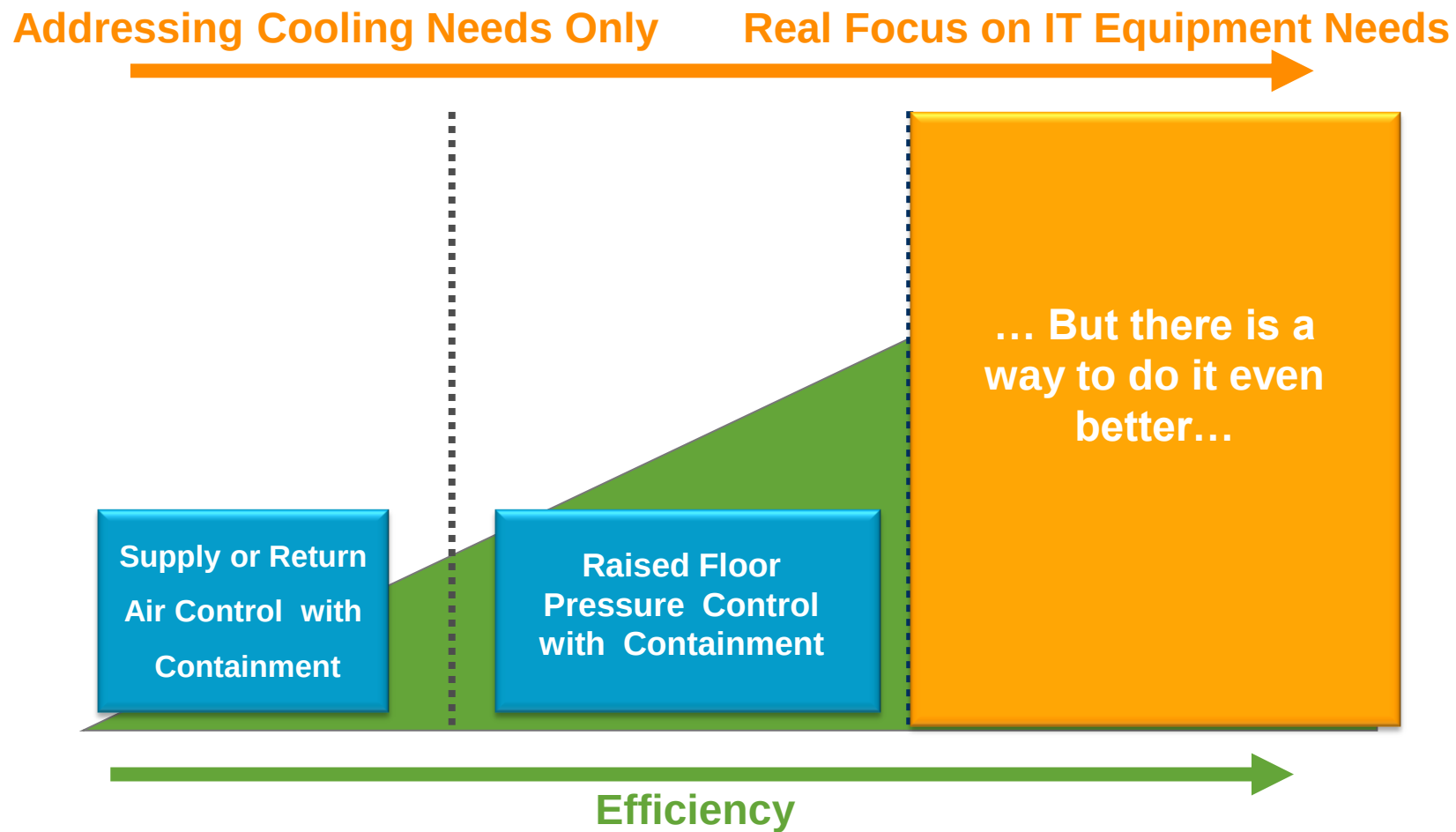


CONTROL AND DIFFERENT IT LOADS PER AISLE

Pressure Control



THE ANSWER TO CUSTOMERS' NEEDS



HOW CAN WE IMPROVE EVEN FURTHER?

Pressure control still focuses on the single unit, it is a control method which is self-referential!

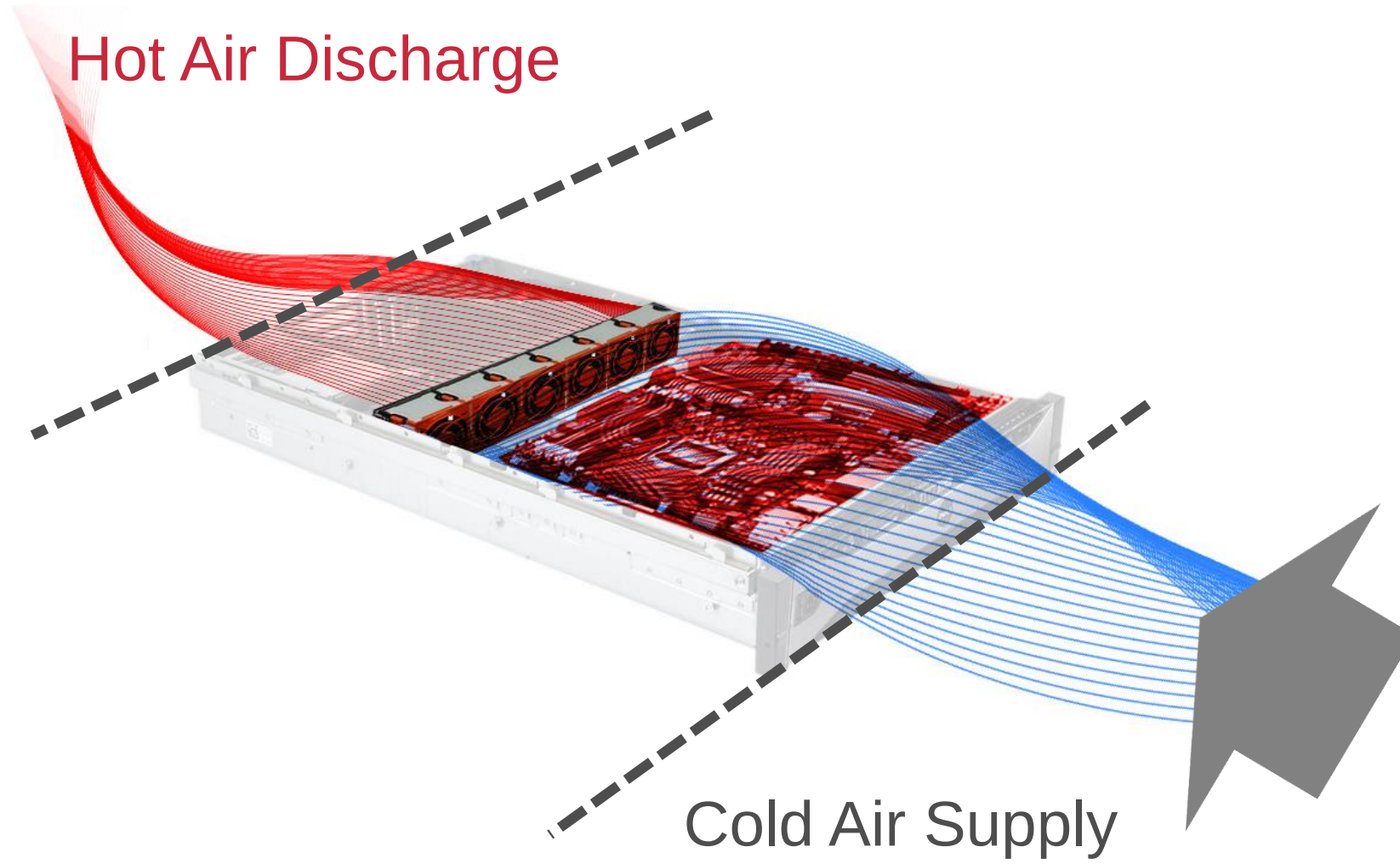
How Can We Improve Even Further?

... We Need to Take One Step Back...

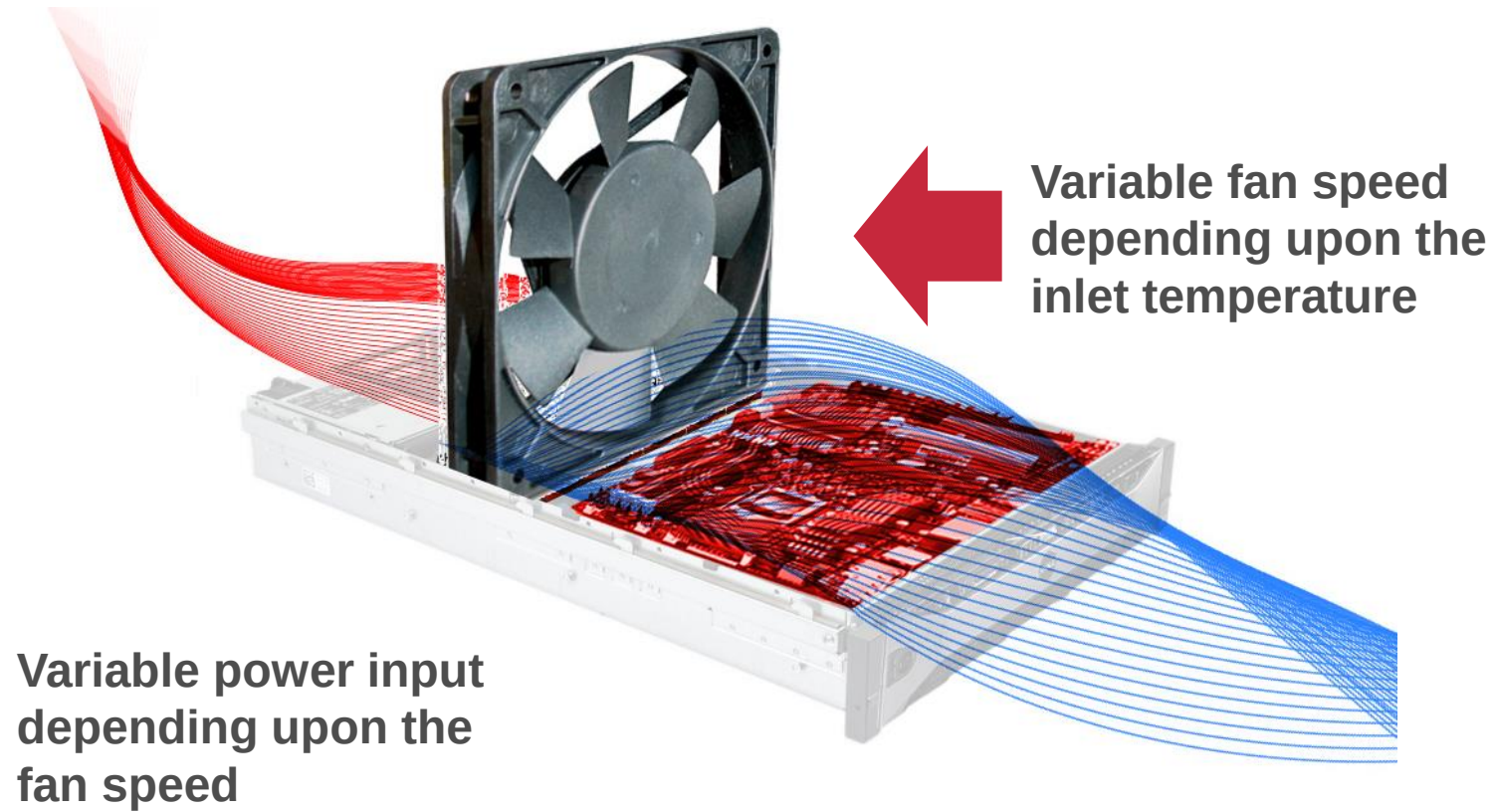
... STARTING FROM THE SERVER



WHEN IT WORKS, IT MAKES HEAT

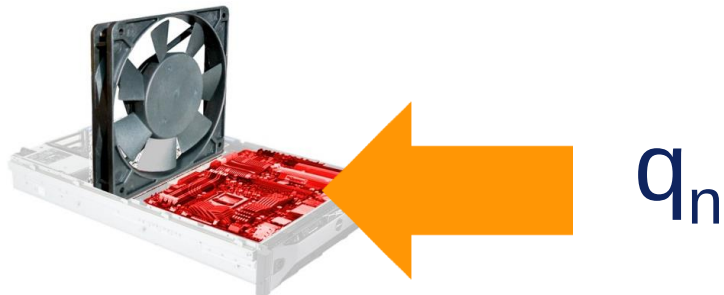


“EQUIVALENT CIRCUIT”



AIRFLOW CAN VARY

Our Thermal Solution Always Needs to Match It!



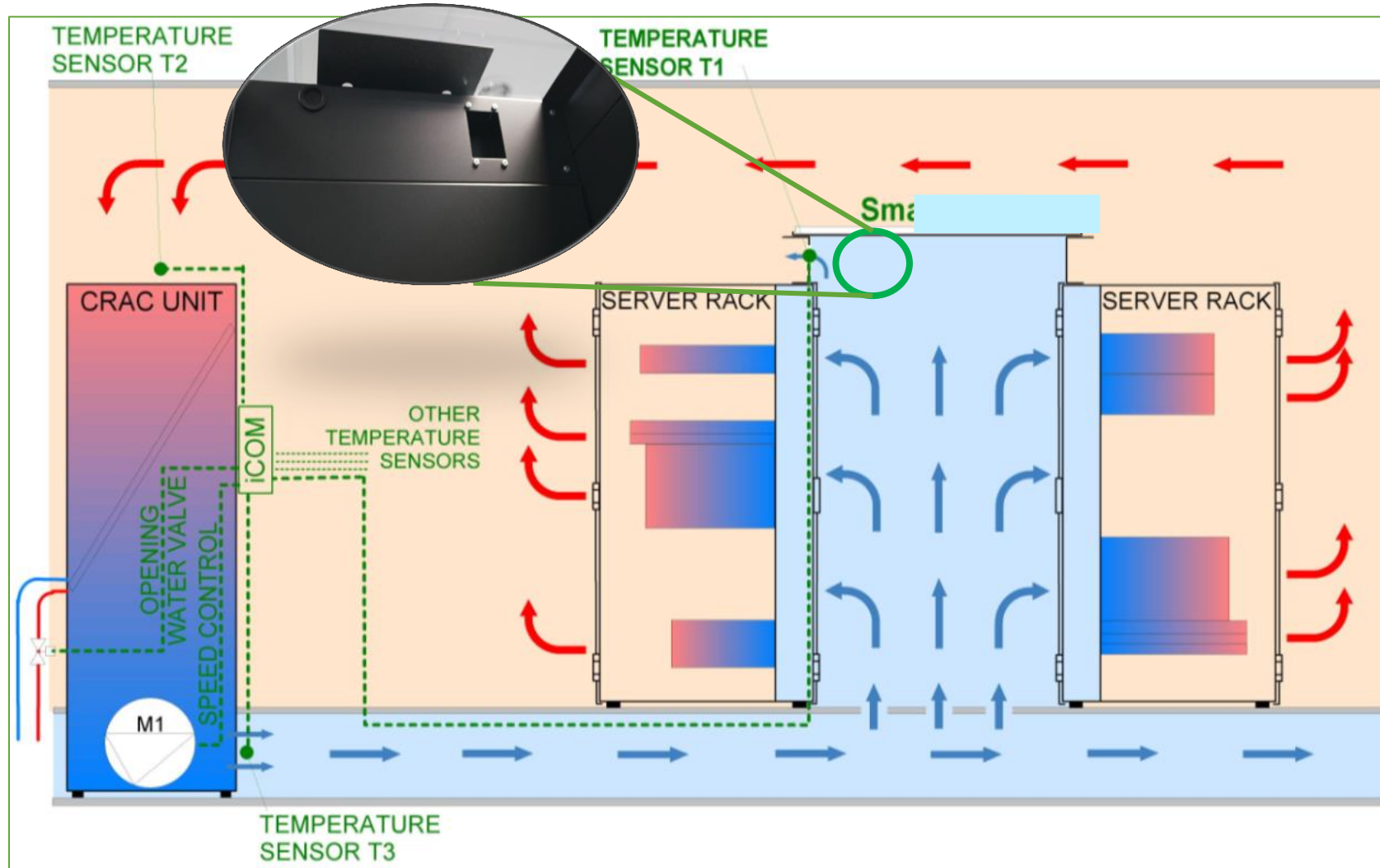
Servers' Airflow

$$q_{\text{servers}} = q_1 + q_2 + \dots q_n$$

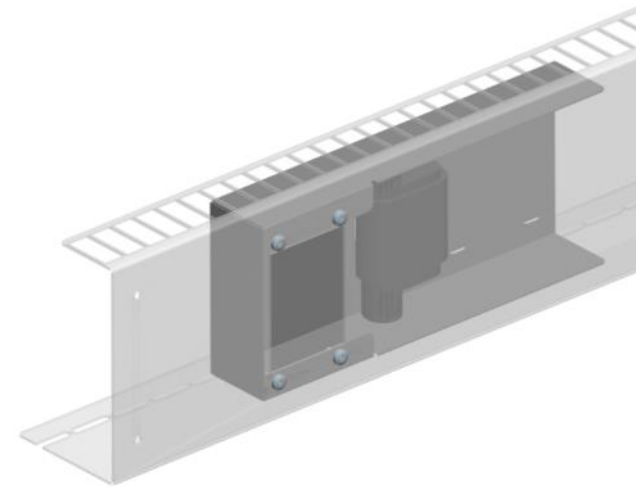
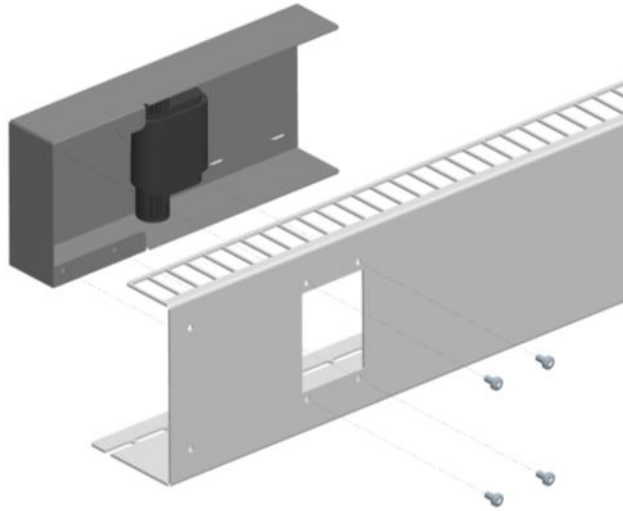
Cooling Unit Airflow

$$q_{\text{cooling}} = q_{\text{servers}}$$

SERVER AIRFLOW DYNAMIC CONTROL

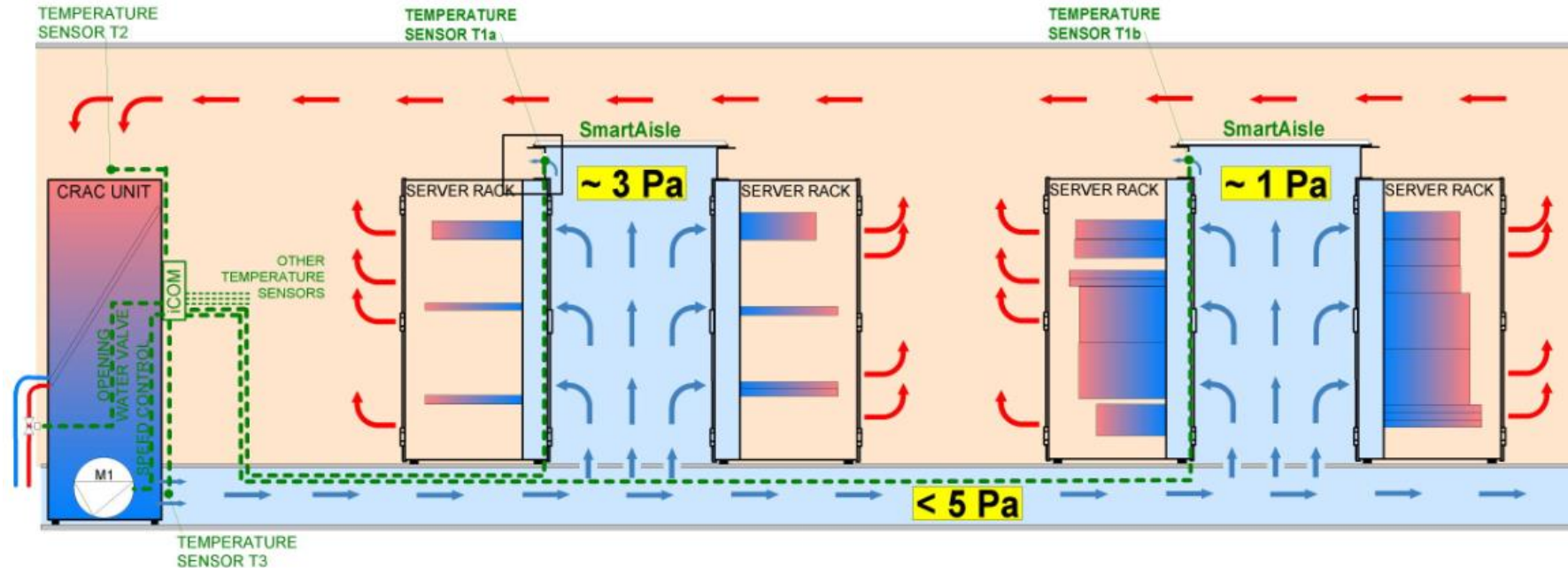


SERVER AIRFLOW DYNAMIC CONTROL: SENSORBOX



CONTROL AND DIFFERENT IT LOADS PER AISLE

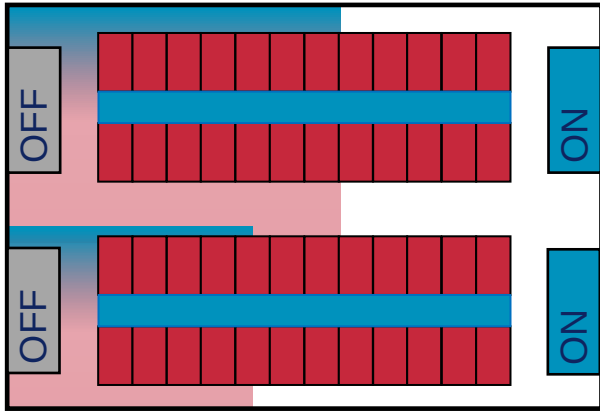
Server Airflow Dynamic Control



Perfect Solution!

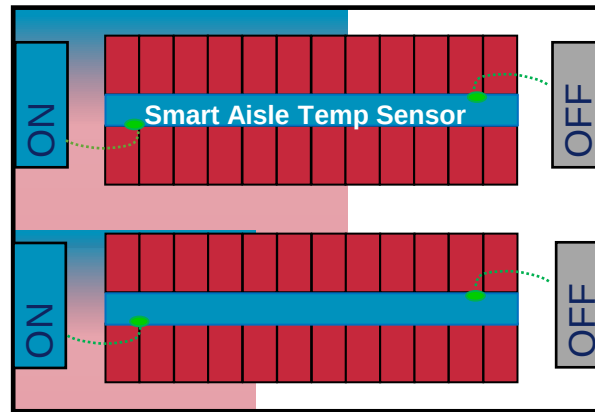
EFFICIENCY AT PART LOADS: ECONOMY STAND-BY

A Higher Level System Efficiency



Normal Team Work:

- Activates the unit according to the internal ID number
- This may result in having the unit pushing air from the other side of the room
- Normal teamwork also induces unit 1 to full capacity before activating unit 2



Economy Stand-by:

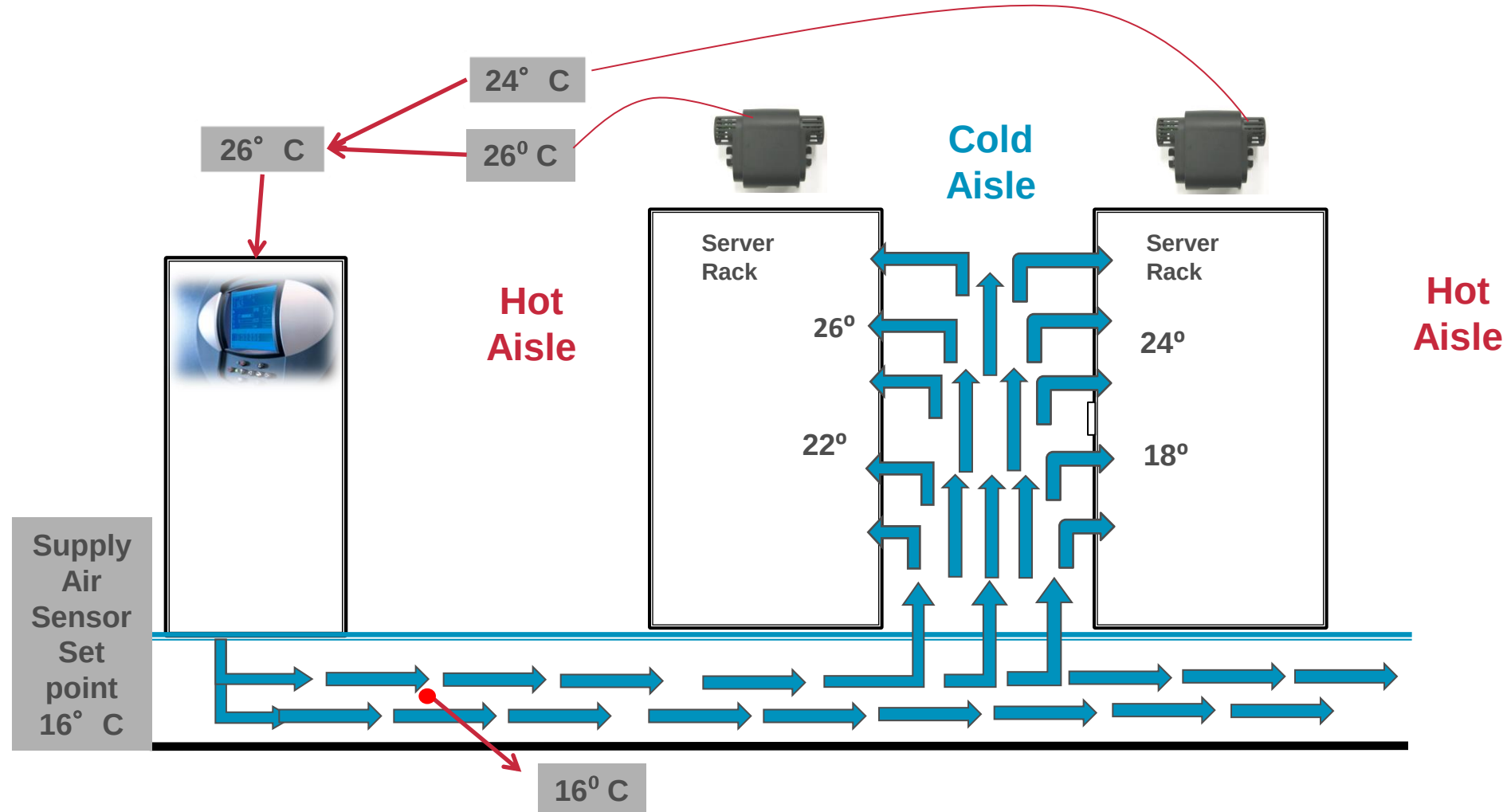
- Calls the units in operation according to their specific remote sensors (still shared among the team)
- Calls the units in operation maintaining them in the optimal working speed for the EC Fan

Economy Stand-by:

- Using Cooling Closest to the Heat Load
- Improving System Efficiency and Increasing Components Life (*less demanding operating point*)

SUPPLY COMPENSATION

Extending the Server Airflow Dynamic Logic to Open Architecture

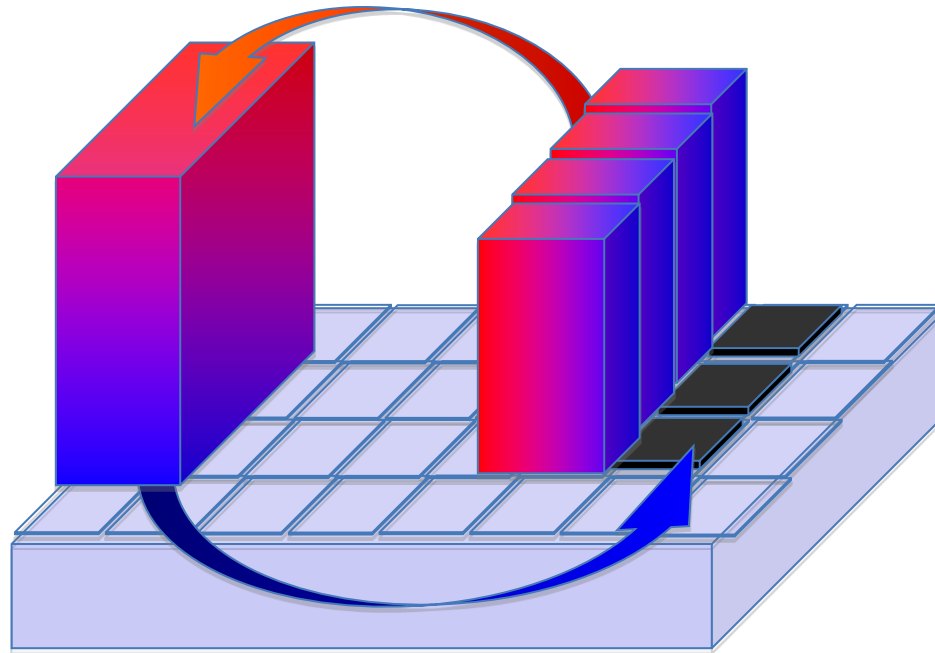


Extending the Server Airflow Dynamic Logic to Open Architecture

Compensation is the link between the control sensors:

- The control evaluates the rack sensor and the fan speed
- If the fan is operating at 100% and the rack temperature is above the set point, the supply temperature set point will be lowered to provide colder air

In this way we can ensure the appropriate cooling even in case of a poor air distribution



Perimetral
Chilled Water

Chilled Water Systems

Liebert® AFC and Liebert® HPC - Data Center Chillers

- Maximized Freecooling effect with fluid temperature up to 26°C

Liebert® PCW - Room Cooling Units

- Optimized Fan Speed Control System
- Optimized water loop based on real Data Center Loads



In the Row
(DX/CW)

In Row Units

Liebert® CRV - In the Row Data Center Cooling Units

- Optimize fan operation
- Better return temperature
- Higher heat density per rack



DX Systems

Liebert® PDX – Direct Expansion Cooling units

- Optimize fan operation
- Better return temperature
- Modulating Capacity Solution



Perimetral
Direct
Expansion



SERVER AIRFLOW DYNAMIC CONTROL

Row Cooling Case Study 1: 90 kW Thermal Load

Increase in Temperature = Increase in Capacity

- Compressor works at a lower modulation
- Fans work at a lower speed
- Lower consumption of fans and compressor

Containment Maximizes Air Utilization

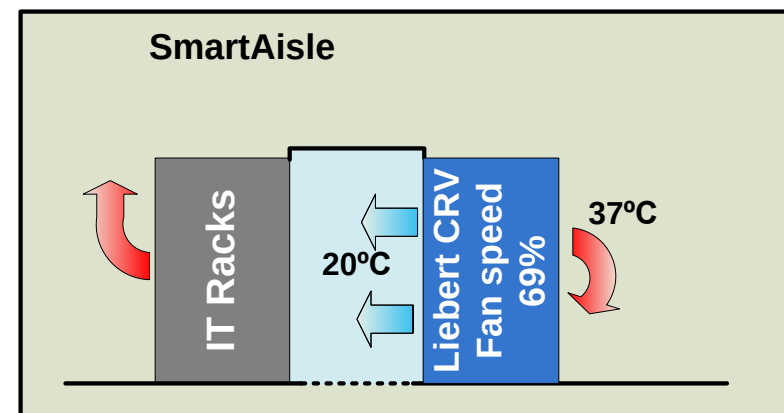
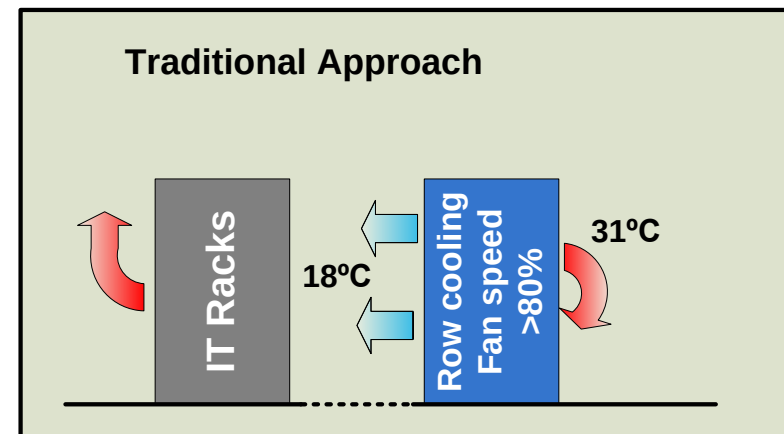


30%
Energy
Saving



8,188 €
Yearly
Savings

Note: Saving calculated in comparison with Traditional In the Row solution without Containment and Control, load: 90 kW, city: Frankfurt



In the Row

Direct Expansion

Chilled Water

SERVER AIRFLOW DYNAMIC CONTROL

DX Cooling Case Study 2: 300 kW Thermal Load

- Integrates the **benefits of containment** with the capabilities of the control for optimized cooling
- The control matches cooling capacity with heat load**
 - Variable speed fans
 - Variable capacity compressors
- Containment maximizes air utilization**

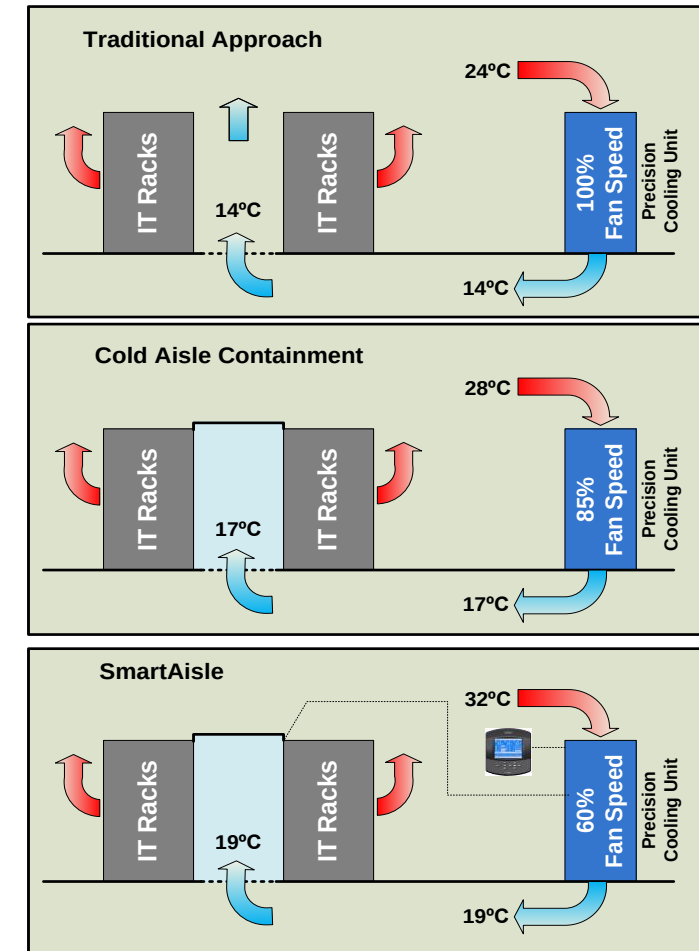


60%
Energy
Saving



79,322 €
Yearly
Savings

Note: Saving calculated in comparison to Traditional DX Floor Mount AC fan solution without Containment and Control, load: 300 kW, city: Frankfurt)

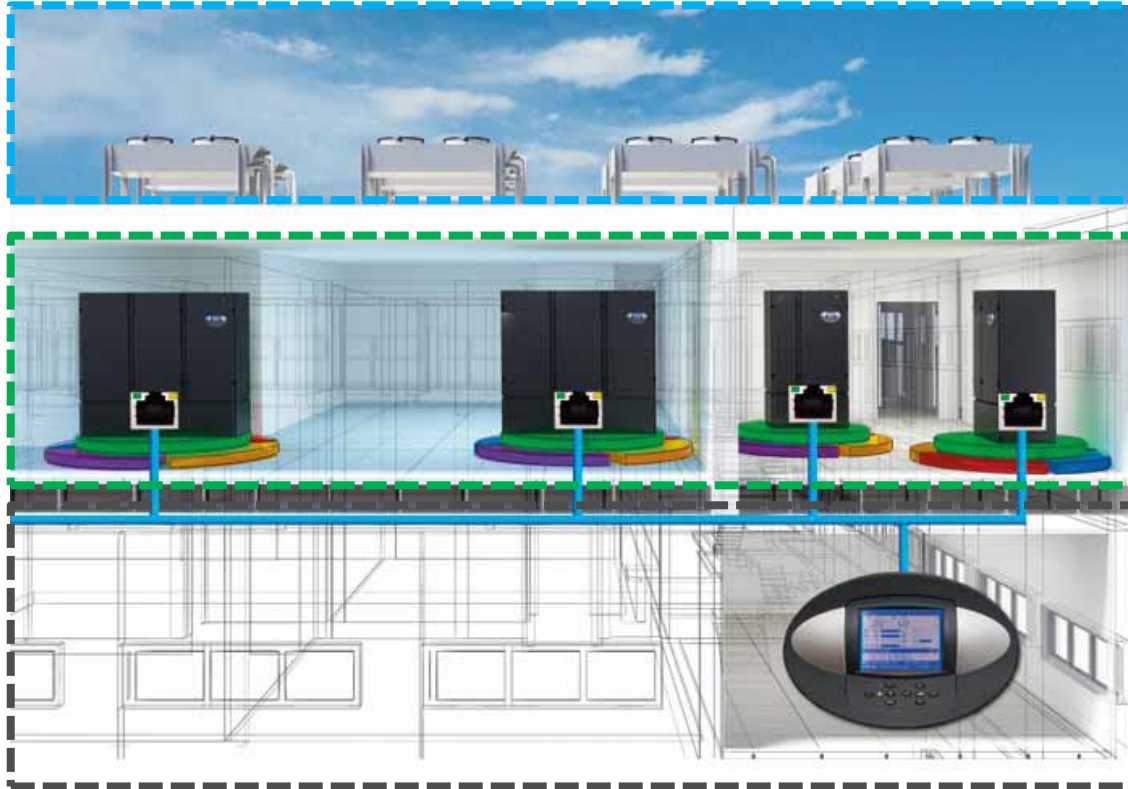
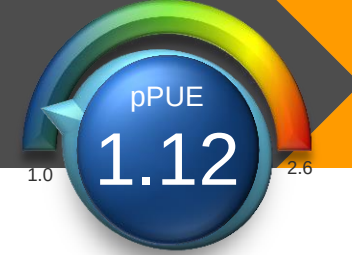


In the Row

Direct Expansion

Chilled Water

DIRECT EXPANSION SOLUTION



Outdoor Condensers:

- Reduced refrigerant charge, with micro-channel coils
- Intelligent communication with Floor mount units

Direct Expansion Floor Mounts:

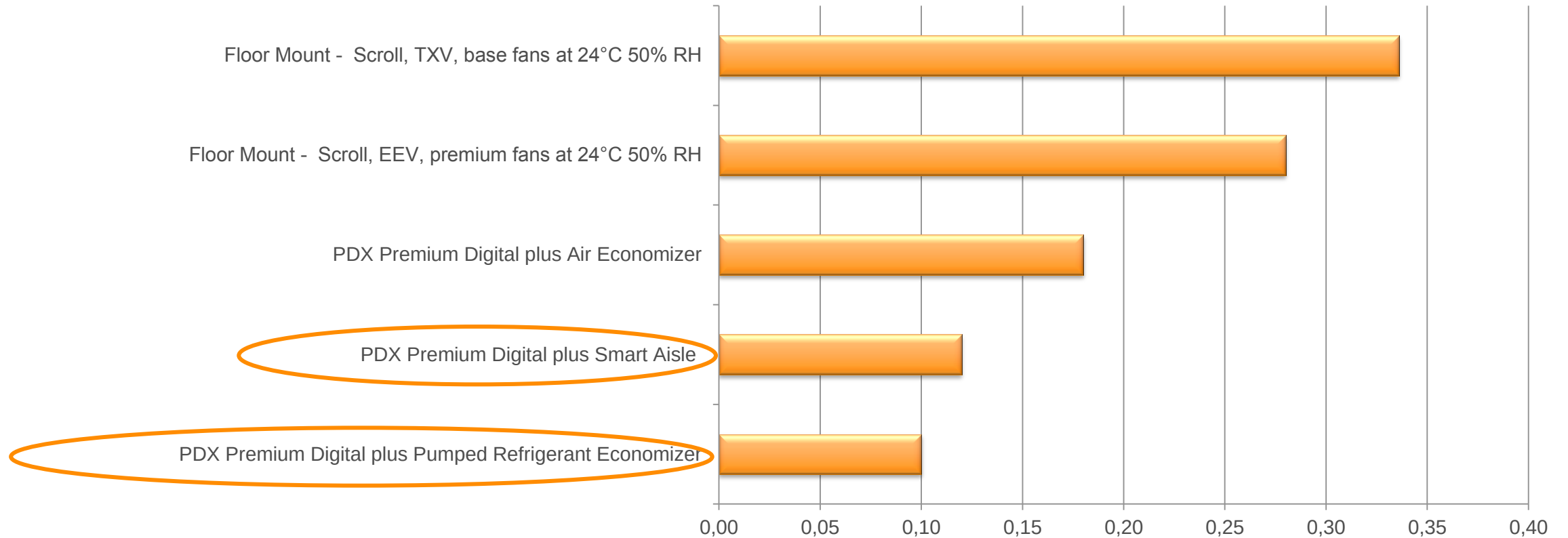
- Designed to suit 38°C of return temperature
- Includes the economizer to provide direct freecooling for the data center, or indirect freecooling

Control of airflow and temperature in front of the servers:

- Always provides the right quantity of air at the right temperature

ENERGY CONSUMPTION OF DIFFERENT DX SYSTEMS

Energy Yearly Consumption / 1 kW Cooling



LIEBERT PDX – FROM 5 TO 120 KW

Liebert® EC Fan 2.0

- Increased Efficiency
- Reduced Noise
- New Blade Design



iCOM™ Control

- First Networking Controller
- IP based
- Featuring teamwork capabilities with other Liebert units thus optimizing resources within the controlled space



Freecooling Modes

- Direct Freecooling
- Water/Indirect Freecooling
- Liebert® EconoPhase™ – Pumped Refrigerant Economizer



Liebert® MC – Microchannel Condenser

- Integrated in the iCOM™ Control
- Microchannel Coil
- EC Fan To Maximize Efficiency at Part Load



Digital Scroll Compressor

- Capacity modulation
- Quick adaptation to changing heat loads
- Strongly reduces energy consumption with SmartAisle™



SERVER AIRFLOW DYNAMIC CONTROL

CW Cooling Case Study 3: 460 kW Thermal Load

- Rates the **benefits of containment** with the capabilities of the control for optimized cooling
- The control **matches cooling capacity** with heat load
- **Containment maximizes air utilization**
 - Increasing the return air temperature to room cooling units, which consequently increase also fluid temperatures.
 - By enlarging the delta T between air and fluid it is possible to lower the fan speed, as the cooling capacity provided by room cooling unit is much higher.



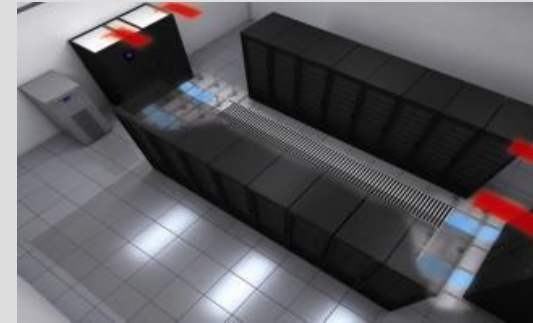
63% on CRAC Unit
67% on Freecooling Chiller
Energy Saving



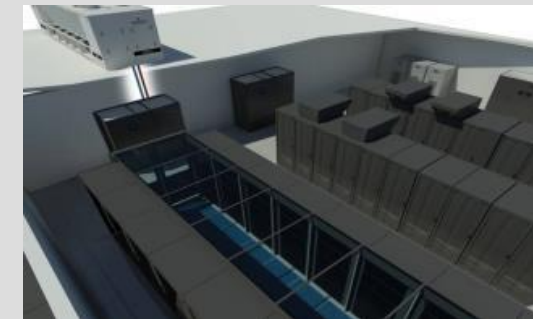
30,740 €
Yearly
Savings

Note: Saving calculated in comparison to Traditional CW Floor Mount AC fan solution without Containment and Control and Freecooling Chiller)

Traditional Approach



Cold Aisle Containment + Floor-mount Chilled Water Unit & Freecooling Chiller

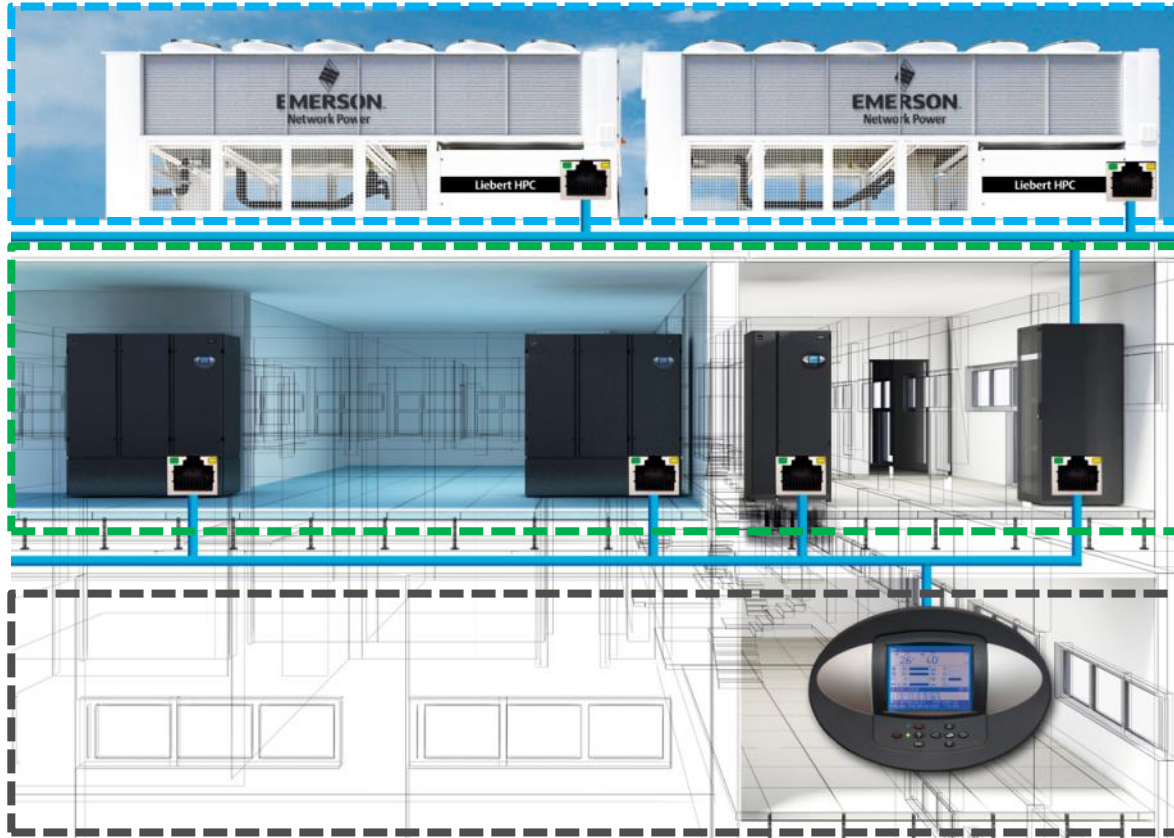


In the Row

Direct Expansion

Chilled Water

CHILLED WATER SOLUTION



Freecooling Chillers:

- Maximizes the freecooling effect
- Increases CW temperatures (up to 26/20°C CWT)

CW Floor Mount units:

- Full range from 30 to 200 kW
- Up to 70% improvements compared to industry standards
- Economizer to provide Direct Freecooling for Data Center

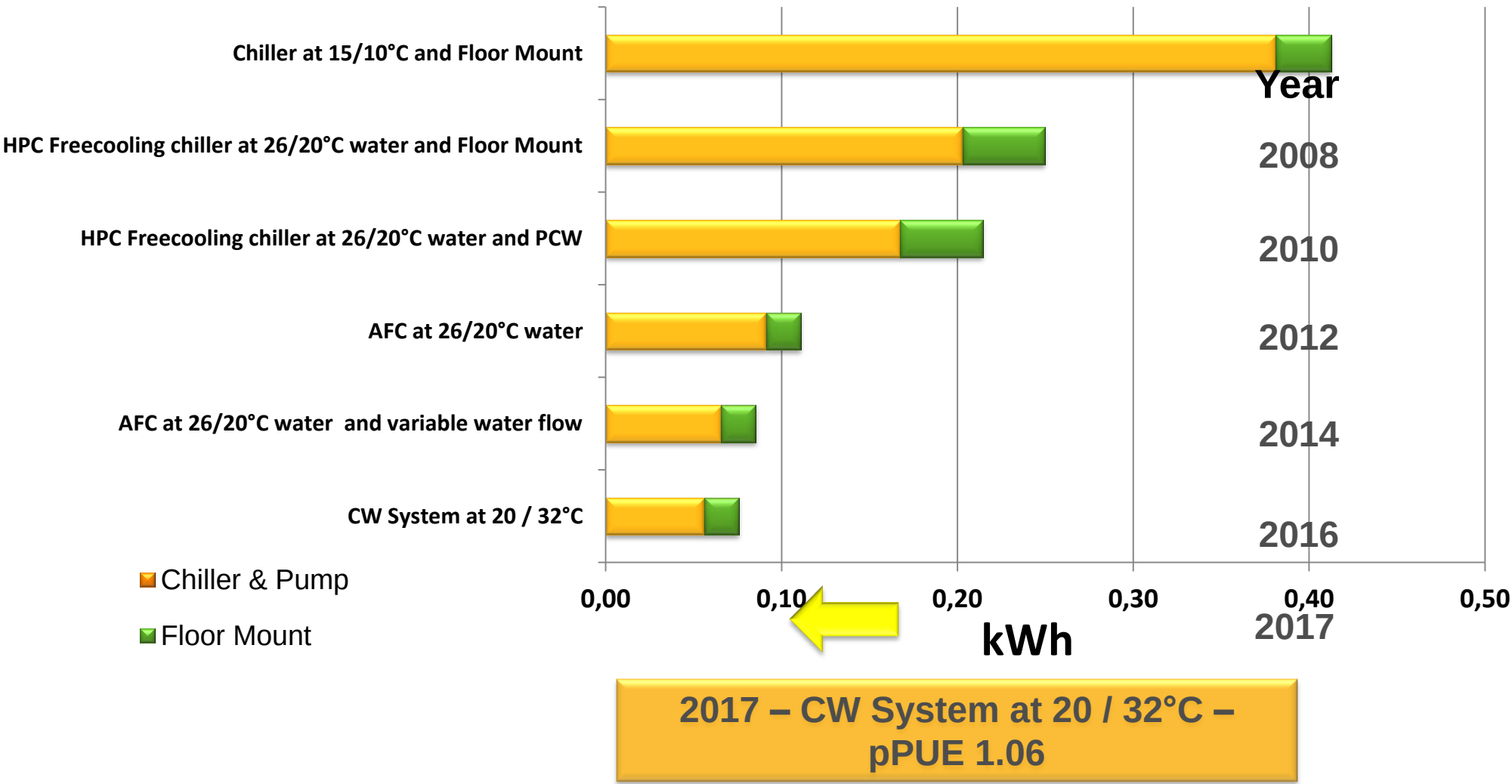
Control of air flow and temperature in front of the servers:

- Always provides the right quantity of air at the right temperature
- Freecooling chillers and floor mount control and set point integration

CHILLED WATER SYSTEMS FOR HIGH WATER TEMP. 20 / 32°C

NEXT LEVEL EFFICIENCY FOR CW SYSTEMS

Energy Yearly Consumption / 1 kW Cooling



LIEBERT PCW – FROM 5 TO 220 KW

Liebert Economizer

Direct freecooling for data centers using outside air when appropriate thus enabling energy optimization



Liebert® EC Fan2.0

New fans technology with composite material fans to optimize unit efficiency



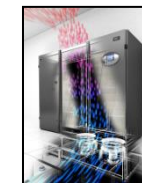
iCOM™ Control

- Control and Monitoring through the iCOM control
- Delivering BMS & NMS Connectivity
- IS Cards available as standard option



Aerodynamic Internal Design

- Unique unit design granting the best efficiency
- Reduces unit pressure drop via: coil geometry, distance between fans and coil, filter positioning



LIEBERT HPC: FREECOOLING CHILLER SPECIFICALLY DESIGNED FOR DATA CENTRES

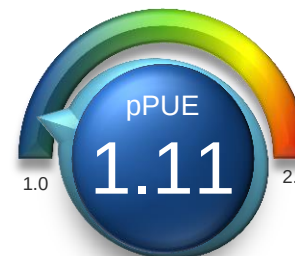
Fast Start Ramp

Fast restart after power failure:
first compressor ON after 20 seconds



Freecooling with SmartAisle™

High water temperatures allow for a high freecooling effect: **high system efficiency**



iCOM™ Control

Strategies for system efficiency:

- Freecooling chiller teamwork and integration with Liebert® floor mount units
- Complete monitoring product offer



High Efficiency Components

- EC Fan
- Electronic expansion valve
- Scroll / Screw compressors
- Pumps with efficiency class IE3

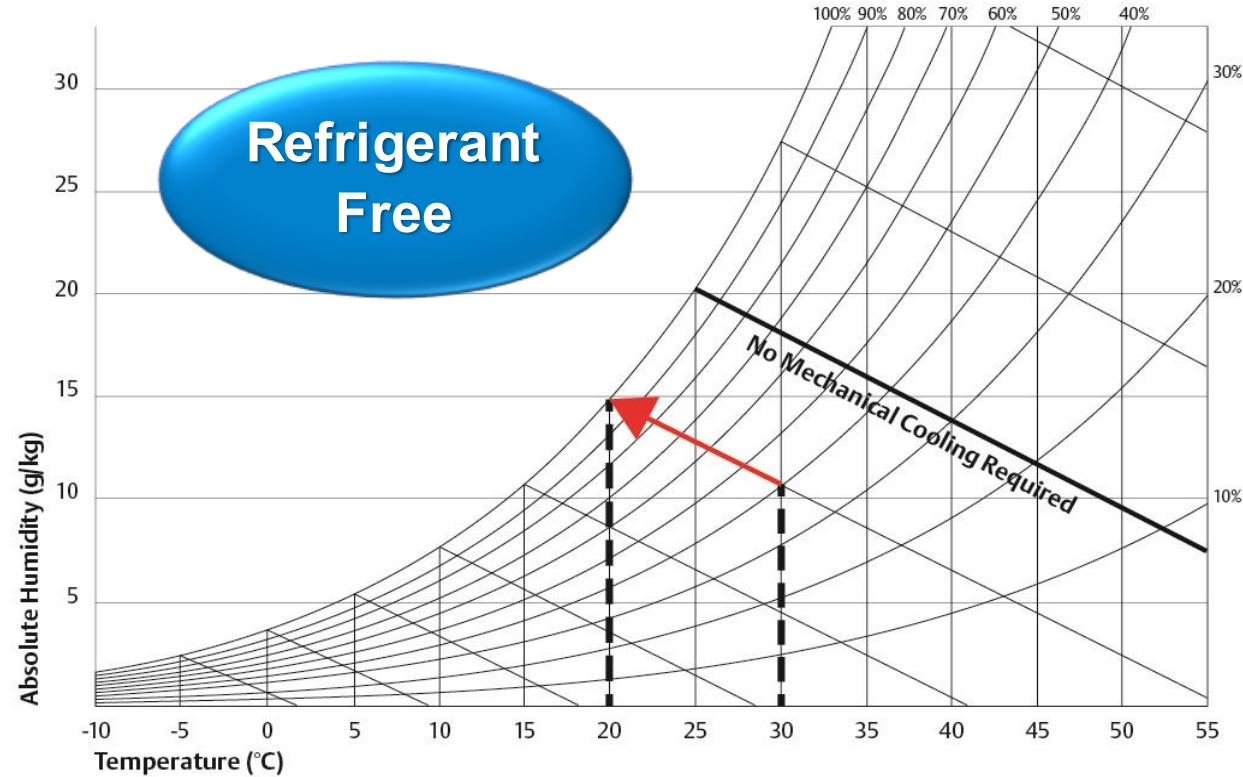


DATA CENTER OPERATING THRESHOLDS

The definition of the data center required temperature and humidity relies also on the external environment conditions.

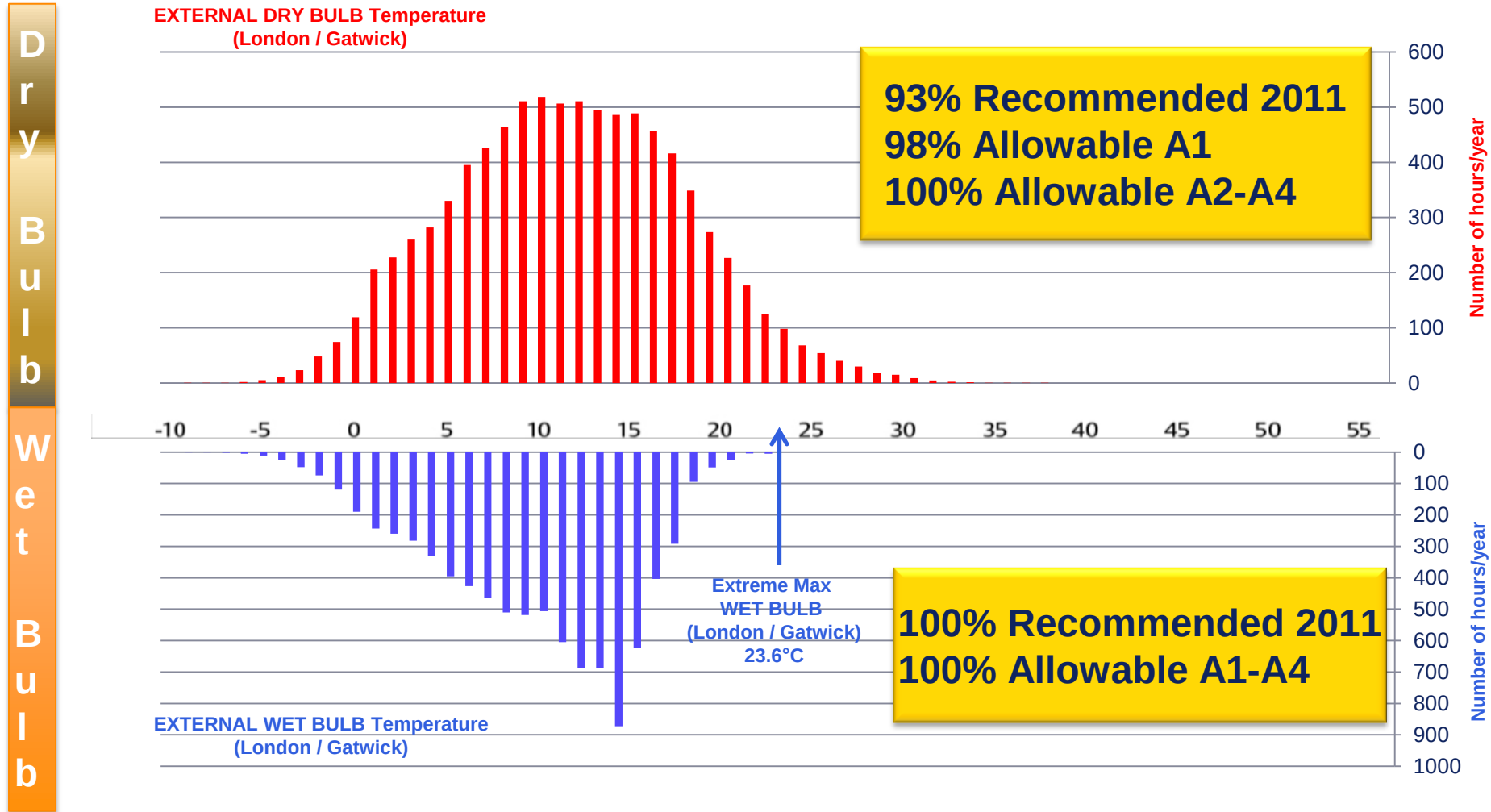
The increase in operating temperatures within which IT infrastructure functions, allows the application of new technologies such as evaporative and adiabatic cooling.

COOLING WITH WATER

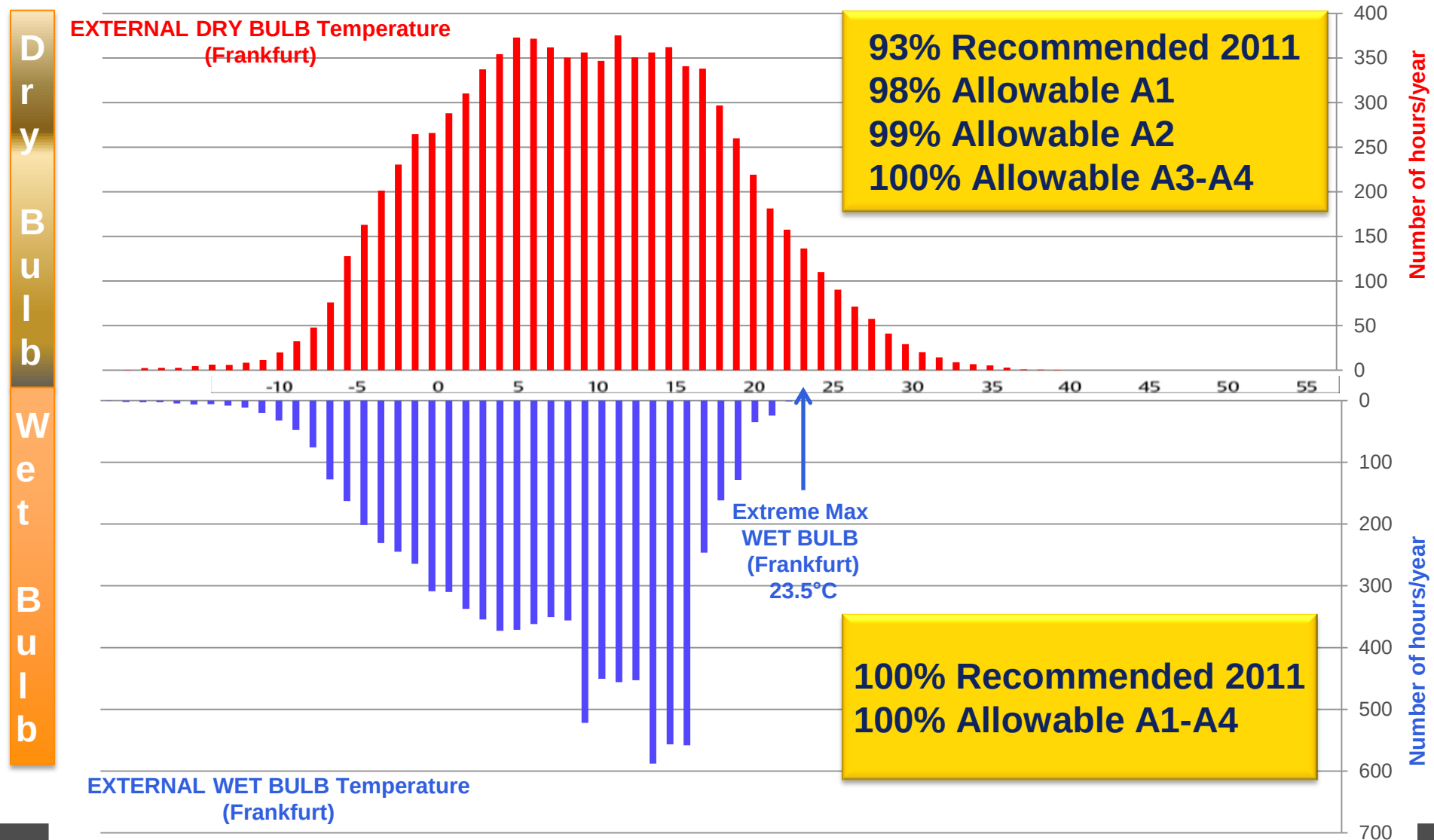


Water Evaporation removes surrounding heat and thus cools down the air temperature.
Colder air allows the transition from Dry Bulb to Wet Bulb Temperature (*the graph shows the change from 30°C to 20°C*)

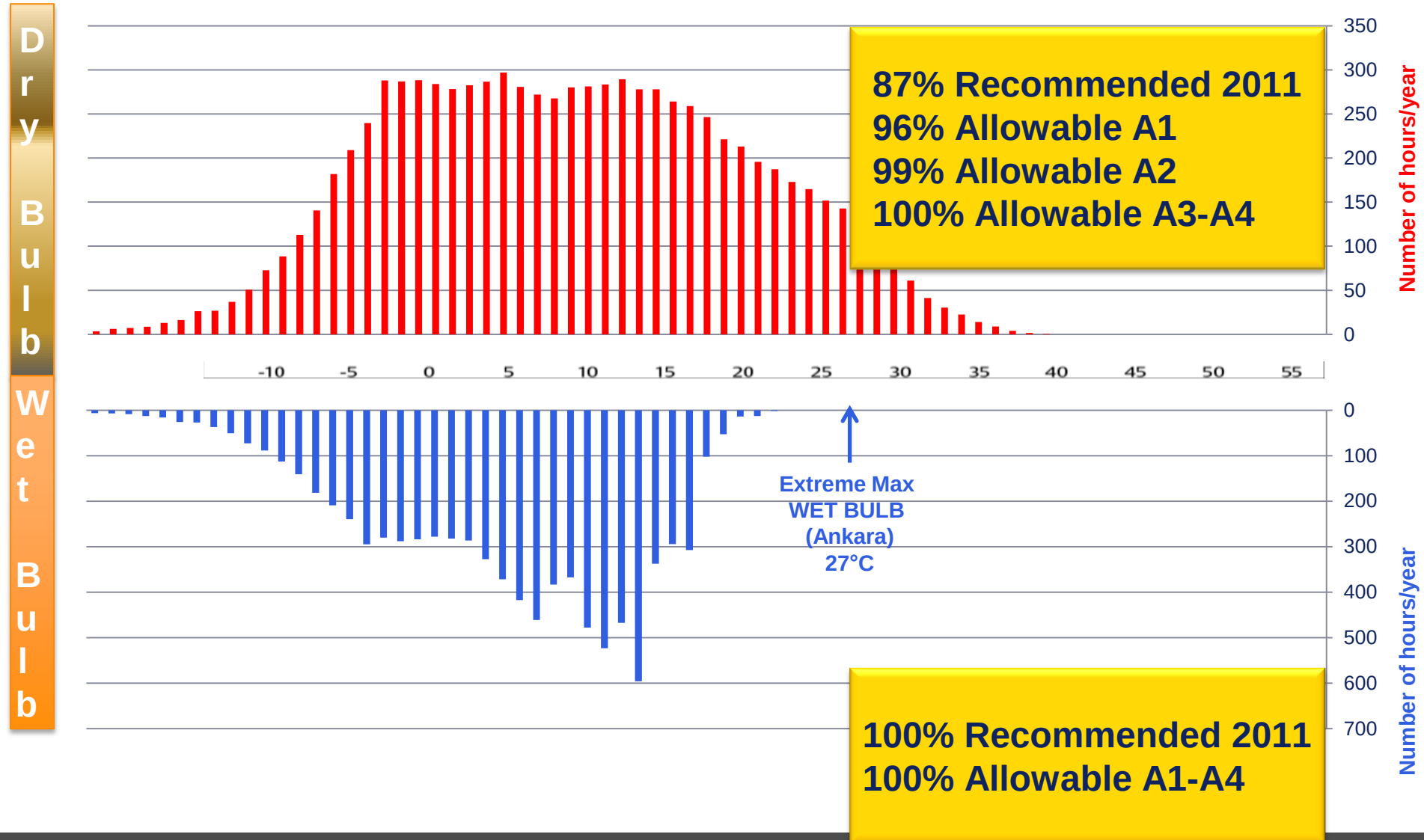
LONDON – DRY/WET BULB AND THE EVAPORATIVE EFFECT



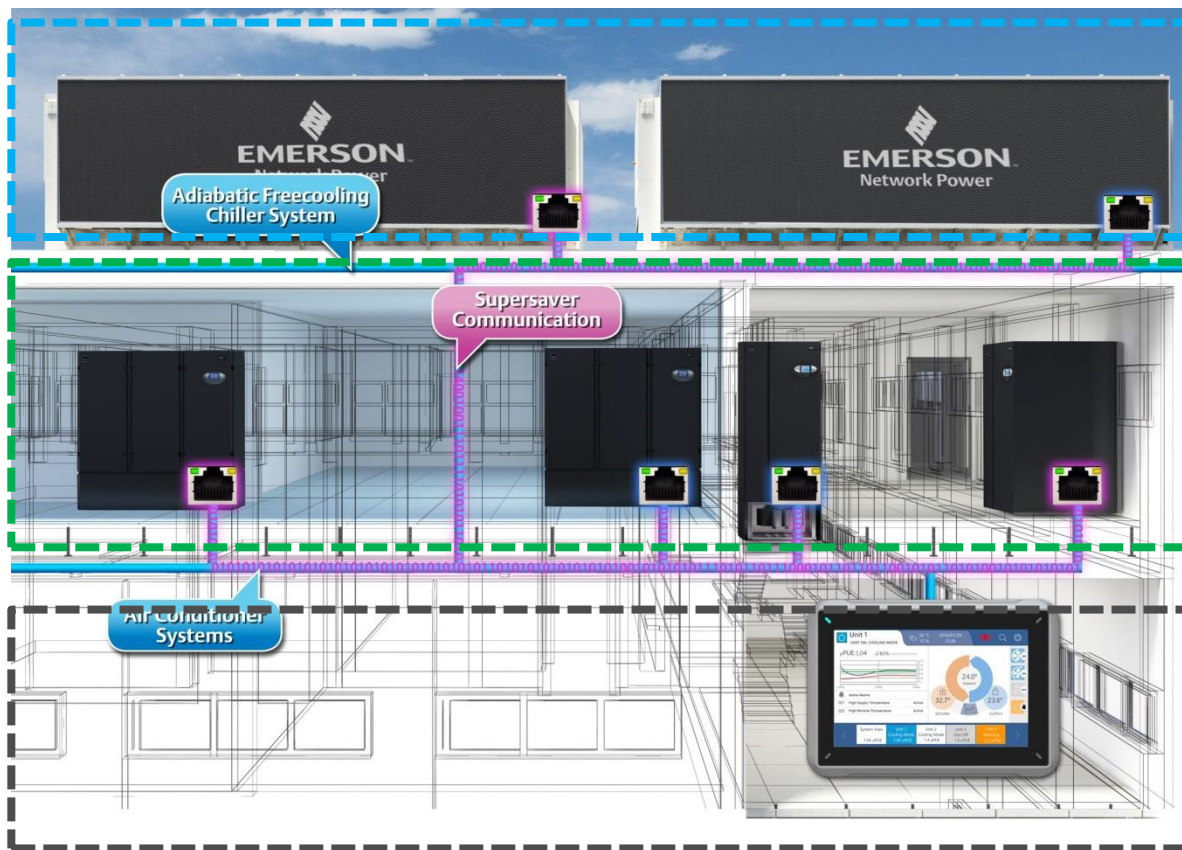
FRANKFURT – DRY/WET BULB AND THE EVAPORATIVE EFFECT



ANKARA – DRY/WET BULB AND THE EVAPORATIVE EFFECT



ADIABATIC CHILLED WATER SOLUTION



Adiabatic Freecooling Chillers:

- Maximizes the freecooling effect
- Increases CW temperatures (up to 26/20°C CWT)

CW Floor Mount Units:

- Full range from 30 to 200 kW
- Up to 70% improvements compared to industry standards
- Economizer to provide Direct Freecooling for Data Center

Control of airflow and temperature in front of the servers:

- Always provides the right quantity of air at the right temperature
- Freecooling chillers and floor mount control and set point integration

LIEBERT® AFC - ONE UNIT, 3 COOLING TECHNOLOGIES

Patent Pending



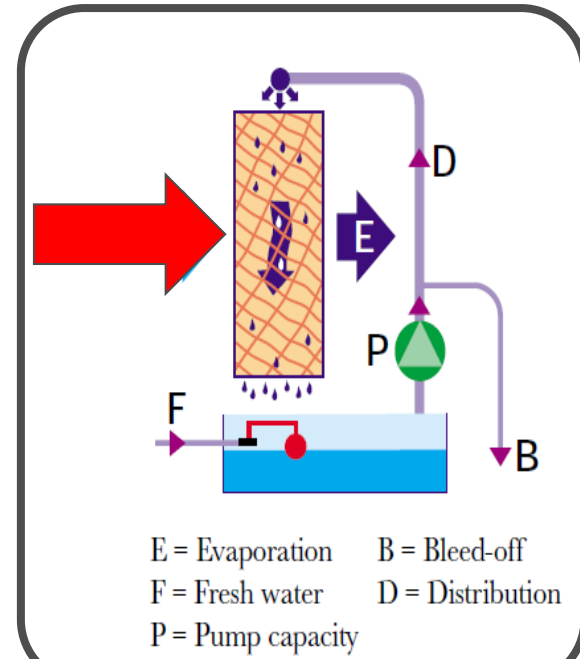
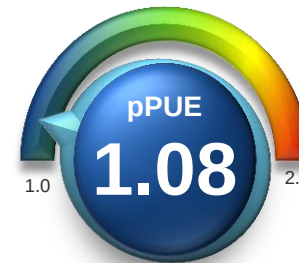
Freecooling



ADIABATIC PAD



Adiabatic Cooling



100% Compressor Back-up

Optimized for return water temperature up to 26°C

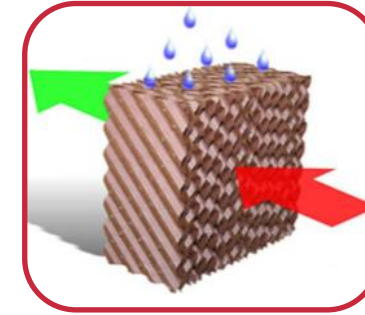
BRINGING AFC TECHNOLOGY AT A HIGHER LEVEL

Optimized for return water temperature up to 32°C

Freecooling



Big Freecooling capacity
with modular V coils



Adiabatic Cooling

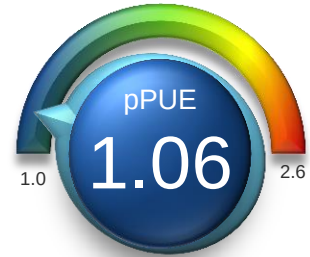


Patent
Pending



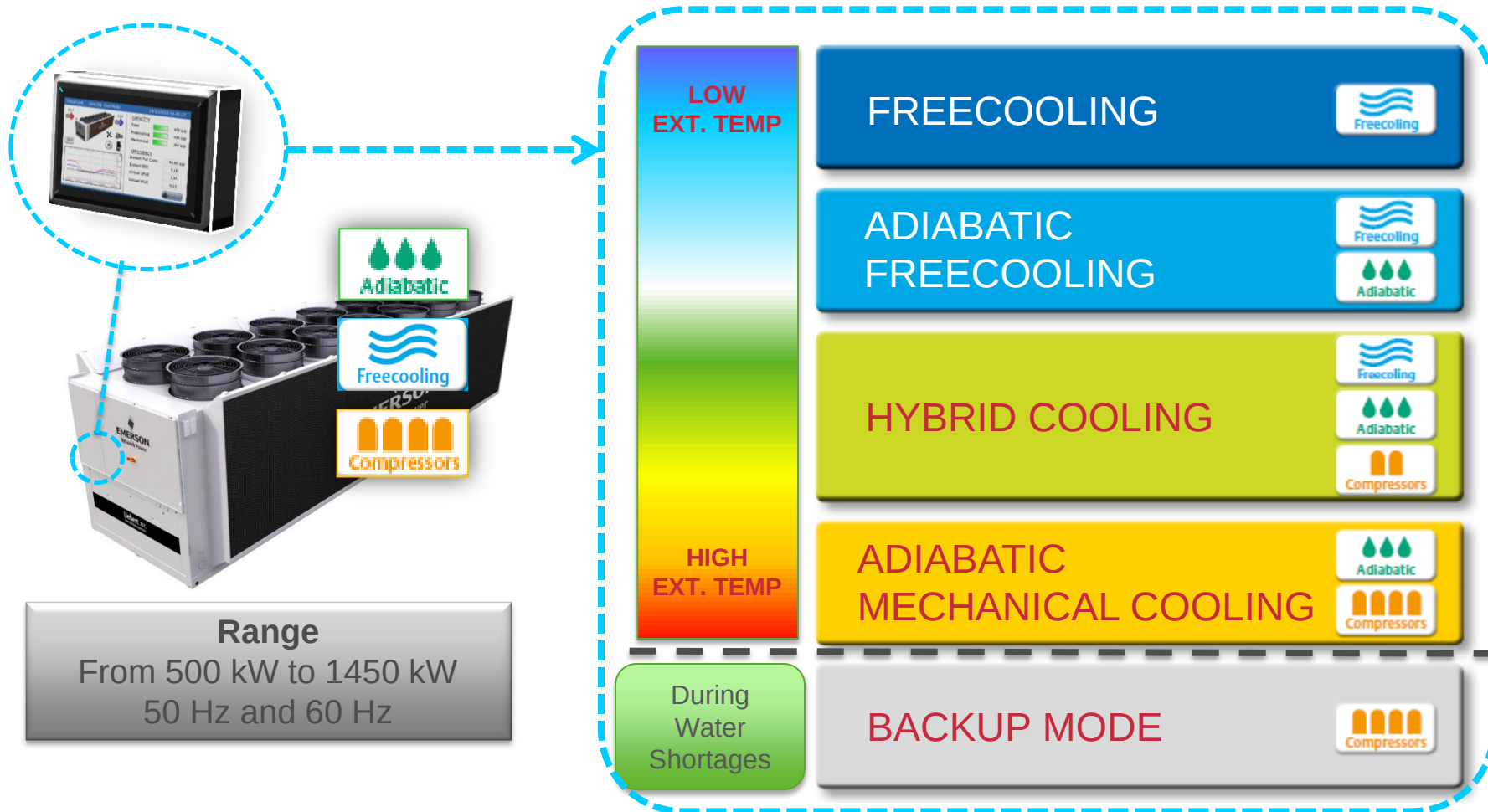
100% Screw Compressor Back-up

High efficiency screw compressors, to ensure 100% cooling
availability under all conditions.

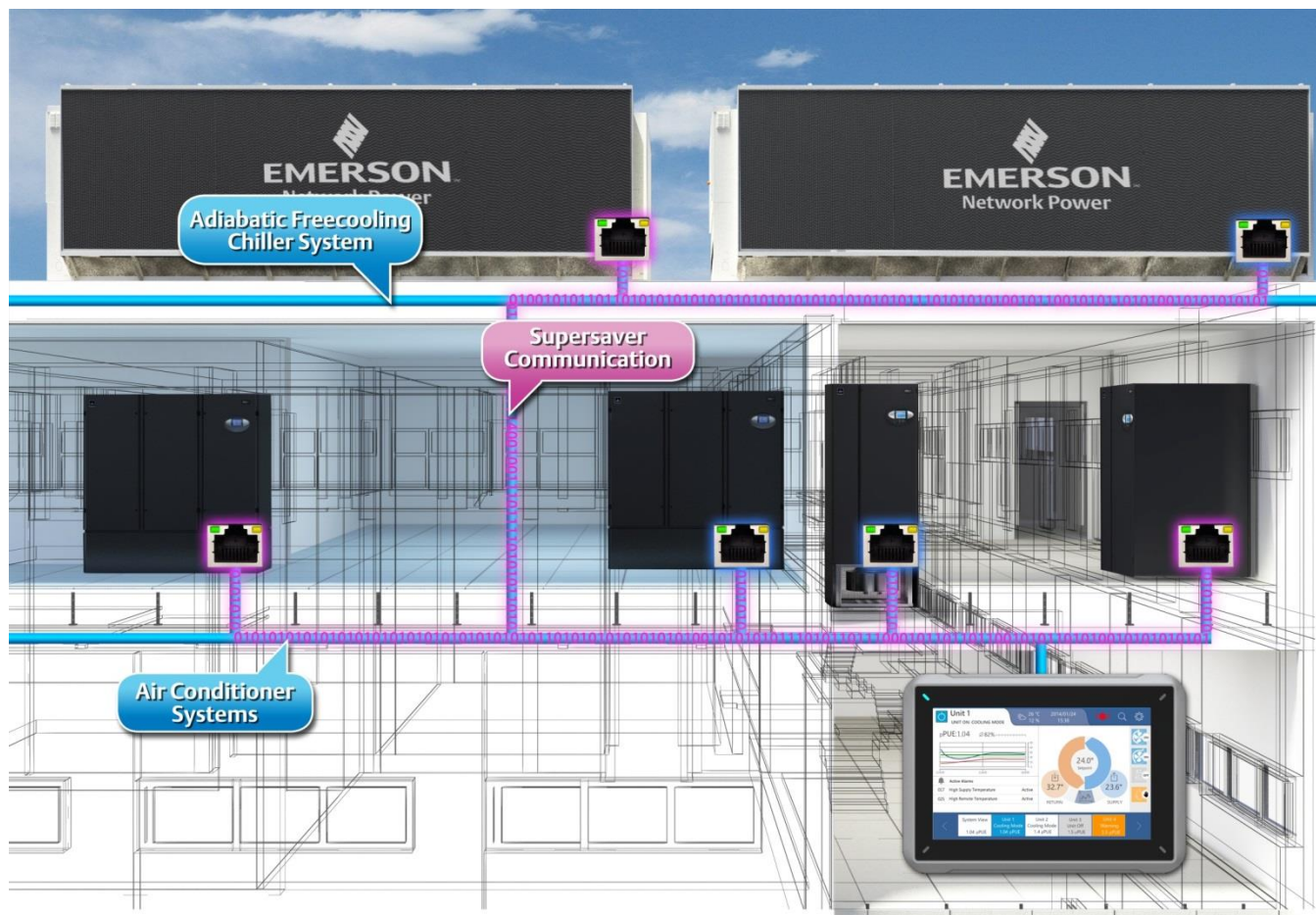


LIEBERT® AFC – OPERATING MODES

The new iCOM™ Control logic constantly measures the external temperature and humidity in order to activate the most efficient operating mode



UTMOST EFFICIENCY AT THE DATA CENTER SYSTEM LEVEL



Liebert® AFC
Adiabatic Freecooling
Chiller

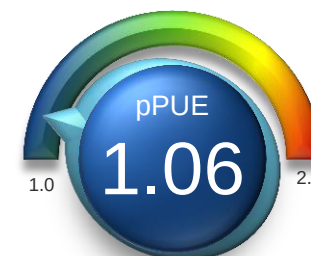
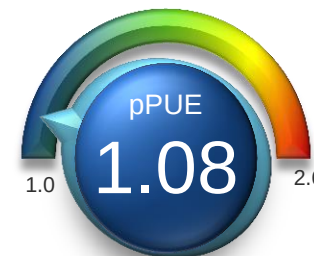
Liebert® PCW

SmartAisle™

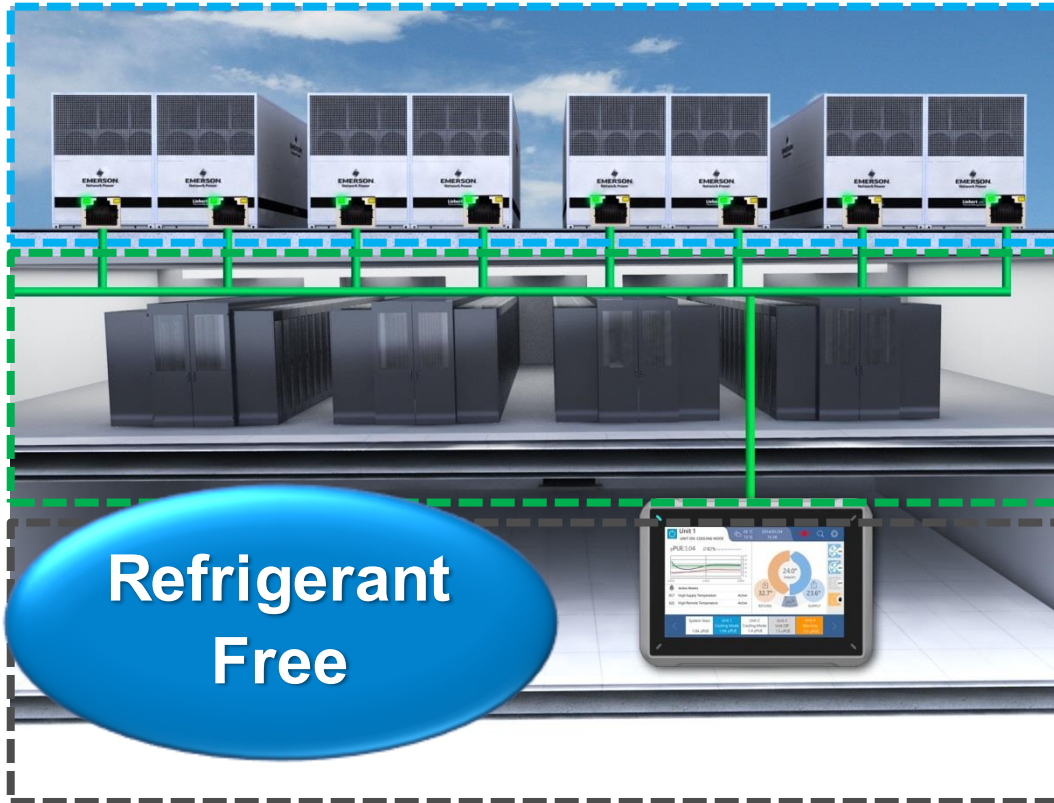
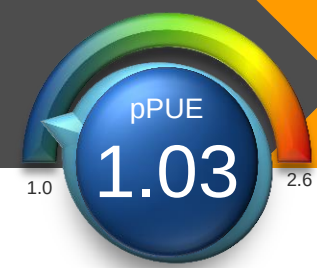
iCOM™ Control

The SUPERSAVER:

THE SOFTWARE LOGIC OPTIMIZING THE ENTIRE COOLING SYSTEM



INDIRECT EVAPORATIVE SOLUTION



Evaporative Cooling Units

- Indirect evaporative freecooling
- Range: 100 and 350 kW
- Perimeter or roof installation
- Reduced installation costs, located outside the white space

Racks Arrangements

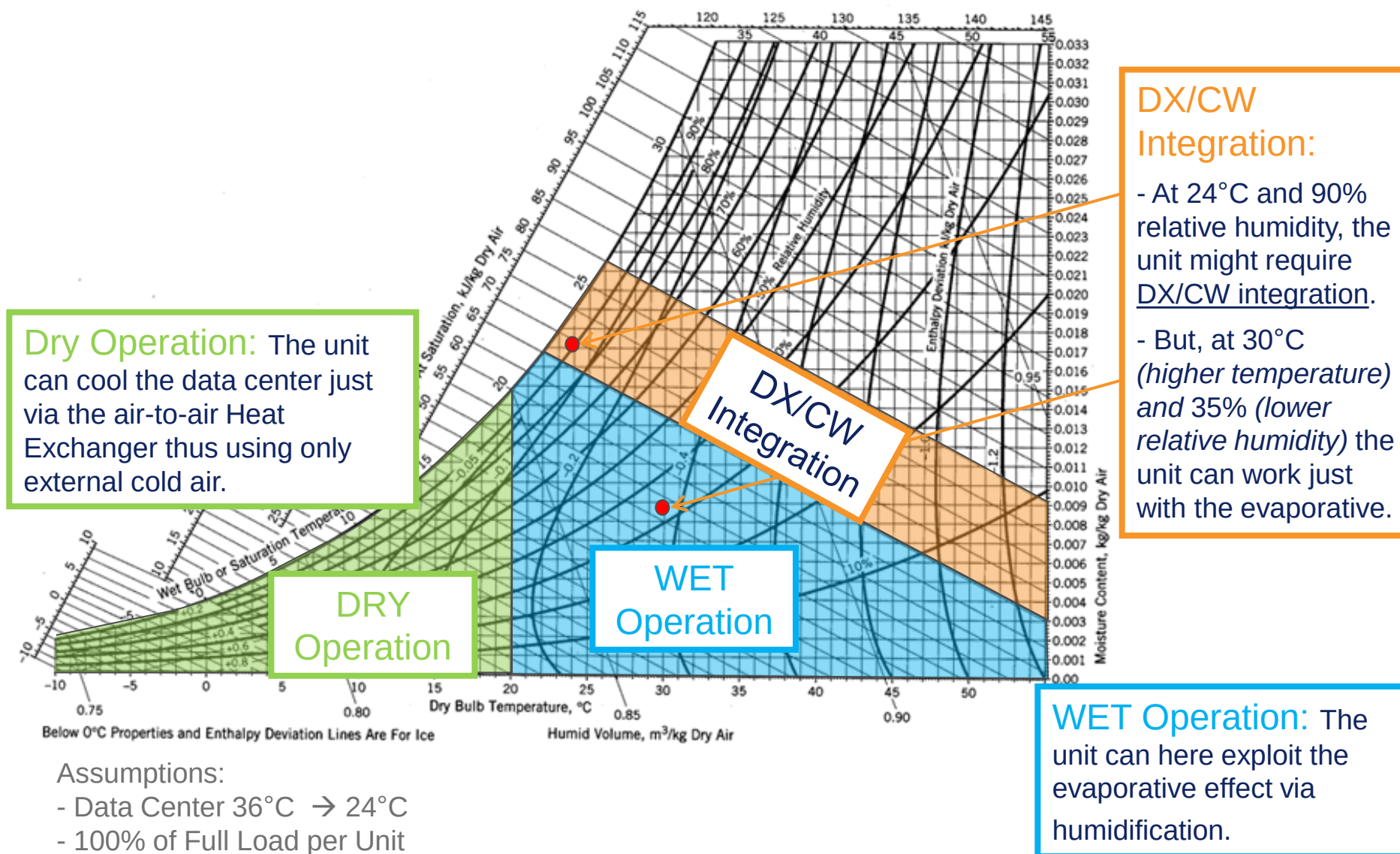
- Hot or cold aisle containment
- Control of air at servers level

Optimizing the System

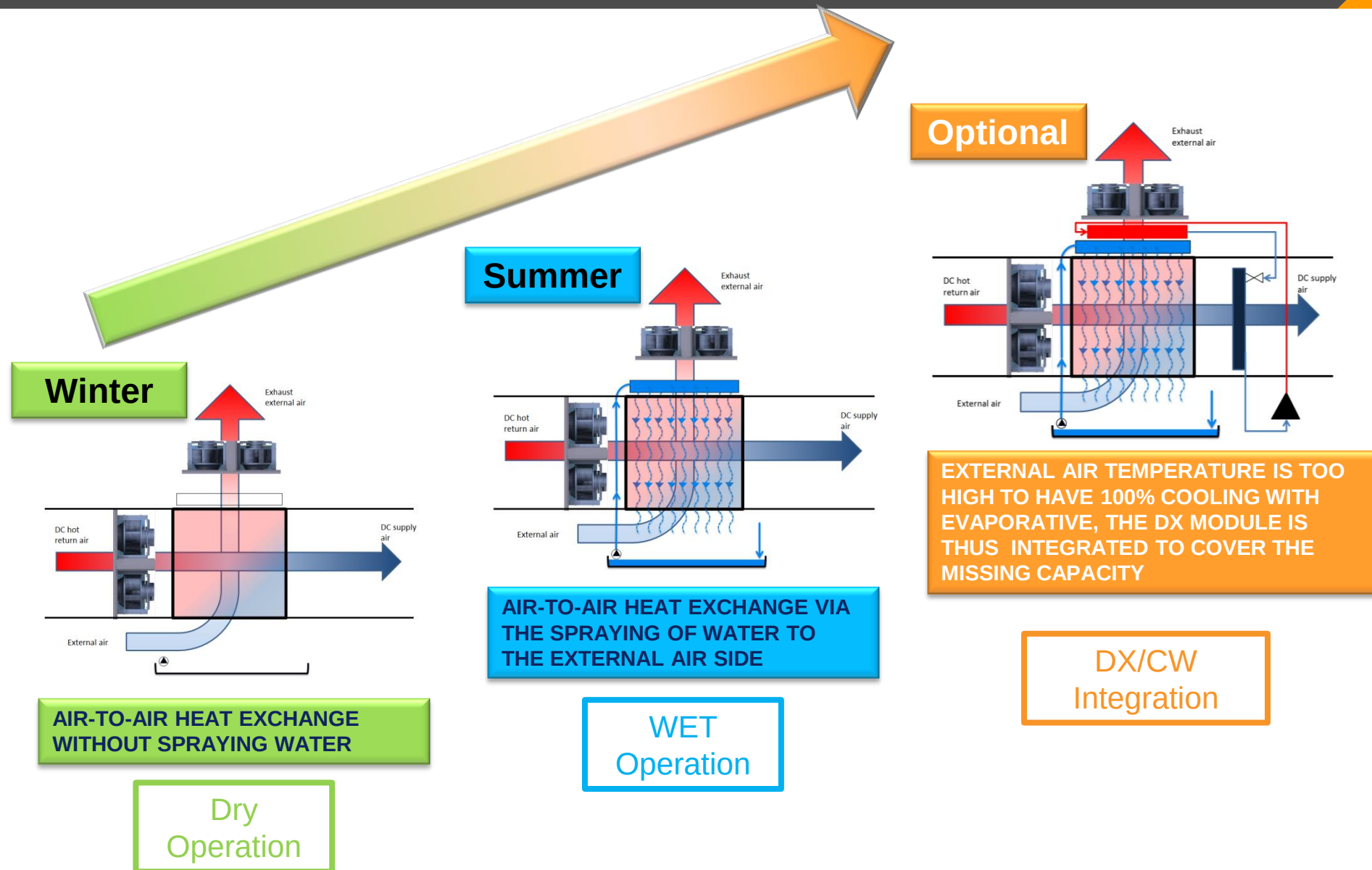
Control of air flow and temperature in front of the servers

Always provides the right quantity of air at the right temperature

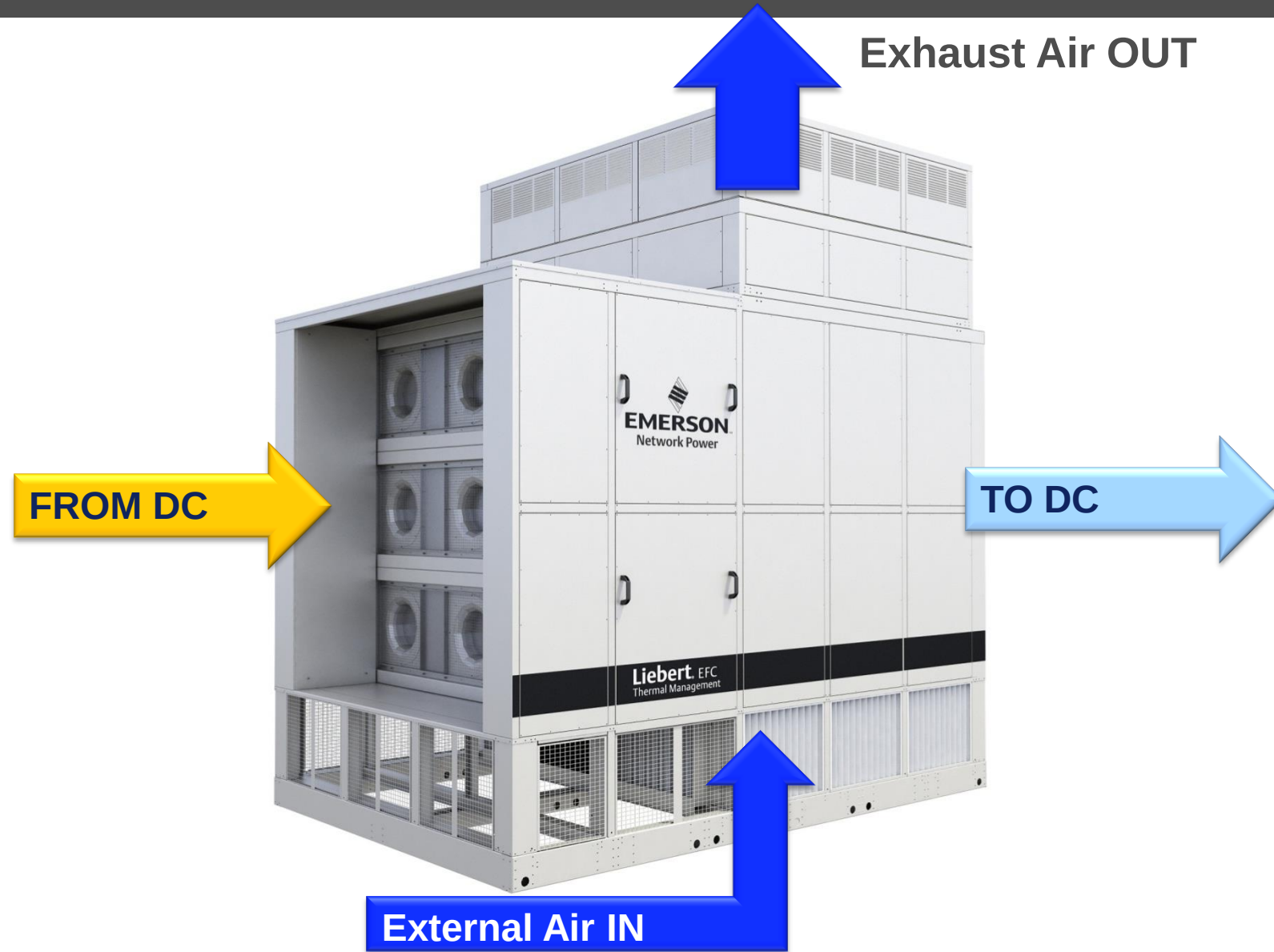
WHERE LIEBERT® EFC WORKS



LIEBERT® EFC: OPERATION MODES



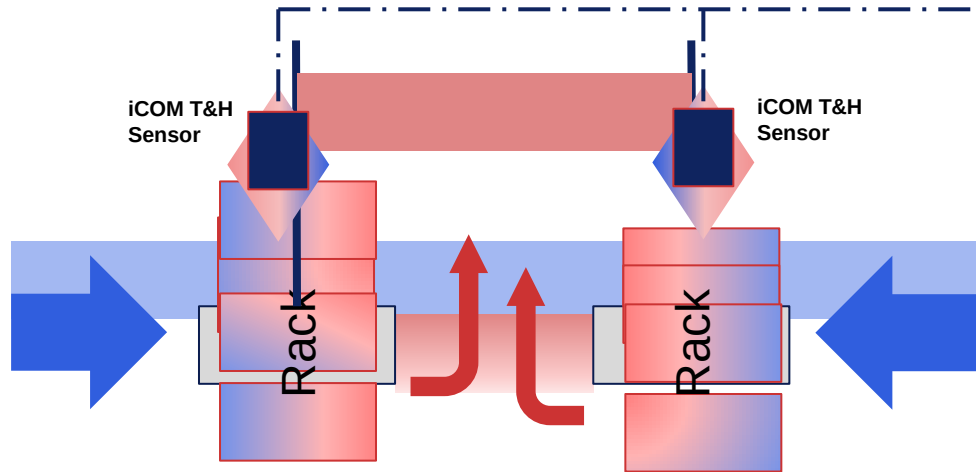
LIEBERT EFC 300 -EVAPORATIVE MODULE



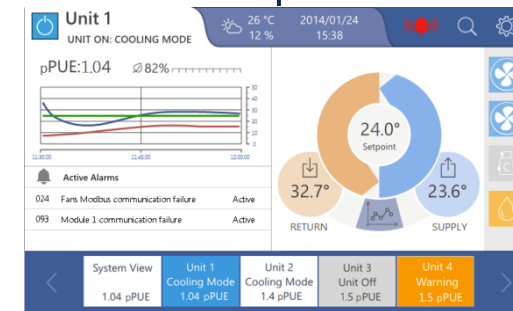
UNIT CONTROL – THE SMARTAISLE™

Does the cooling unit have the right TEMPERATURE & AIRFLOW CONTROL?

- SmartAisle control logic **optimizes internal air volumes and temperatures** following the specific servers' needs.
- SmartAisle control logic allows Liebert® EFC to **exactly match servers' airflow** thus ensuring that not a single Watt is wasted in moving or cooling unrequired air.



Hot aisle or cold aisle containment can be managed in the same way

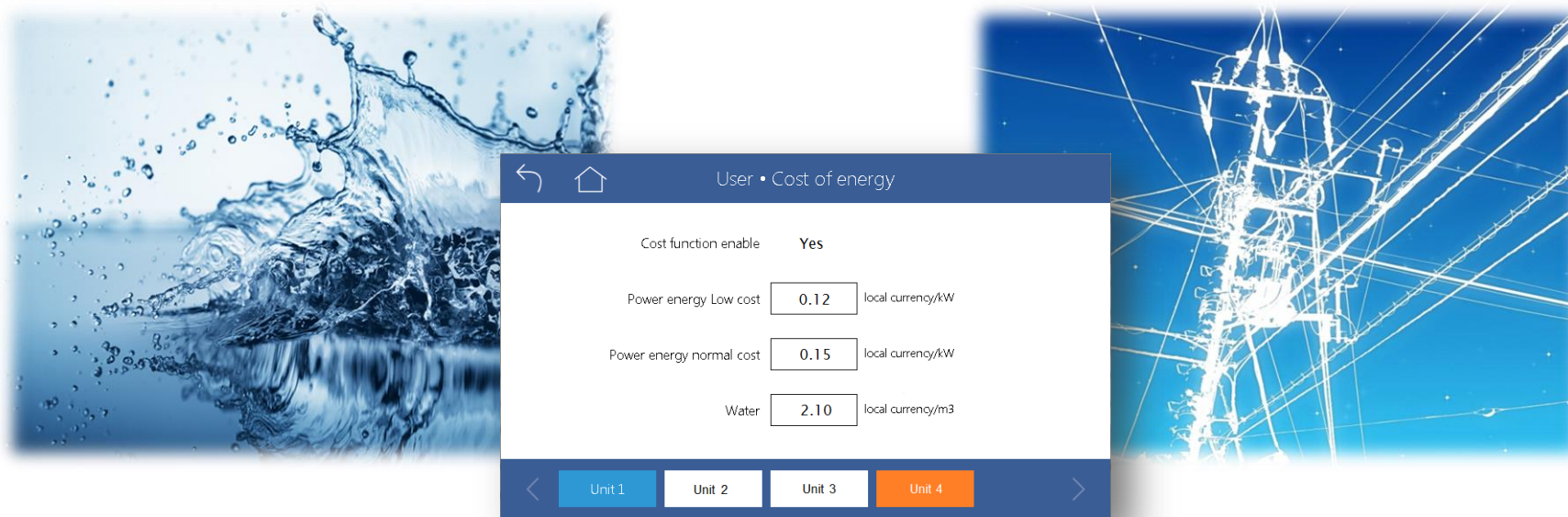


UNIT CONTROL – THE COST FUNCTION

Patent
Pending

WATER or ELECTRICITY, what costs less?

The **user-friendly control**, enables users to **select the exact temperature** at which the evaporative device starts to spray water in the air. This is how Liebert® EFC can optimize the operation based upon different customer's needs.



LIEBERT® EFC – AVAILABILITY, CAPACITY & EFFICIENCY



Availability

- Cooling Continuity & Control Always ON
- Reduced Risk of Unit Failure
- Components Redundancy
- LIFE™

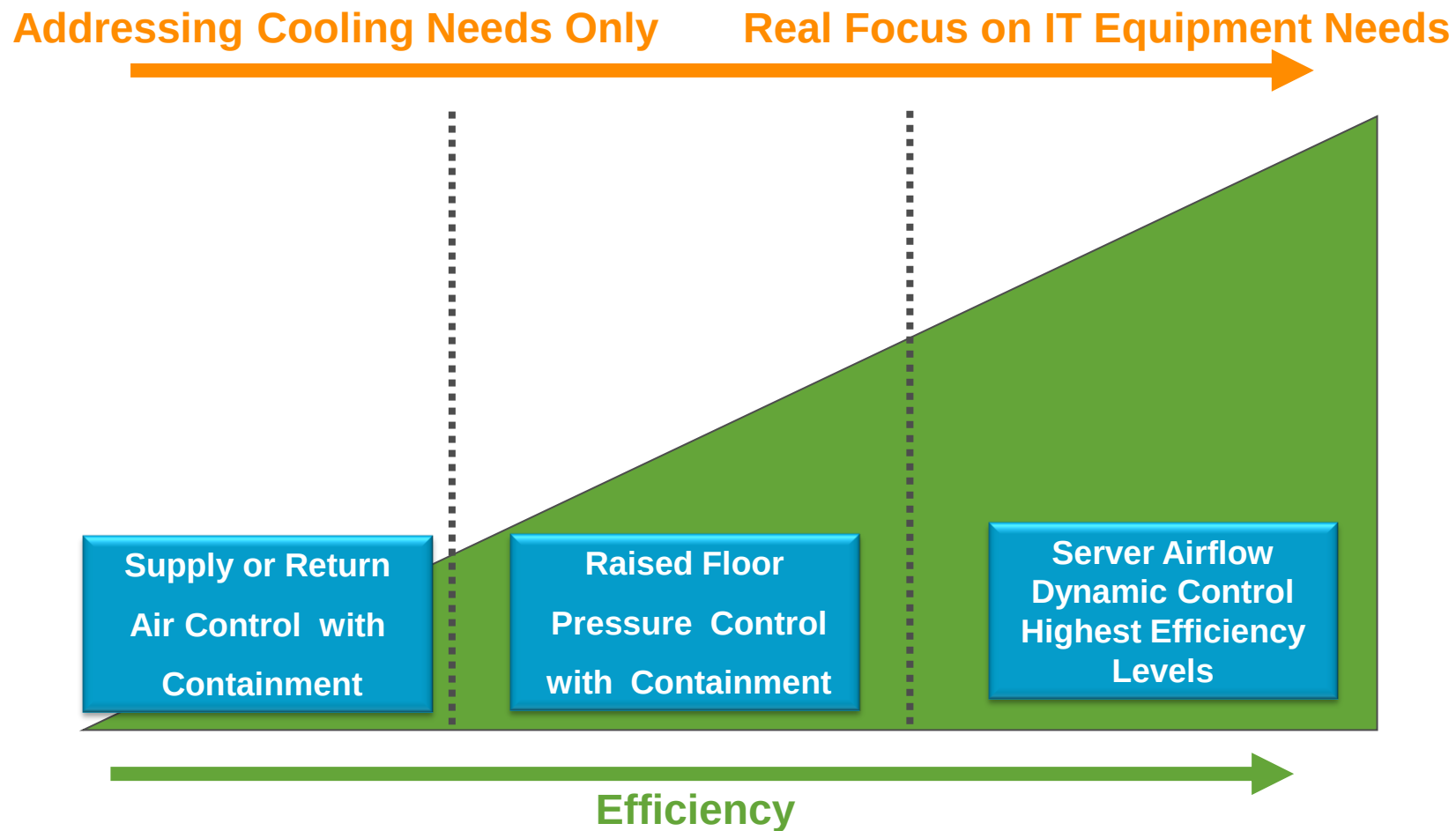
Capacity

- 100% Capacity Modulation
- Scalability
- Adaptation to Indoor/Outdoor Conditions
- Teamworking & Electrical Infrastructure Optimization

Efficiency

- Best pPUE
- Cost Function (Electricity – Water)
- Winter Saver
- SmartAisle™ Teamwork

THE ANSWER TO CUSTOMERS' NEEDS





Questions & Answers

