EUROVENT
MIDDLE EAST

HVACR
Leadership Workshops

Event Introduction:
Building Retrofit

Brian Suggitt
President
Eurovent Middle East

Agenda

1. **UAE Retrofitting Market and Improving Environmental Performance of Buildings through Retrofit**
2. DX Retrofits for Commercial Buildings
3. Retrofit solutions using VRF
4. Retrofitting of AC and Ventilation Units with Smart Electronic Components Integrated in Hydronic Plants
5. Improving Part Load Efficiency in Existing Buildings
6. Improving savings on Chilled Water Pumps through balancing of the terminal units
7. Moderated Discussion

UAE Retrofitting Market

Ms Afra Al Owais
Vice Chair
Emirates Green Building Council

EmiratesGBC
مجلس الامارات للابنية الخضراء
Emirates Green Building Council

Improving Building Performance through Retrofitting

Afra Al Owais, Vice Chair
Emirates Green Building Council

About Us

About EmiratesGBC

EmiratesGBC is a membership-driven organization formed in 2006 with the goal of advancing green building principles for protecting the environment and ensuring sustainability in the UAE.

Our Mission

EmiratesGBC is a catalyst for collaboration and a hub for excellence to promote sustainability of the built environment in the UAE.

Our Vision

For the UAE to be a global leader for sustainability in the built environment.

UAE Vision and Regulations

Government Strategies

UAE Vision 2021

The UAE Government wants to ensure sustainable development while preserving the environment, and to achieve a perfect balance between economic and social development”

National Climate Change Plan of the UAE (2017-2050)

Consolidates the UAE’s climate action under a single framework and identifies strategic priorities, covering both mitigation and adaptation measures.

UAE Clean Energy Strategy

To diversify the energy mix by 2050: 44% clean energy, 38% gas, 12% clean coal and 6% nuclear

Green Building Regulations

New Buildings Regulations

- Estidama Pearl Rating System applied in Abu Dhabi.
- In Dubai, Dubai Green Building Regulations and Specifications (DGBRS) are applied. Al Sa'fat green building rating system was introduced in 2016.
- Ras Al Khaimah developed its green building regulations, Barjeel.

Existing Buildings Programs

Dubai

- Dubai Demand Side Management Program 2030 – Retrofit target of **30,000** buildings.

- Dubai government is developing an **Energy Performance Label** to evaluate the energy performance of exiting buildings.

- EmiratesGBC published the **BEA Energy and Water Benchmarking Report** to support the labelling scheme, evaluate the performance of hotels, schools and malls, and support the retrofit market.

Existing Buildings Programs

Abu Dhabi, Sharjah & Ras Al Khaimah

دائـــرة الـــطـــاقـــة
DEPARTMENT OF ENERGY

- Abu Dhabi Demand Side Management and Energy Rationalization Strategy (DSM) 2030 - Retrofit target of 3,000 government buildings.

هيئة كهرباء ومياه الشارقة
Sharjah Electricity & Water Authority

- In 2018 Sharjah Electricity and Water Authority launched the Retrofit Program under the mandate of the Energy Efficiency Program - To become the city of conservation.

reem
فريق رأس الخيمة لكفاءة الطاقة والطاقة المتجددة
RAK ENERGY EFFICIENCY AND RENEWABLES TEAM

- Ras Al Khaimah Energy Efficiency and Renewable Energy Strategy 2040 - Retrofit target of 3,000 buildings.

Green Building Figures

18,767 Villas and **2,245** Buildings Design Pearl Certified as of February 2019

19,042 Cumulative number of Green Buildings in Dubai* as of 2018

2,465 Total buildings in Dubai retrofitted as of 2018

350 LEED certified Projects in the UAE
39 LEED certified Projects in Abu Dhabi
177 LEED certified Projects in Dubai

* permitted by DM, Trakhees, Dubai Silicon Oasis, and Dubai Development Authority)

Sources: EmiratesGBC City Briefs and Taqati 2019 Annual Report

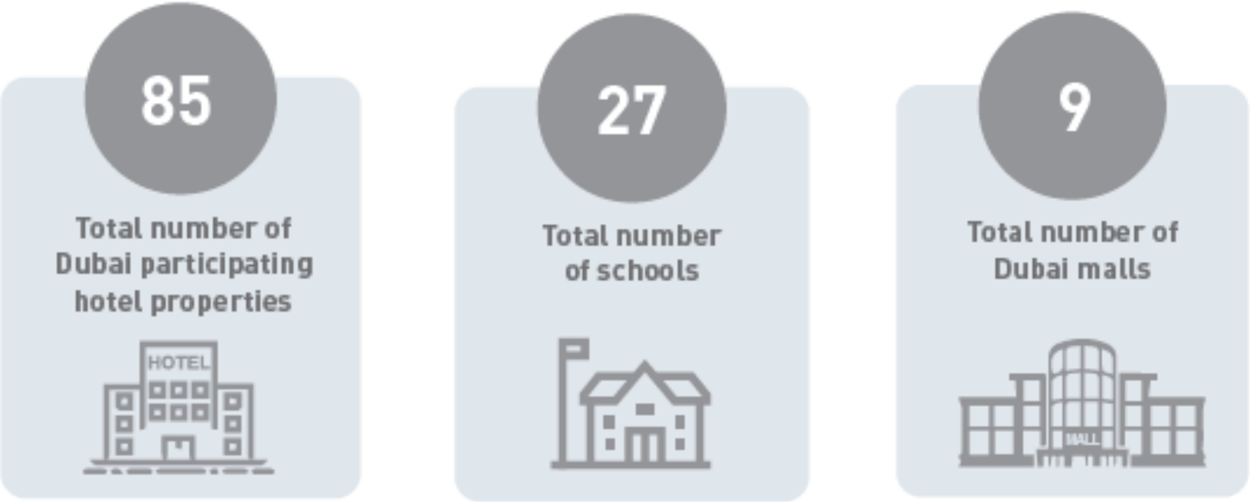
Retrofit Potential

Objectives of the Report:

- **Support Dubai's energy labelling policy** of existing buildings
- Accelerate the **retrofit market**
- Assess the **building performance** of hotels, schools and malls

121 properties from the UAE submitted data.

103 participating Dubai based properties



Hotels & Resorts Results

Best Hotel & Hotel Apartments Performers

ENERGY
EUI 1 < 171 kWh/m²/year
EUI 2 < 23 kWh/guest night/year

WATER
WUI 1< 915 litres/m²/year
WUI 2< 155 litres/guest night/year

Median Hotel & Hotel Apartments Performers

ENERGY
EUI 1 = 249 kWh/m²/year
EUI 2 = 69 kWh/guest night/year

WATER
WUI 1 = 1,486 litres/m²/year
WUI 2 = 363 litres/guest night/year

Worst Hotel & Hotel Apartments Performers

ENERGY
EUI 1 > 414 kWh/m²/year
EUI 2 > 168 kWh/guest night/year

WATER
WUI 1 > 2,632 litres/m²/year
WUI 2 > 915 litres/guest night/year

Best Resorts Performers

ENERGY
EUI 1 < 193 kWh/m²/year
EUI 2 < 71 kWh/guest night/year

WATER
WUI 1 < 1,093 litres/m²/year
WUI 2 < 586 litres/guest night/year

Median Resorts Performers

ENERGY
EUI 1 = 334 kWh/m²/year
EUI 2 = 148 kWh/guest night/year

WATER
WUI 1 = 1,676 litres/m²/year
WUI 2 = 855 litres/guest night/year

Worst Resorts Performers

ENERGY
EUI 1 > 444 kWh/m²/year
EUI 2 > 249 kWh/guest night/year

WATER
WUI 1 > 4,927 litres/m²/year
WUI 2 > 997 litres/guest night/year

Hotels & Resorts Results

Best vs Worst Performers

Overall, best performers consume

58% less energy

per area than worst performer

Best hotel performers consume

65% less water

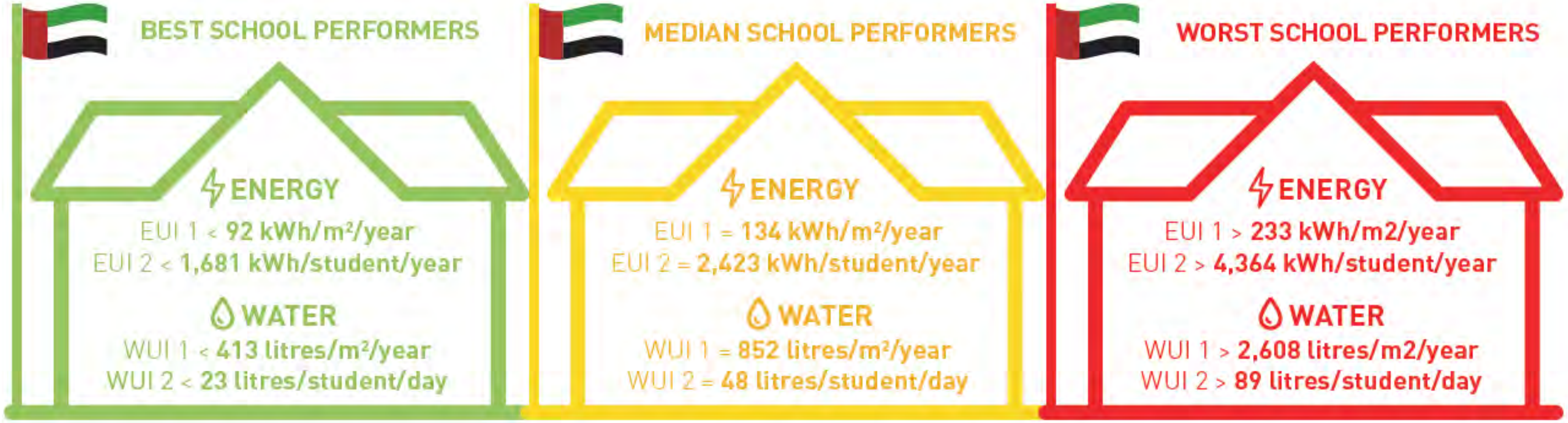
per area than worst performer

Best resorts performers consume

78% less water

per area than worst performer

Schools Results



The best performers consume
61% less energy
per area than worst performers

The best performers consume
84% less water
per area than worst performers

Malls Results

Key Findings

LOWEST CONSUMER

ENERGY

EUI 1 = **378 kWh/m²/year**
EUI 2 = **1.84 kWh/footfall/year**
EUI 3 = **253 kWh/m²/year**

WATER

WUI 1 = **658 litres/m²/year**
WUI 2 = **5.17 litres/footfall/day**
WUI 3 = **1,510 litres/m²/year**

AVERAGE CONSUMER

ENERGY

EUI 1 = **462 kWh/m²/year**
EUI 2 = **3.81 kWh/footfall/year**
EUI 3 = **409 kWh/m²/year**

WATER

WUI 1 = **1,260 litres/m²/year**
WUI 2 = **10.76 litres/footfall/day**
WUI 3 = **2,809 litres/m²/year**

HIGHEST CONSUMER

ENERGY

EUI 1 = **580 kWh/m²/year**
EUI 2 = **5.03 kWh/footfall/year**
EUI 3 = **646 kWh/m²/year**

WATER

WUI 1 = **1,586 litres/m²/year**
WUI 2 = **15.74 litres/footfall/day**
WUI 3 = **3,849 litres/m²/year**

Lowest vs Highest Consumers

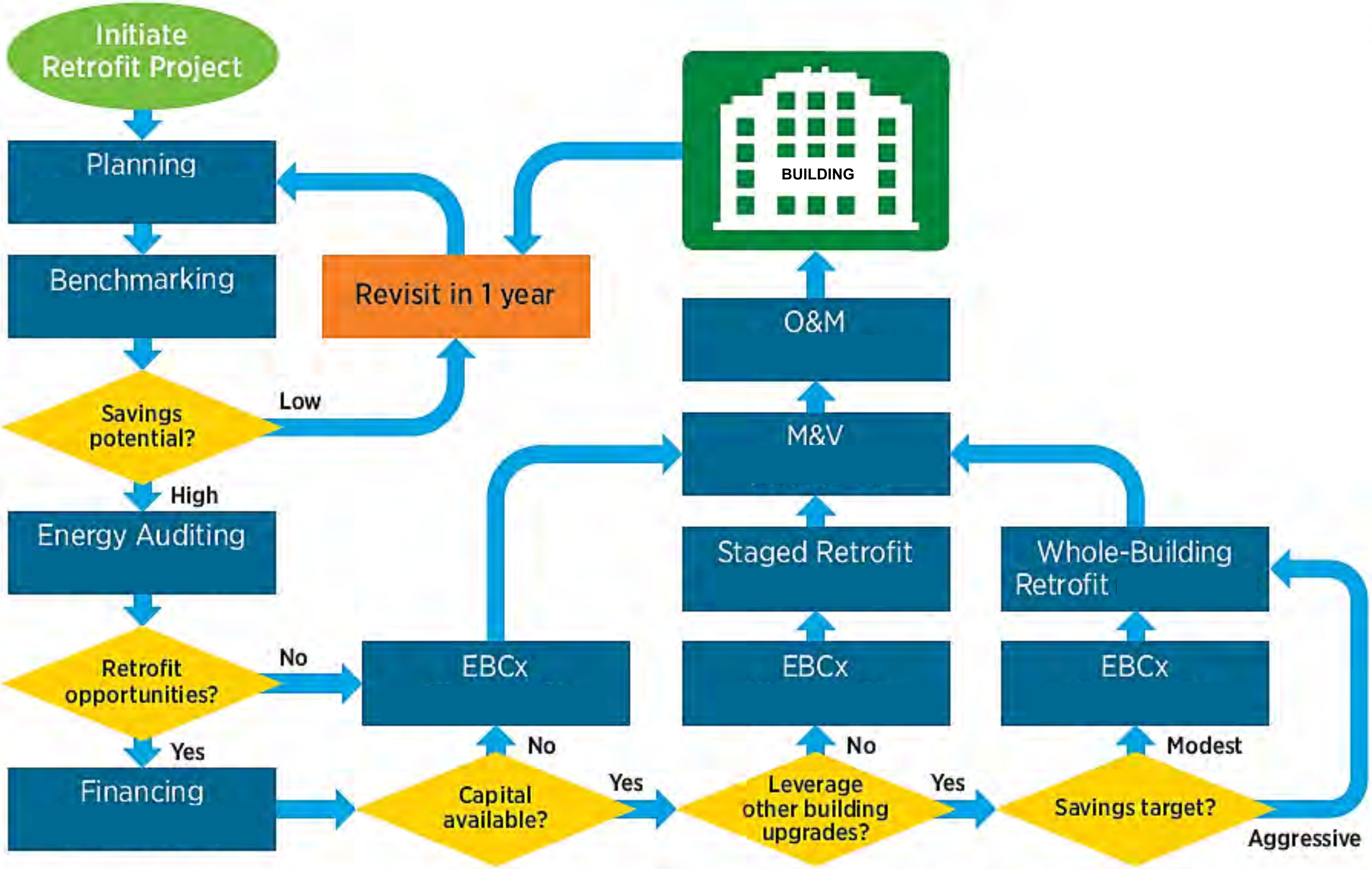
The lowest consumer uses **35% less energy** per area than the highest consumer

The lowest consumer uses **58% less water** per area than the highest consumer

EUI 1: The Net Energy Use Intensity 1 is the total energy used by the property (including both landlord and tenant electricity and district cooling but excluding fuel) divided by the gross conditioned floor area.
EUI 2: The Net Energy Use Intensity 2 is the total energy used by the property divided by the annual footfall.
EUI 3: The Landlord Energy Use Intensity 3 is the common spaces electricity and cooling divided by the common spaces area

WUI 1: The Water Use Intensity 1 is the total water used by the property (including tenants but excluding makeup water and treated sewage effluent) divided by the gross conditioned floor area.
WUI 2: The Water Use Intensity 2 is the total water used in the common places the property divided by the annual footfall.
WUI 3: The Common Services Water Use Intensity 3 is the water used by common spaces divided by common spaces area.

Retrofit Process



Structure of the guide relative to a typical retrofit decision-making process

Conclusion

- There is a strong potential for savings and operational efficiencies
- Remedial actions include audits, retrofits, or the use of awareness campaigns or trainings to drive changes in behaviour
- Retrofits are a substantial measure in advancing to Net Zero and the decarbonization of existing buildings

Emirates Green Building Council

PO BOX 121838 Dubai, UAE
+971 (0)4 346 8244
www.emiratesgbc.org

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DX Retrofits for Commercial Buildings

Mr Srinivasan Rangan

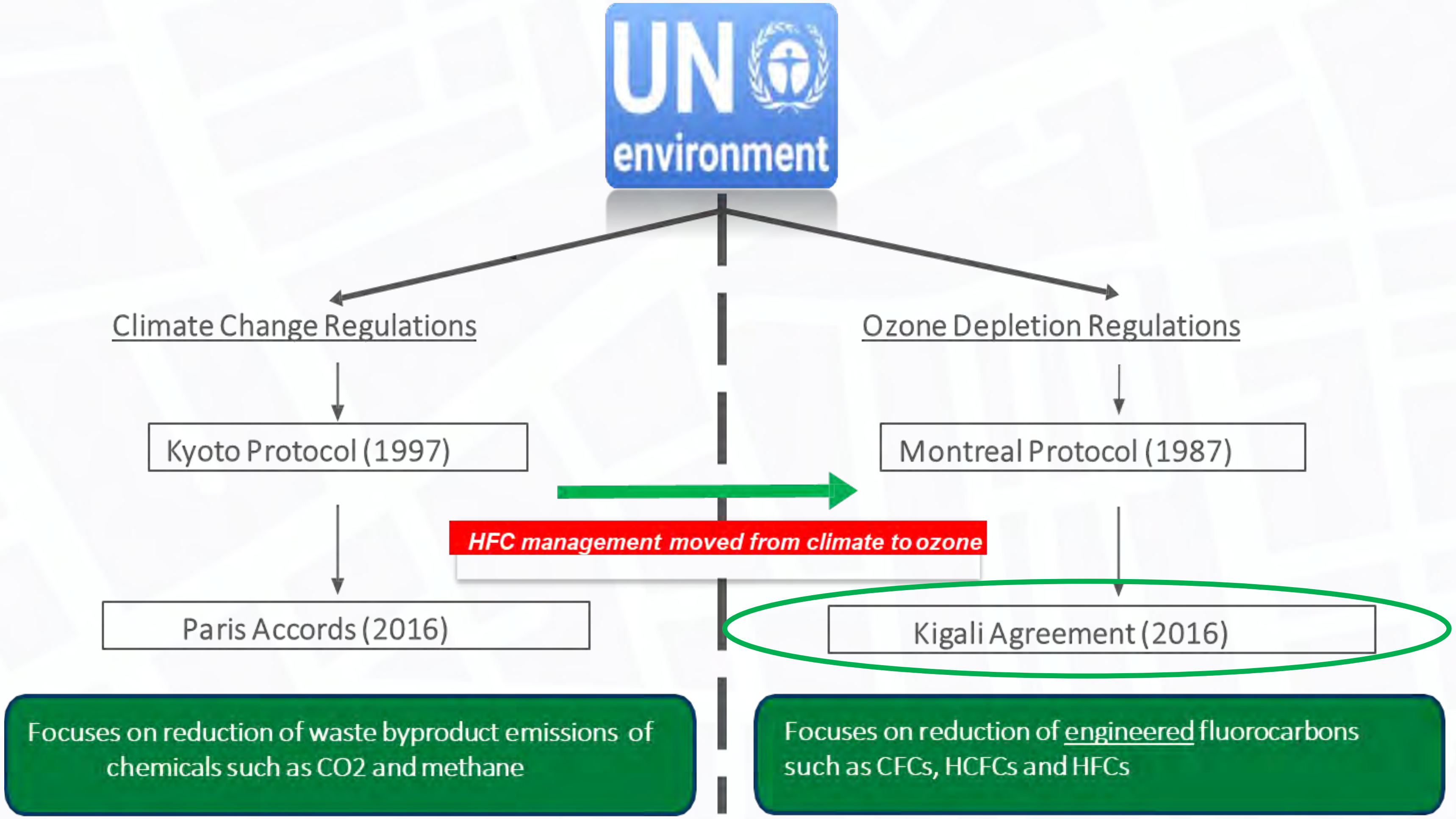
Director, Marketing and Product Management

Rheem MEA

Agenda

- Regulations
- Sustainability
- Techno-Commercial Considerations
- Engineering & Maintenance Considerations
- Case Study – AC – Ducted Units
- Case Study – WH – A Landmark Building

United Nations Environment Programme



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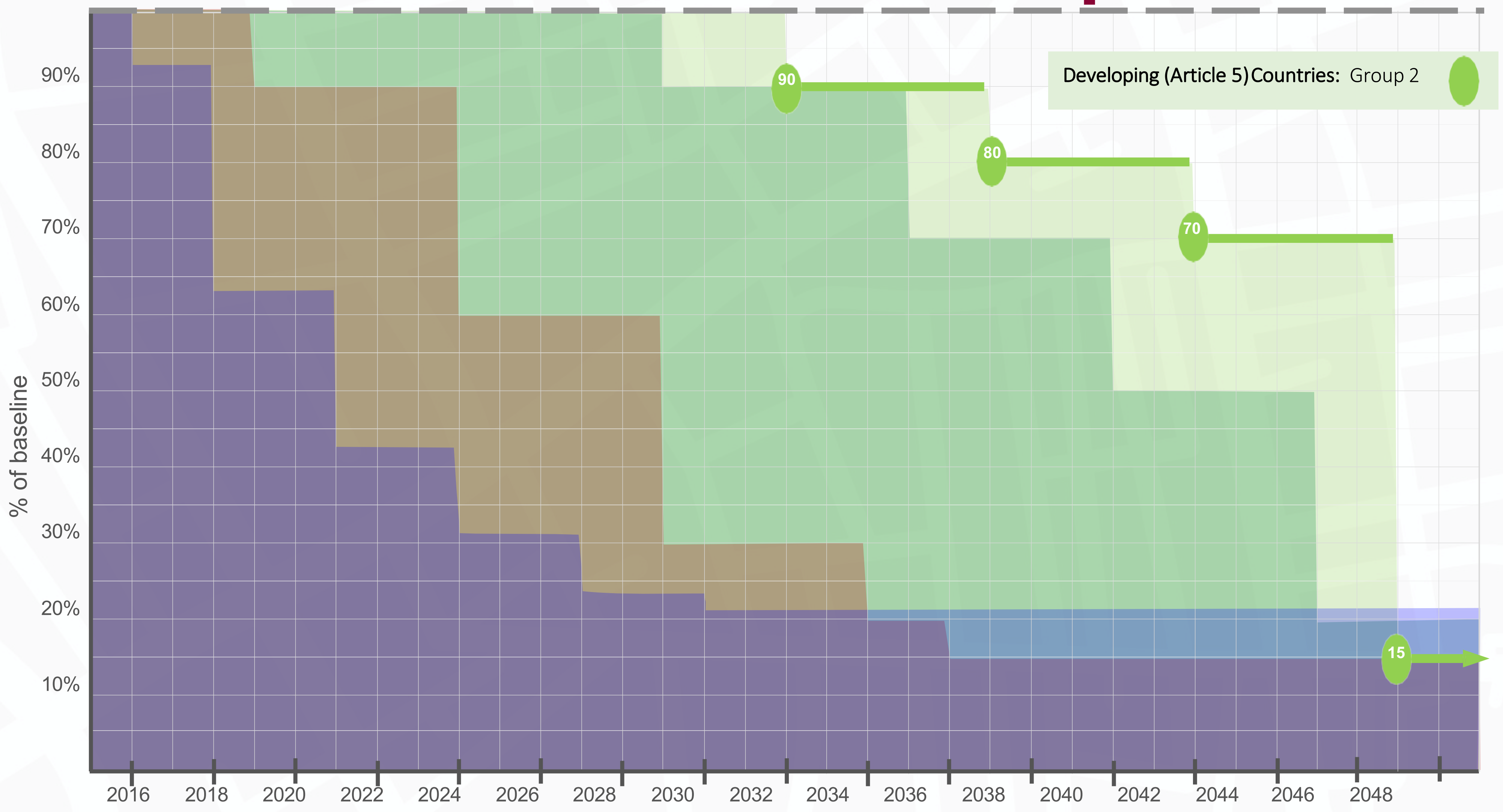
Phase Down of HFCs – Group 2



Trends in efficiency

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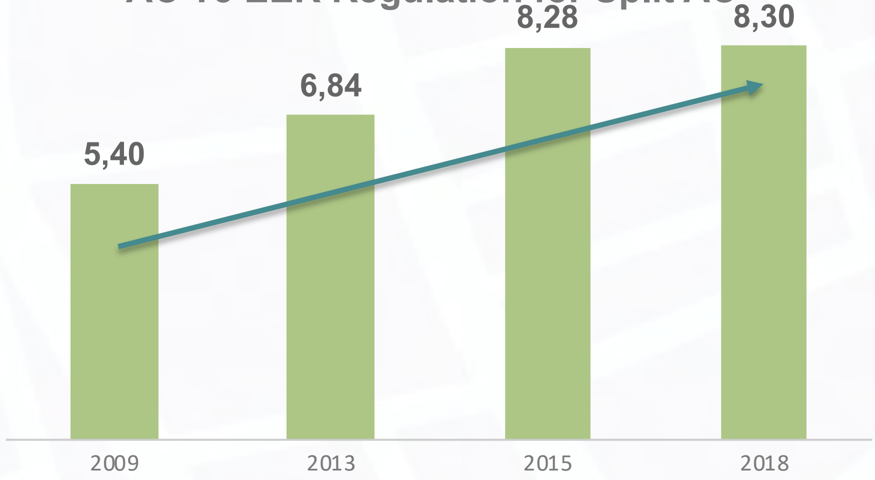
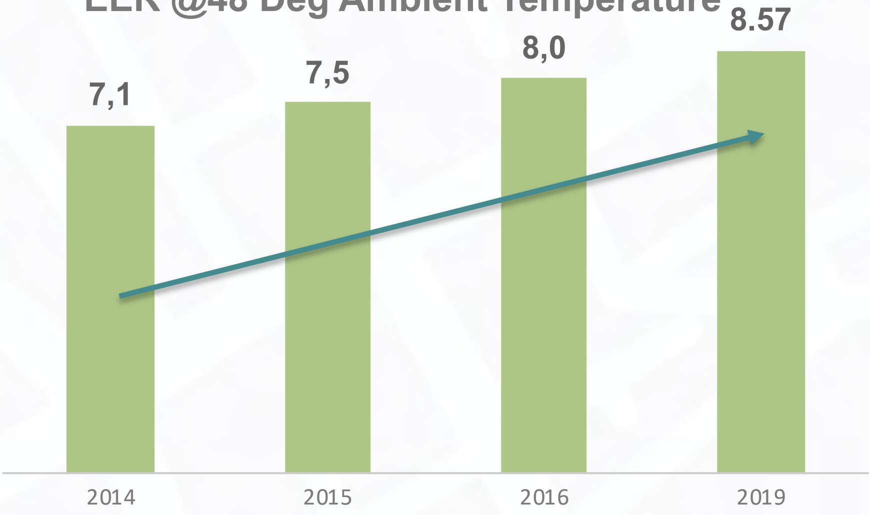
AC T3 EER Regulation for Split AC

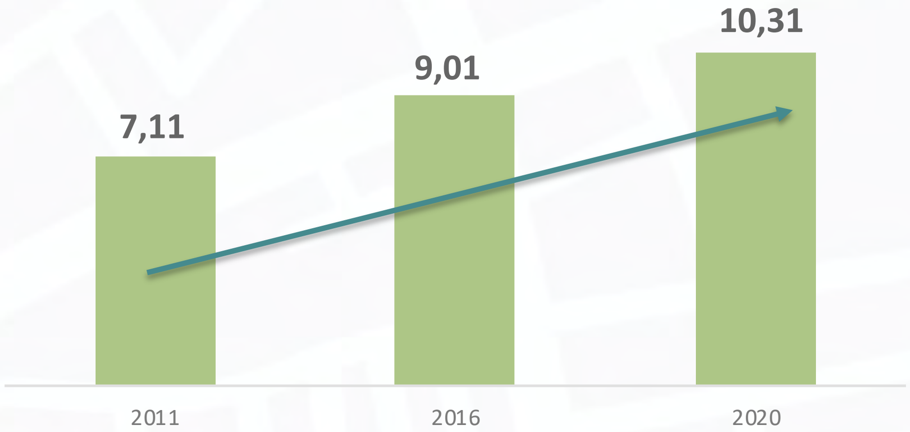


KUWAIT

EER @48 Deg Ambient Temperature



AC T3 EER Regulations for 5 Star Split AC



United Arab Emirates

- Ducted Split minimum 8.3 EER at T3 condition
- Dubai Municipality minimum 11.8 EER at T1
- Abu Dhabi Pearl 1, 11.6 EER at T1
- Abu Dhabi Pearl 2 min. requirement for govt. buildings

Oman

- AC T3 Regulation, Split AC: 8.28 EER

GCC countries raising Energy efficiency bar!

Sustainability

Degrees of Innovation
(*Intelligent Products*)

Strategically Integrating Sustainability into manufacturer's Product Development Process

Degrees of Efficiency
(*Responsible Processes*)

Capturing Greenhouse Gas and Zero Waste to Landfill Baseline Data & Reduction Opportunities

Degrees of Leadership
(*Inspired People*)

Integrating Sustainability into Product Training

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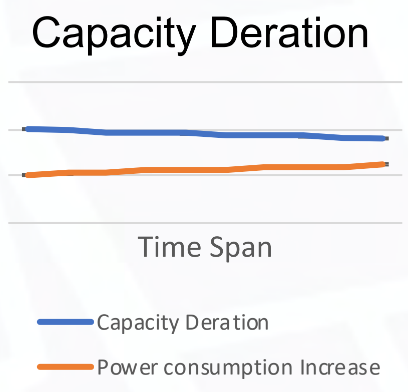
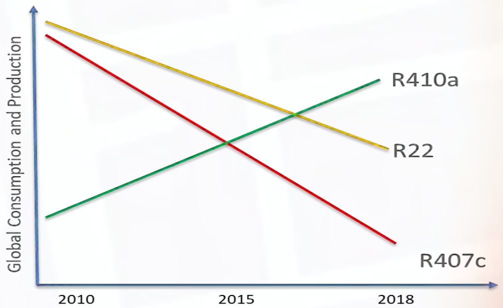
Technical Considerations



- Improved cooling comfort
- Indoor Environment Quality (IEQ)

Fixed Speed vs Inverter



- Pipe Sizes & filter drier
- Refrigerant charge
- Corrosion resistance

Maintenance Consideration

Sustainable V/S Compliance

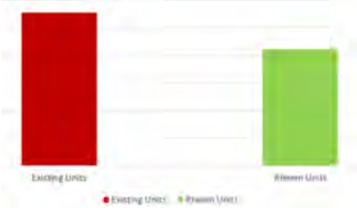
10 Package Units **Av. EER at T3**

8.1 **ESMA at T3**

Commercial Considerations

Lifecycle Cost Analysis

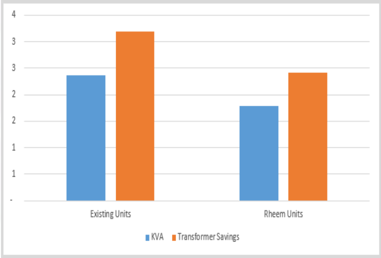
- Compressor Warranty
- Avg. Annual Service Cost



SUSTAINABILITY

TECHNOLOGY

Capital Cost Savings



Engineering and Maintenance Considerations

- **Installation Footprint**
- **Existing Duct Details**: Duct layout and leakage
- Condensate Drain and Electrical Wiring
- Location of the unit should be such to provide **proper access for maintenance**
- Strength of the roof during installation
- **Incomer Power Feeder Capacity** & Type (single phase/ three phase)
- **R22 to R-410A:** R-410A is not a drop-in replacement for R-22

Case Study 1 - Ducted AC

Installation details

Building Name: G+1 Office Of Al Shirawi Engineering Services Group

No. of units: 32

Old units: R22

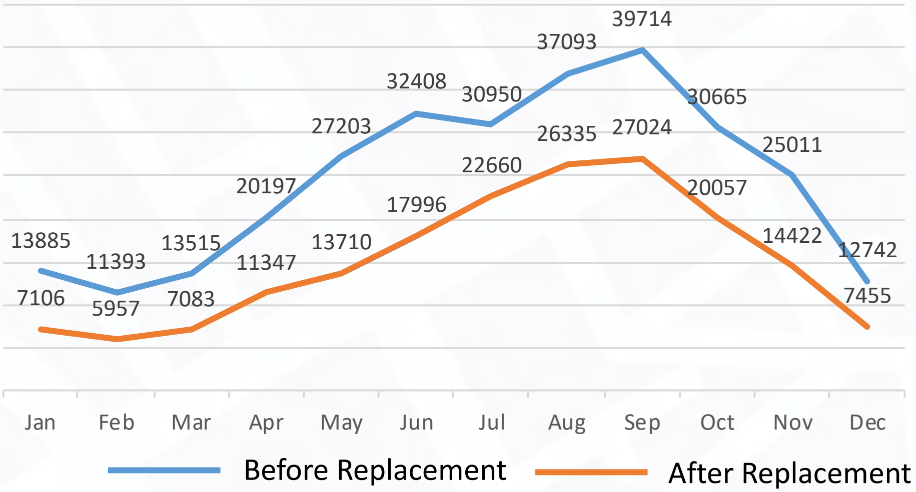
New units: R410A

Old vs New Units

Old Units

New Units

Energy Consumption kWh



Summary

- % of saving : 38.5%
- Total savings in One year = 113,624 units
- DEWA Tariff 32 fils / kwh (2016/17)
- Total savings per year = AED 36,359
- More reliable, less breakdown
- Reducing carbon emission 51.05 Tonnes

Why replace an old AC?

Sr. No.	Parameter	Old Unit	New Unit
1	Operating and repair costs		
2	Energy Efficiency		
3	Regulatory Compliance		
4	Foot Print		
5	Utility Bills		
6	Environment friendly		
7	Reliability		
8	Peace-of-mind		

Case Study 2 - Water Heating

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Installation details

Highest level of safety equipment for a landmark building

Building Name: Confidential

No of Units: Approx. 900

Capacity: 15 & 20 US Gallon Capacity

Old vs New Units

IEC

Old Units

IEC + UL LISTED

New Units

EP Series Point-Of-Use Water Heater

UL LISTED

Summary

- **UL174 Construction:** Tested and Listed
- Over-temperature protector cuts off power in excess temperature situations
- Maximum tank working pressure of **150 PSI**
- Factory tested @ **300 PSI**
- **ASME rated** T & P relief valve

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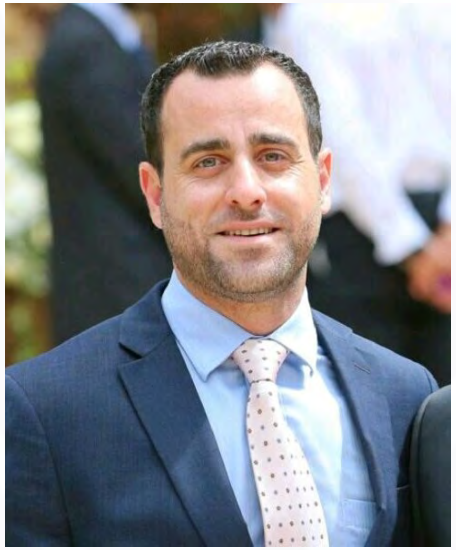
Retrofit solutions using VRF



Mr Iyad Al Jurdy
Senior Manager, Air Solutions Engineering Sales
LG Electronics Middle East and Africa HQ

Agenda

- Retrofit Considerations
- Retrofit Candidates
- Introduction to VRF
- VRF Systems Benefits
- Technical Analysis
- Financial Analysis

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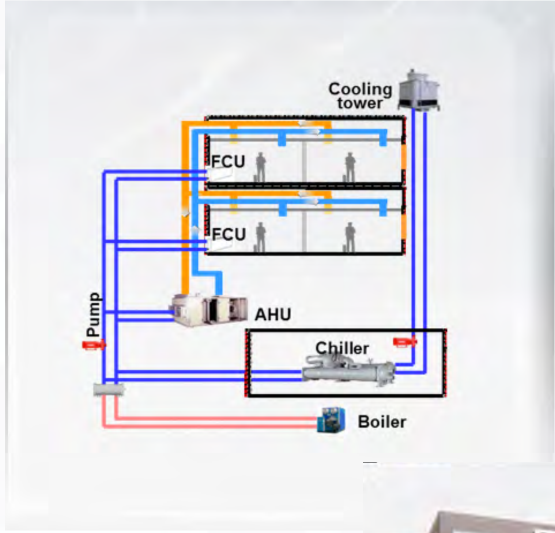
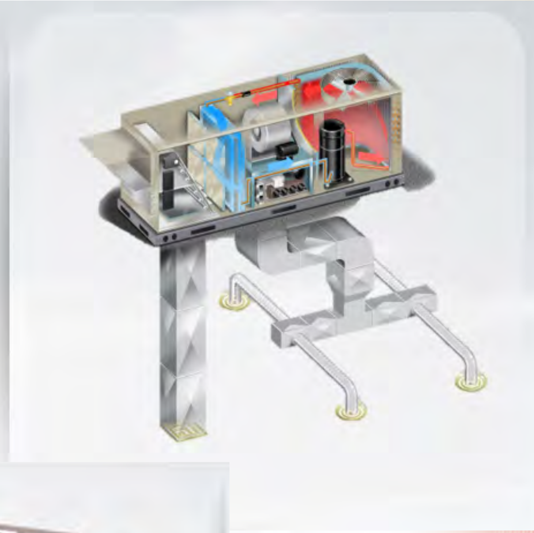
Retrofit Considerations

- Building Characteristics: Size, zoning, application,…etc.
- Energy Audit: Show the variation in building load throughout the day, season and year.
- Life cycle cost analysis: Incorporate initial cost, running and service cost as well as replacement cost and salvage value of the equipment, if applicable.
- Opportunity Cost: Savings of retrofitting with VRF on electrical and civil infrastructure.



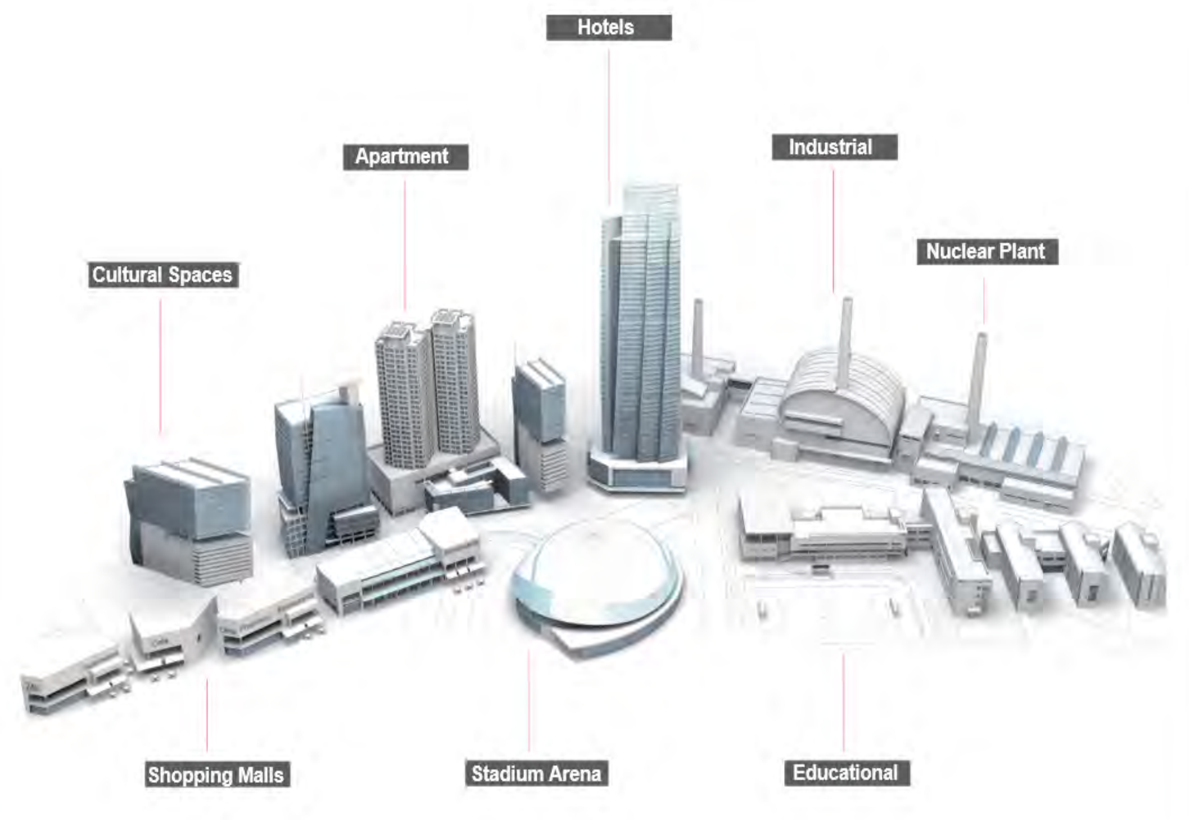


Retrofit Candidates

- Buildings in need of additional or complementary cooling.
- Old facilities with no Air-conditioning infrastructure.
- Heritage facilities where external facade cannot be tampered with .
- Buildings with leaking ductwork and/ or uncalibrated VAV systems.
- Older systems and non-compliant conventional systems
- Old, clogged or leaking chilled water piping.
- Accessibility issues for heavy cranes.
- Limited space to add ductwork due to Low floor to floor height.

Introduction to VRF

- Introduced in Asia about 40 years ago
- Reached European markets in 1987
- Expanded into North American market early 2000s
- Made its first appearance in the Middle Eastern market by 2005
- Been steadily gaining market share from conventional HVAC system

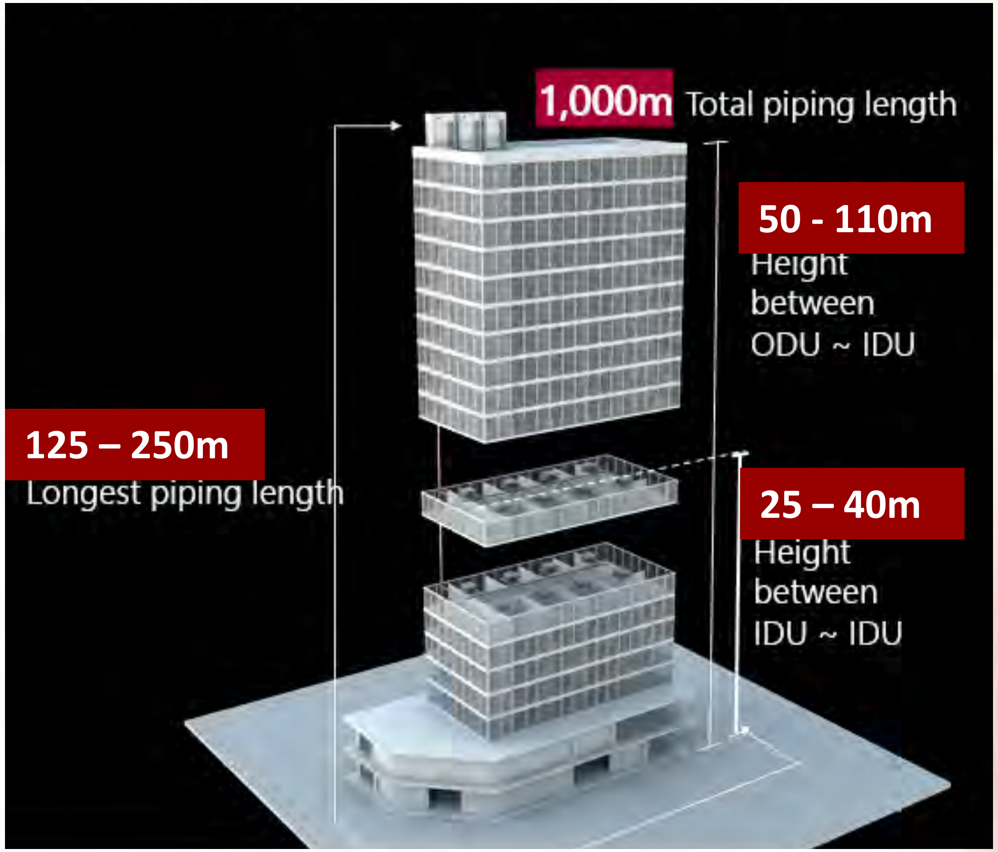


System Architecture

- DC Inverter scroll for accurate load matching.
- DX refrigerant based serves as both the heating and cooling medium.
- Up to 64 fan-coil units can be fed from a single system.
- Condenser range: 3HP – 20HP or more.
- Built in Redundancy
- Ideal for part load efficiency

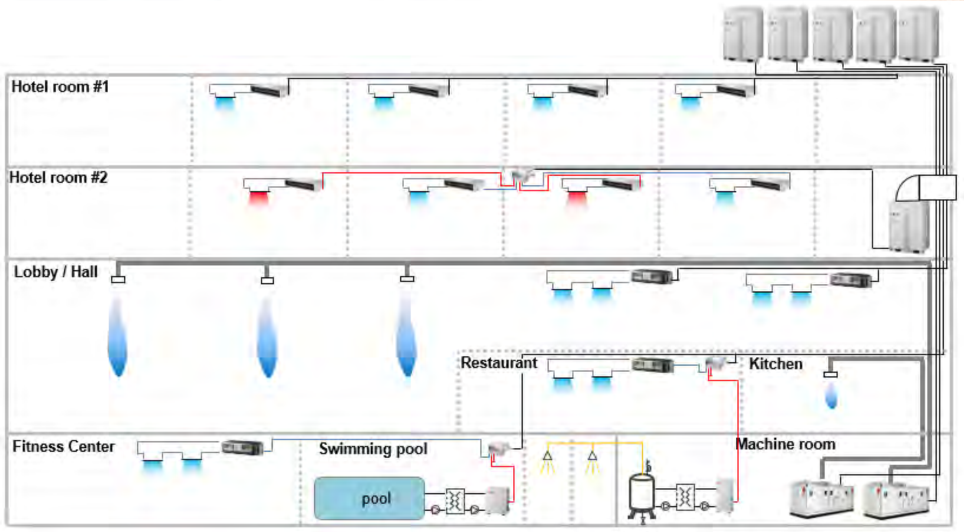
Piping Flexibility

- Long piping capabilities
- Suitable for medium and high rise buildings.
- No need for oil traps or intermediary accessories
- Complex oil and refrigerant management logic to improve durability and reliability
- Sophisticated controls that allow individualized comfort.
- Inverter technology and refrigerant flow control are the key the system’s capabilities.



Installation Flexibility

- Modular or centralized installation
- Can be installed outside or inside the building
- Suitable for underground installation
- No need for Cranes
- Less structural reinforcement of roofs.
- Reduces building height and costs.
- Non intrusive installation
- Easy to route the copper piping around beams and existing obstacles



Communication Flexibility

- Plug and play controls
- Compatibility – BACnet, Modbus, LonWorks, KNC,..etc.
- Connectivity – Wifi or Bluetooth
- Remote Monitoring – Via Web or BMS
- Remote Troubleshooting – Via specialised service software.

Leak Concerns

- Brazed piping with minimal or no flange connections
- Perform 24-hour pressure test
- Use certified contractors
- Refrigerant measurement feature
- Refrigerant leak monitoring system (optional feature)
- Smart error identification
- Local and email alarm feature

Retrofit Benefits using VRF

- General estimates that VRF systems can achieve up to 30% or higher.
- Removal of the cooling tower or Air Cooled chiller from the roof provide an aesthetically pleasing profile.
- The smaller footprint of the VRF system frees additional areas for storage or other uses.
- Increase sellable space due to the reduction in vertical shaft space and freed mechanical rooms.
- Individual controls for each zone enhances occupants comfort.
- Eliminate ductwork, roof penetrations and curbs and therefore, potential leaks
- Minimum disruption to the daily work schedule.
- Re-circulated air wouldn't be shared from another space
- Improve indoor air quality and reduces absenteeism due to illnesses
- Individual metering

Technical Analysis

SCAC vs. RTU vs AC.CHW vs. VRF

INSTALLATION

Items	DX (ON/OFF Type)	Single Package (On/Off Type)	Air Cooled Chiller	VRF
Proposed Tonnage (TR)@Actual	100	100	100	150
Q'ty of IDU/ODU	85 / 85	- / 8	85 / 2	85 / 10
Outdoor Unit	85 Outdoor Unit	8 Nos Package Units	2 Aircooled Chiller	10 Outdoor Unit
Indoor Unit/FCU	85 FCU	Not required	85 FCU	85 FCU
RCC Foundation block for Outdoor Unit	85 RCC foundation blocks for 85 outdoor units	8 Nos	2 Nos + Additional for Pumps, Headers,Expansions etc	10 RCC foundation block for 30 outdoor unit
Risers	85 riser for gas pipe 85 riser for liquid pipe	Not required	2 riser for chilled water supply (Min) 2 riser for chilled watar return (Min)	10 riser for gas pipe 10 riser for liquid pipe
Shaft	Small Shaft (Small size of copper pipes)	Medium Size Shaft for Ducts	Big shaft (Big size of Chilled Water pipes)	Small Shaft (Small size of copper pipes)
Pipings	85 gas refrigerant Copper pipe	Not required	Header and chilled water supply pipe	10 gas refrigerant copper pipe
	85 liquid refrigerant Copper pipe		Header and chilled water return pipe	10 liquid refrigerant copper pipe
Pipings Insulation	Insultation for 85 gas pipe	Not required	Insulation for header and chilled water supply pipe	Insultation for 10 gas pipe
	Insulation for 85 liquid pipe		Insultation for header and chilled water return pipe	Insulation for 10 liquid pipe
Electrical & Controls	85 communication cable from outdoor to FCU	Not required	Multiple BMS points (Control Logic setting by BMS Contractor)	10 communication cable from outdoor to 85 FCUs
	85 thermostats	8 Thermostats	85 thermostats	85 thermostats
	85 Isolators	8 Isolators	Isolators for AHU's /FCU's + MCC panel for Chiller + Pumps	10 Isolators
	Not required	Not required	DDC	Not required
	Not required	Not required	Relay/Control Board for AHU/FCUs	Not required
	Not required	Not required	Supply Air Sensor for AHU/FCUs Return Air Sensor for AHU/FCUs	Not required
	Not required	Not required	BMS Points: Points for Thermostat Points for Sensors Point for 2Way/3Way valve Point for Duty Pump Point for Standby Pump Point for BTU Meter	Not required
	Not required	Not required	BMS (Monitoring & Control)	Not required
	85 Power cables for outdoor units (Single Phase)	8 Power cables (3Phase)		10 Power cable for outdoor unit (3 Phase)
	85 Power cables for FCUs (Single Phase)	Not Applicable	Power cables & MCC panel for Chiller,AHU/FCU, Pumps	85 Power cable for FCUs (Single Phase)
	Transformer & Substation	Transformer & Substation	Transformer & Substation	Transformer & Substation

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CONVENIENCE

Items	DX (ON/OFF Type)	Single Package (On/Off Type)	Air Cooled Chiller	VRF
Proposed Tonnage (TR)@Actual	100	100	100	150
Q'ty of IDU/ODU	85 / 85	- / 8	85 / 2	85 / 10
Quick Cooling of occupied space	On/Off Compressor and Temperature sensor logic Fast cooling is not possible.	On/Off Compressor and Temperature sensor logic Fast cooling is not possible.	Takes time to reach set temperature	Inverter Compressor with Temperature sensor & Pressure Sensor logic similar to VRF system. Quickly reaches set temperature
Uniform Temperature in occupied space	Temperature is not uniform Frequent On/OFF of fan and compressor Overcooling of occupied space.	Temperature is not uniform Frequent On/OFF of fan and compressor Overcooling of occupied space.	Overcooling of Occupied Space	Uniform & precise temperature control by inverter logic Set temperature is maintained in the occupied space ensuring better comfort. No overcooling of occupied space
Low Noise	Frequent On/OFF noise from compressor	Frequent On/OFF noise from compressor	Noise level is more	No On/OFF noise due to Inverter Compressor
Low Noise Operation at Night Time	High Noise at night time.	High Noise at night time.	Not available	Noise reduces by 4~5dB(A)at night time At night time load is less, so Compressor frequency is lesser & fan speed is lower. Overall noise level reduces compared to day time.
Design Flexibility: Pipe Length & Elevation	50m to 70m pipe length 30m elevation	Not applicable		225m pipe length 110m elevation Total Pipe Length 1000m
Commissioning	Manual commissioning. Check outdoor, Indoor and refrigerant piping and controls	Manual commissioning. Check outdoor, Indoor and refrigerant piping and controls	Separate commissioning required : -. Chiller -. Water pumps -. AHU/FCU -. Valves -. Controls (BMS) Requires considerable commissioning time.	All checks done with commissioning software via PC or Smart device. Outdoor, indoor, refrigerant pipe & controls is checked in one step with the commissioning software. Convenient for installer; saves time.

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MAINTENANCE

Items	DX (ON/OFF Type)	Single Package (On/Off Type)	Air Cooled Chiller	VRF
Proposed Tonnage (TR)@Actual	100	100	100	150
Q'ty of IDU/ODU	85 / 85	- / 8	85 / 2	85 / 10
Self Diagnostic Function	System Cannot diagnose faults by itself No Error codes display in Thermostat Technician takes time for finding fault More time required for troubleshooting More standby time	System Cannot diagnose faults by itself No Error codes display in Thermostat Technician takes time for finding fault More time required for troubleshooting. More standby time	Fault Detection in the BMS system No Error codes display in Thermostat Technician takes time for finding fault More time required for troubleshooting More standby time	VRF System can diagnose faults by itself Error codes displayed in Thermostat Easy for technician to diagnose the fault Quick troubleshooting Less standby time
Smart Diagnosis & Quick Repair	Cannot use smart devices for diagnosis Manual Checking for service/trouble shooting & maintenance. More standby time	Cannot use smart devices for diagnosis Manual Checking for service/trouble shooting & maintenance. More standby time	Technicians have to rely on BMS system & manual checks Separately Check AHUs/FCUs Separately Check Chiller Separately Check Valves, Pumps, etc	System Check & Diagnosis with software & Smart Devices (Smart phone, tab etc) Convenient for technicians Less standby time Less maintenance time
Maintenance Check List	Cleaning heat exchanger coil of outdoor unit	Cleaning heat exchanger coil of outdoor unit	Checking Oil level in Chiller	Cleaning heat exchanger coil of outdoor unit
	Cleaning air filters of FCUs	Cleaning air filters of FCUs	Checking heat exchanger coil	Cleaning air filters of FCUs
	Cleaning heat exchanger coil of FCU	Cleaning heat exchanger coil of FCU	Checking Fan and motor of Chiller	Cleaning heat exchanger coil of FCU
	Checking fan and motors of outdoor unit	Checking fan and motors of outdoor unit	Cleaning air filters of AHUs/FCUs	Checking fan and motors of outdoor unit
	Checking fan and motor of FCU	Checking fan and motor of FCU	Cleaning heat exchanger coil of AHUs/FCUs	Checking fan and motor of FCU
	Checking of refrigerant leaks	Checking of refrigerant leaks	Checking fan and motor of FCU/AHU	Checking of refrigerant leaks
	Checking of Controls	Checking of Controls	Cleaning of strainers	Checking of Controls
			Checking of pumps	
			Checking of sensors	
			Checking of gauges	
			Checking of controls	

Financial Analysis

SCAC vs. RTU vs AC.CHW vs. VRF

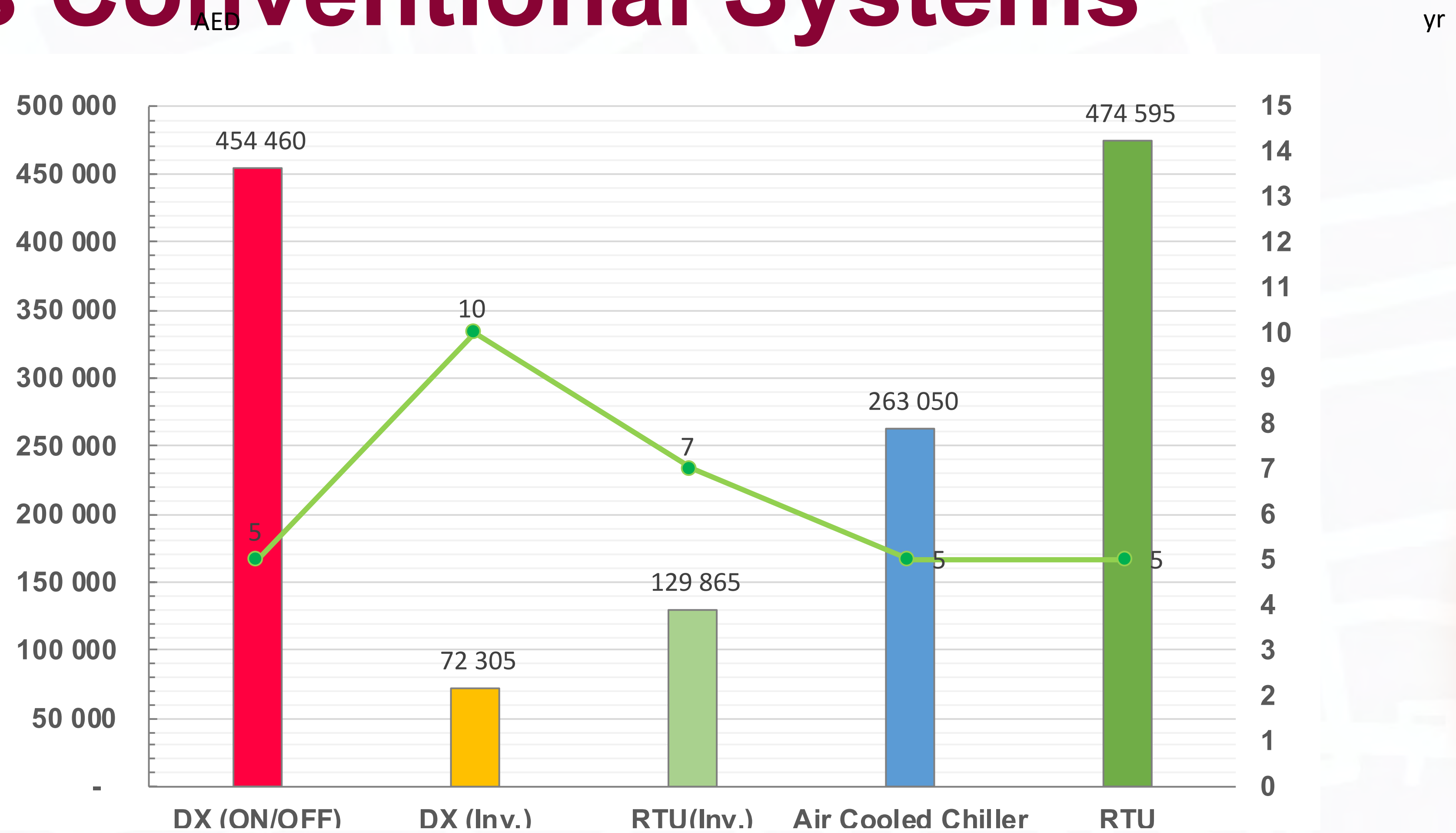
VRF vs Conventional Systems

Items	DX (ON/OFF Type)	DX (Inverter Type)	Single Package (Inverter Type)	Air Cooled Chiller	Single Packaged Unit	VRF
Proposed Tonnage (TR)@Actual	100	100	100	100	100	100
Capital Cost Total (Equipment) +(Installation)+ (DEWA)	292,500	341,250	395,000	380,750	305,000	482,500
kW/TR@ Actual	1.70	1.45	1.40	1.63	1.60	1.30
Operating Cost Total (Runnig)+ (Maintenance)	361,347	332,620	332,874	342,703	361,856	318,383

Total Cost (AED) - 15 Years	5,712,705	5,330,543	5,388,110	5,521,300	5,732,840	5,258,245
Total Savings (AED) - 15 Years	454,460	72,298	129,865	263,055	474,595	-
Total Savings (%) - 15 Years	8%	1%	2%	5%	8%	

VRF vs Conventional Systems

Payback Analysis



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5. Improving Part Load Efficiency in Existing Buildings
6. Improving savings on Chilled Water Pumps through balancing of the terminal units
7. Moderated Discussion

Retrofitting with Smart Electronic Components

Mr Matteo Zanesco
Managing Director
CAREL Middle East DWC LLC

Agenda

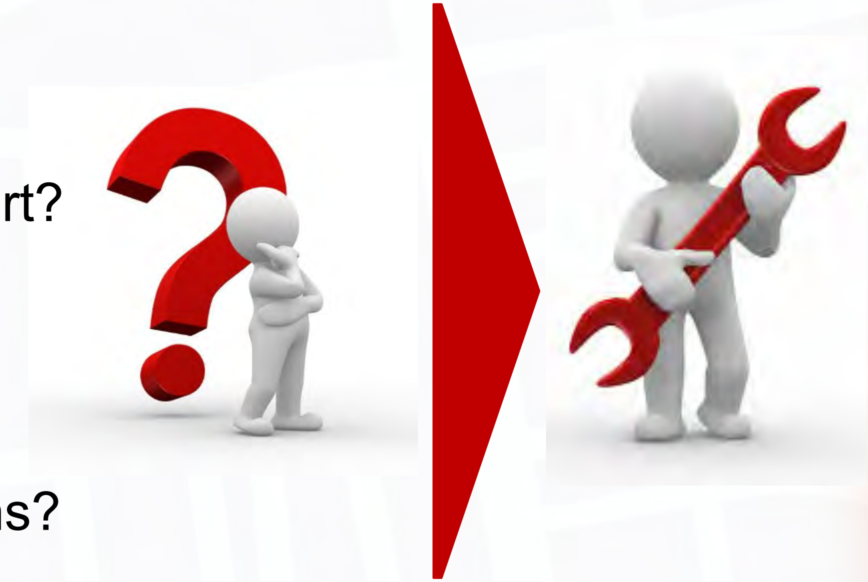
- Drivers, trends and goals for retrofitting in AC and Ventilation
- Impacts in IAQ, Energy Performance.
- Integrated systems for controls of Hydronic plants
- High Efficiency technologies
- SMART & Integrated information and IOT
- Conclusions

Drivers, trends and goals

Why

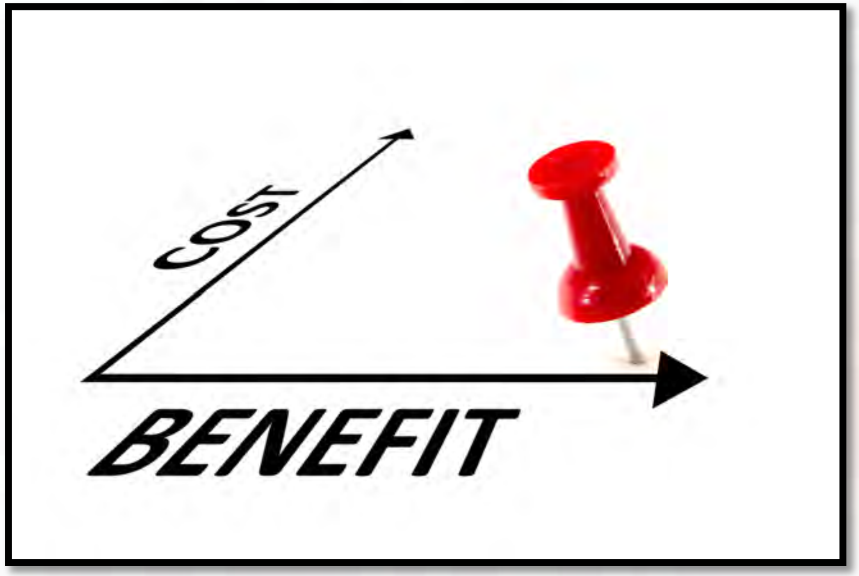
- Is the HVAC system over 10 years old?
- Are energy bills escalating without a logical explanation?
- Are building occupants complaining about comfort?
- Are repair costs continually rising?
- Has the building developed an indoor air quality problem?
- Do you need to be compliant with new regulations?

Retrofit

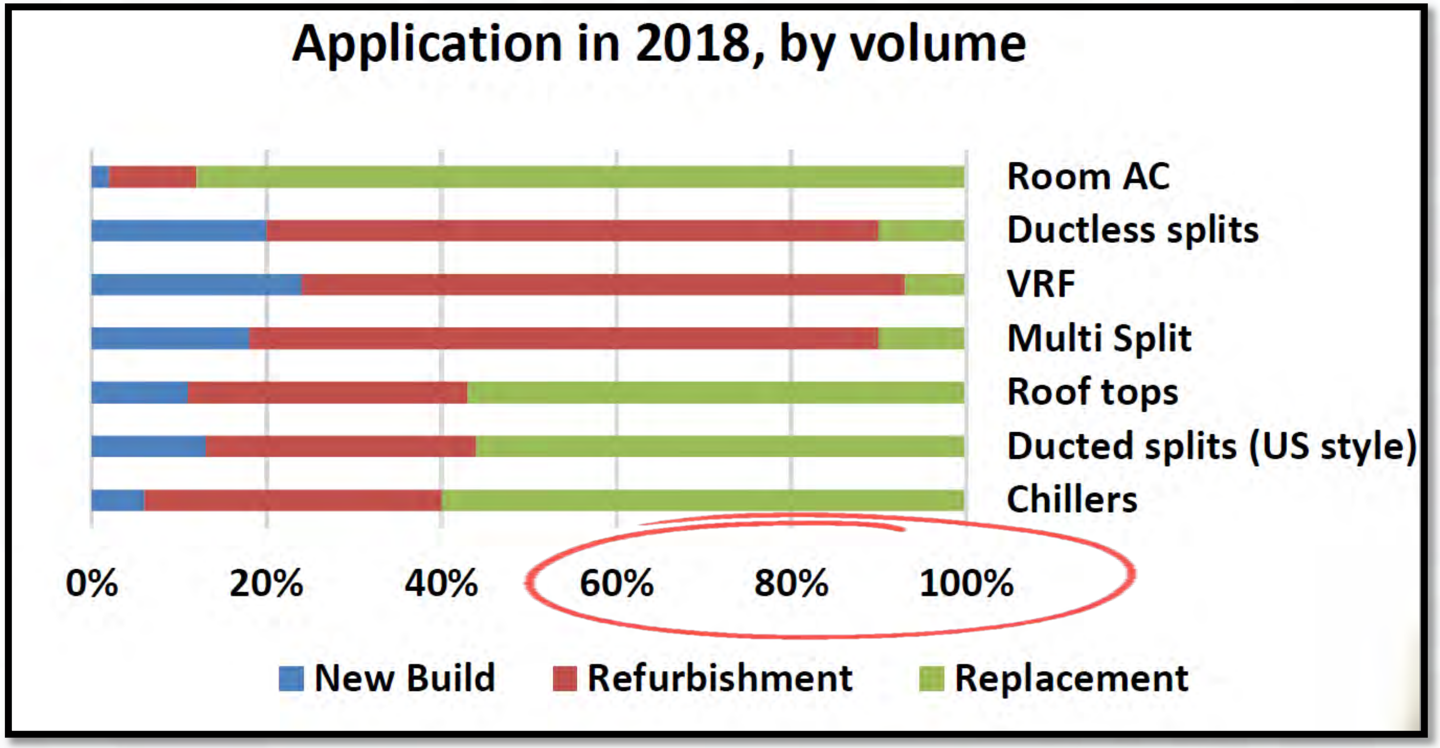


Wide range of intervention

- Ducts sealing or replacement
- Replacement of old compressors with high efficiency screw compressors
- Adding variable-frequency drive operation
- Adding demand-controlled ventilation
- Fan speed controls
- Cooling capacity controls
- Adding smart temperature and humidity controls
- Installing sensors or IAQ



Trends



www.bsria.com/us

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Goals

Efficiency

Increase energy performances

Reduce maintenance costs

Control Expenditures

Well-Being

Enhance People comfort and productivity

Better health

Regulations

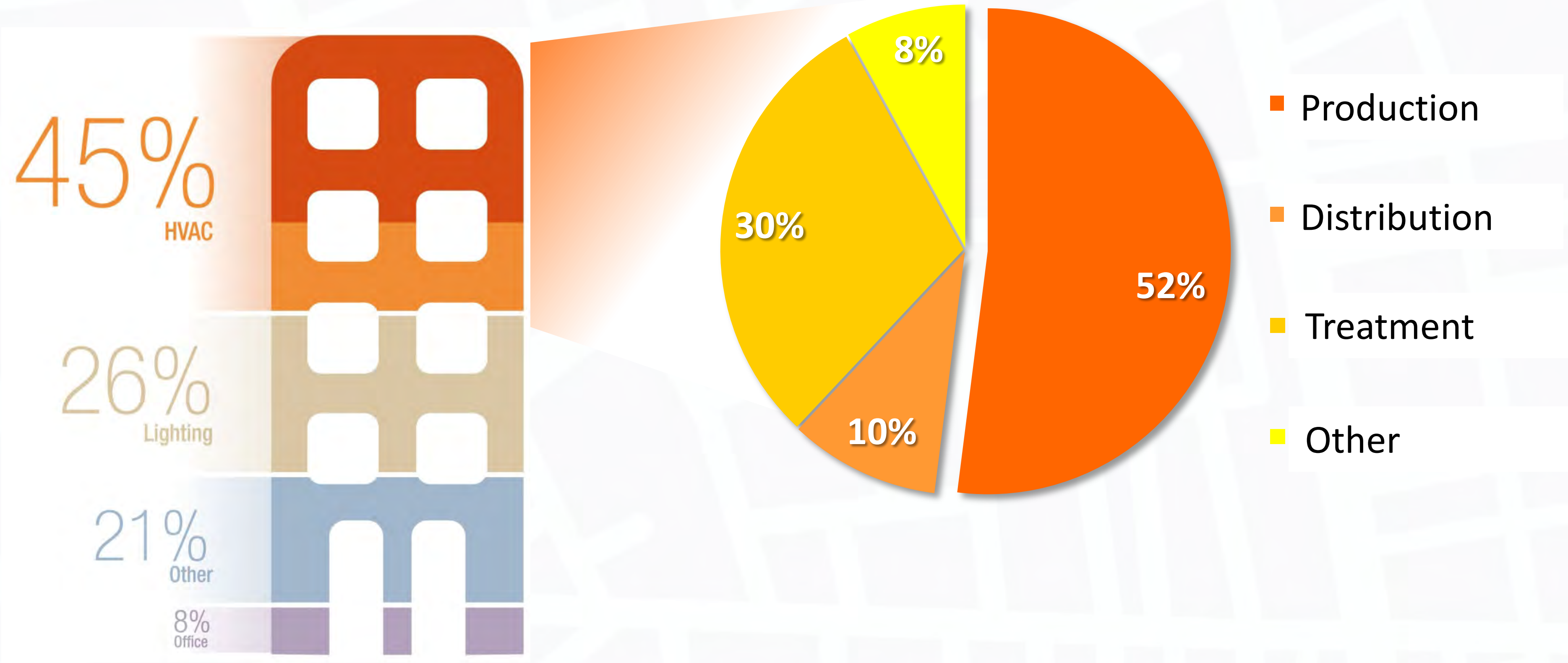
Reduce emissions and environmental impact

Phase out old refrigerants

Directives

Impacts in IAQ, Energy Performance

Energy Performance Impact



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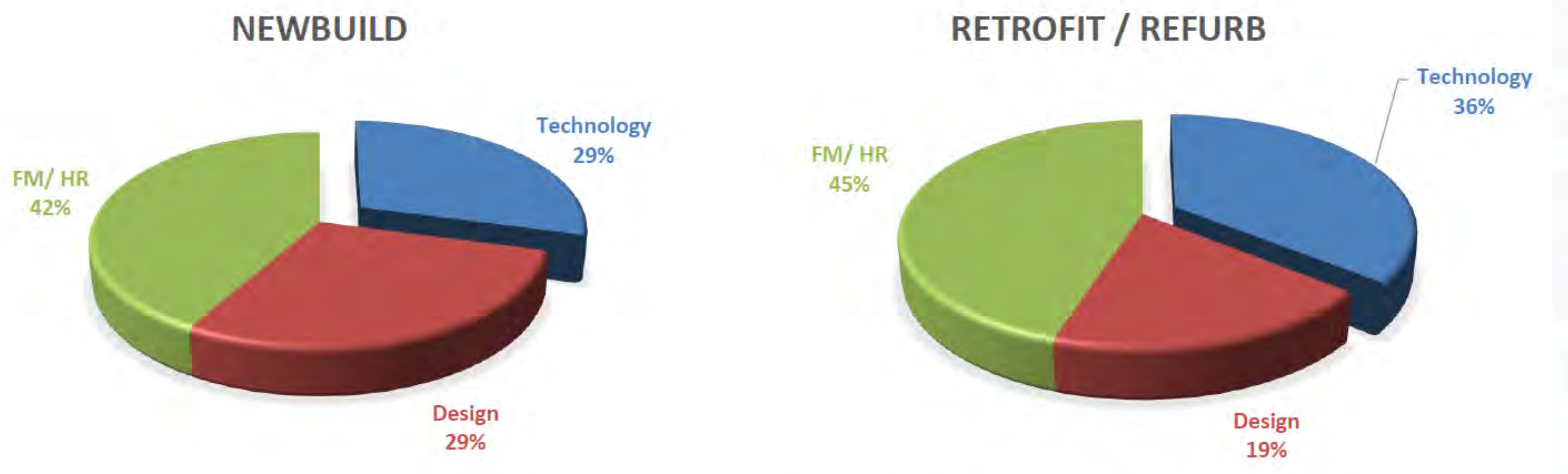
Energy Performance

Energy efficiency

Reactive Approach
New Technologies

ProActive Approach
Integrated management and optimization

Wellness in Buildings
Healthy Buildings – Role of Technology



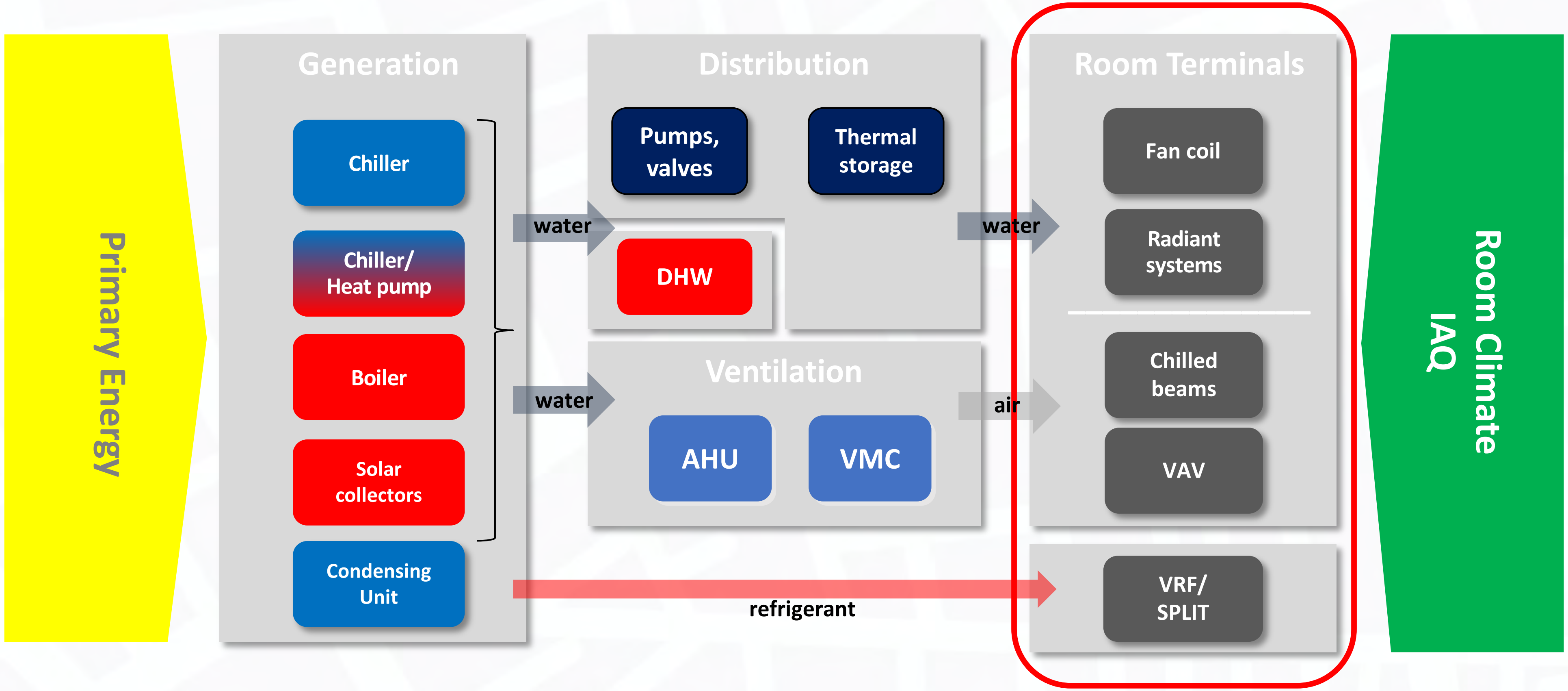
Source: International Well Building Institute, Interpreted and re-analysed by BSRIA

Technologies

- Integration and Advanced controls
- High Efficiency components
- Smart and remote controls

Integrated systems

Hydronic plants: different areas



Integration

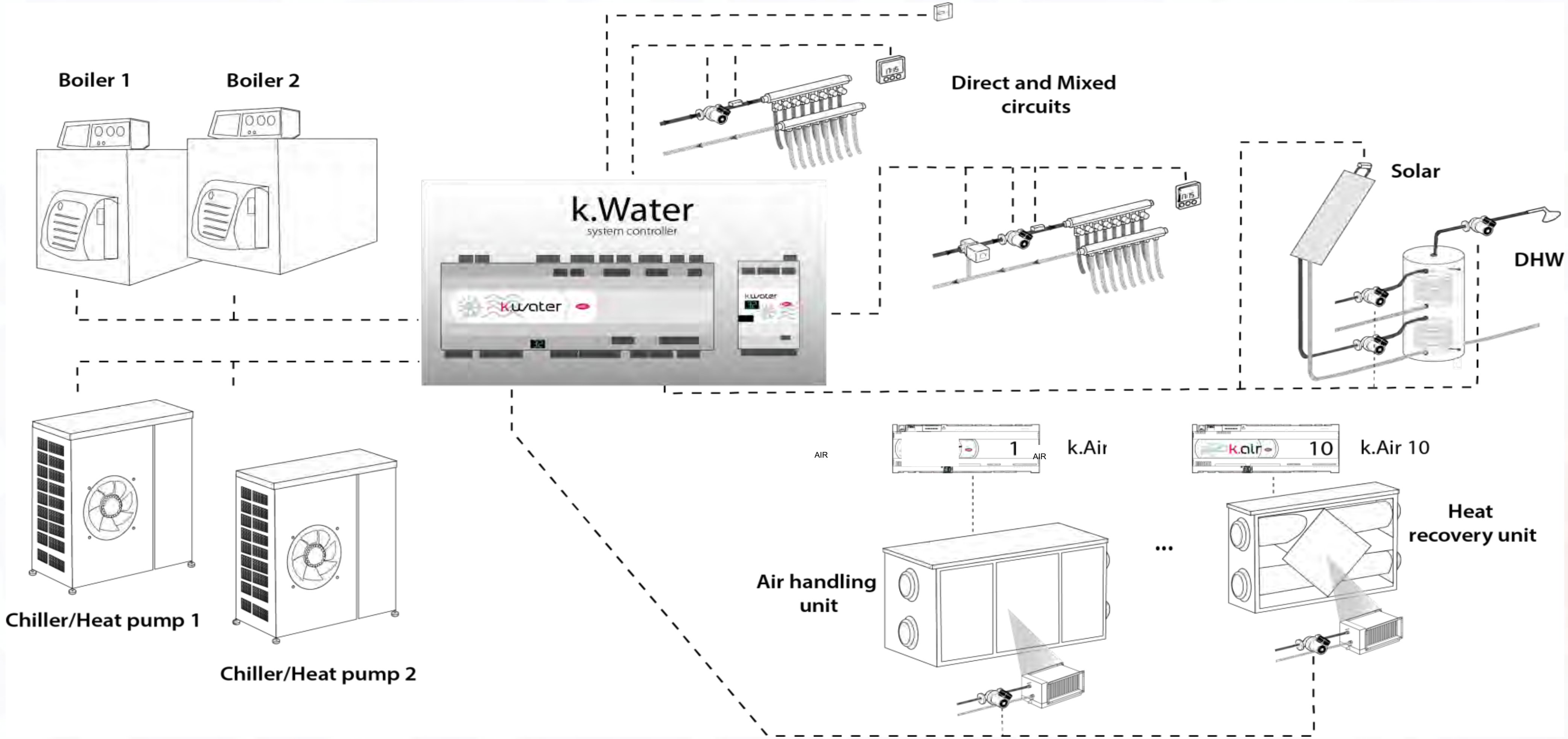
Chillers

Air Handling
Units

Water
Distribution

Heat
Generators

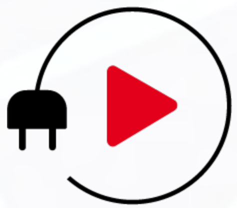
Integrated systems



Must have

Flexibility

One product able to adapt to different plant configurations



Ready to use

Reduce installation and setup timing

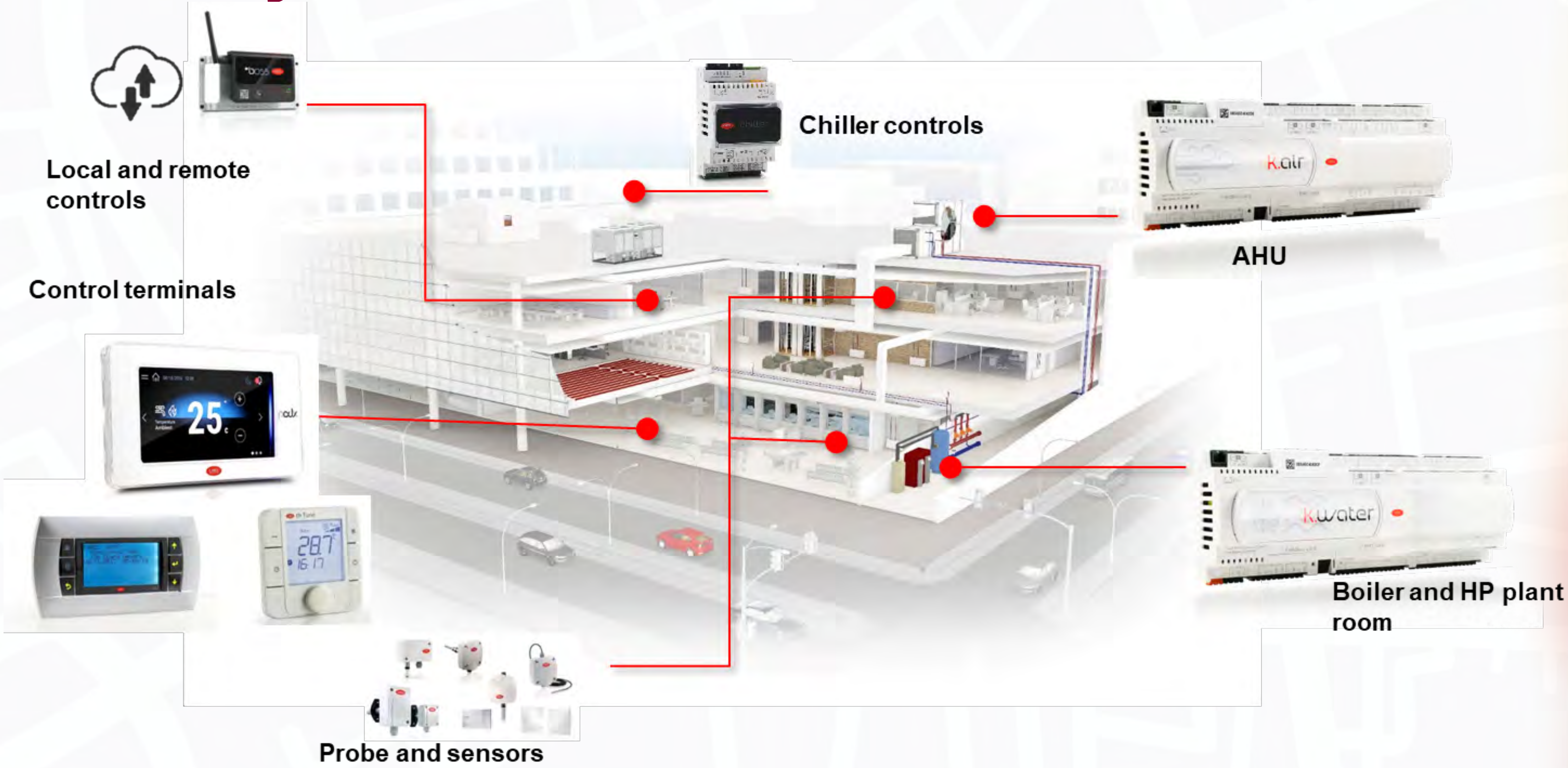
Integration

Standard Protocols ModBus, BACnet through TCP/IP and RS485.
Certifications

Connectivity

Remote access and monitoring capability

Ready to use solutions



Ready to use solutions

Pre-loaded AHU configurations

PC-based tool for custom configurations

Wizard for manual set up

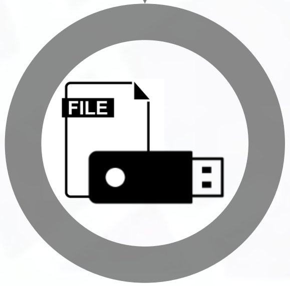
Easy configuration!

Ready to use solutions

Configuration tool makes configuration and start-up easier than ever. Only a few steps are required for commissioning.

STEP 1
Start immediately from the scheme of your unit to create the regulation.

STEP 2
Use the tool, which guides you step-by-step to select components and create the configuration file



STEP 3
Upload the configuration directly via a USB key

STEP 4
Complete the field installation, and with a little fine-tuning operations, the system is ready to go

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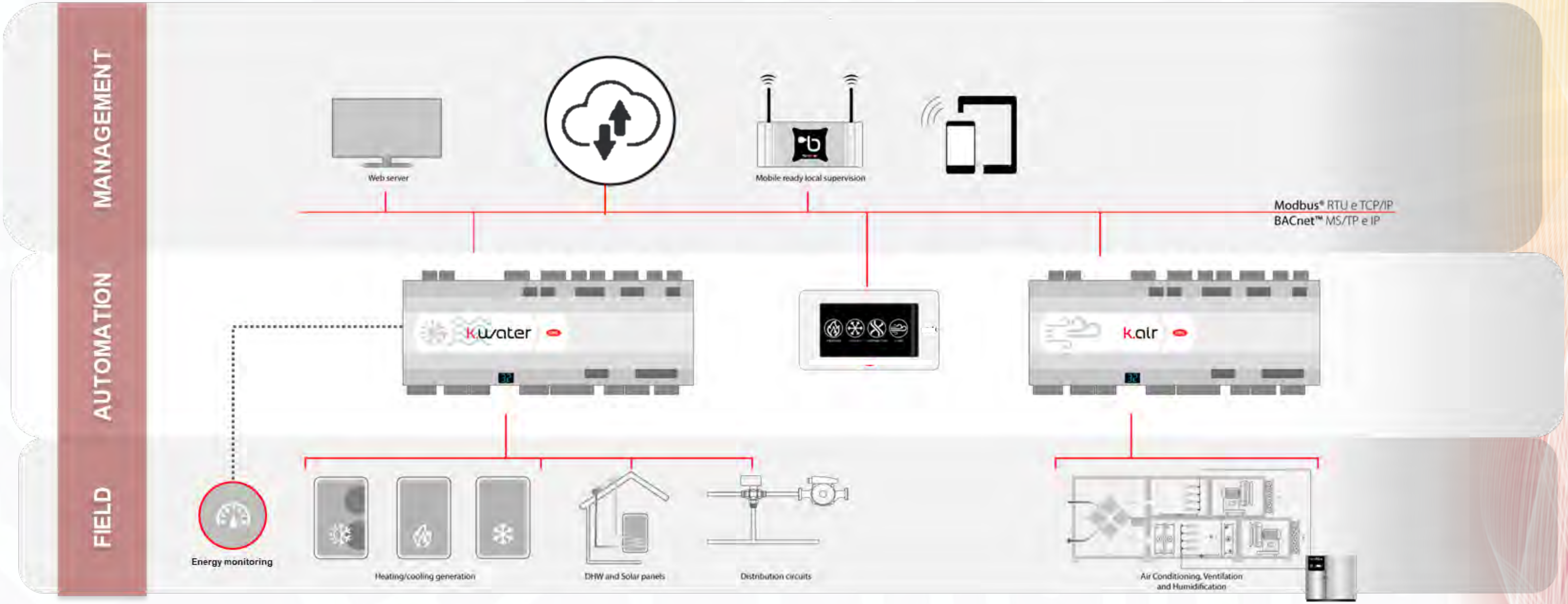
Complete integration

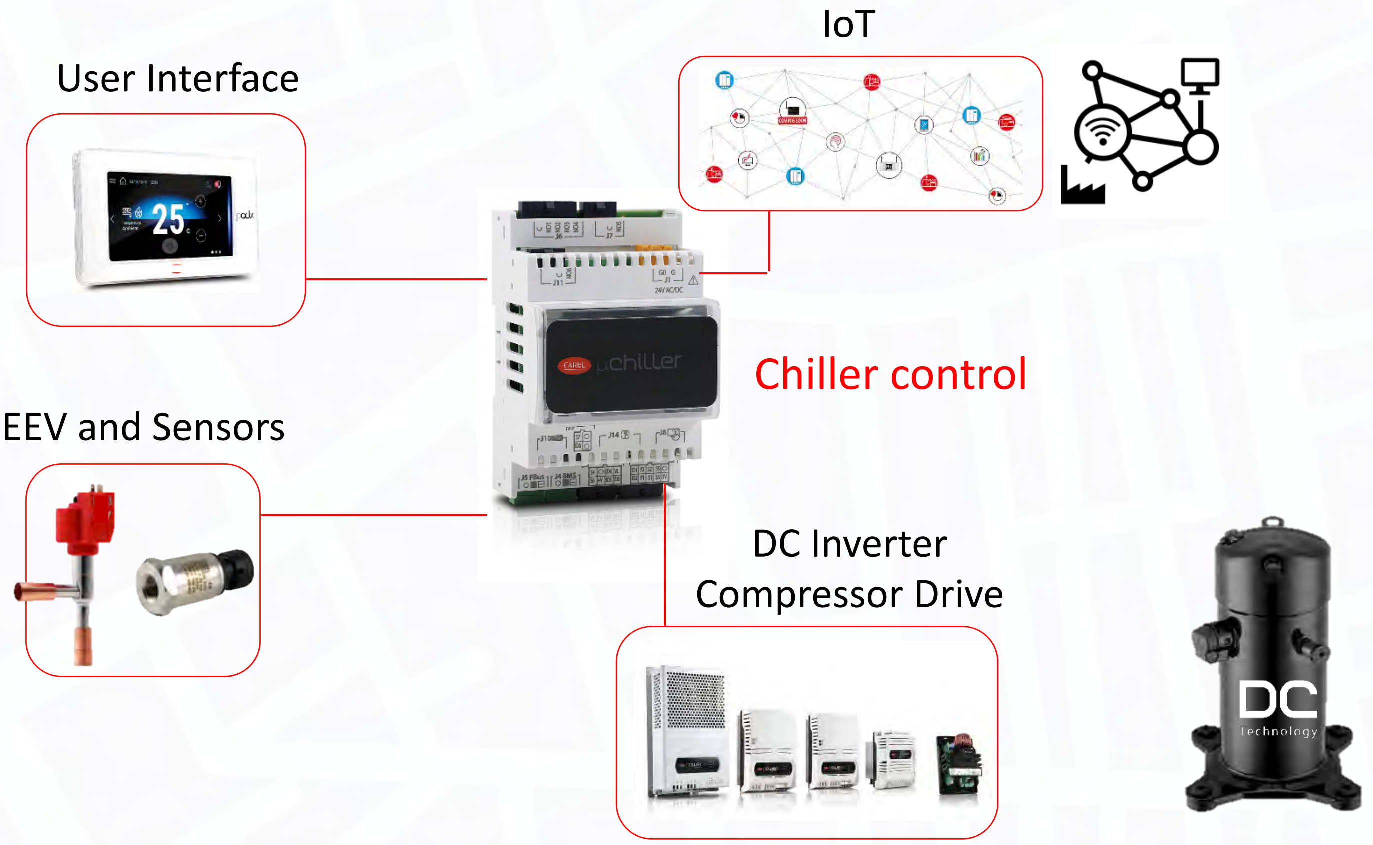


Installation benefits

Compatibility	• Easy to fit into existing BMS layout • ModBus, BacNEt
Adaptability	• Wireless connections throught Gateways • Local wireless supervisors
Accessibility	• On field connection (Wifi, BT) through mobile device (Dedicated App) • Remote monitoring via Cloud services.

High Efficiency Components

Chiller Solutions for High Efficiency



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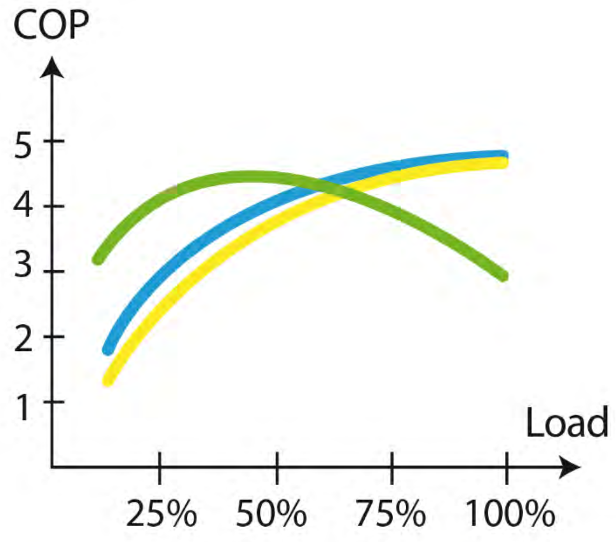
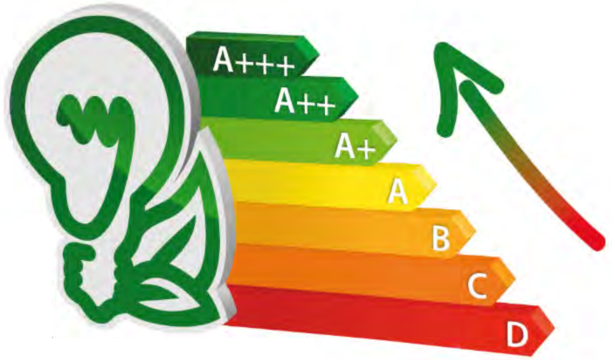
Chiller Solutions for High Efficiency





ON-OFF	
EER	4.50
SEER	3.34

ON/OFF + EEV		
EER	4.60	
SEER	3.72	+11%

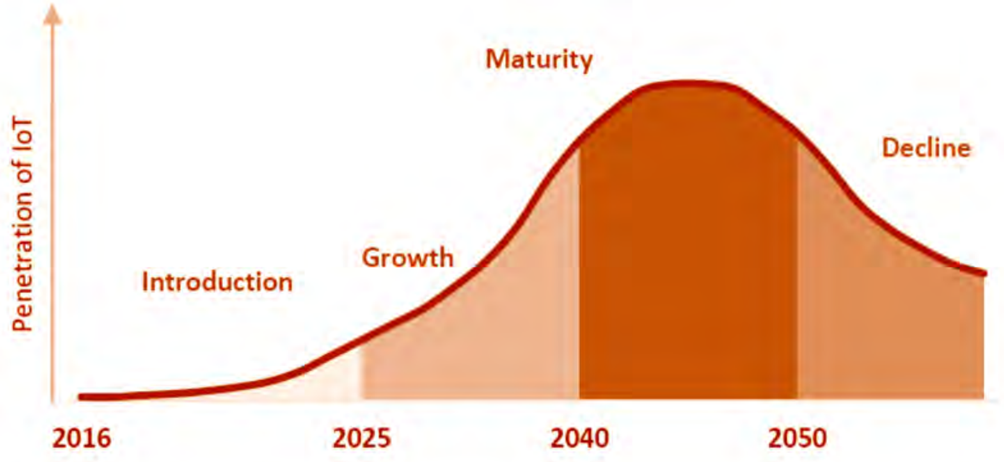
DC Inverter + EEV		
EER	3.90	
SEER	4.56	+37%

SMART & Integrated Information and IOT

IOT Trends

Market development of IoT Field device for HVAC

(source BSRIA, 2020)

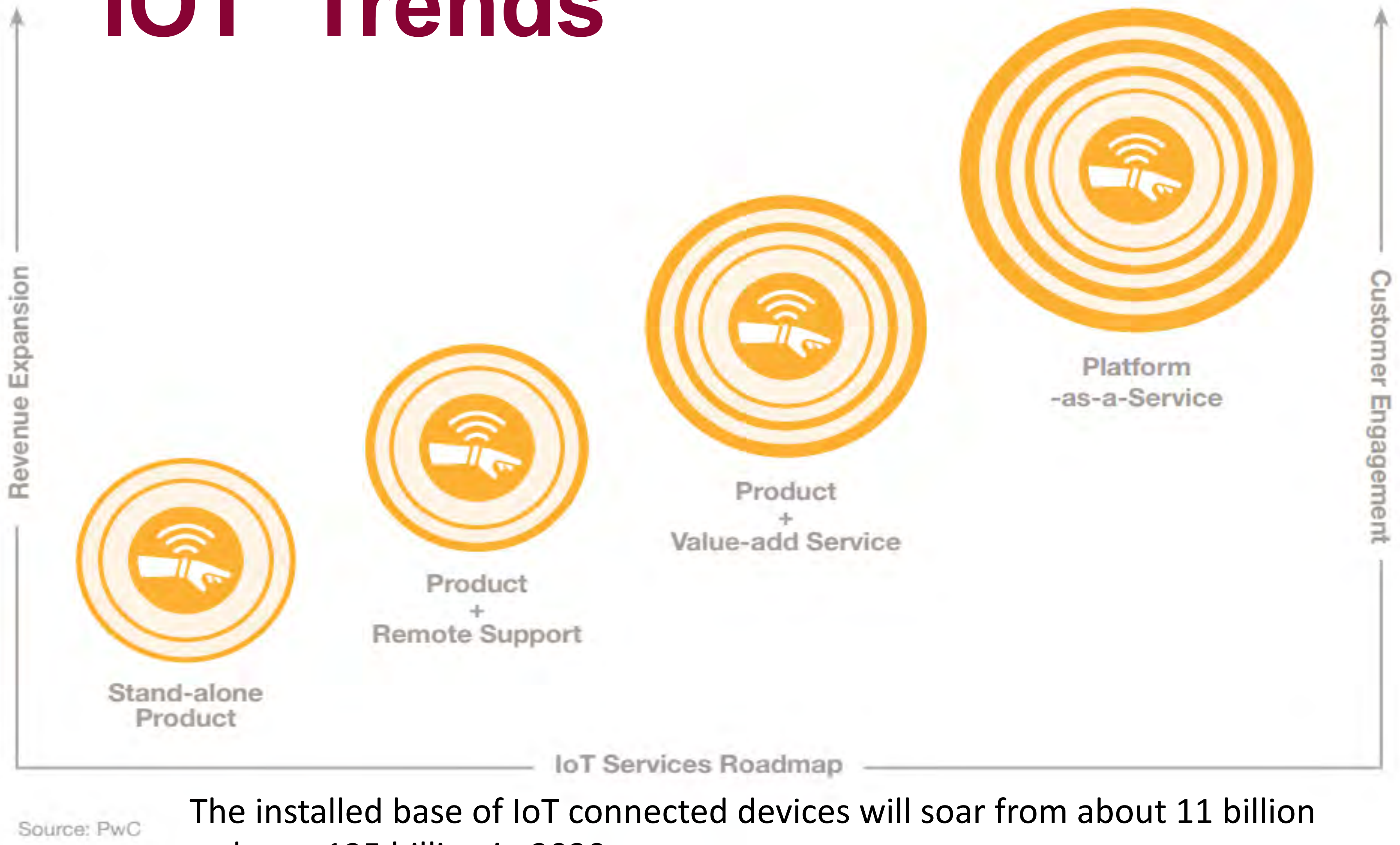


Product	% of IoT connected product 2019	% of IoT connected product 2025	% of IoT connected product 2040
Valve	1%	5%	20%
Dampers	0.5%	3%	25%
Sensors	3%	10%	40%

Trends:

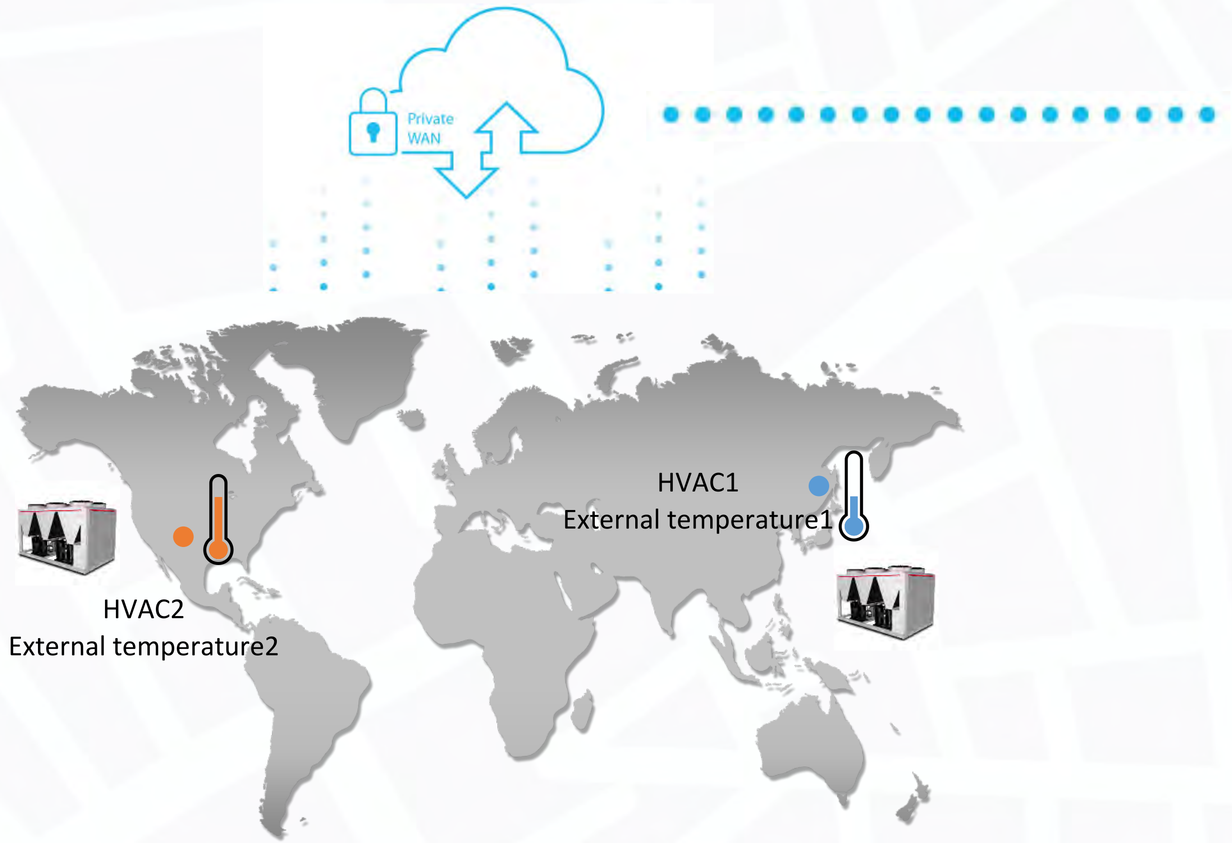
- IoT new services
- Supervision software to the cloud - from Local to Remote
- Real time monitoring / Remote control
- Smart phones as individual control device
- User customization and individual control
- New Analytics software and AI

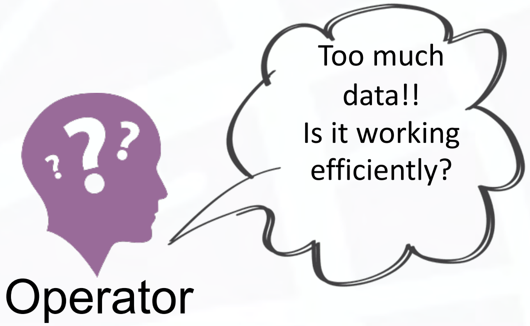
IOT Trends

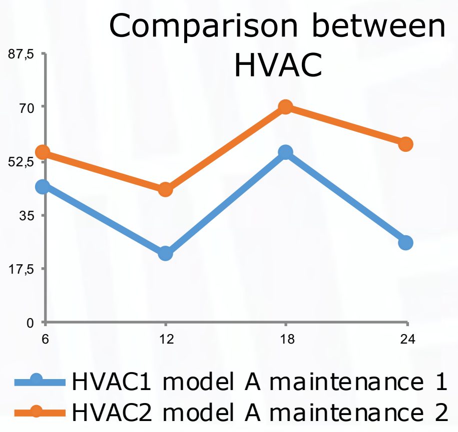


The installed base of IoT connected devices will soar from about 11 billion today to 125 billion in 2030 *Source (BCG)*

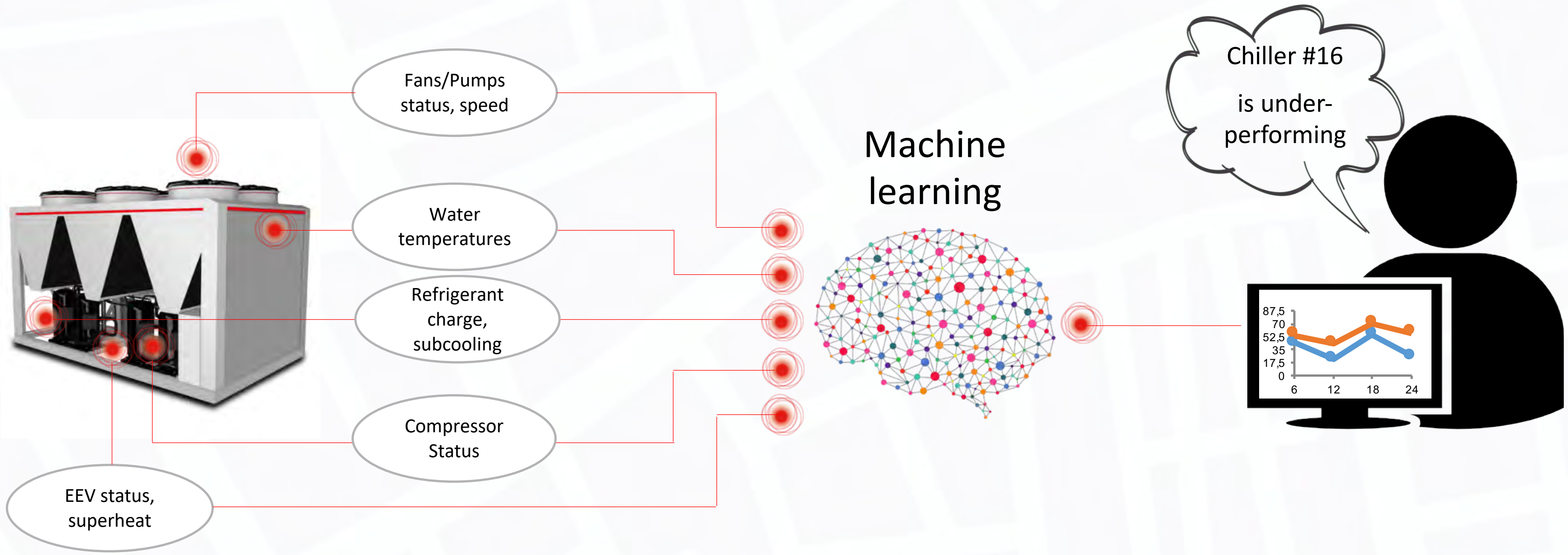
Connected chiller





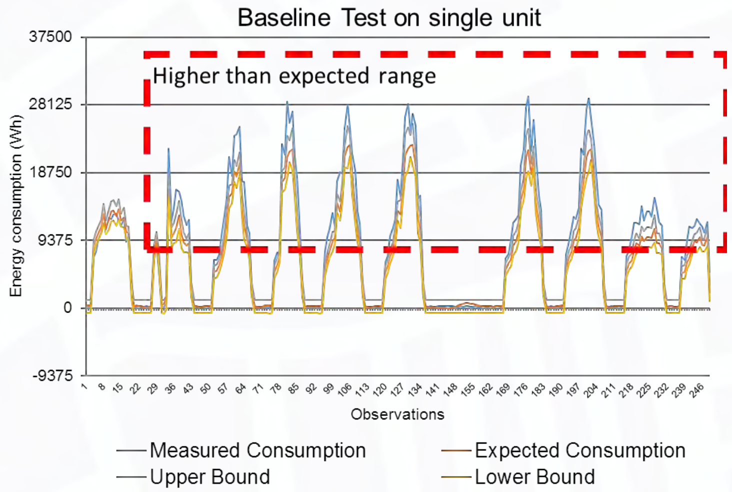


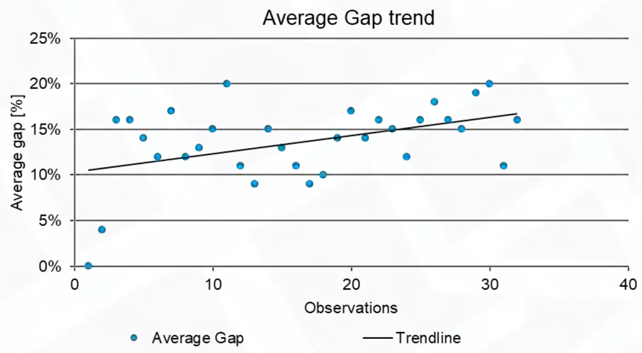
Connected chiller

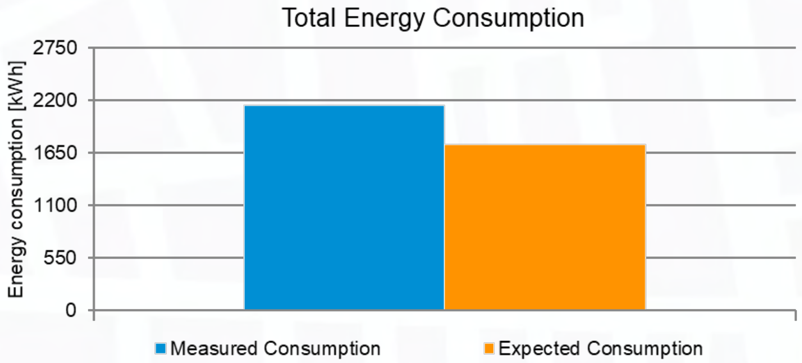


Connected chiller

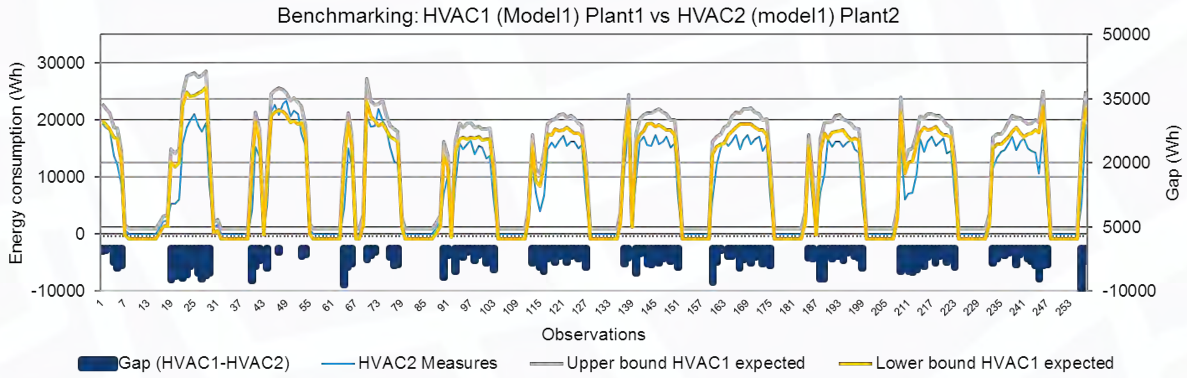
Predictive Maintenance



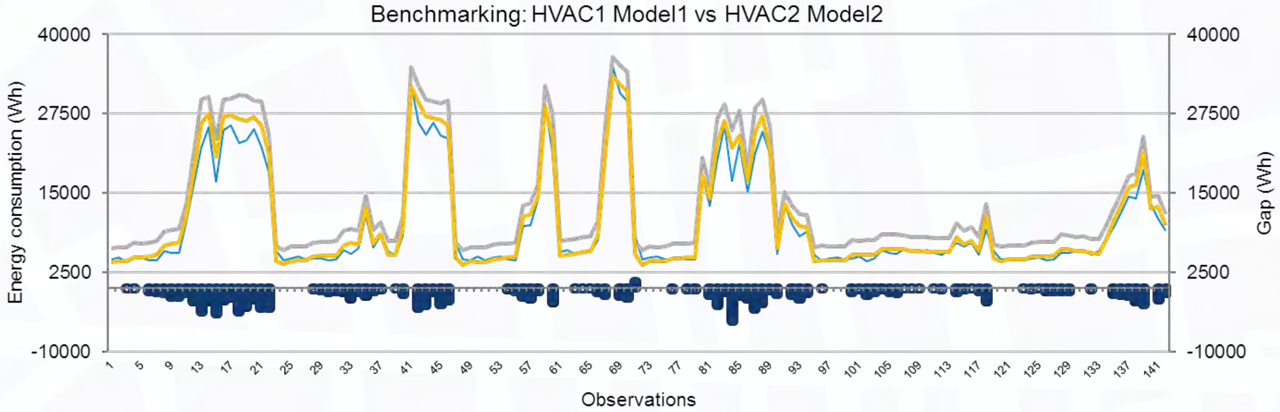




Connected chiller



Benchmarking



Conclusions

- Retrofitting still represents a strong market driver.
- Different technological areas and a wide range of different goals are involved, like efficiency and indoor air quality.
- The role of integrated systems will be fundamental to efficiently manage different technologies.
- Flexibility, Compatibility, Adaptability: key aspects to integrate existing units
- Switching to high-efficiency components has beneficial returns on the retrofitting investment.
- IOT and Smart Connected Units can improve both integration and efficiency, opening new business streams.

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7. Moderated Discussion

Improving Part Load Efficiency in Existing Buildings

Mr Zakeer Hussan
Channel Partner Manager, HVAC Segment Leader
ABB

Agenda

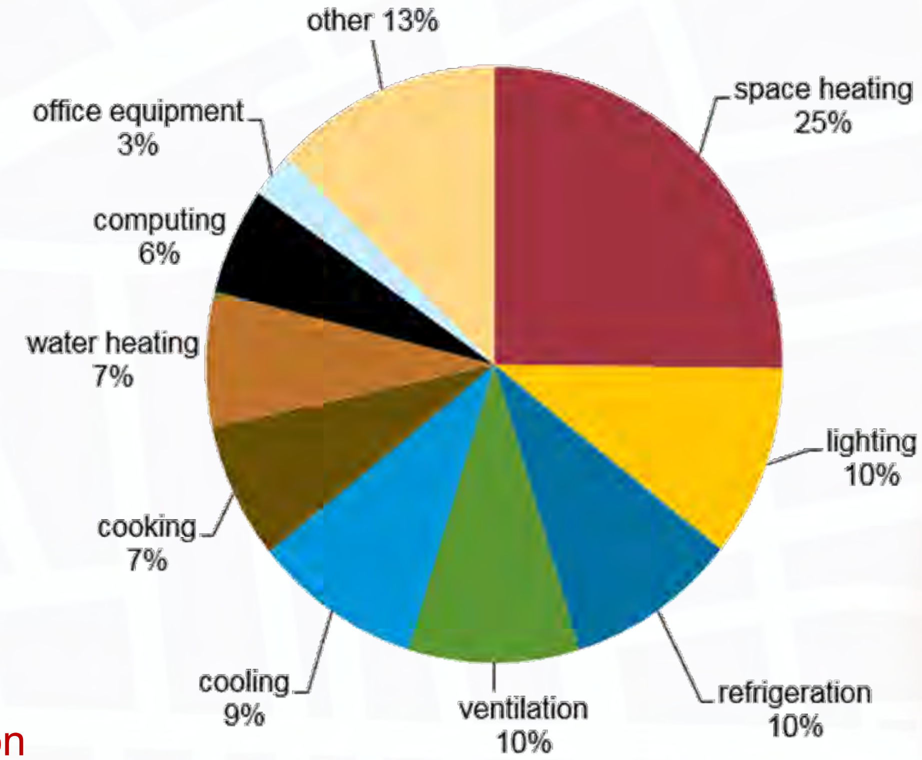
- Building energy consumption and the HVACR portion of it
- Legislation on building energy performance
- Legislation on HVACR system components
- Specifying HVACR efficiency for buildings
- Choosing motor technology for higher system efficiency
- Getting the most efficiency out of an HVACR system
- Benefiting of HVACR system digitalization
- Power quality effect on building efficiency

HVACR in buildings

Impact on overall building energy consumption

99% of the time buildings operate at the load below **80%**

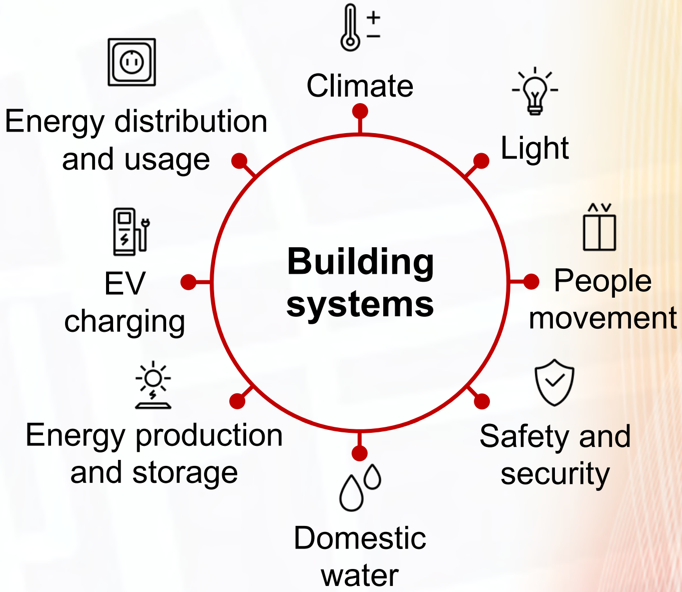
Over **50%** of commercial building annual energy consumption goes for HVACR



Source: US energy information administration

Legislation on building energy performance
Key considerations

- Buildings consume most energy in Europe, absorbing about 40% of final energy.
- Amended Energy Performance of Buildings Directive (2018/844/EU) aiming to decarbonize the national building stocks by 2050, with indicative milestones for 2030, 2040 and 2050
- The numerical criteria of building energy efficiency are mostly based on energy consumption per building square meter.
- Certification systems for buildings in Germany DGNB, the USA LEED and Britain BREEAM with assessment criteria include more or less same aspects such as water efficiency, energy and atmosphere, materials and resources, indoor environmental quality.
- EN 15232 standard: Energy Performance of Buildings – Impact of building automation, controls, and building management

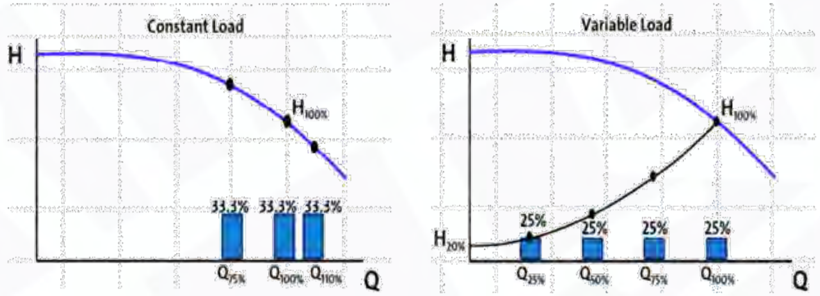


Legislation on HVACR system components
Key considerations

- In 2009, the European Parliament and Council passed a directive defining ecodesign requirements for energy related products ErP Directive 2009/125/EG to reduce energy consumption across EU.
- Ventilation units – Commission Regulation No 1253/2014 of 7 July 2014
- Fans driven by motors with input power 0.125 – 500 kW – Commission Regulation No 327/2011 of 30 March 2011
- Circulators – Commission Regulation No 622/2012 of 11 July 2012 supplementing No 641/2009 of 22 July 2009
- Water pumps – Commission regulation No 547/2012 of 25 June 2012
- Electric motors – Commission Regulation No 4/2014 of 6 January 2014 supplementing No 640/2009.
- Compressors – Lot 31. Preparatory study on Low pressure & Oil-free compressor packages of 7 June 2017
- Ecodesign preparatory study for Building Automation and Control Systems (BACS)

Legislation on HVACR system components

Key considerations

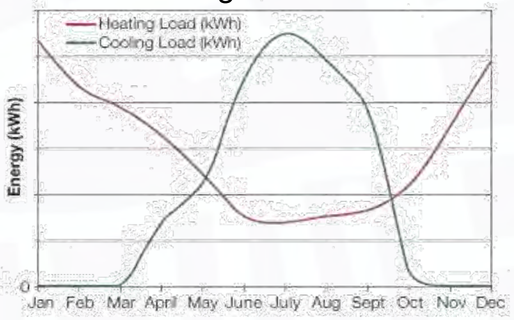


- Circulators – Commission Regulation No 622/2012 of 11 July 2012 supplementing No 641/2009 of 22.07.2009 and Water pumps – Commission regulation No 547/2012 of 25.06.2012
- Energy efficiency index EEI and Minimum efficiency index MEI are calculated considering pump efficiency at part load.
- Energy conservation standard for clean water pumps by Department of Energy USA, since 27.01.2020
- Pump Energy Index (PEI) represents a pump's efficiency as compared to the minimum efficiency defined by the Department of Energy USA.
- There are separate PEI calculations depending on the load type: for constant load weighted average is taken at 75%, 100% and 110% of best efficiency point flow rate; for variable load weighted average is taken at 25%, 50%, 75% and 100% of BEP.

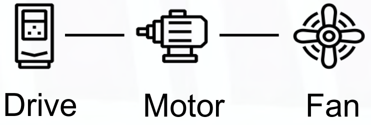
Specifying HVACR efficiency for buildings
Key considerations

- Nobody specifies the efficiency of HVACR system at part load.
- When the part load efficiency is significantly lower, building owners will never realize the savings that were calculated.
- Some solutions when run at part load do not give full efficiency owing to motor design and motor controls. It is important to ensure high efficiency of a motor-drive package at part loads.
- It is important to consider not only efficiency of a powertrain (HVACR applications like pump, motor and drive), but also power system efficiency affected by VSDs through reactive power and harmonics.

Building annual load



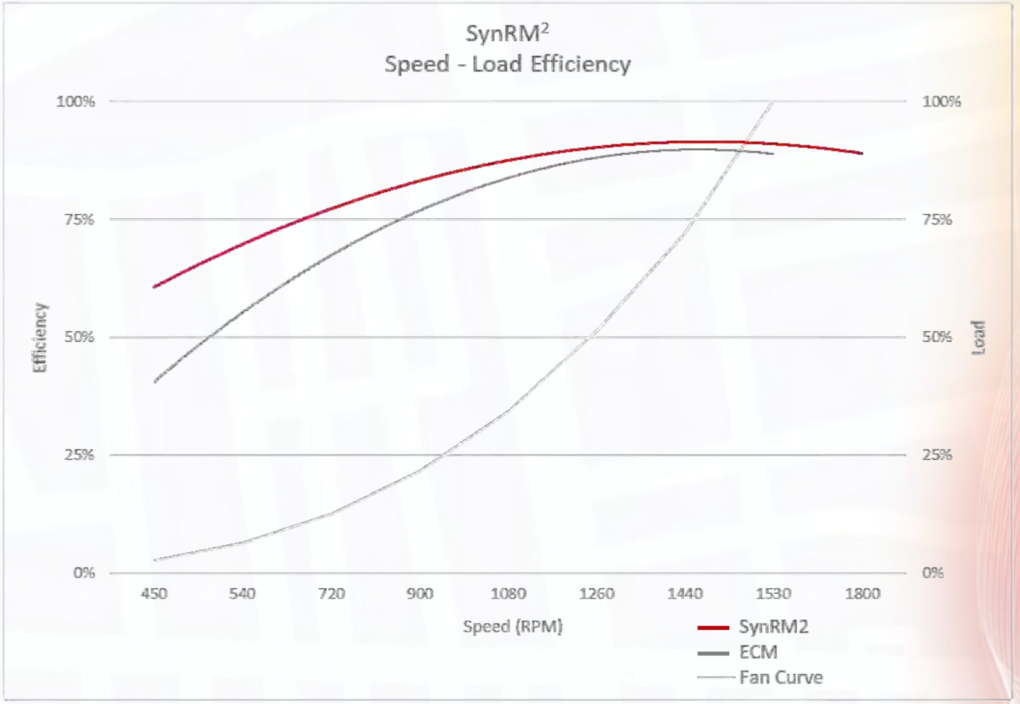
HVACR powertrains



Choosing motor technology for higher system efficiency

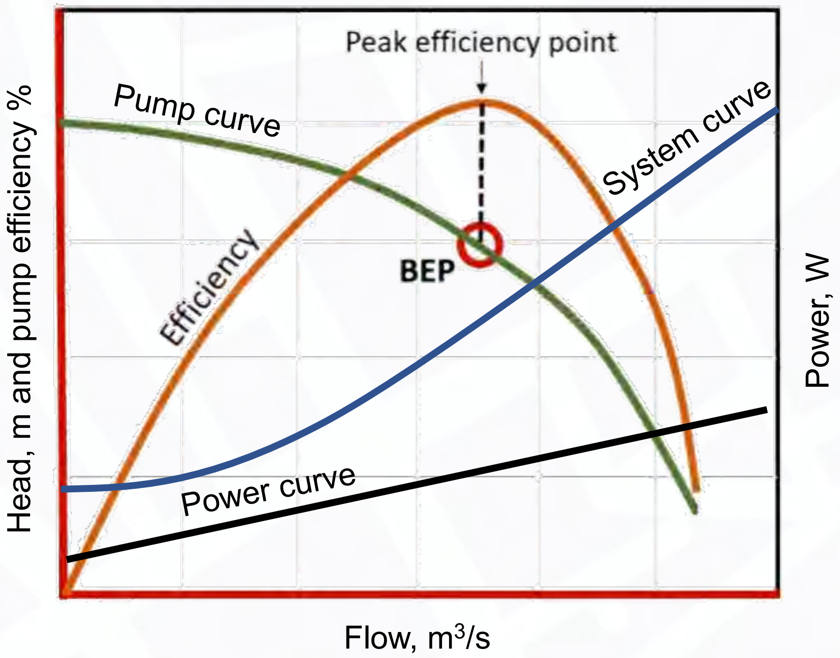
Part load efficiency for different motor types

- Different motor types present in the market: induction, permanent magnet, synchronous reluctance, electronically commutated.
- Important to consider efficiency at part load operation where the system is most of the time – the difference between 100% and 40% might be 10% and more.



Getting the most efficiency out of pumping system

Running pumps at part loads

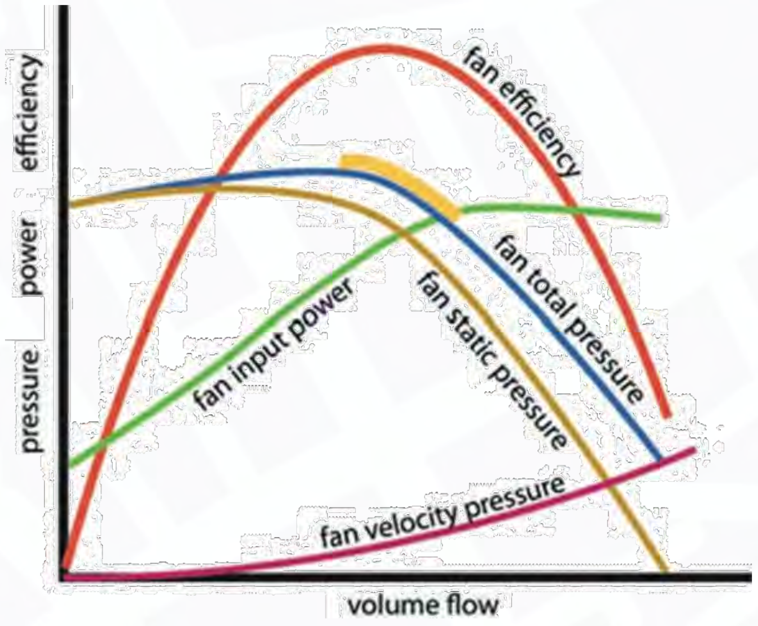


$$P = \frac{Q\rho g H}{\eta}$$

Flow control methods:

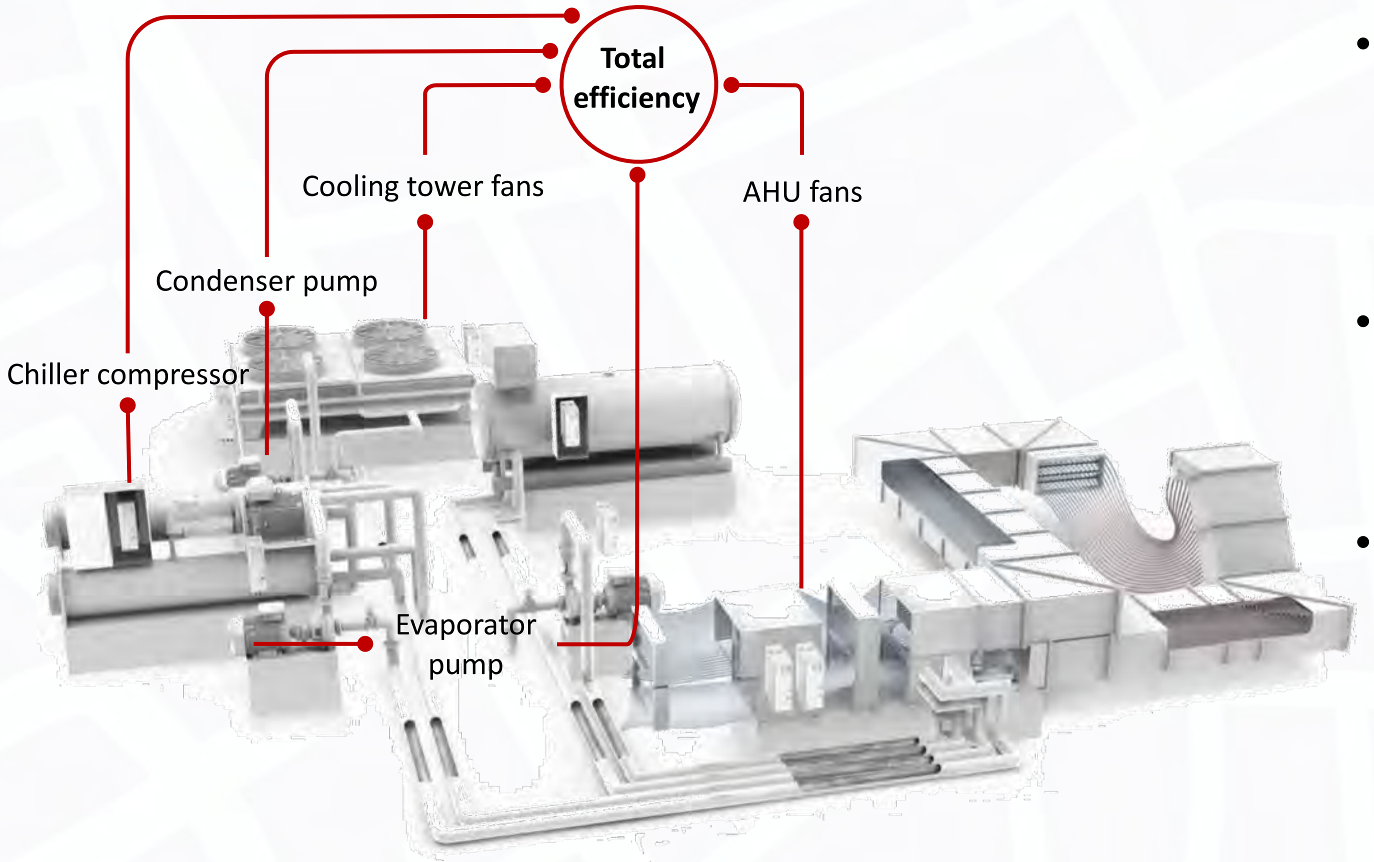
- Using throttles for flow control with no energy savings
- Using cascade control when the new pump steps in when needed
- Using pump parallel operation with drive control – pumps run at the most efficient points for current situation

Getting the most efficiency out of ventilation system
Single fans vs fan arrays



- There is a potential to achieve higher efficiency in the system with multiple fans running closer to their peak efficiencies, rather one large fan controlled over a wide operating range.
- Larger fans are more efficient than smaller fans, also, larger motors are more efficient than smaller motors at peak load, but at part loads small fans in array offer a great scalability which affects system efficiency.

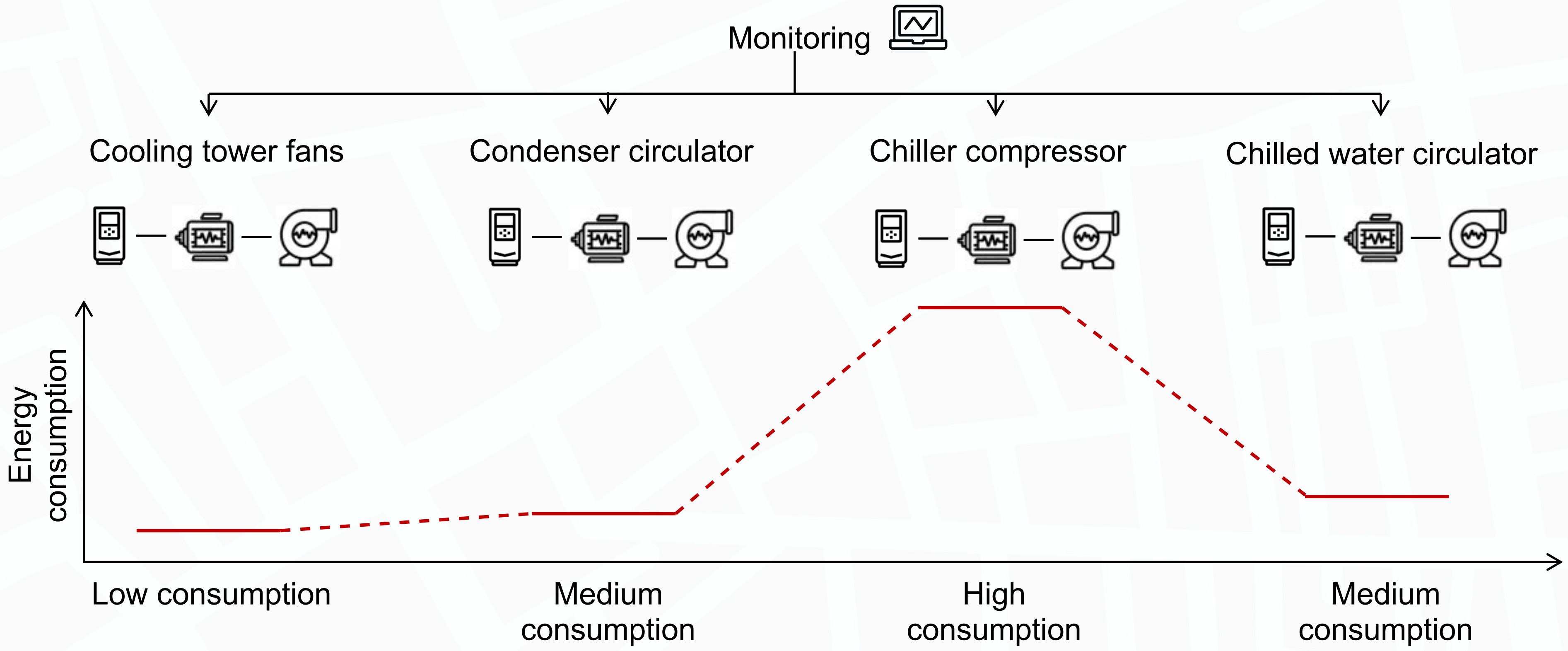
Overall HVACR system efficiency
Taking a complex approach



- In cooling, you need to consider the whole system to optimize it. If you start controlling the condenser, it will affect the compressor, which also impacts the evaporator.
- A system approach and right balance are needed between how the compressor, condenser and evaporator are controlled.
- Sometimes, running two compressors at part loads is more efficient than running one compressor at full load and another at part load.

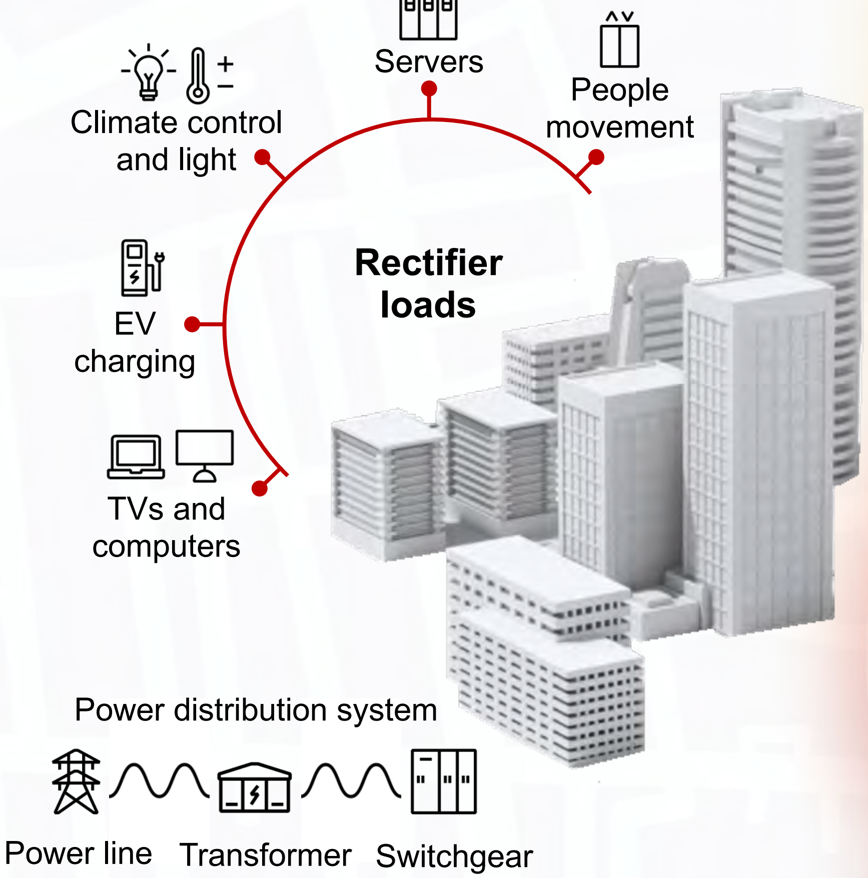
Benefits of HVACR system digitalisation

Monitor, correct, optimise throughout system lifetime



Power quality impact on efficiency for buildings
Key considerations

- Back in the late 90's less than 20% of building loads were rectifier or non-linear loads
- Biggest concern was displacement power factor (due to reactive power loads) impact on power quality
- Today close to 100% of the building load is rectifiers like LED lighting, TVs, servers, computers and chargers, as well as speed control in HVAC systems, lifts and escalators
- Any rectifier load causes harmonic currents, which distort the voltage of the building and add load to the electrical network
- Because of this added impact, power utilities in some countries are changing meters and charge non-wattage penalties on both displacement power factor and harmonics = true power factor



Harmonics and power factor
How system efficiency is affected

- Harmonic currents lower the total true power factor (not cos Φ)
- Harmonic currents increase the total line current leading to increase in cable and fuse size
- “Extra current” is not active current – it’s reactive current the power plant and power system have to deliver as well
- Many electrical utilities charge penalties for reactive current or low power factor
- Traditional EC motor current drawn from the network is about 25-40% higher than the load is
- Many EC fan systems require centralized harmonic mitigation equipment which has a cost impact
- Trying to fix this with passive filters, the capacitors are typically disconnected at 50% load changing it to an AC choke

6-pulse drive with an active supply unit and integrated low harmonic line filter

True power factor = 1.0
Line current ≈ 100%

6-pulse drive with a choke

True power factor ≈ 0.93
Line current ≈ 110%

Drive without a choke

EC motor

True power factor ≈ 0.78
Line current ≈ 128%

Summary

- Over 50% of commercial building annual energy consumption goes to HVACR.
- Legislations on building energy performance get stricter and force owners take measures on energy consumption reduction.
- Legislations on HVACR system component efficiency get stricter and start taking into account part load efficiency.
- Building HVACR system part load efficiency should be part of specification.
- Digital technologies help get information on energy consumption by different parts of a HVACR system allowing to run optimisation measures for higher system efficiency.
- Power quality – presence of harmonics, capacitive/reactive loads affecting power factor – contributes into building energy losses through power system as well.

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4. Retrofitting of AC and Ventilation Units with Smart Electronic Components Integrated in Hydronic Plants
5. Improving Part Load Efficiency in Existing Buildings
6. **Improving savings on Chilled Water Pumps through balancing of the terminal units**
7. Moderated Discussion

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Improving savings on Chilled Water Balancing

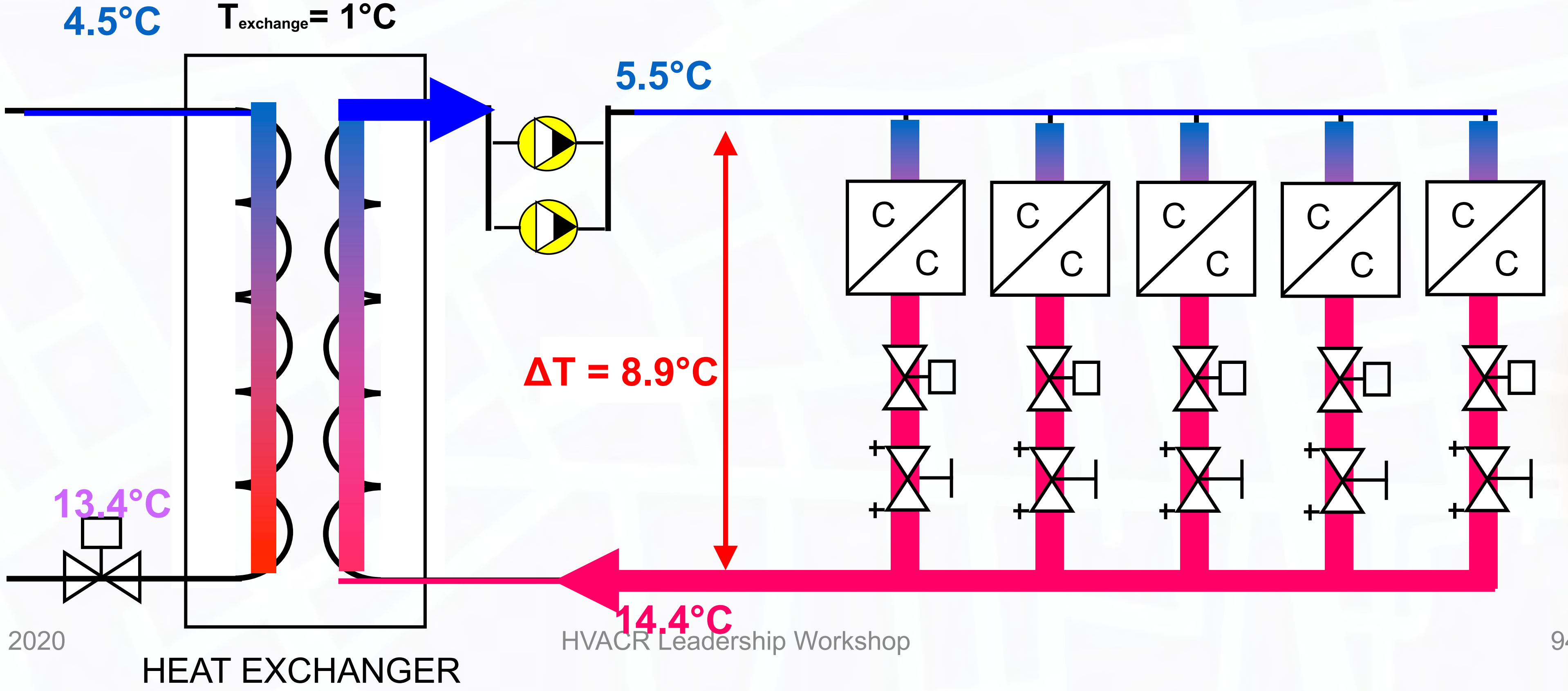
Mr Anis Ben Ali Ouerghi
Technical Manager
Danfoss FZCO

Agenda

- Low Delta T General Causes
- Hydronic Balancing
- Pressure Independent Balancing & Control Valves
- Smart Actuator – Delta T Management
- Conclusion

General Arrangement
Temperature requirement - Design

- Delta T chilled water

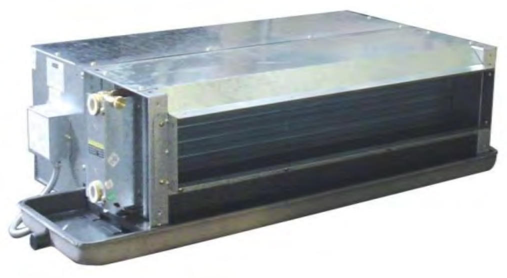


Low delta T syndrome

Low delta T syndrome in commercial buildings - prevention and solutions

Reasons for Low delta T syndrome

Cooling coil: oversized cooling coil might lead to bigger tube when modulating and the water velocity will be less than the minimum of 0.3m/s (min 0.3m/s & max 1.5m/s) below 0.3m/s the flow will not be turbulent for proper exchange and lead to reduced return temperature.



Poor maintenance leads to lower exchange and discomfort. Dirty air filters lead to inefficient exchange & low return chilled water temperature.

Blocked strainer leads to less flow which will push the controller to open the valve further and cause overflow.

Variable Flow

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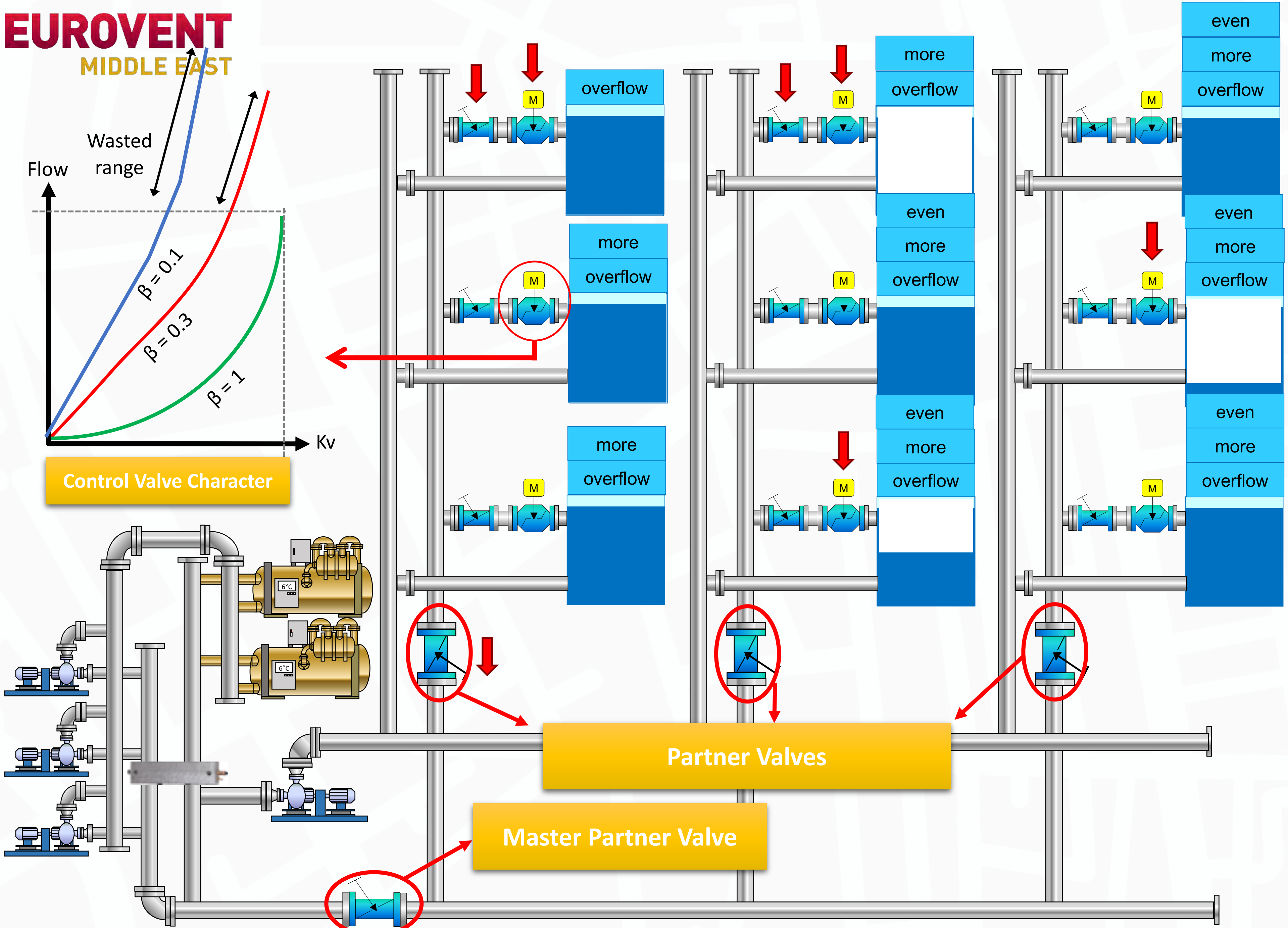
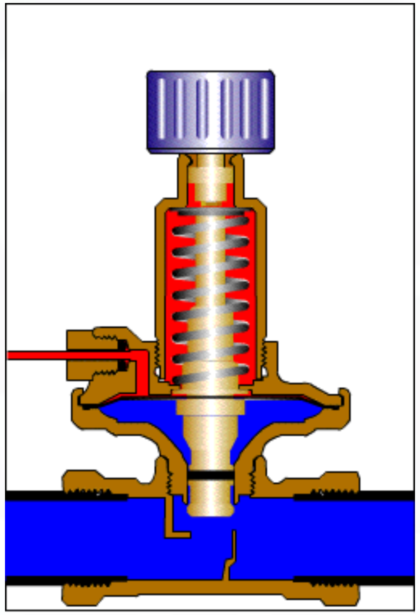
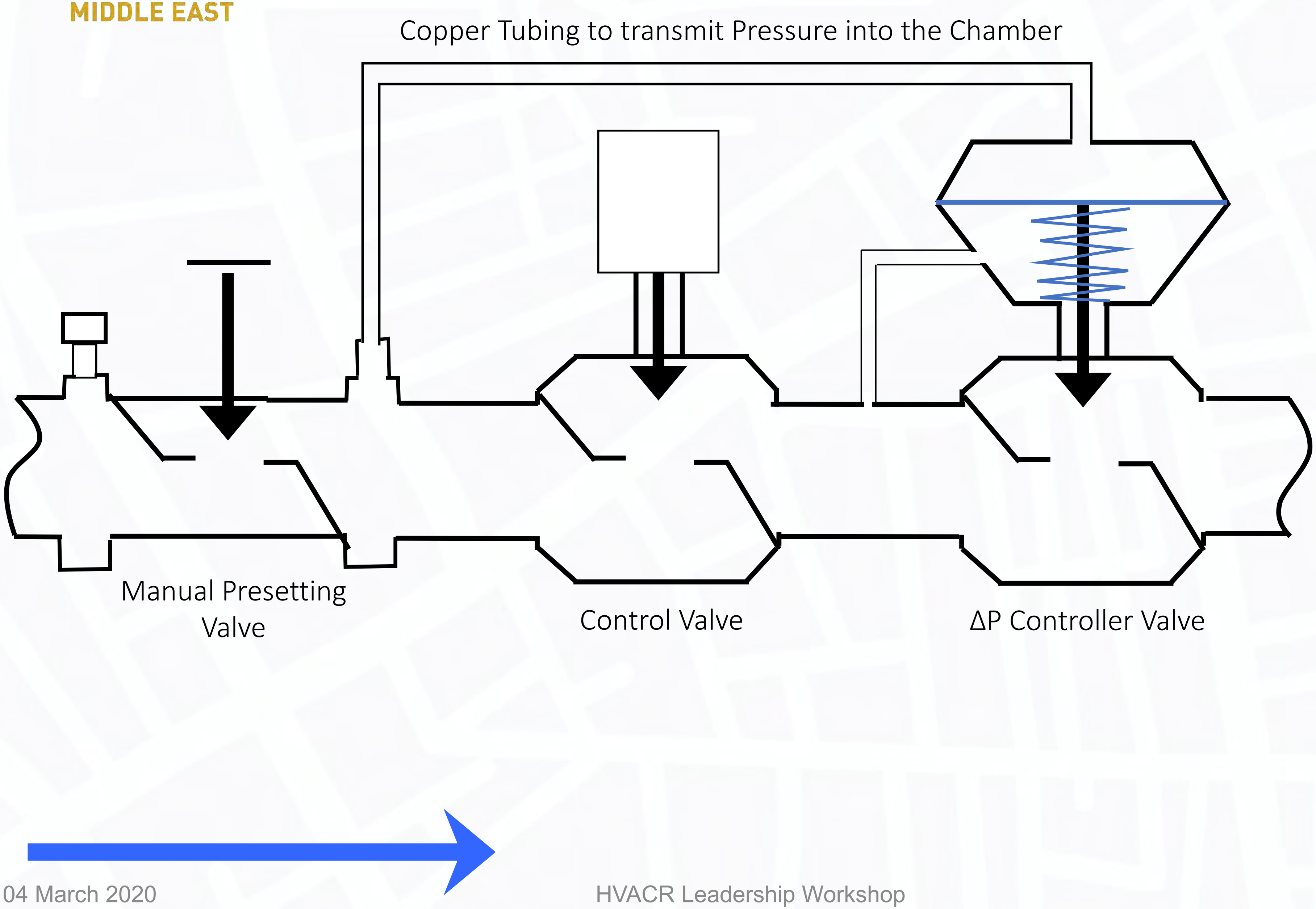


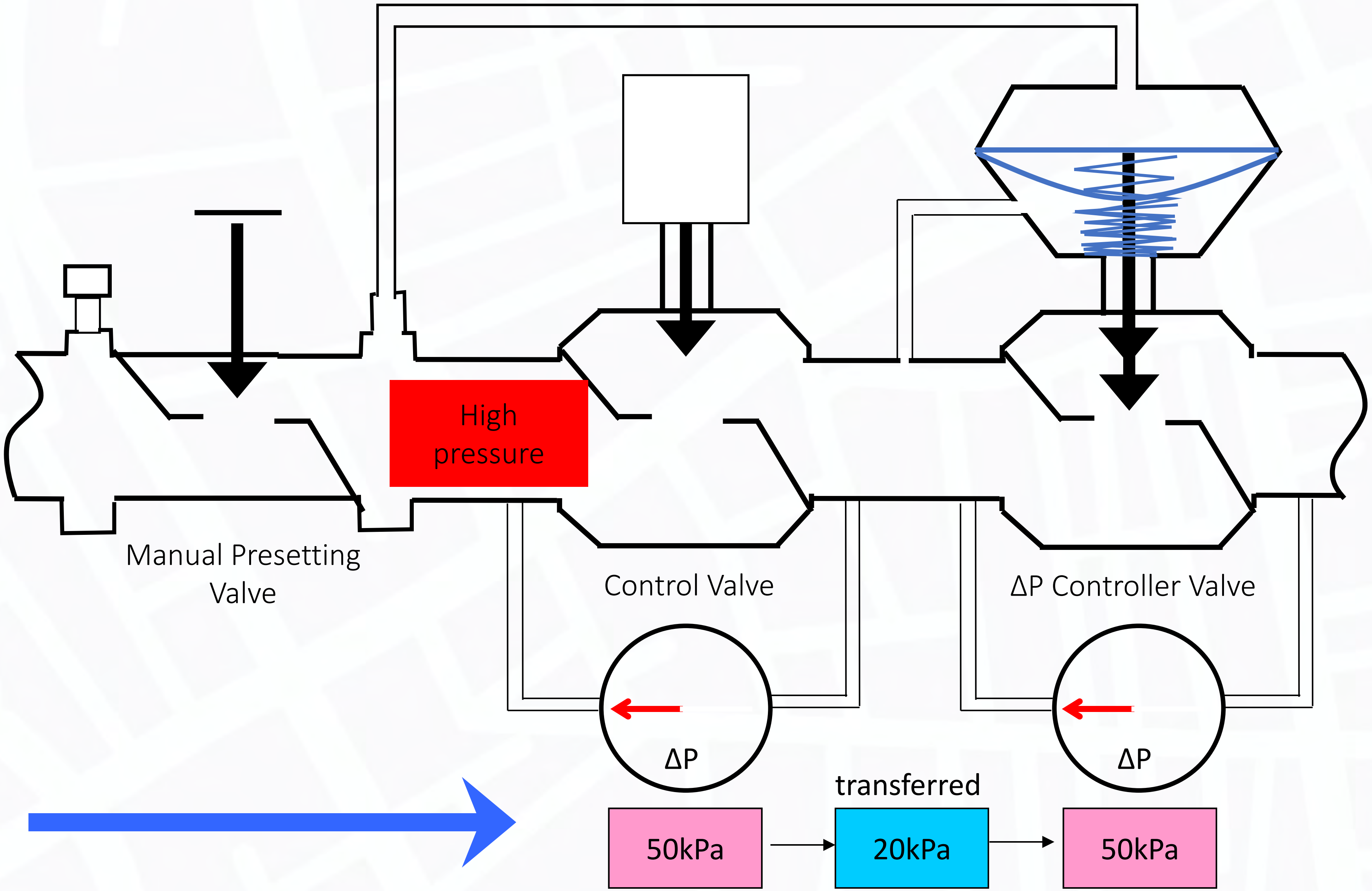
Hydronic Balancing

Manual Balancing

Automatic balancing




Copper Tubing to transmit Pressure into the Chamber
Manual Presetting Valve
Control Valve
ΔP Controller Valve


High pressure
Manual Presetting Valve
Control Valve
ΔP Controller Valve
ΔP
ΔP
transferred
50kPa
20kPa
50kPa

What is the AB-QM?

The AB-QM is a **P**ressure **I**ndependent **B**alancing and **C**ontrol **V**alve (PIBCV):

- Control valve

- Automatic balancing function

How does the AB-QM work?

The top part of the AB-QM is a control valve.

How does the AB-QM work?

The bottom part of the AB-QM is a differential pressure controller that keeps a constant differential pressure across the control valve independent of pressure fluctuations in the system.

Flow $Q = Kv \times \sqrt{\Delta P}$

Fixed dP means constant flow & full authority.

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Applications and sizes

AB-QM & TWA-Z /HF

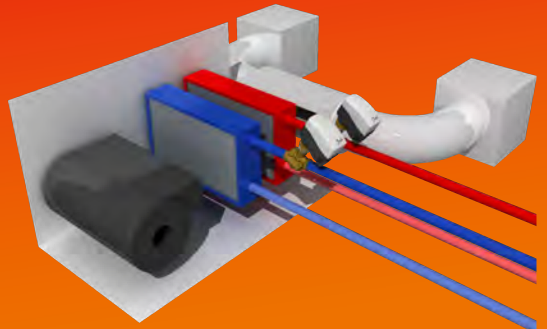
AB-QM & ABN/M A5 LOG/LIN

AB-QM & AME/V 110/120 NL/X

AB-QM & AME 435QM

AB-QM & AME 55QM

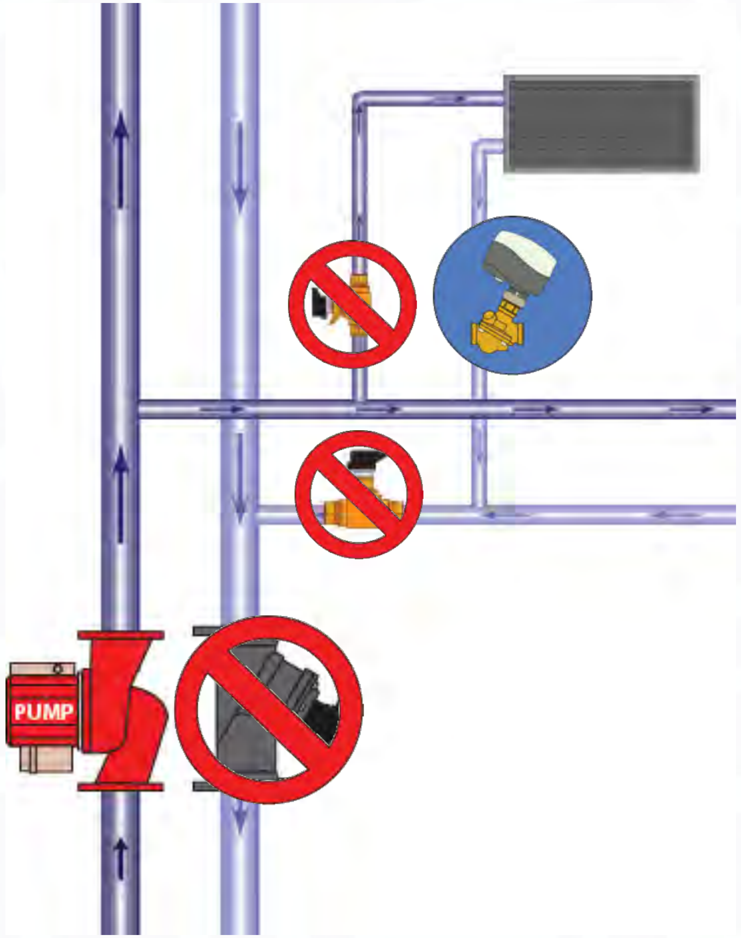
AB-QM & AME 85QM



Less Mounting/Installation

Mounting cost

- Installation time DN15 valve approx. 70 minutes
- Installation time DN40 approx. 80 minutes
- Installation time DN80 approx. 120 minutes
- Less commissioning time
  (normally at least 30 min./valve)
- No delay of handover
- Phased handovers

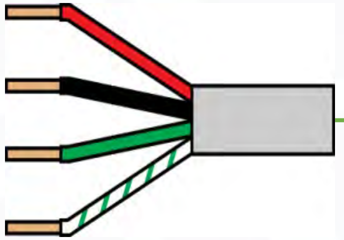


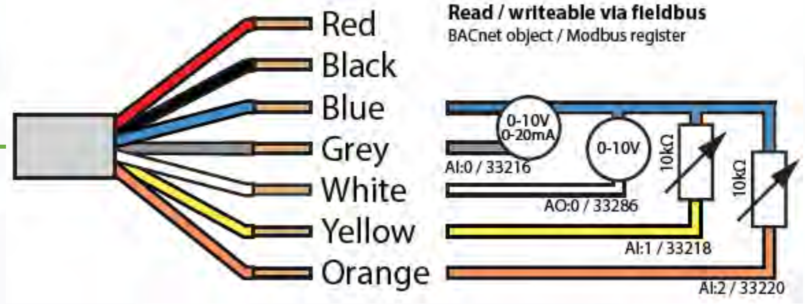
Communicating Smart Actuator

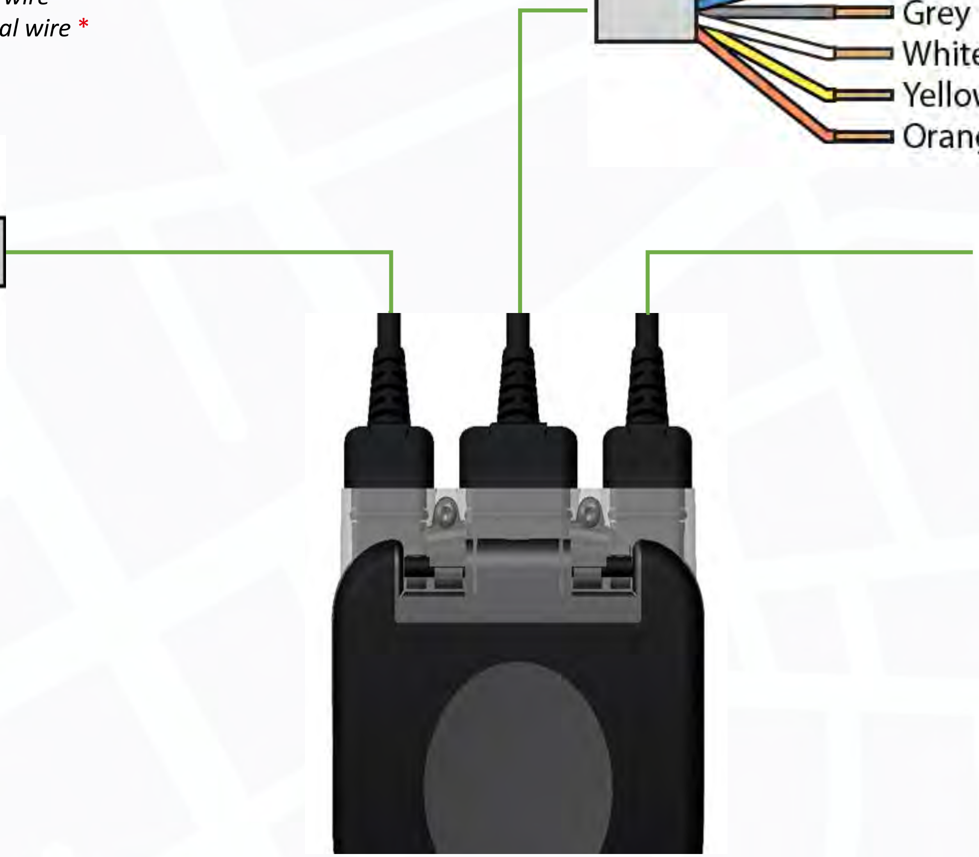
- More efficient building process
- More automation (data)
- Higher demands
  - Comfort
  - Energy efficiency

Flexibility in connections

NovoCon® digital port
Red: Power
Black: Common ground for power and bus signal wire
Green: '+' non-inverting signal wire *
Green/White: '-' inverting signal wire *



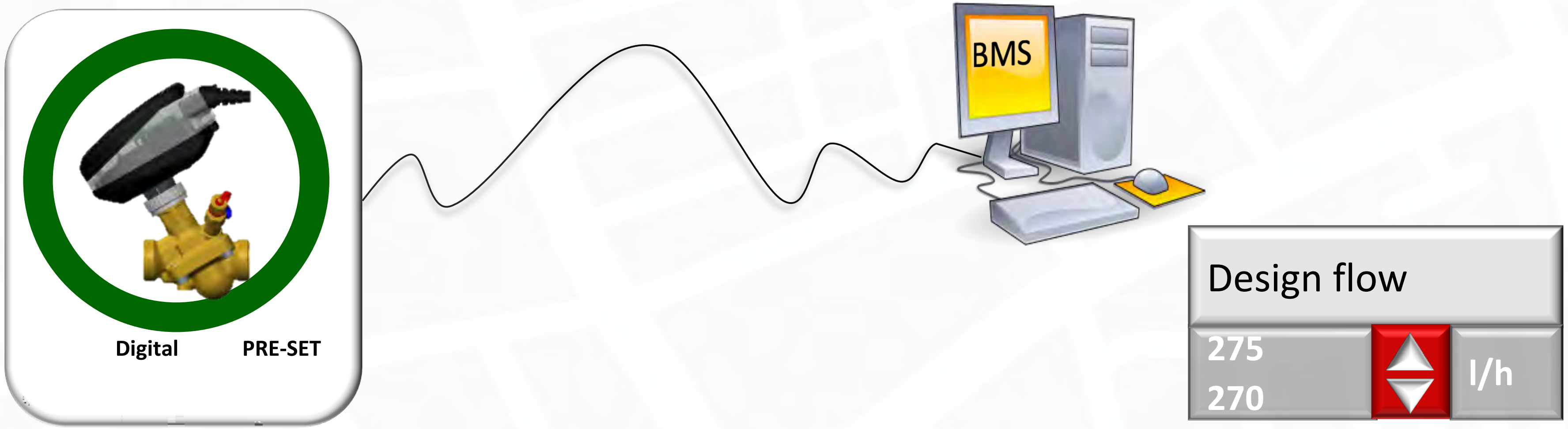


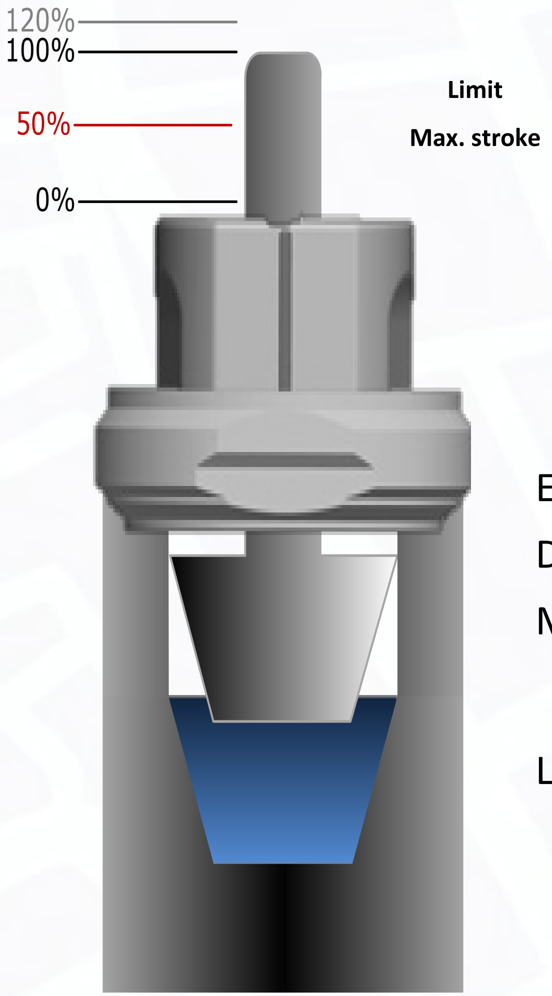


Digital port for daisy chain

***Twisted pair cabling** canceling out electromagnetic interference (EMI)

Remote setting design flow and Flow / Energy / Temperature indication





Design flow

225 l/h

Example:

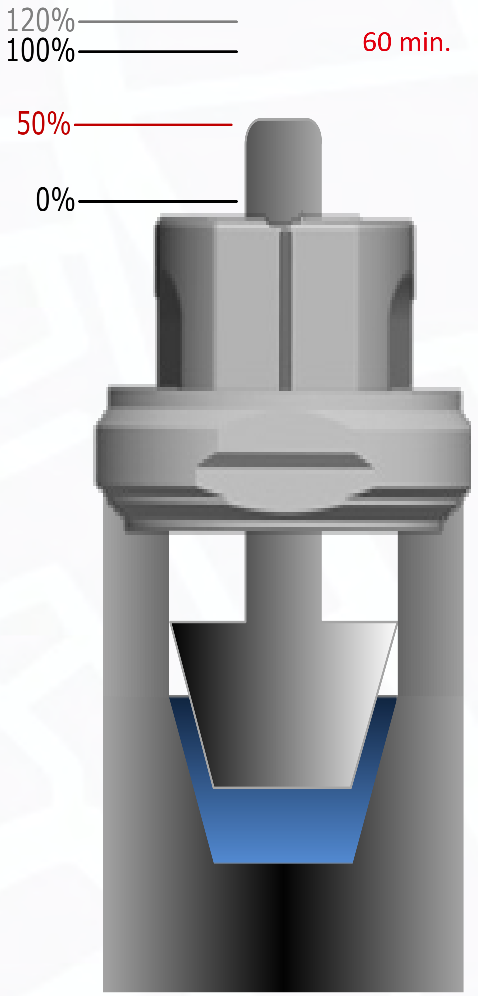
Designflow: 225 [l/h]

Maximum flow AB-QM DN15: 450 [l/h]

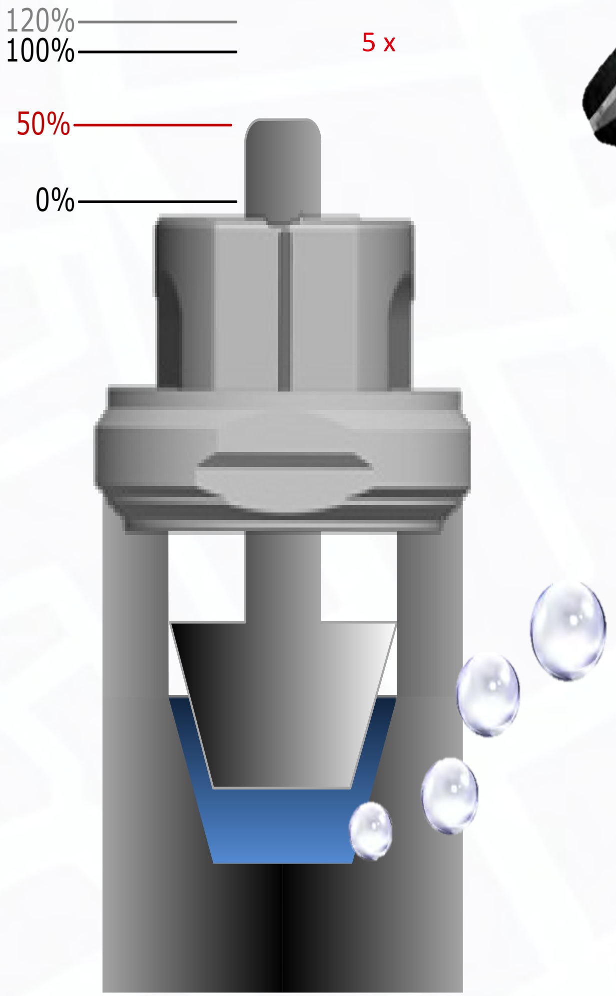
Limitation stroke NOVOCON®: $\frac{\text{Designflow}}{\text{Maximum flow}} \cdot 100 \quad [\%]$

Remote Features

Flushing Programme



De-Air program



Remote status feedback

- Error: No signal
- Error: Calibration
- Warning: high temperature electronics
- Warning: abnormal supply voltage
- Closing error due to obstruction
- No 0-10V control signal

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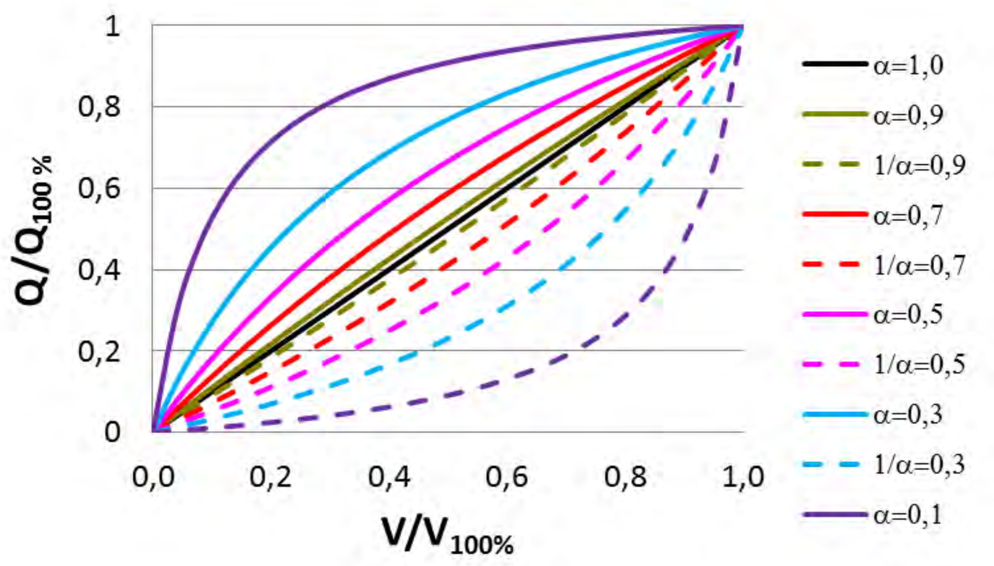
Remote alpha setting for optimal control

Optimal control is possible, if we have linear response of system. Characteristic of HEX can be compensated with characteristic of actuator by appropriate α value.

On NovoCon you can set the value remotely using BACnet command.

α=0.2 (logarithmic), α=1 (linear).

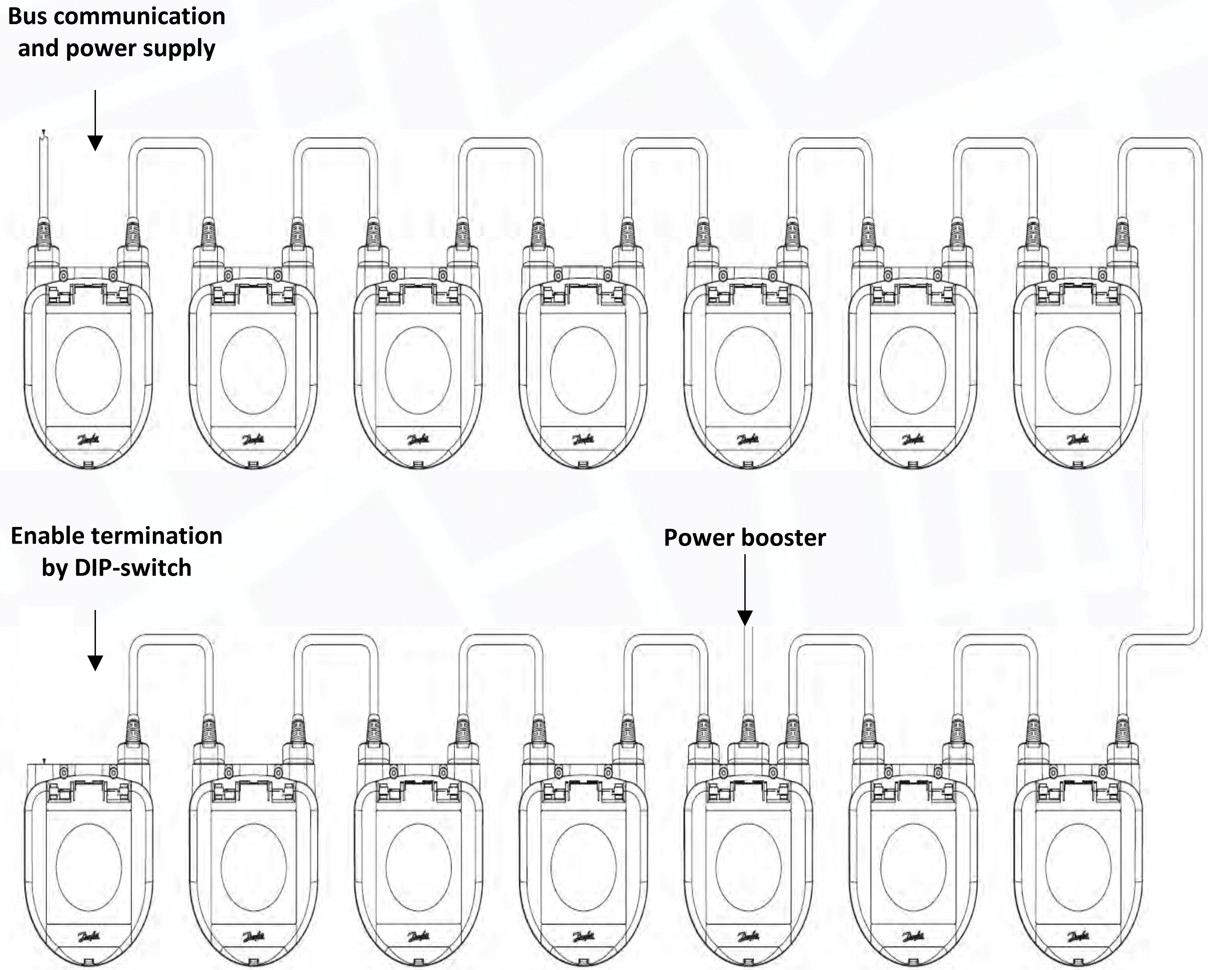
Relationship between HEX (full line) and valve+actuator (dashed line) characteristic



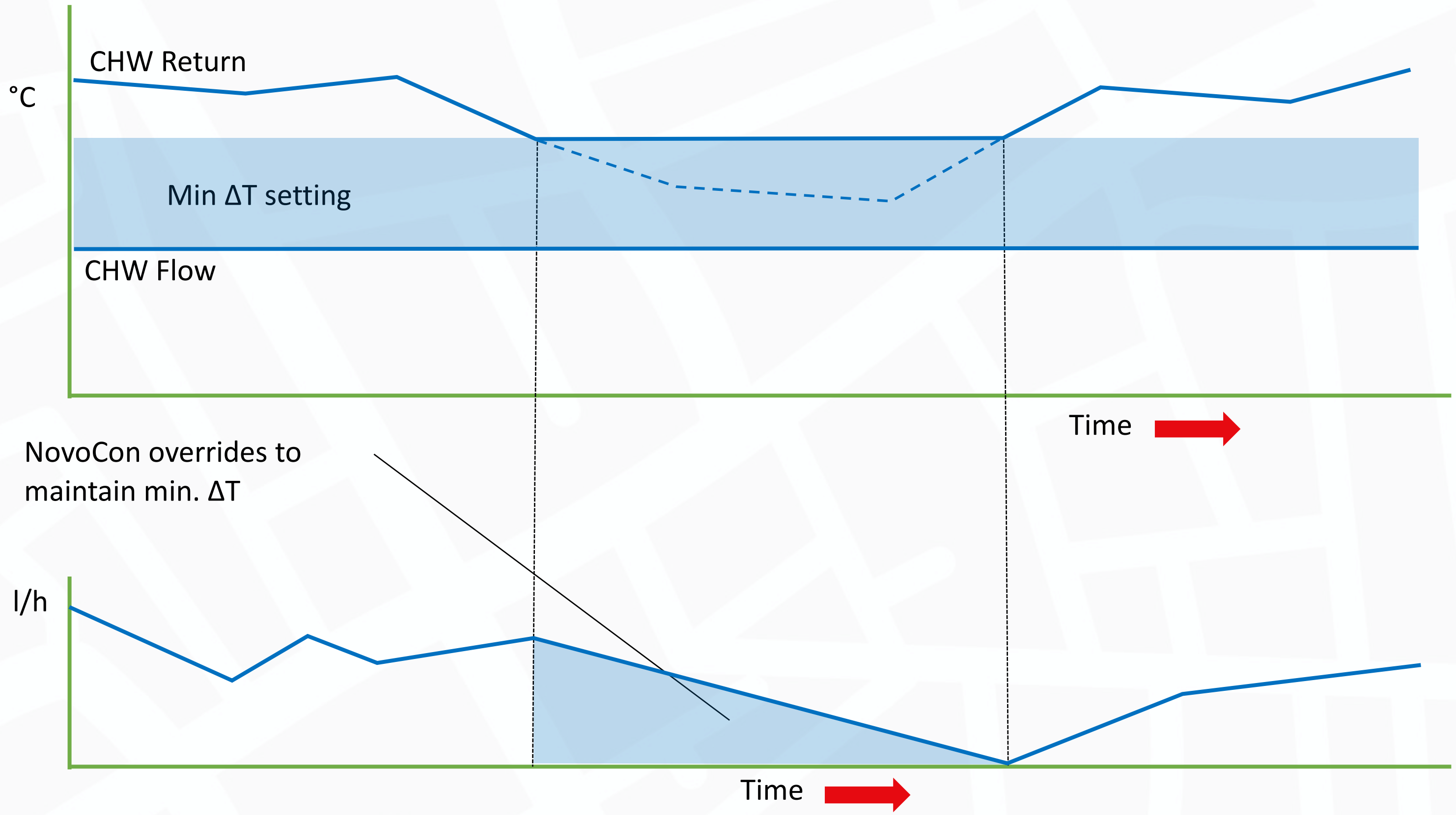
Daisy-chaining

Additional voltage booster each 7 – 11 NovoCon's.

Chain max. 64 pcs



Energy Management
Minimum Delta T Management



Description:
Smart actuator overrides the DDC control signal and maintains a minimum temperature difference between the flow and return temperatures by closing the valve when the user defined minimum is not achieved. When the flow temperature increases/decreases, so will the calculated minimum setpoint for the return temperature. This always ensures a minimum energy transfer to the FCU irrespective of the flow temperature.

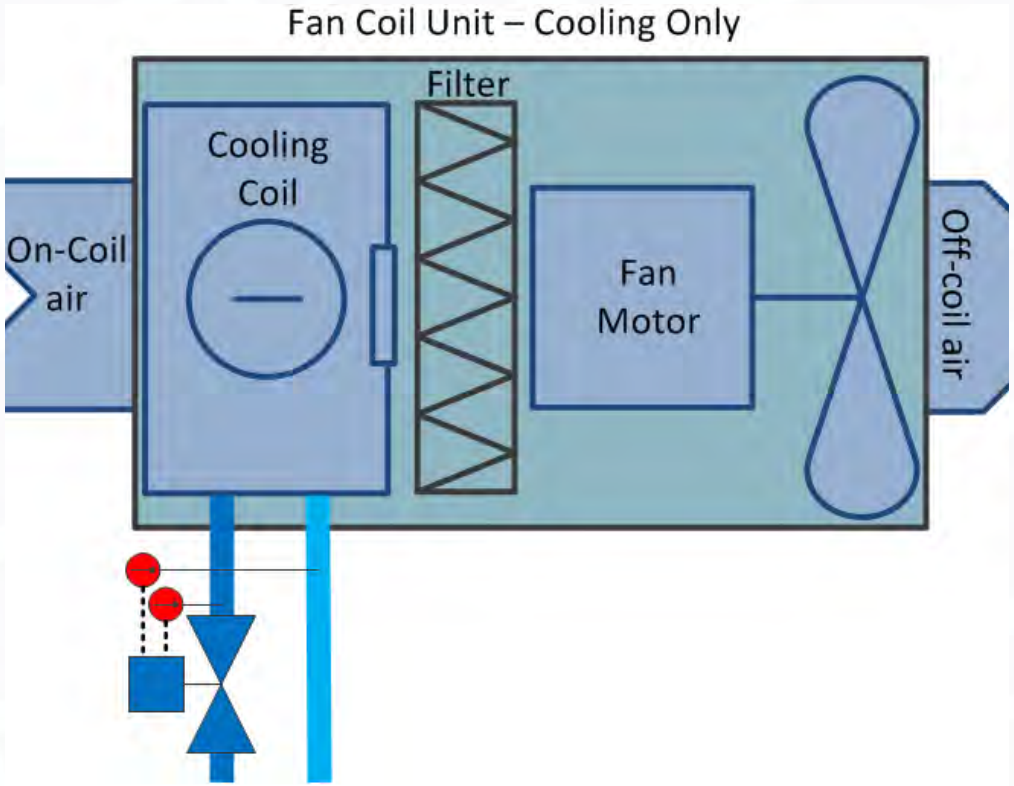
FCU/AHU Application

Description:

- Actuator being primarily controlled by a DDC bus control signal in % valve opening.
- Actuator will override the DDC control signal when the user defined delta T is not achieved and the valve will begin to close.
- Actuator is gathering energy information about the FCU via 2 PT1000 pipe sensors.

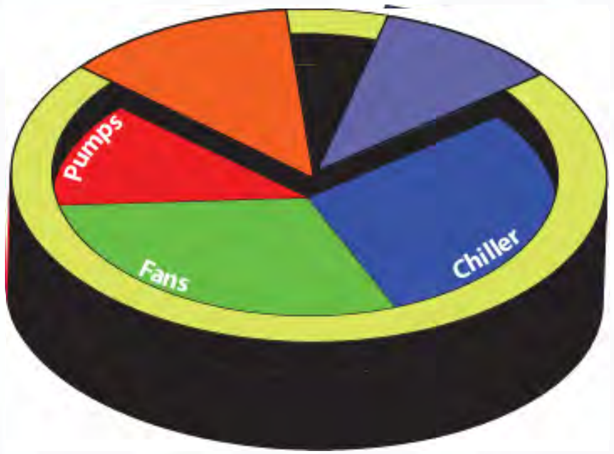
Note:

- BV:22 will be activated if the sensors are missing or not connected properly.
- BV:23 will be activated to alert the user the user that this override function is active.
- BV:24 will be activated to alert the user if the user defined min. ΔT is out of the achieveable range.
- ΔT & temperature sensing units may be changed to °F via MSV:23.
- Logged Energy kWh may be changed to MJ or kBTU via MSV:27.



Conclusions

- By reducing overflows the pump can run on a lower speed
- By improving the DT of the installation the efficiency of the chiller can be improved
- By increasing the performance of the control the temperature setting can be optimised



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7. **Moderated Discussion**

Moderated Discussion

Markus Lattner
Managing Director
Eurovent Middle East

Moderated Discussion

- ❖How to approach retrofitting
- ❖Challenges for retrofitting
- ❖Life Cycle Costs
- ❖Digitalisation

Final Remarks

Markus Lattner
Managing Director
Eurovent Middle East

Workshop Partners

Media Partner

climate control MIDDLE EAST

KEY PERSPECTIVES ON THE REGION'S HVACR INDUSTRY

Hotel Partner

Le MERIDIEN


Thank You!
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