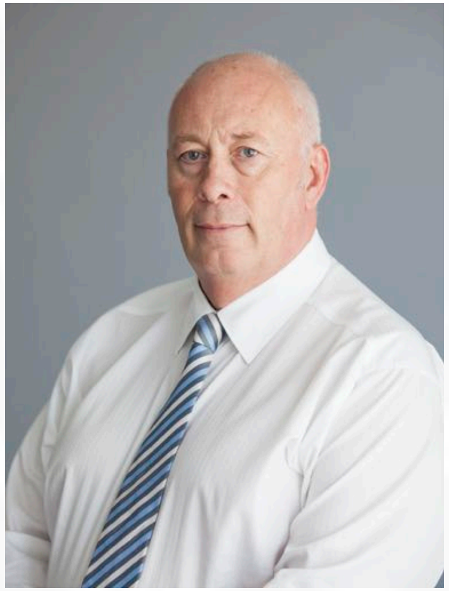
EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Event Introduction:
Air Handling Units



Brian Suggitt
Chairman
Eurovent Middle East

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Eurovent Middle East

RELATED ORGANISATIONS

Agenda

1. Fundamentals of Air Handling Units
2. Energy Recovery in Fresh Air Units
3. Air Filters: ISO 16890
4. EC Fan Technology: new build and retrofit
5. Case Study: AHUs in Residential Sector
6. Eurovent Certified Performance Program for AHUs
7. Moderated Discussion
8. Networking Dinner

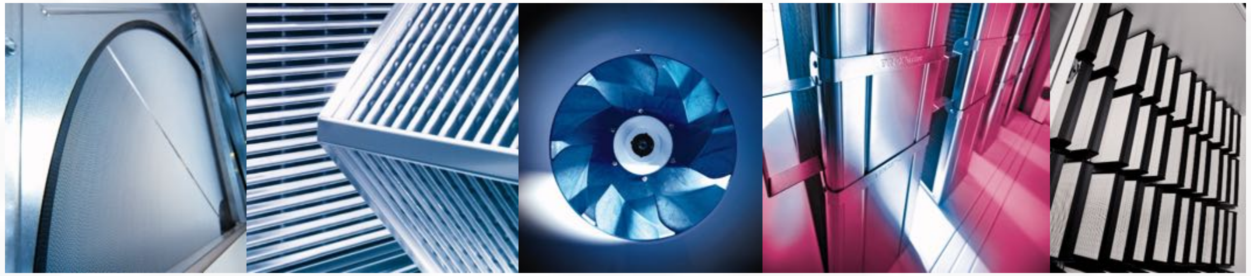
Fundamentals of Air Handling Units

Martin Lenz
Group Leader R&D, Chairman PG “AHU” at Eurovent
Trox GmbH, Germany


TROX

Agenda

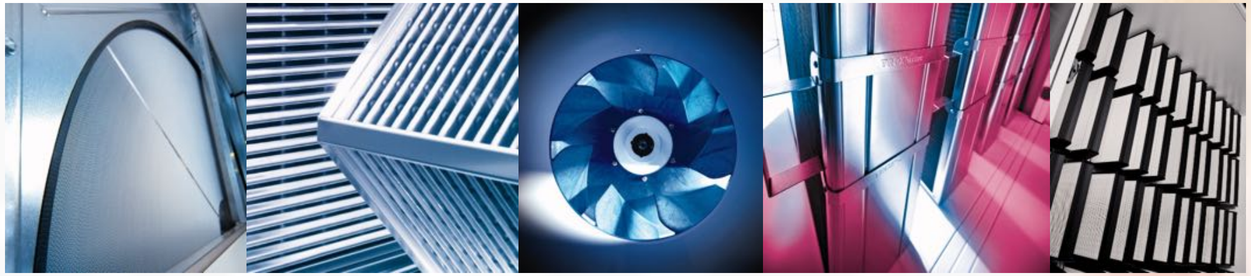
Components



Controls

Selection, Quality & Operation

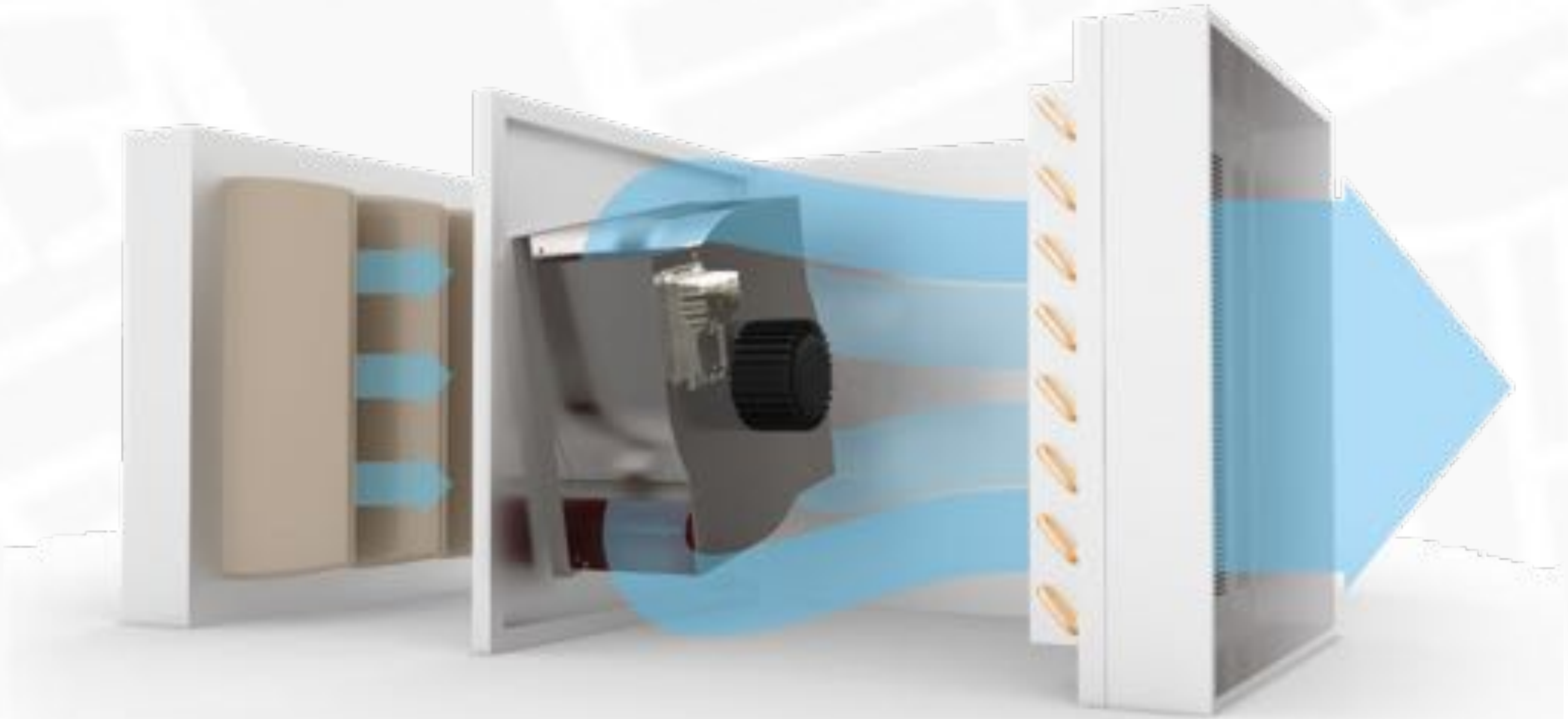
Components

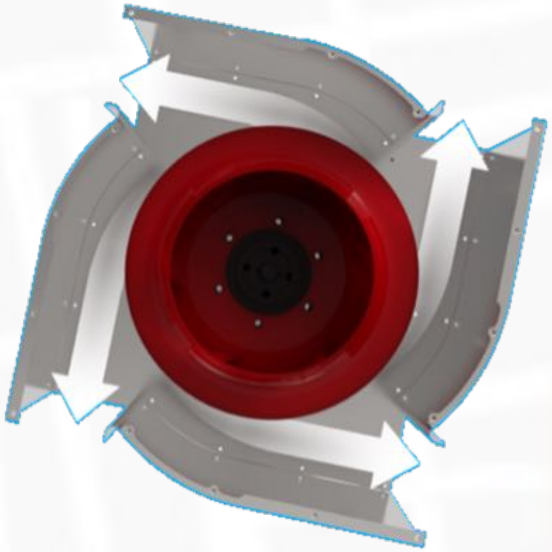


Trends and things that you might not have seen before

Fans

Improvement of efficiency by reducing losses at outlet side!



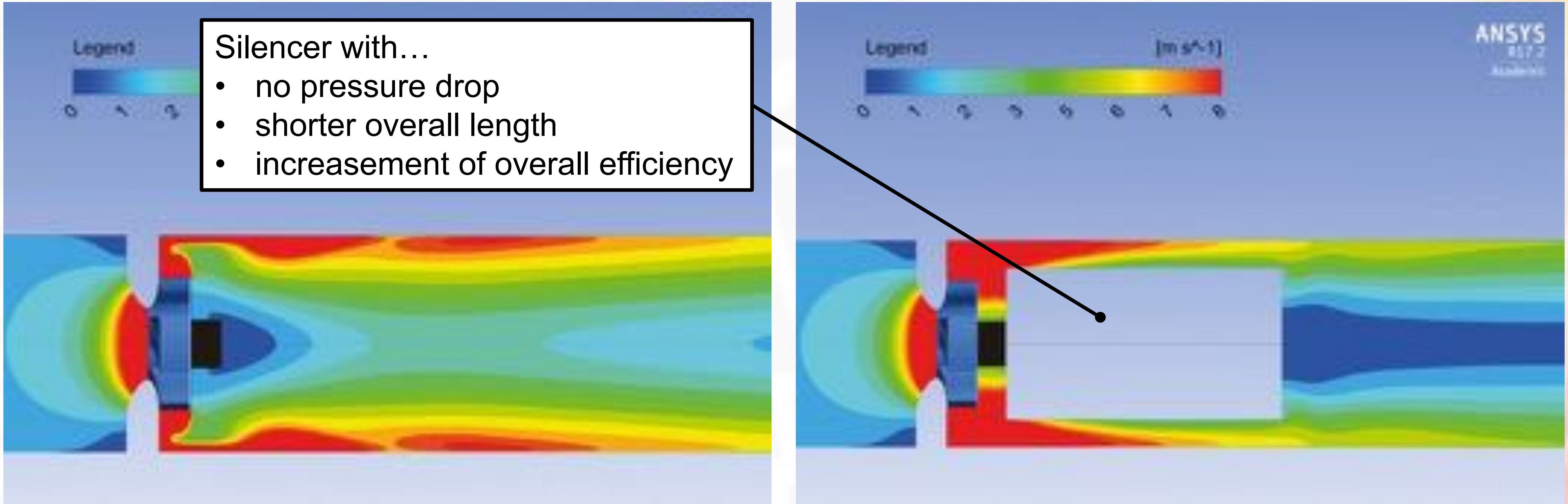


© Nicotra Gebhardt

>5%points efficiency improvement

Fans

Improvement of efficiency by reducing losses at outlet side!



Fans

Improvement of efficiency by reducing losses at outlet side!

>5% efficiency improvement compared to classic solution with splitters

>3% efficiency improvement compared to stand-alone plug-fan

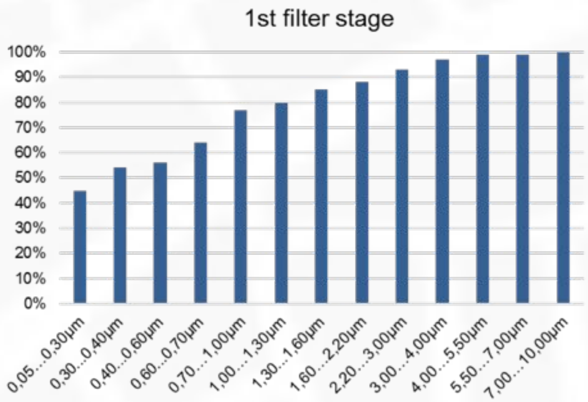
Fans

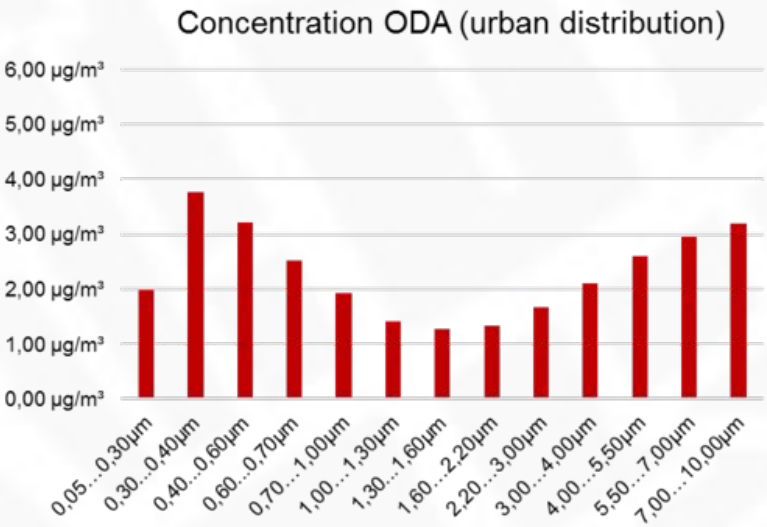
Improvement of efficiency by using EC-/PM-technology also for larger AHU

Filters

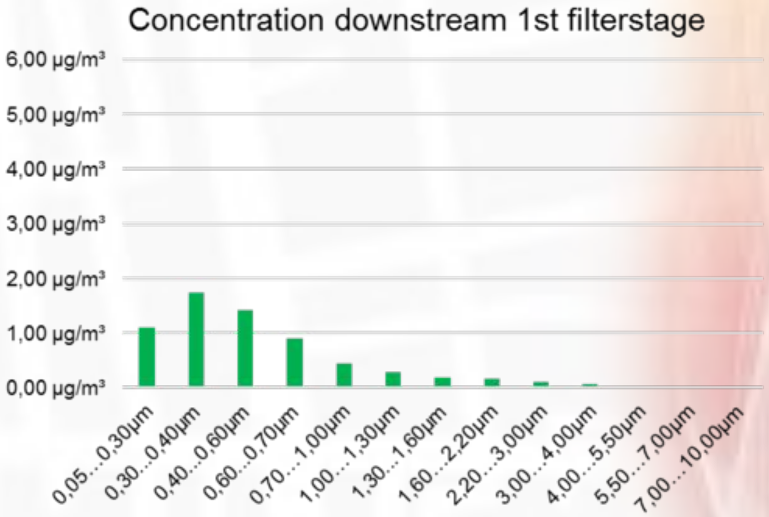
Selection depending on local requirements/project specific

Example:
PM10 = 30 µg/m³
urban area



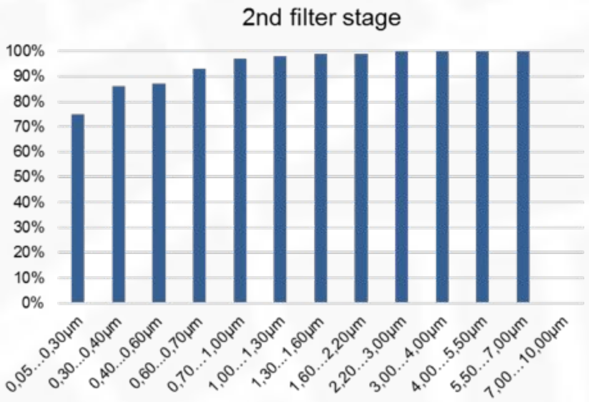


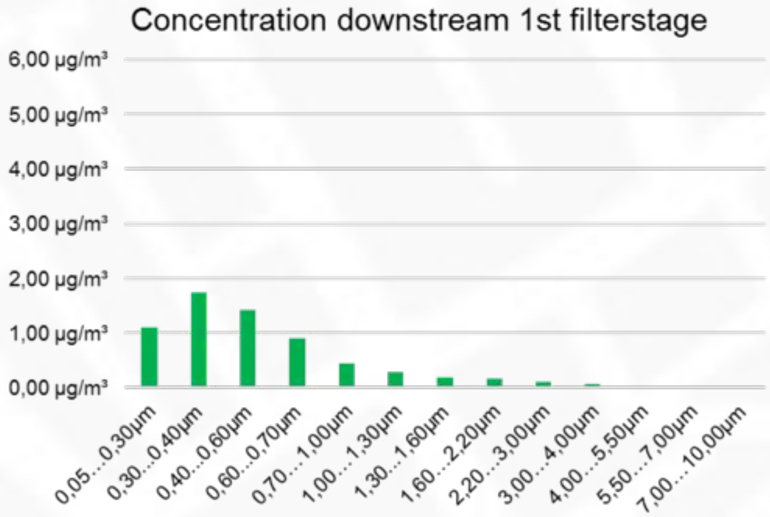
ePM1 65%
F7



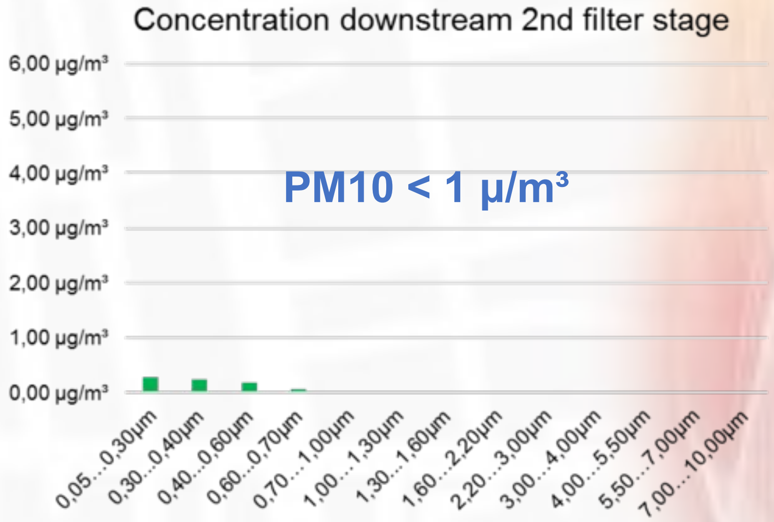
Filters

Selection depending on local requirements/project specific





ePM1 85%
F9



Heat recovery systems

Rotors

- optimized sealing to reduce leakages
- optimized profile structure to reach high efficiencies while keeping pressure drops low

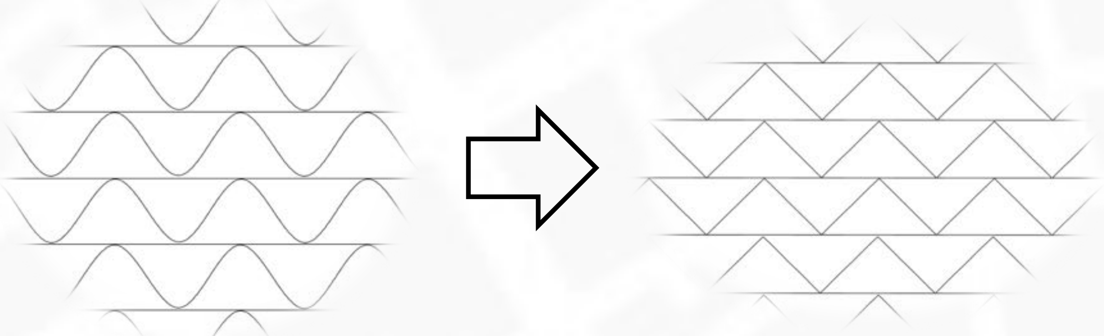
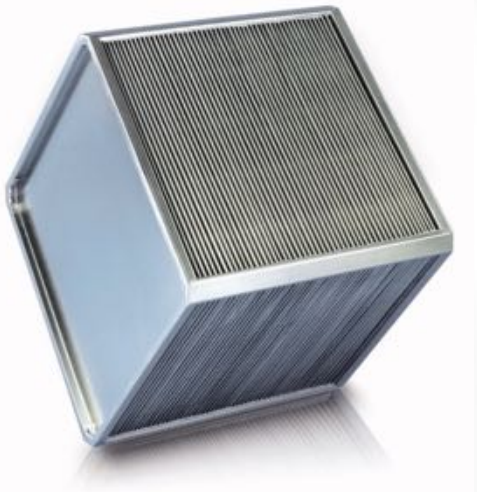
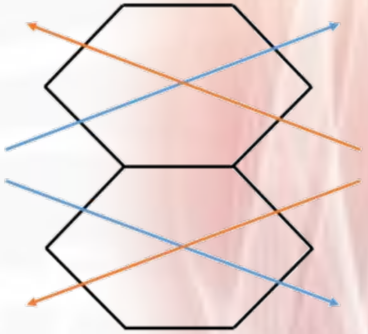


Plate heat exchangers



- optimized profile structure and low fin spaces to reach eco-design limits

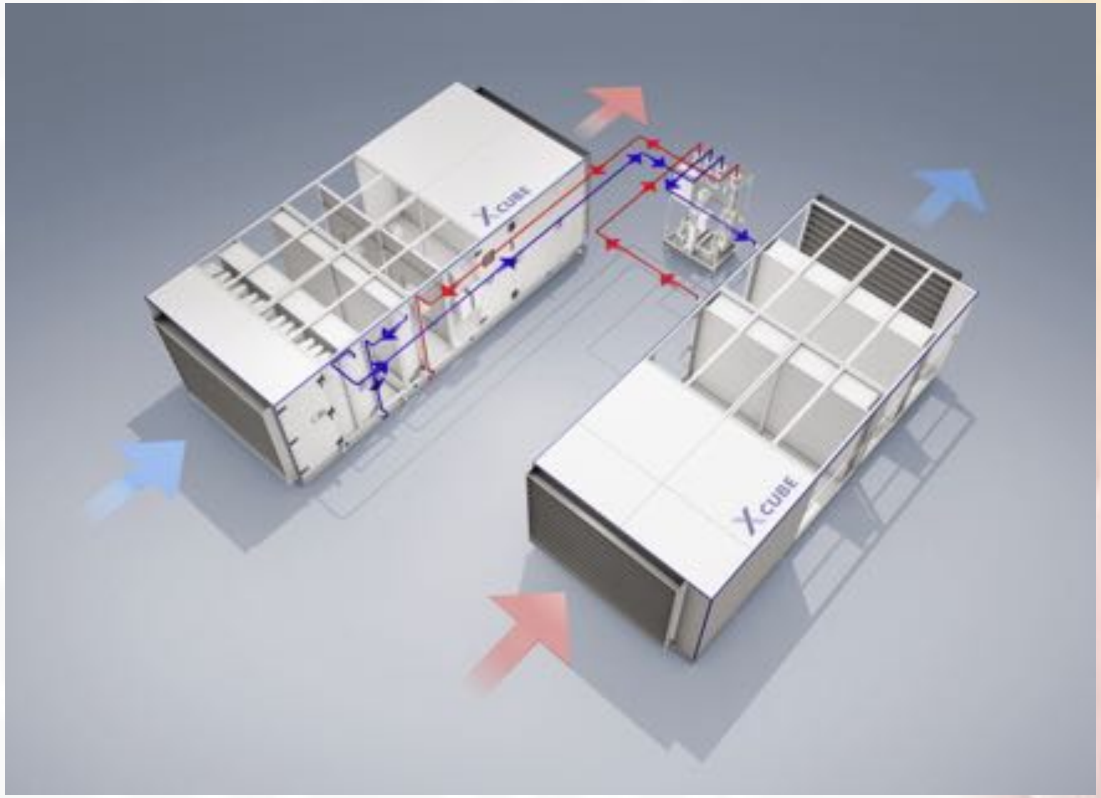


- parallel placement of cross-counter-flow exchangers

Heat recovery systems

Run-around coils

- necessity of completely separated air flows
- limited space (ODA & ETA can be devited)
- multifunctional use (feeding of thermal capacity while using the coils of RAC)
- dehumidification capacity recovery by using an integrated re-heater in RACs



Controls



The secret of using high efficient components in the most efficient way

Controls for AHUs or systems

Advantages of integrated controls:

prevention of unnecessary interfaces

system pretested

data points preconfigured

"plug & play"
(especially for small units)

predictive maintenance

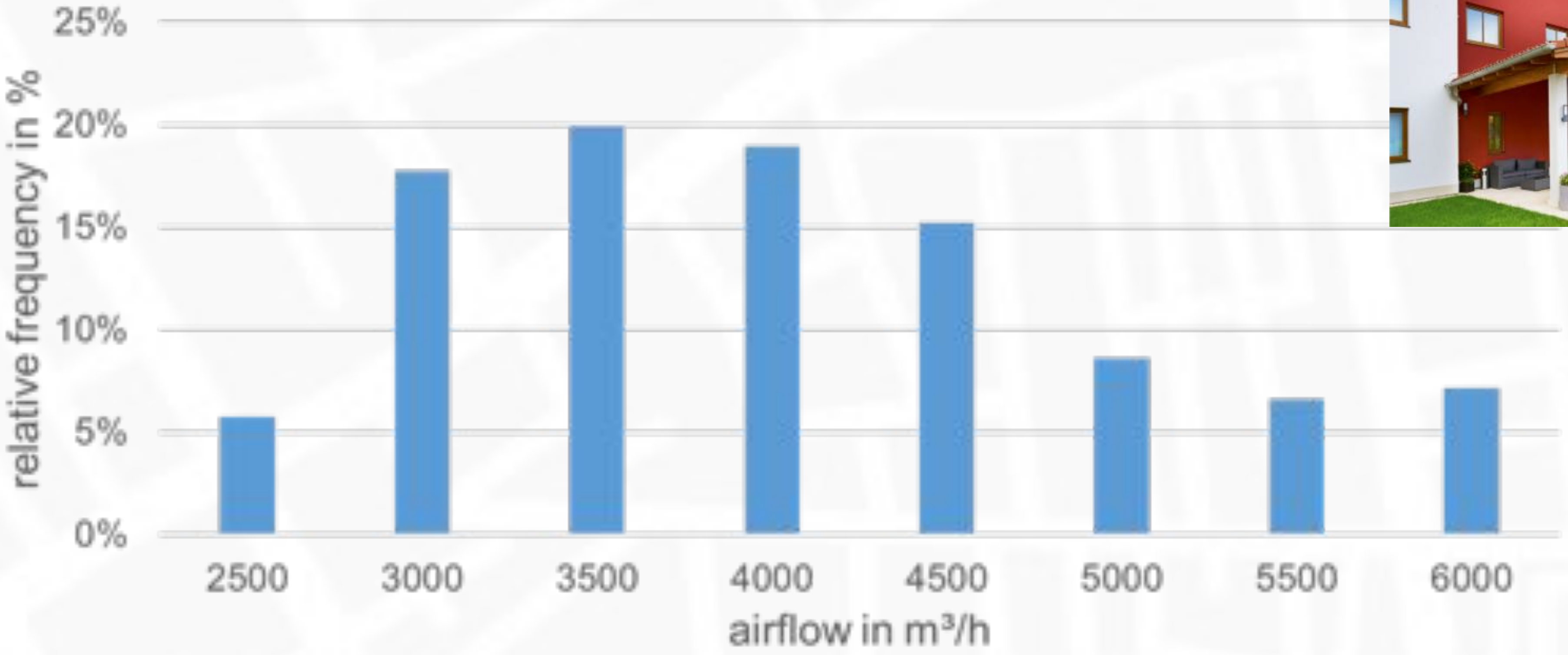
clean and hygiene-optimized wiring

bus connection for reduced amount of cables

Controls for air handling systems

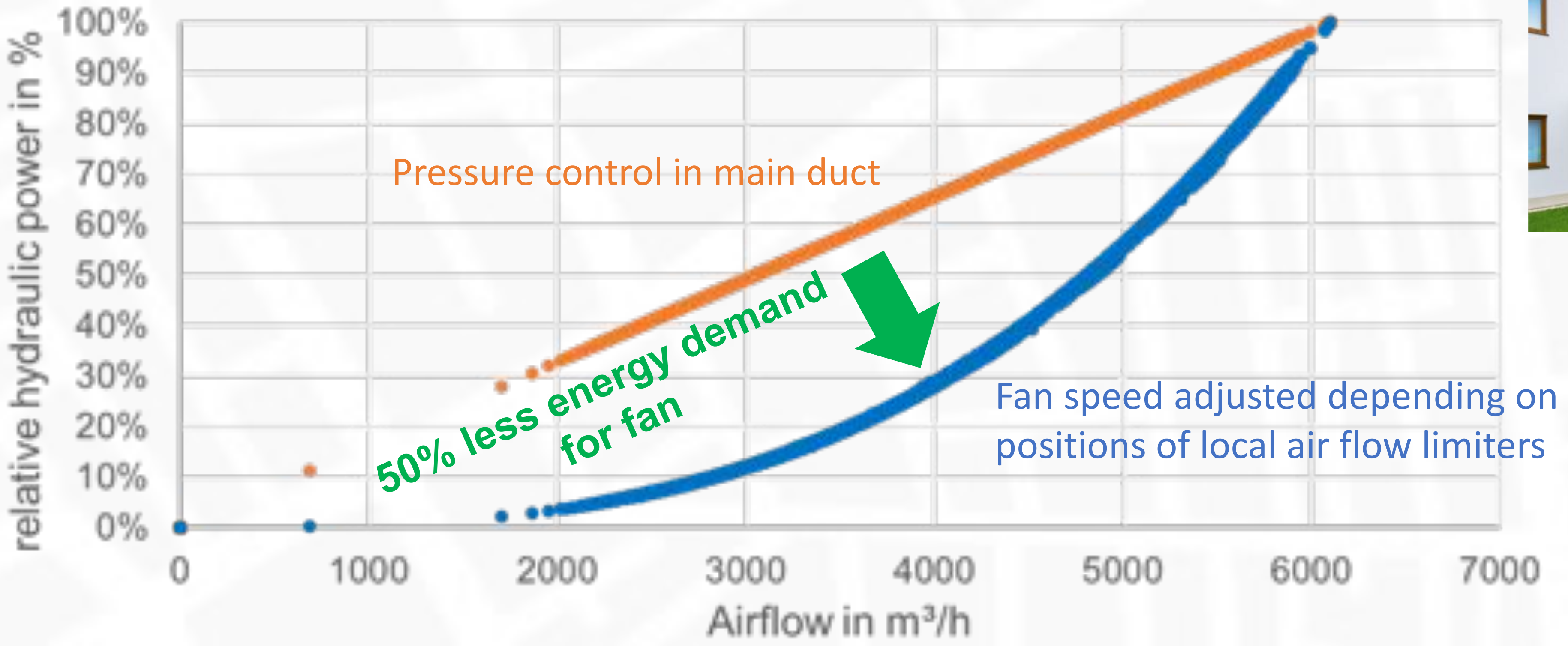
Interaction of the AHU with other HVACR equipment

Exemplary fan speed control in a hotel (real data):



Controls for air handlings systems

Interaction of the AHU with other HVACR equipment
Exemplary fan optimizer in a hotel (real data):



Smart controls lead to…

saving of time and stress

saving of energy

fan speed is controlled depending on position of local air flow controllers; amount of recirculation depending on local air quality and heating/cooling demand etc.

easy monitoring solutions

saving of costs

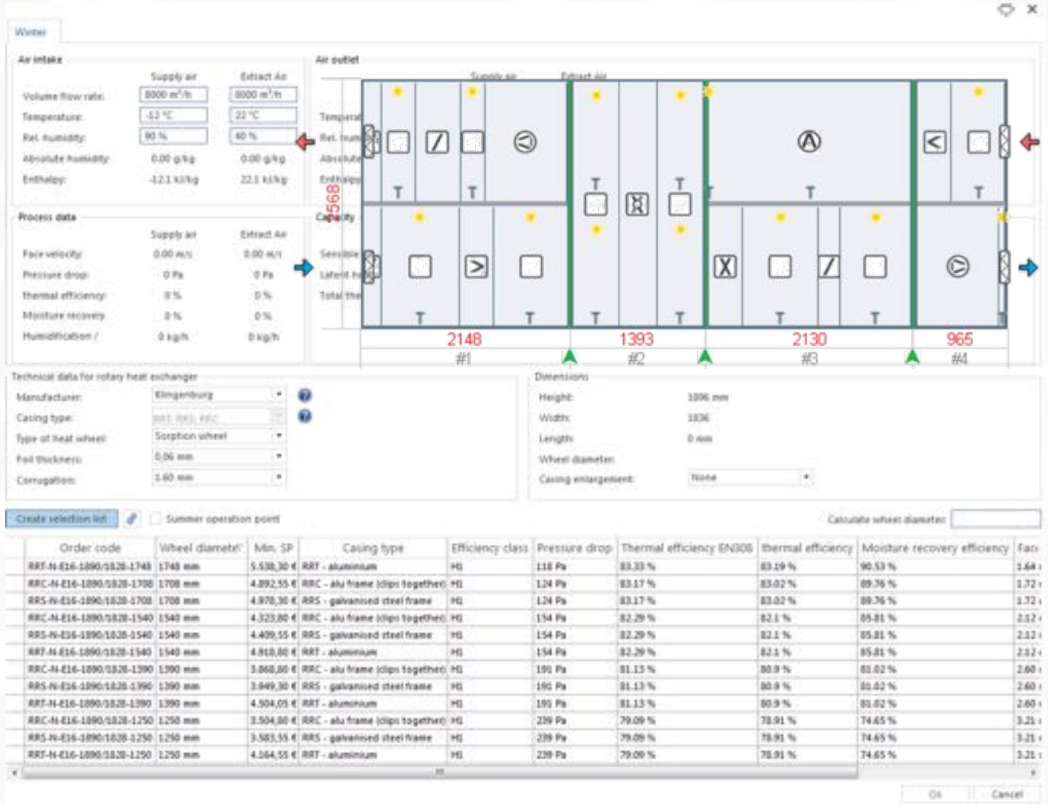
Selection, Quality and Operation

Make your life easy

Selection

Tailor made solutions lead to perfection in…

the choice of components



fitting to the application

Quality – Durability

Corrosion protection

class according ISO 12944, production process, stainless steel etc.

Stability

transportation, installation & maintenance

High quality components

particularly the use of good components lead to a good unit

Warranty

get long-term assurance

Quality – Hygiene & Maintenance

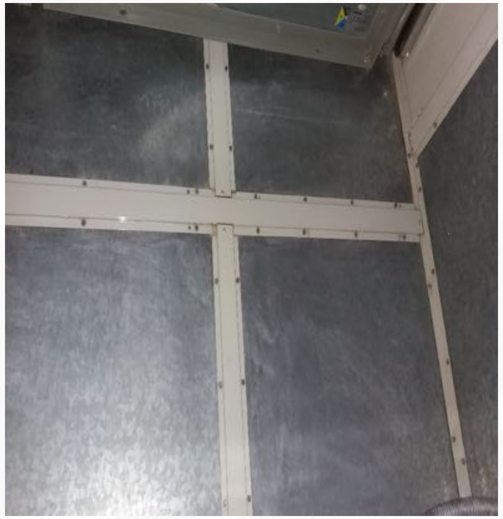
Imagine you would have to clean the unit…

You would not like...

- edges
- gaps
- protruding parts (screws etc.)
- small openings
- less space
- unsuitable drip trays
- …

Quality – Hygiene & Maintenance

See the difference…



Quality of technical data

Incorrect technical data lead to…

- sub-optimal selection of components
- limited comfort conditions
  - → poor air quality
  - → undersized thermal capacity
  - → high sound level

Get trustful and reliable data by…

- using certified components

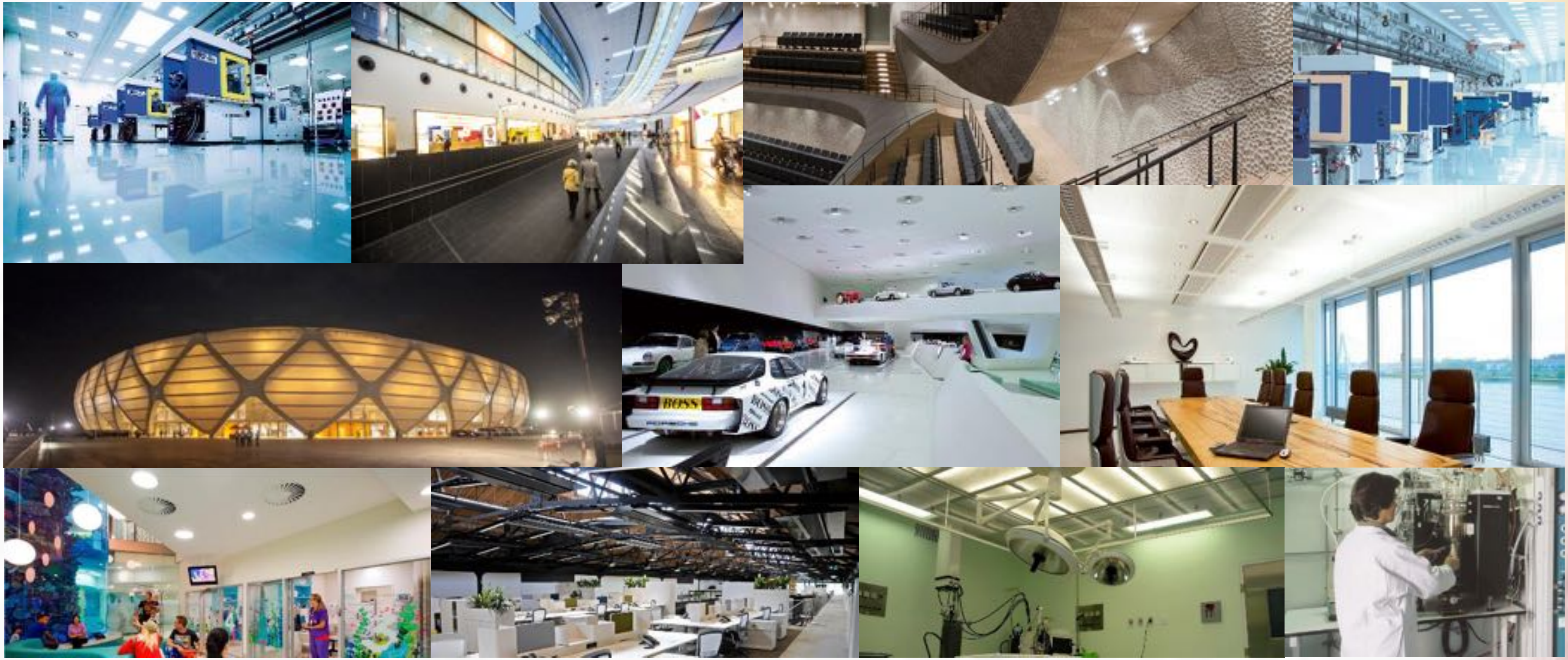
- convince yourself in factory acceptance test

Conclusion

Never forget: The lowest power consumption can be achieved with…

…having no air handling system

But imagine there would be no ventilation in…



Get highest comfort conditions with lowest energy consumption!!!

Energy Recovery in Fresh Air Units

Arun Diwaker
Business Development Manager
Desiccant Rotors International

RH Management:
Dual Wheel Systems

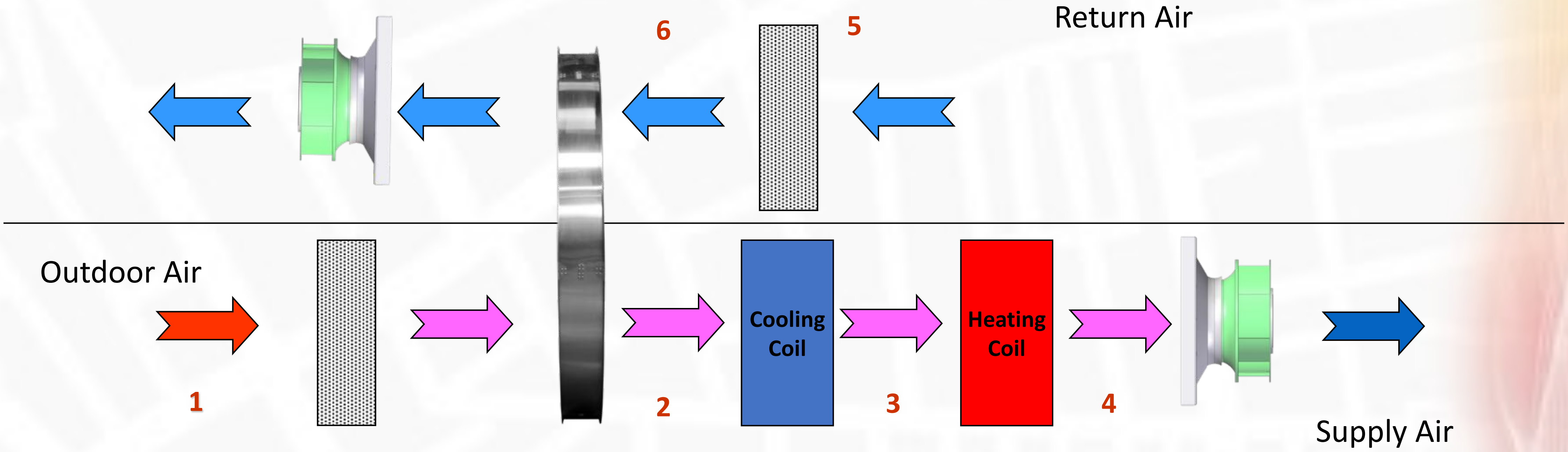
OPTION I: Rotary passive desiccant air-to-air heat exchanger coupled with dehumidification coil. (EW+CC +EH)

OPTION II: Rotary passive desiccant air-to-air heat exchanger coupled with dehumidification coil and wrap around heat pipe. (EW+CC+WHP)

OPTION III: Rotary passive desiccant air-to-air heat exchanger coupled with dehumidification coil and sensible air to air heat exchanger. (EW+CC+SW)

OPTION IV: Rotary passive desiccant air-to-air heat exchanger coupled with dehumidification coil and passive desiccant dehumidification wheel. (EW+CC+PDHC)

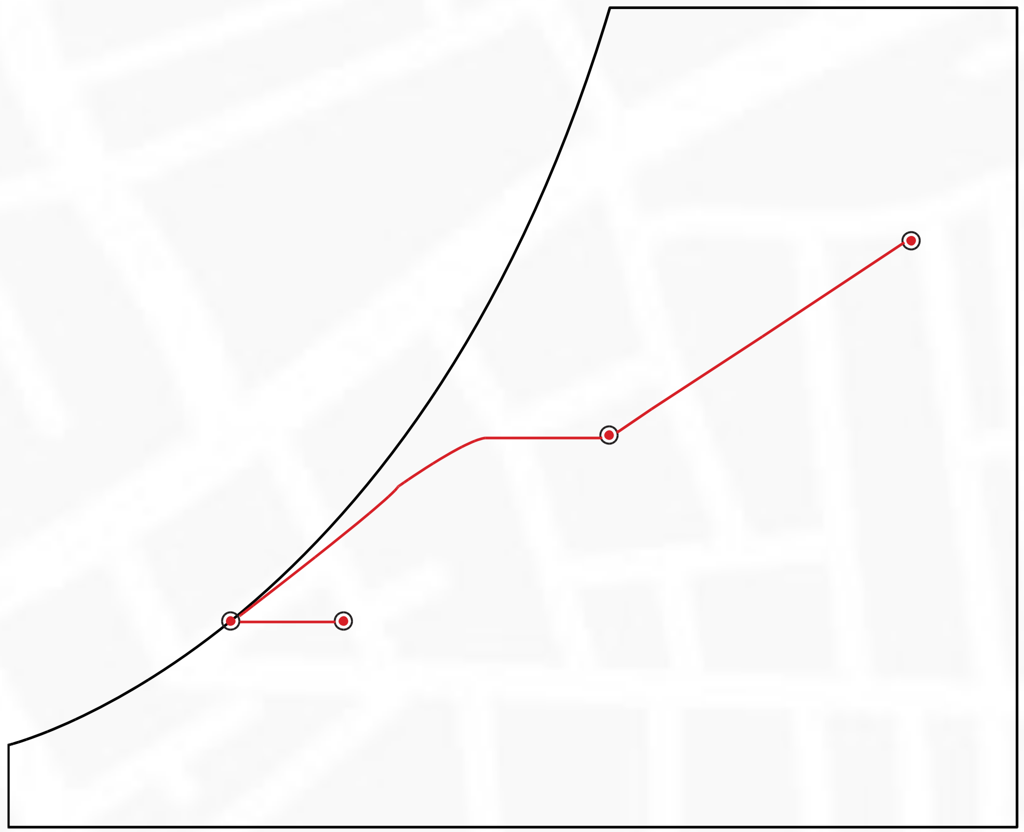
Schedule of DOAS:
Enthalpy Wheel, Cooling Coil, Heater



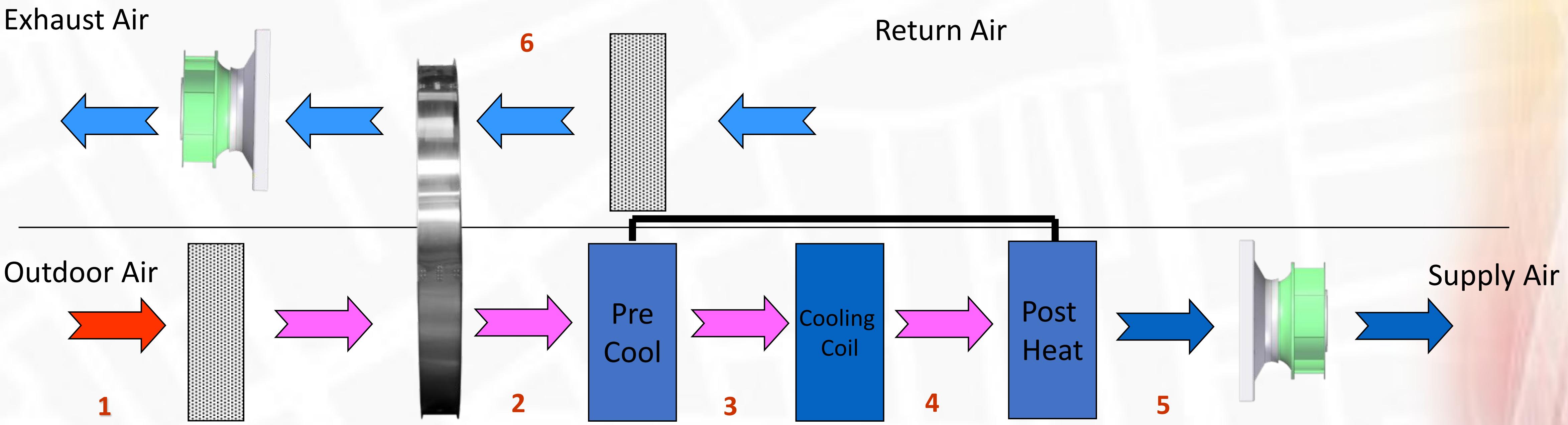
Schedule of DOAS:
Enthalpy Wheel, Cooling Coil, Heater

1				2			3			4			4			Cooling Coil		
Outdoor Air Conditions			**Freq. Hours**	Off Wheel Air Conditions			Off Coil Conditions			Supply Air Conditions			Return Air Conditions			Sensible Load (TR)	Total Load (TR)	**Heater Load (Kw)**
DBT °C	G/Kg	Kj/Kg		DBT °C	G/Kg	Kj/Kg	DBT °C	G/Kg	Kj/Kg	DBT °C	G/Kg	Kj/Kg	DBT °C	G/Kg	Kj/Kg			
46	**20.46**	**99.19**	**0**	**29.8**	**13.49**	**64.43**	**9**	**7**	**26.58**	**15**	**7**	**32.69**	**25**	**10.93**	**52.91**	**9.92**	**17.50**	**10**

Psychometric Chart:
Enthalpy Wheel, Cooling Coil, Heater



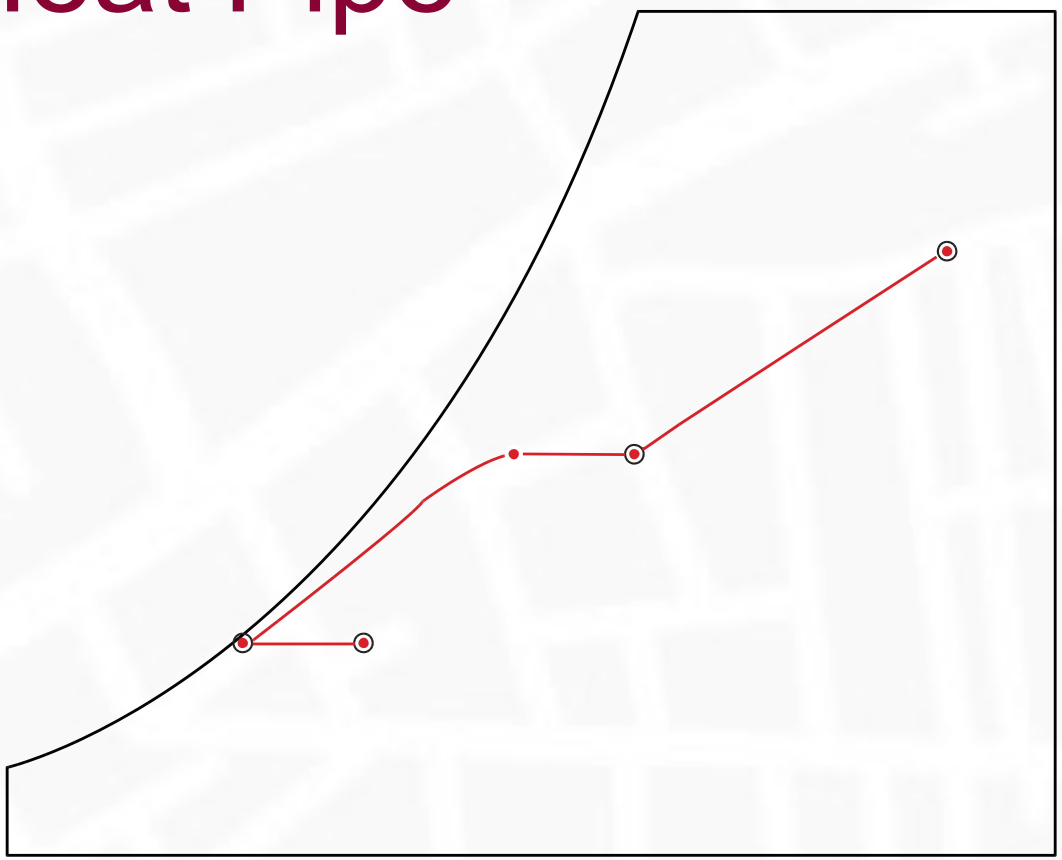
Enthalpy Wheel, Cooling Coil, Wrap around Heat Pipe



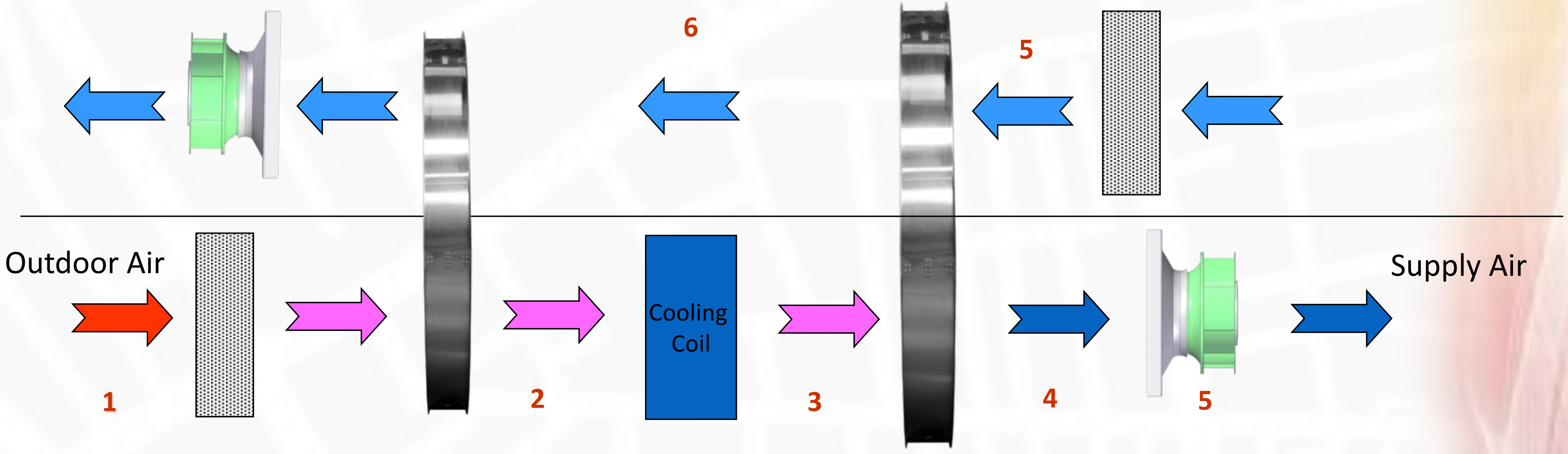
Enthalpy Wheel, Cooling Coil, Wrap around Heat Pipe

1				2			3			4			5			6			Cooling Coil Capacity	
Outdoor Air Conditions			Freq. Hours	Off Wheel Air Conditions			Pre Cool Air Conditions			Off Coil Air Conditions			Post Heat Air Conditions			Return Air Conditions			Sensible Load (TR)	Total Load (TR)
DBT °C	G/Kg	Kj/Kg		DBT °C	G/Kg	Kj/Kg	DBT °C	G/Kg	Kj/Kg	DBT °C	G/Kg	Kj/Kg	DBT °C	G/Kg	Kj/Kg	DBT °C	G/Kg	Kj/Kg		
46	20.46	99.19	0	29.81	13.49	64.43	23.5663	13.49	57.95	9	7	26.58	15.2	7.00	32.9	25	10.93	52.91	6.94	14.52

Enthalpy Wheel, Cooling Coil, Wrap around Heat Pipe



Enthalpy Wheel, Cooling Coil, Sensible Wheel



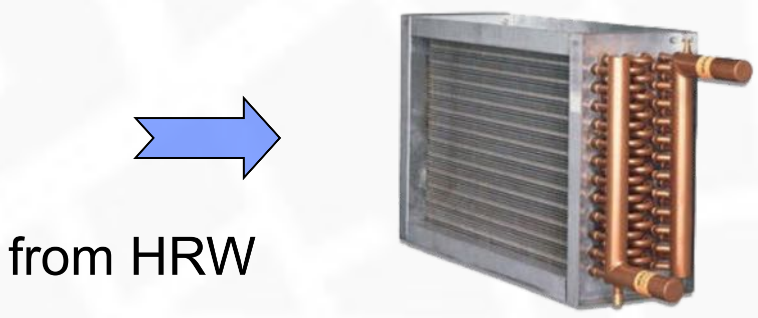
Enthalpy Wheel, Cooling Coil, Sensible Wheel

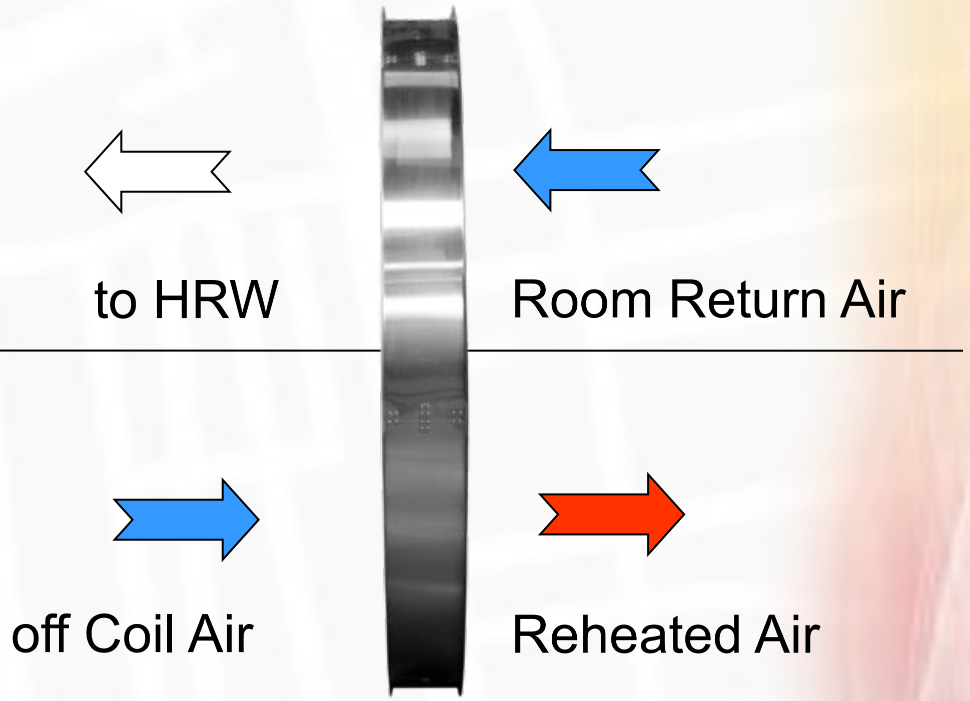
1				2			3			4			5			6			Cooling Coil	
Outdoor Air Conditions			**Freq. Hours**	Off Wheel Air Conditions			Off coil Conditions			Supply air Conditions			Return air Conditions			Return air on EW Conditions			Sensible Load (TR)	**Total Load (TR)**
DBT ° C	G/Kg	Kj/Kg		DBT ° C	G/Kg	Kj/Kg	DBT ° C	G/Kg	Kj/Kg	DBT ° C	G/Kg	Kj/Kg	DBT ° C	G/Kg	Kj/Kg	DBT ° C	G/Kg	Kj/Kg		
46	**20.46**	**99.19**	**0**	**23.64**	**13.49**	**58.26**	**9**	**7**	**26.58**	**17**	**7**	**34.73**	**25**	**10.93**	**52.91**	**17.00**	**10.93**	**44.69**	**6.98**	**14.56**

Enthalpy Wheel, Cooling Coil, Sensible Wheel

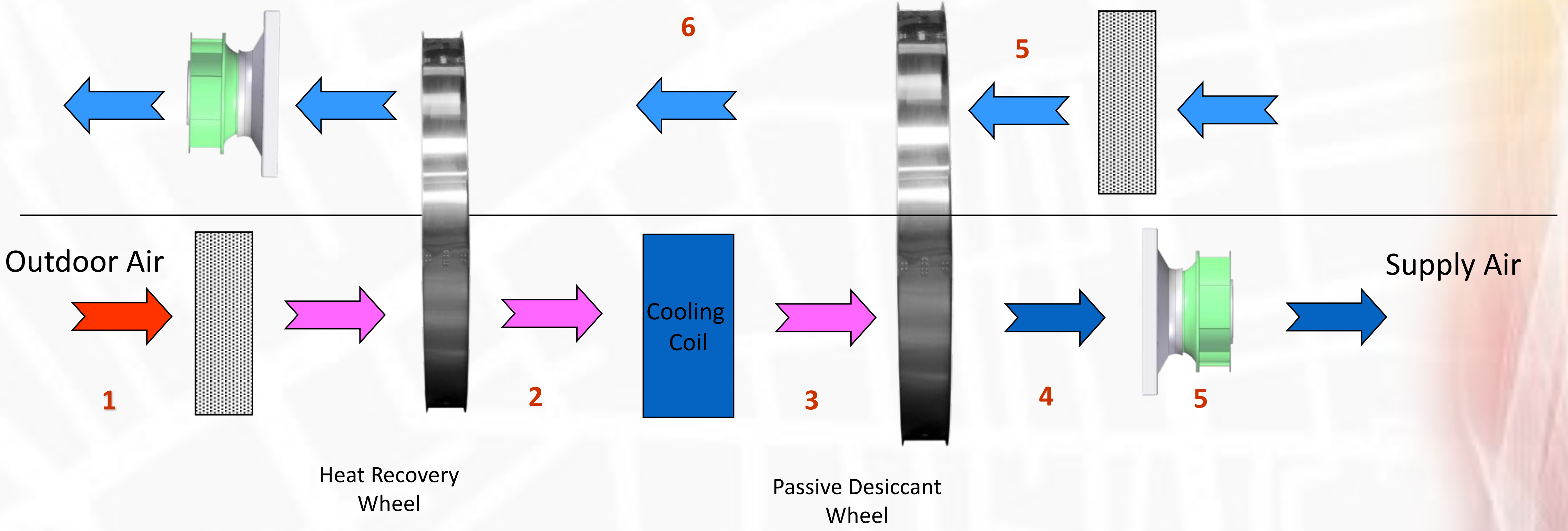
Basics of Sensible Wheels

- Free Heat
- Reheat Controls using VFD
- Improved Energy Recovery (T of Return Air reduced)





Enthalpy Wheel, Cooling Coil, Passive Desiccant Wheel



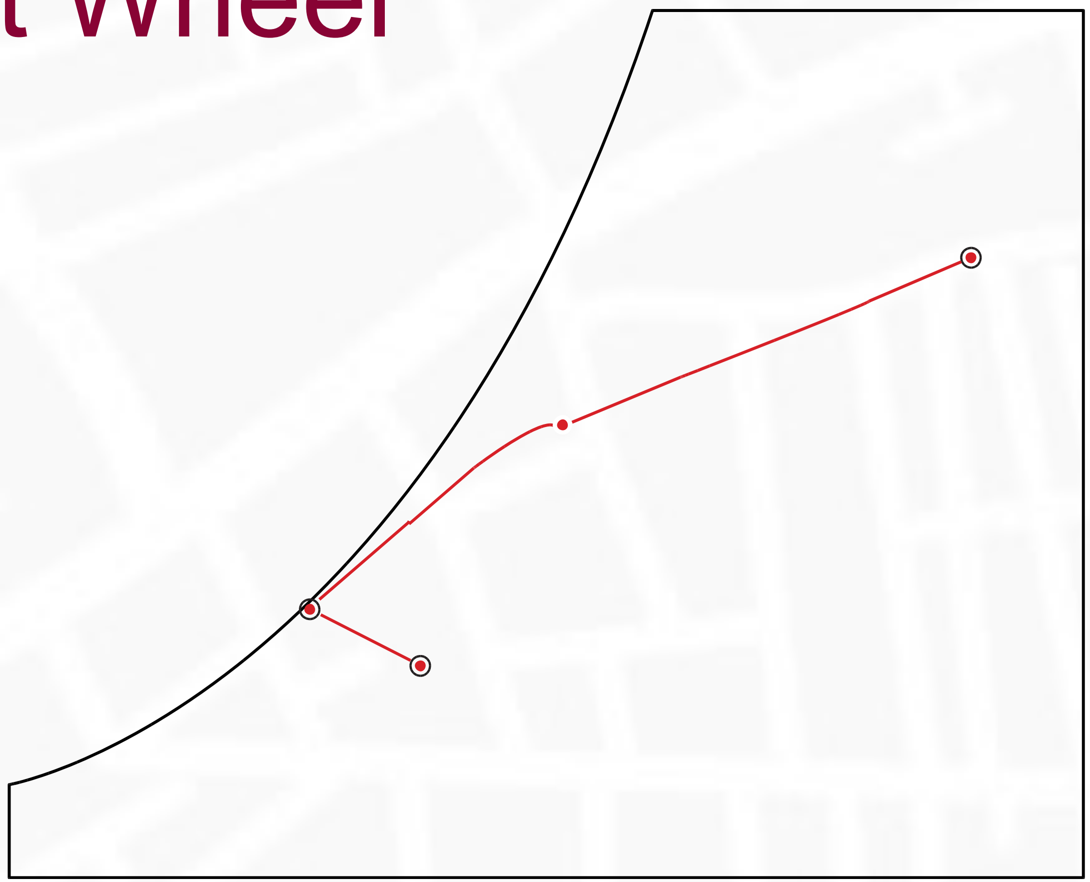
EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Enthalpy Wheel, Cooling Coil, Passive Desiccant Wheel

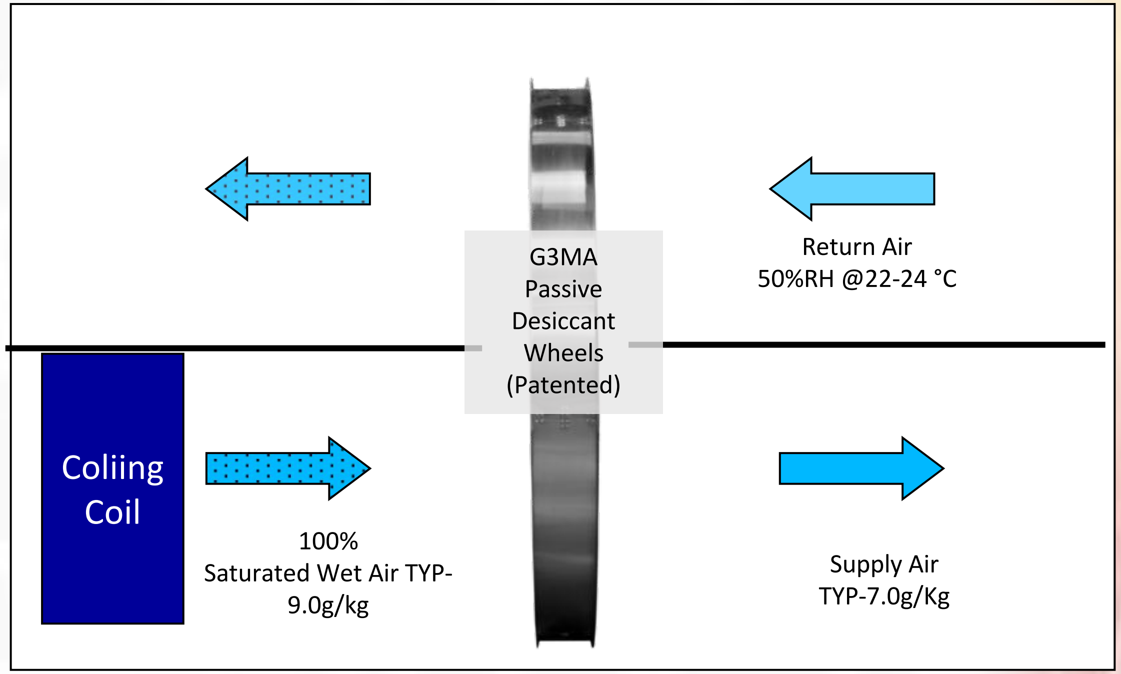
1				2			3			4			5			6			Cooling Coil	
Outdoor Air Conditions			**Freq. Hours**	Off Wheel Air Conditions			Off coil Conditions			Supply air Conditions			Return air Conditions			Return air on EW Conditions			Sensible Load (TR)	**Total Load (TR)**
DBT ° C	G/Kg	Kj/Kg		DBT ° C	G/Kg	Kj/Kg	DBT ° C	G/Kg	Kj/Kg	DBT ° C	G/Kg	Kj/Kg	DBT ° C	G/Kg	Kj/Kg	DBT ° C	G/Kg	Kj/Kg		
46	**20.46**	**99.19**	**0**	**25.46**	**14.88**	**64.64**	**12.22**	**8.9**	**34.8**	**17.86**	**7.00**	**35.61**	**25**	**10.93**	**52.91**	**19.36**	**12.83**	**51.93**	**6.31**	**13.29**

Enthalpy Wheel, Cooling Coil, Passive Desiccant Wheel



Passive Desiccant Wheel

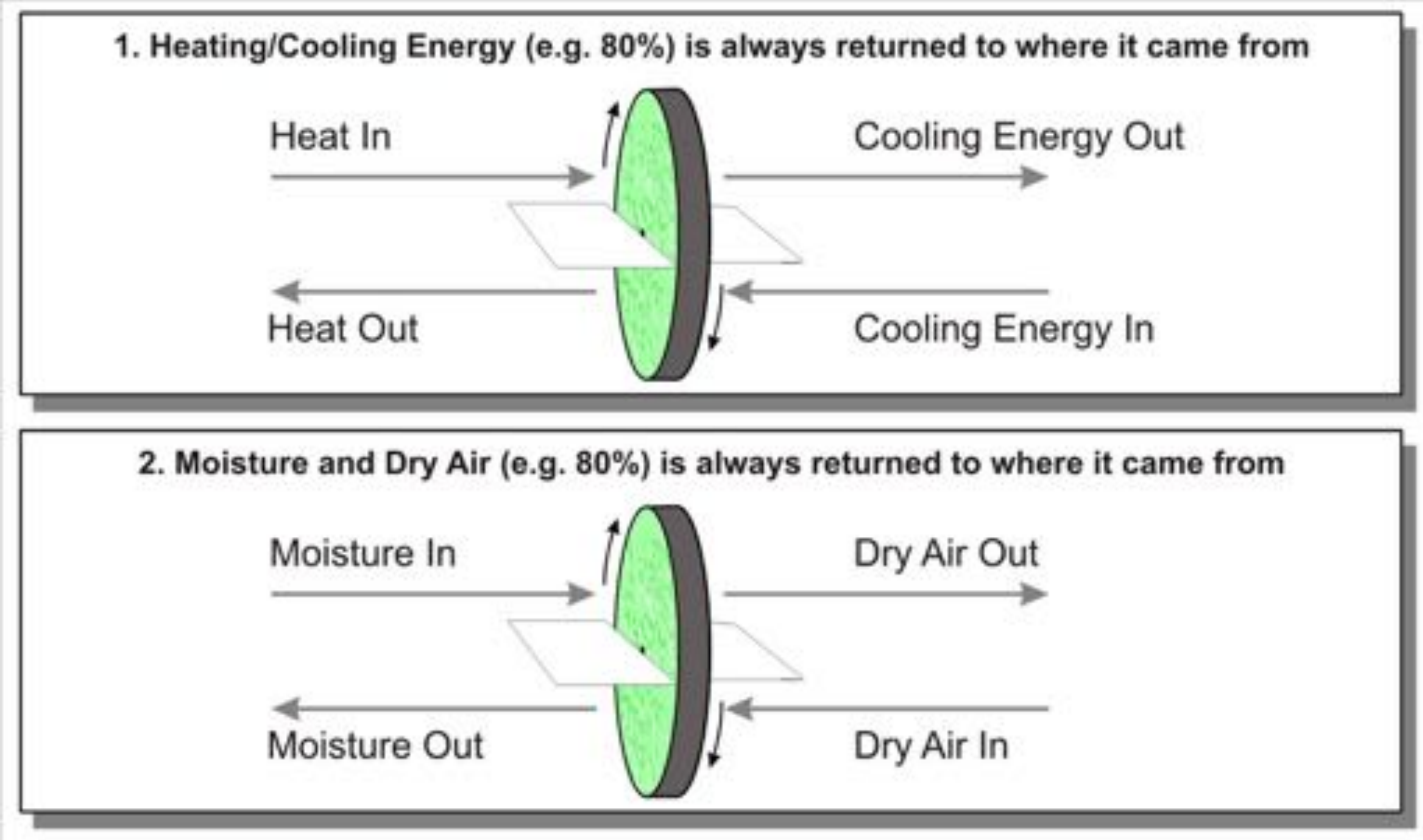
The unique passive desiccant wheel has the ability to be regenerated with the 50% RH room return air allowing for substantial moisture removal through dehumidification of the saturated (100% RH) Fresh Air being supplied to the room. This is intelligently controlled by the DRISmart EMS to regulate speed optimization for different load conditions and different outside conditions.



Advantage with G3MA “Passive” Wheel

- Removes moisture from a saturated air stream without heat/thermal regeneration
- High performance in-situ synthesized desiccant
- Fully water washable
- 100% non-flammable
- No washing away of desiccant on continued exposure to saturated/wet air

Working Principle of Heat Recovery Wheel



Energy Recovery Wheels: Essentials

- ***Energy Recovery Wheels* Molecular Sieve MS 3Å** is recommended to limit cross contamination to absolute minimum and ensure exclusion of contaminants in the air streams, while transferring water vapor molecules.
- ***Energy Recovery Wheels*** should be specially treated for prevention of any microbial growth on its surface and certified per the DIN EN ISO 846 standard, showing 0% fungi and bacterial growth.
- **Certified for Zero Flame Spread requirements:** NFPA–90A certification for 0% Flame spread classification and tested in accordance with NFPA 225 and ASTM–E84-95 Standard Test Method for Surface Burning.

Air Filters:
ISO 16890 & Eurovent 4/23

Dani Elamani
Technical Manager
Camfil Middle East

Agenda

- **ISO 16890 – the new global air filtration standard**
  - What are the benefits of this new standard?
  - Comparison to standards EN779 & ASHRAE 52.2
  - Overview of ISO 16890 filter classification
- **Eurovent 4/23 – how to select air filters based on ISO 16890**
  - In relation to local outdoor air quality (ODA)
  - In relation to required supply air quality (SUP)
  - Cumulated filter efficiency of multi-stage filtration

ISO 16890

Air Filters for General Ventilation

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Introduction

- Global situation

USA	Europe	Middle East / Asia
ASHRAE 52.2	EN 779:2012	ASHRAE 52.2, EN779 and local standards

- A significant harmonisation for the air filtration industry has been recently adopted.

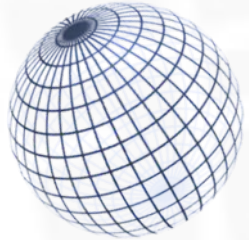
- A new standard for filter testing and classification with global coverage.

ISO16890 “Air Filters for General Ventilation”

Why a new global standard?
What are the customer benefits?

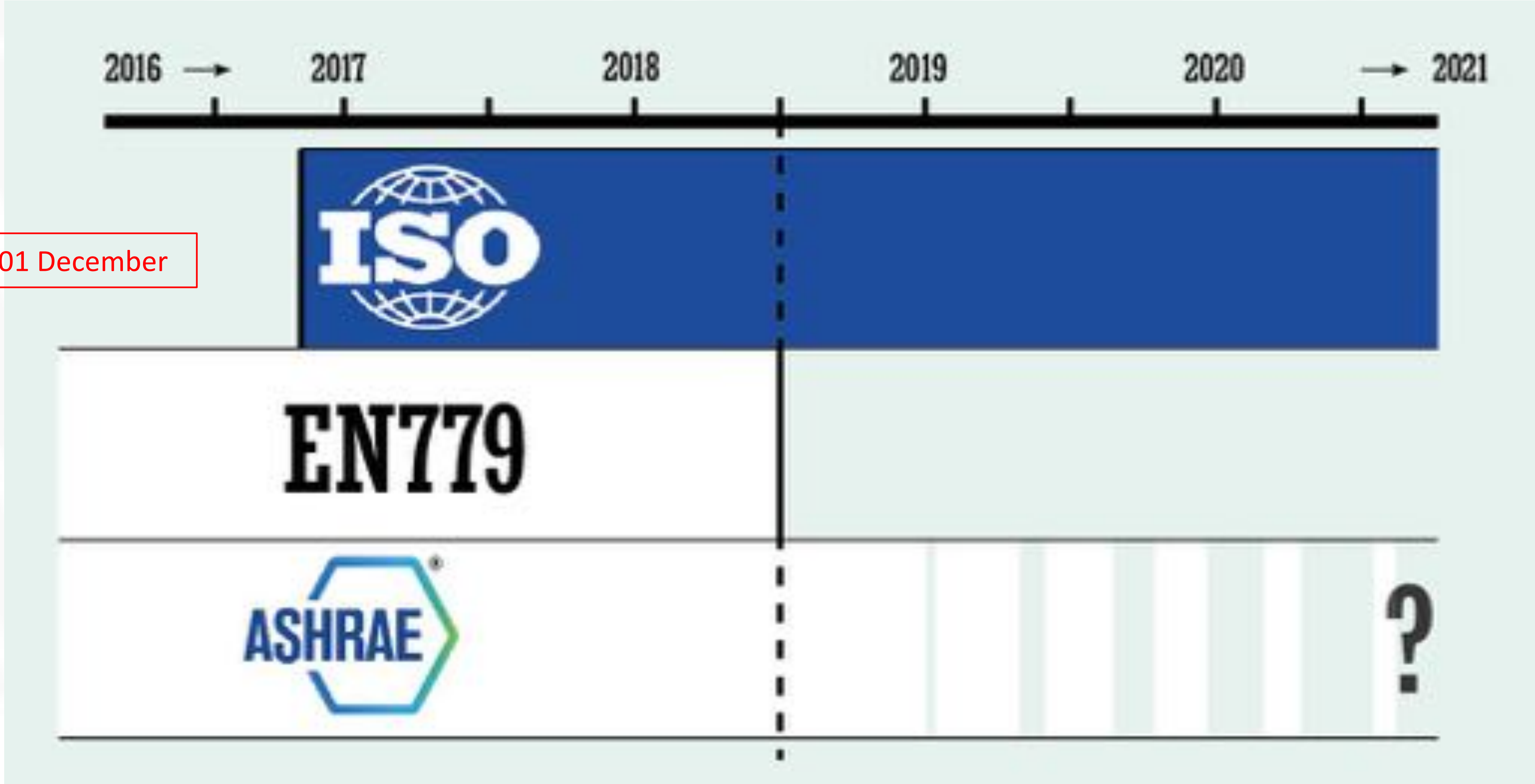
Recognition
–
Air filters positively influence air quality and human health

More intuitive
–
Filter efficiency and classification aligned with real world air pollution



Global applicability
–
Eliminate confusion

ISO 16890: Timeline



01 December

Comparison of Test Standards

	EN779:2012	ASHRAE 52.2	ISO16890
Filter test method	Testing efficiency with **0,4µm particles**	Testing efficiency with 0,3-10 µm particles. Classifications relate to results for **E1, E2 & E3 efficiency classes – MERV rating**	Testing efficiency with 0,3-10 µm particles. Classifications relate to result for **PM1, PM2.5 & PM10**
Discharging method	Discharges filter media only, using IPA soak **Tough discharging** method	Discharges entire filter Using KCL salt **Soft discharging** method (not mandatory – App. J)	Discharges entire filter using IPA vapor **Tough discharging** method
Filter loading method	Dustloading with ASHRAE dust **Coarse & sticky dust**	Dustloading with ASHRAE dust **Coarse & sticky dust**	Dustloading with ISO fine dust **Finer & less sticky dust**
Classification system	**9 Classes**	**16 Classes**	**49 classes** in **4 Filter Groups**

ISO16890: How Does it Work?

The standard is written in four parts:

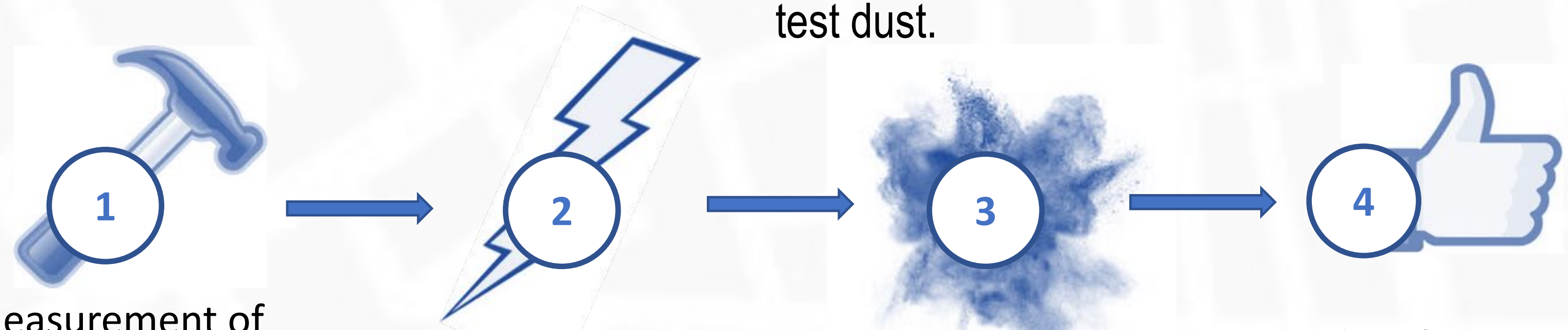
Part 1:
Technical specifications, requirements and classification system.

Part 2:
Measurement of fractional efficiency.

Part 3:
Determination of the arrestance and the air flow resistance versus the mass of test dust.

Part 4:
Conditioning method to determine the minimum fractional test efficiency.

IN PRACTICE:



Measurement of fractional efficiency

Discharging method

Gravimetric test method (optional)

Classification system

Filter Classification

4 filter groups

ePM 1	ePM 2.5	ePM 10	ISO Coarse
0,3 – 1 µm	0,3 – 2,5 µm	0,3 – 10 µm	ISO Fine Dust Initial arrestance
Corresponding to **E1** ASHRAE 52.2	Corresponding to **E2** ASHRAE 52.2	Corresponding to **E3** ASHRAE 52.2	Filters with **ePM10 < 50%**

ISO16890: Classification System

Table 4 – Filter groups

Group designation	Requirement			Class reporting value
	$ePM_{1,\ min}$	$ePM_{2,5,\ min}$	ePM_{10}	
ISO Coarse	—	—	< 50%	Initial grav. arrestance
ISO ePM10	—	—	≥ 50%	ePM_{10}
ISO ePM2,5	—	≥ 50%	—	$ePM_{2,5}$
ISO ePM1	≥ 50%	—	—	ePM_1

Filter Classification
3 Simple Rules:

- Reported efficiency – is an average between the initial and the discharged efficiency.

- To be able to report – initial new efficiency needs to be over 50%.

AND

- To be able to report – discharged efficiency needs to be over 50% (ePM1 and ePM2.5)

ISO 16890 Test Report

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

ISO 16890-1:2016 - Air Filter Test Results					Testing Organization: RISE Research Institute of Sweden, Brinellgatan 4, 501 15 Borås, Sweden, +46010516500
GENERAL					
Report no.: 6P07577-25-rev1	Date of tests: 2017-02-16 - 2017-02-23				Date of report: 2017-03-02
Supervisor: CM				Device obtained (when and how obtained):	
Test(s) requested by: Camfil AB				The device was sent and obtained on 2017-02-14	
DEVICE TESTED					
Model: Hi Flo II XLT 7/640 50+ (HFGX-F7-592/592/640-10-25)		Manufacturer: Camfil AB			Construction: Pocket filter, 10 Pockets
Article number: 610165	Type of medium: Glass	Net effective filtering area: 7.3 m^2			Filter dimensions (width x height x depth): 592x592x640 mm
TEST DATA AND ATTACHED TEST REPORTS					
Test air flow rate: 0.944 m^3/s	Test aerosols: KCl (1-10 µm) DEHS (0.3-1 µm)	Test report to ISO 16890-2			Report no. 6P07577-25-rev1 Appendix 2
		Test report to ISO 16890-3 (optional)			Report no. 6P07577-25-rev1 Appendix 3
		Test report to ISO 16890-4			Report no. 6P07577-25-rev1 Appendix 4
RESULTS					
Initial pressure differential: 72 Pa	Initial grav. arrestance: 97 %	$ePM_{1,min}$: 63 %	$ePM_{2.5,min}$: 73 %		ISO rating
Final test pressure differential: 300 Pa	Test dust capacity: 1160 g	ePM_1: 64 %	$ePM_{2.5}$: 73 %	ePM_{10}: 91 %	**ISO ePM $_1$ 60 %**

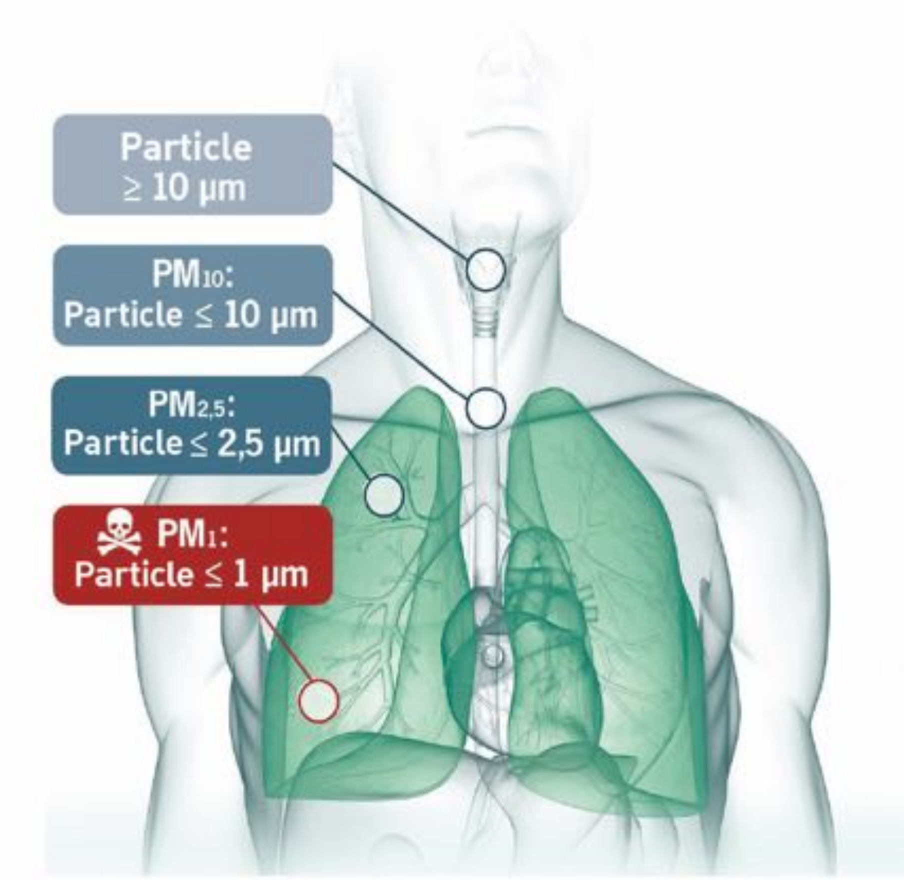
Eurovent 4/23

Selection of ISO 16890 rated Air Filters for General Ventilation Applications

Eurovent 4/23

- Recommendation for the selection of ISO 16890 rated air filters for general ventilation applications
- Developed in a joint effort by the participants of the Eurovent Product Group ‘Air Filters’
- Published on 09 January 2018

Introduction
Impact on Health



PM10	PM2.5	PM1
Particles 10 µm in diameter or smaller can reach the respiratory ducts and potentially cause decreased lung function.	**Particles 2.5 µm** in diameter or smaller can penetrate the lungs and cause decreased lung function, skin and eye problems.	**Particles 1 µm** in diameter or smaller are most dangerous. They are tiny enough to enter the bloodstream and lead to cancer, cardiovascular diseases and dementia.

Outdoor Air (ODA) - How clean is my Outdoor Air?

- 3 Outdoor Air Classes (ODA 1-3)
- Based on WHO Tresholds:
- Annual mean for PM2.5 < 10 µg/m3
- Annual mean for PM10 < 20 µg/m3

Category	Description	Typical environment
ODA 1	**OUTDOOR AIR, WHICH MAY BE ONLY TEMPORARILY DUSTY** Applies where the World Health Organisation WHO (2005) guidelines are fulfilled (annual mean for PM2.5 ≤ 10 µg/m^3 and PM10 ≤ 20 µg/m^3).	
ODA 2	**OUTDOOR AIR WITH HIGH CONCENTRATIONS OF PARTICULATE MATTER** Applies where PM concentrations exceed the WHO guidelines by a factor of up to 1,5 (annual mean for PM2.5 ≤ 15 µg/m^3 and PM10 ≤ 30 µg/m^3).	
ODA 3	**OUTDOOR AIR WITH VERY HIGH CONCENTRATIONS OF PARTICULATE MATTER** Applies where PM concentrations exceed the WHO guidelines by a factor of greater than 1,5 (annual mean for PM2.5 > 15 µg/m^3 and PM10 > 30 µg/m^3).	

Supply Air Classes (SUP)

SUP 1	refers to supply air with concentrations of particulate matter which fulfilled the WHO (2005) guidelines limit values multiplied by a factor x 0,25 (annual mean for PM2.5 ≤ 2.5 µg/m³ and PM10 ≤ 5 µg/m³).
SUP 2	refers to supply air with concentrations of particulate matter which fulfilled the WHO (2005) guidelines limit values multiplied by a factor x 0,5 (annual mean for PM2.5 ≤ 5 µg/m³ and PM10 ≤ 10 µg/m³).
SUP 3	refers to supply air with concentrations of particulate matter which fulfilled the WHO (2005) guidelines limit values multiplied by a factor x 0,75 (annual mean for PM2.5 ≤ 7.5 µg/m³ and PM10 ≤ 15 µg/m³).
SUP 4	refers to supply air with concentrations of particulate matter which fulfilled the WHO (2005) guidelines limit values (annual mean for PM2.5 ≤ 10 µg/m³ and PM10 ≤ 20 µg/m³).
SUP 5	refers to supply air with concentrations of particulate matter which fulfilled the WHO (2005) guidelines limit values multiplied by factor x 1,5 (annual mean for PM2.5 ≤ 15 µg/m³ and PM10 ≤ 30 µg/m³).

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Examples for Supply Air Classes (SUP)

CATEGORY	GENERAL VENTILATION		CATEGORY	INDUSTRIAL VENTILATION	
SUP 1	-	-	SUP 1	**Applications with high hygienic demands.** Examples: Hospitals, pharmaceutics, electronic and optical industry, supply air to clean rooms.	
SUP 2	**Rooms for permanent occupation.** Example: Kindergardens, offices, hotels, residential buildings, meeting rooms, exhibition halls, conference halls, theaters, cinemas, concert halls.	 	SUP 2	**Applications with medium hygienic demands.** Example: Food and beverage production.	
SUP 3	**Rooms with temporary occupation.** Examples: Storage, shopping centers, washing rooms, server rooms, copier rooms.	 	SUP 3	**Applications with basic hygienic demands.** Example: Food and beverages production with a basic hygienic demand.	
SUP 4	**Rooms with short-term occupation.** Examples restrooms, storage rooms stairways.	 	SUP 4	**Applications without hygienic demands.** Example: General production areas in the automotive industry.	
SUP 5	**Rooms without occupation.** Examples: Garbage room, data centers, underground car parks.	 	SUP 5	**Production areas of the heavy industry.** Examples: Steel mill, smelters, welding plants.	

Recommended Minimum Efficiency

			SUPPLY AIR				
OUTDOOR AIR			SUP 1* PM2.5 ≤ 2.5 PM10 ≤ 5	SUP2* PM2.5 ≤ 5 PM10 ≤ 10	SUP3** PM2.5 ≤ 7.5 PM10 ≤ 15	SUP4 PM2.5 ≤ 10 PM10 ≤ 20	SUP5 PM2.5 ≤ 15 PM10 ≤ 30
Category	PM2.5	PM10	ePM_1	ePM_1	$ePM_{2.5}$	ePM_{10}	ePM_{10}
ODA 1	≤ 10	≤ 20	60%	50%	60%	60%	50%
ODA 2	≤ 15	≤ 30	80%	70%	70%	80%	60%
ODA 3	> 15	> 30	90%	80%	80%	90%	80%

Table 3: Recommended min. ePMx filtration efficiencies depending on ODA and SUP category. Annual mean PMx values in µg/m³

* Minimum filtration requirements ISO ePM_1 50% refer to a final filter stage

** Minimum filtration requirements ISO $ePM_{2.5}$ 50% refer to a final filter stage

Presented efficiency values concern both single filter and multi-stage filtration systems with a cumulated efficiency.

Multi-Stage Filtration
Estimation of cumulated efficiency

To facilitate rough estimations, it is recommended to use the following formula to determine the combined filtration efficiency for respective particle size fractions:

$$ePM_{x,\,cum} = 100 \cdot \left(1 - \left(\left(1 - \frac{ePM_{x,\,s1}}{100}\right) \cdot \left(1 - \frac{ePM_{x,\,s2}}{100}\right) \cdot\cdot\cdot\cdot\cdot \left(1 - \frac{ePM_{x,\,sn+1}}{100}\right)\right)\right)$$

Where

$ePM_{x,cum}$ is the total cumulated efficiency for x fraction

$ePM_{x,sn+1}$ is the fractional efficiency for each filter stage

Multi-Stage Filtration
Estimation of cumulated efficiency

Office in Dubai: ODA 3 & SUP 2 = min. ePM1 80%

Stage 1
ePM1 60%

Stage 2
ePM1 60%

$$ePM1_{\,cum} = 100 \times \left(1 - \left(1 - \frac{60}{100}\right) \times \left(1 - \frac{60}{100}\right)\right) = 84\%$$

Summary

- ISO16890 is a new global standard for testing and classification of air filters
- It brings clear benefits for specifiers, purchasers and users of air filters
- Selecting ePM1 filters will result in improved air quality and lower health risk
- Eurovent 4/23 merges theoretical and practical aspects of designing Indoor Air Quality in terms of air filtration
- Eurovent 4/23 provides hands on and effective advice for HVAC planners and manufactures of ventilation equipment to correctly design filtration

EC Technology for AHUs: New-Build and Retrofit

John Fernandez
Managing Director
ebm-papst Middle East

Overview

- What is an EC Plug Fan?
- Electronically-Commutated (EC) Motor Technology
- Variable Speed Drive (VSD) and Control Options
- Backward-Curved Impeller Design

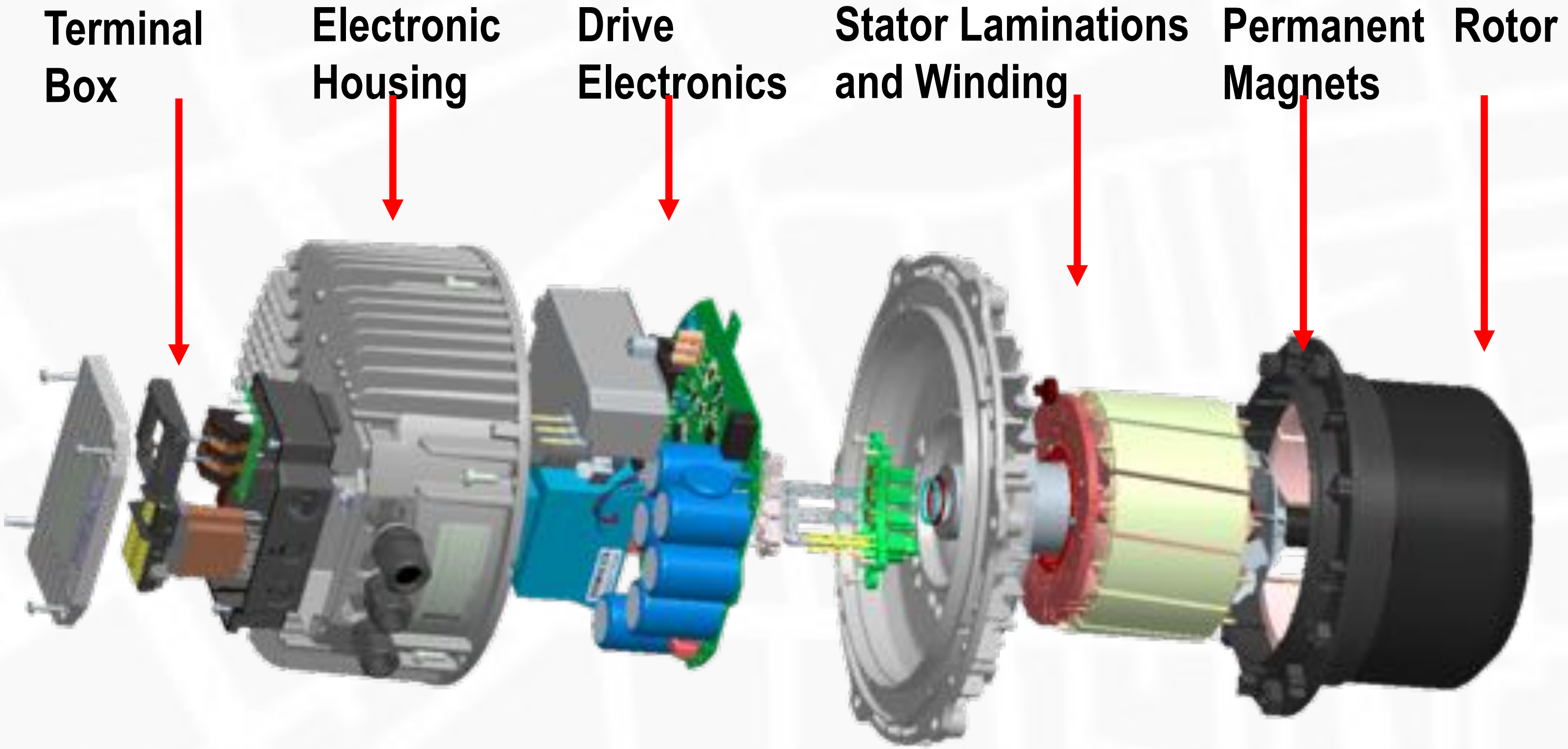
- Fan Array Applications

What is an EC Plug Fan?

A Plug-and-Play Air Movement System

EC Motor Technology

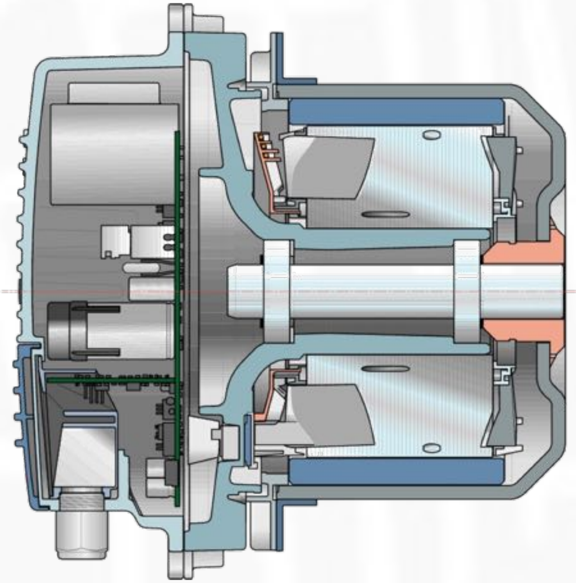
Motor Construction



EC Motor Technology

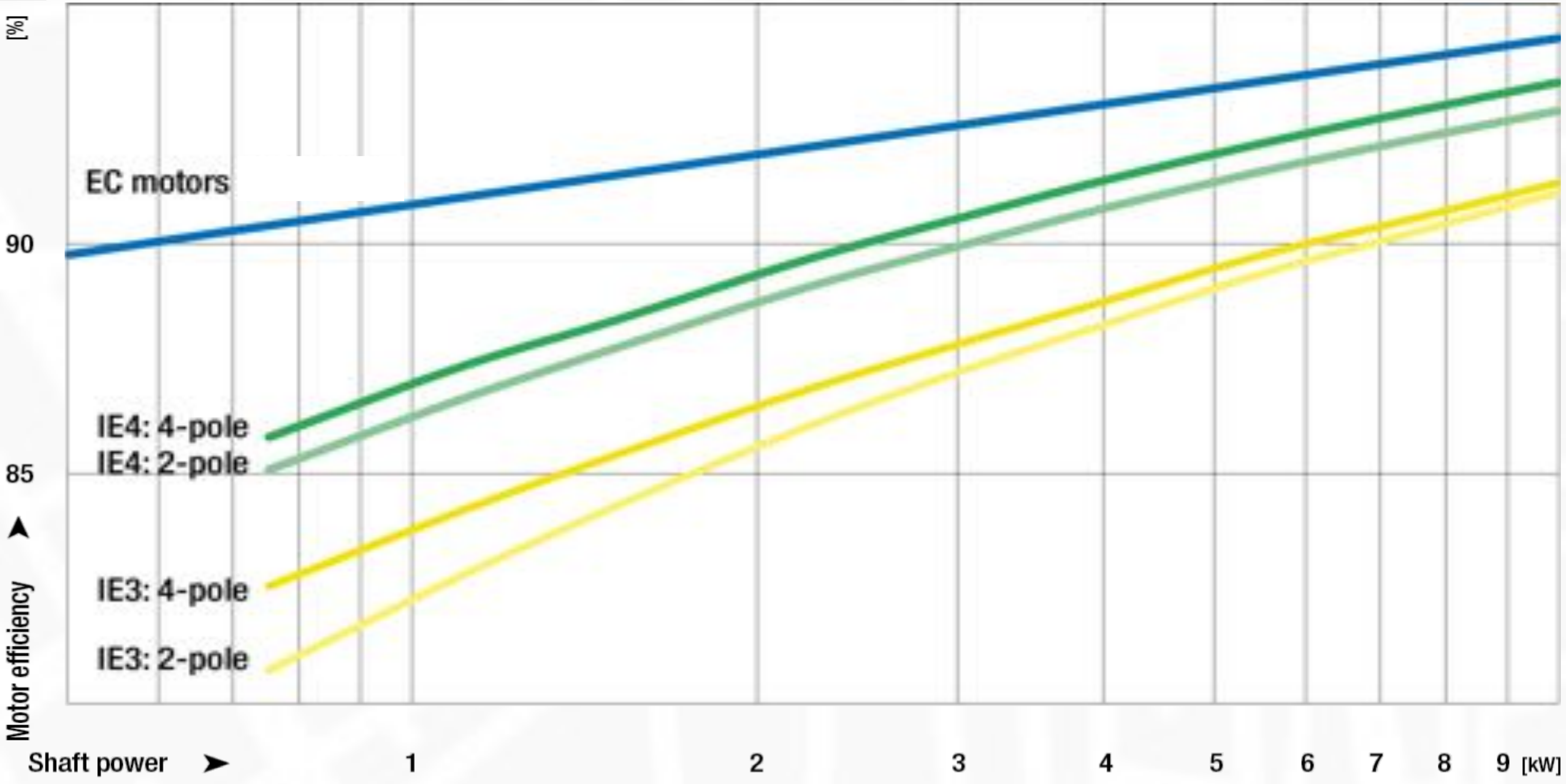
High Efficiency – Low Heat Losses

- **Motor Efficiency up to 95%**
- Low “Copper Losses”
  - ✓ Optimum Winding Design
  - ✓ Low Overhang
- Low “Iron Losses”
  - ✓ Use of Permanent Magnets
  - ✓ No Hysteresis Loss
- Synchronous Operation
  - ✓ No Slip Losses



EC Motor Technology

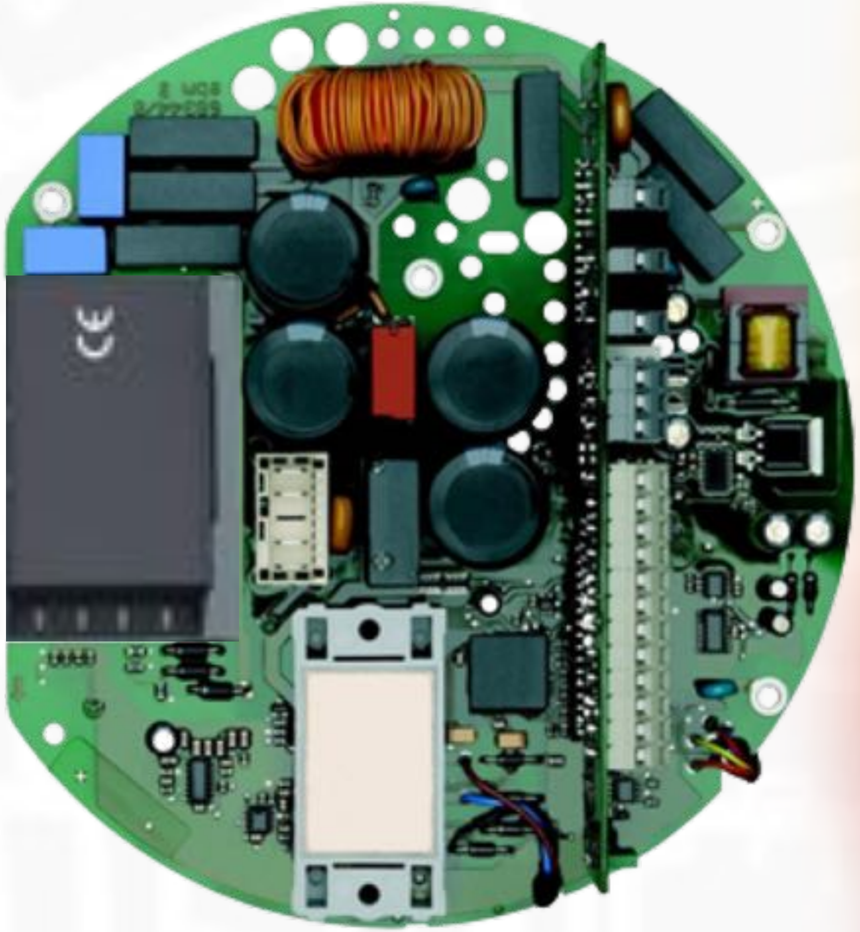
Comparative Efficiency



Variable Speed Drives (VSD)

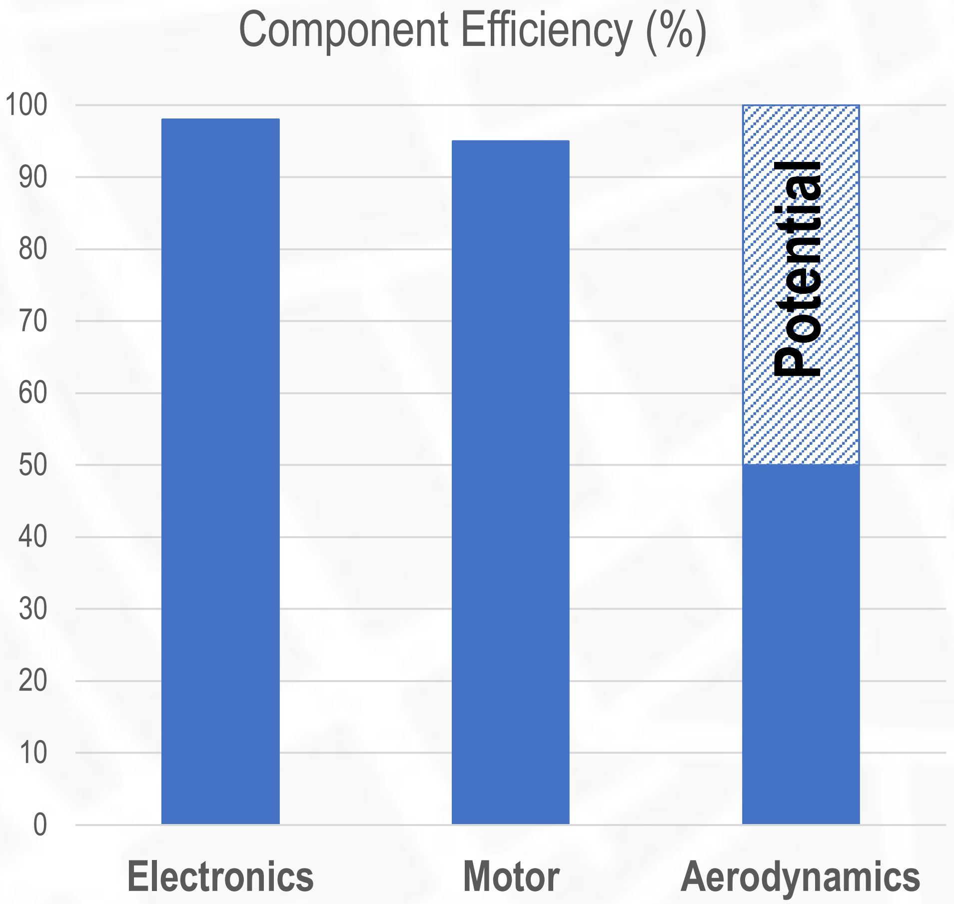
Integrated Control Electronics

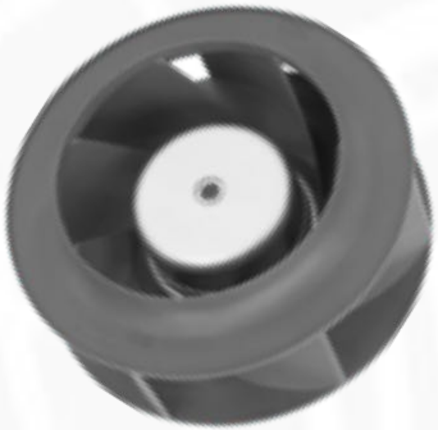
- AC/DC Supply Management
  - Rectification & Smoothing
  - Passive/Active PFC
  - EMC Filtration
- Safety Functions
  - Locked Rotor Protection
  - Phase Failure Detection
  - Over-temperature Protection
- Infinitely-Variable Speed Control
  - Closed-Loop Sensor Control
  - Open Loop Control
- BMS, Alarm, Network Integration



Backward-Curved Impeller Design

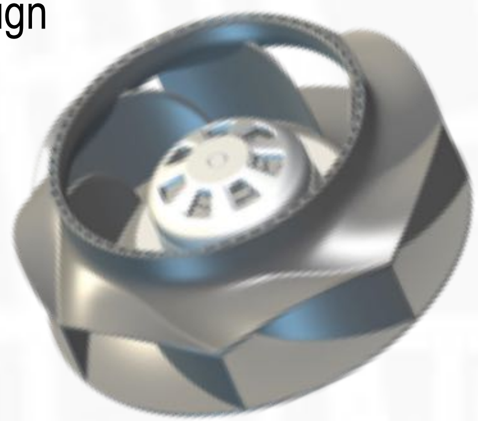
The Focus of Recent R&D





Standard Design

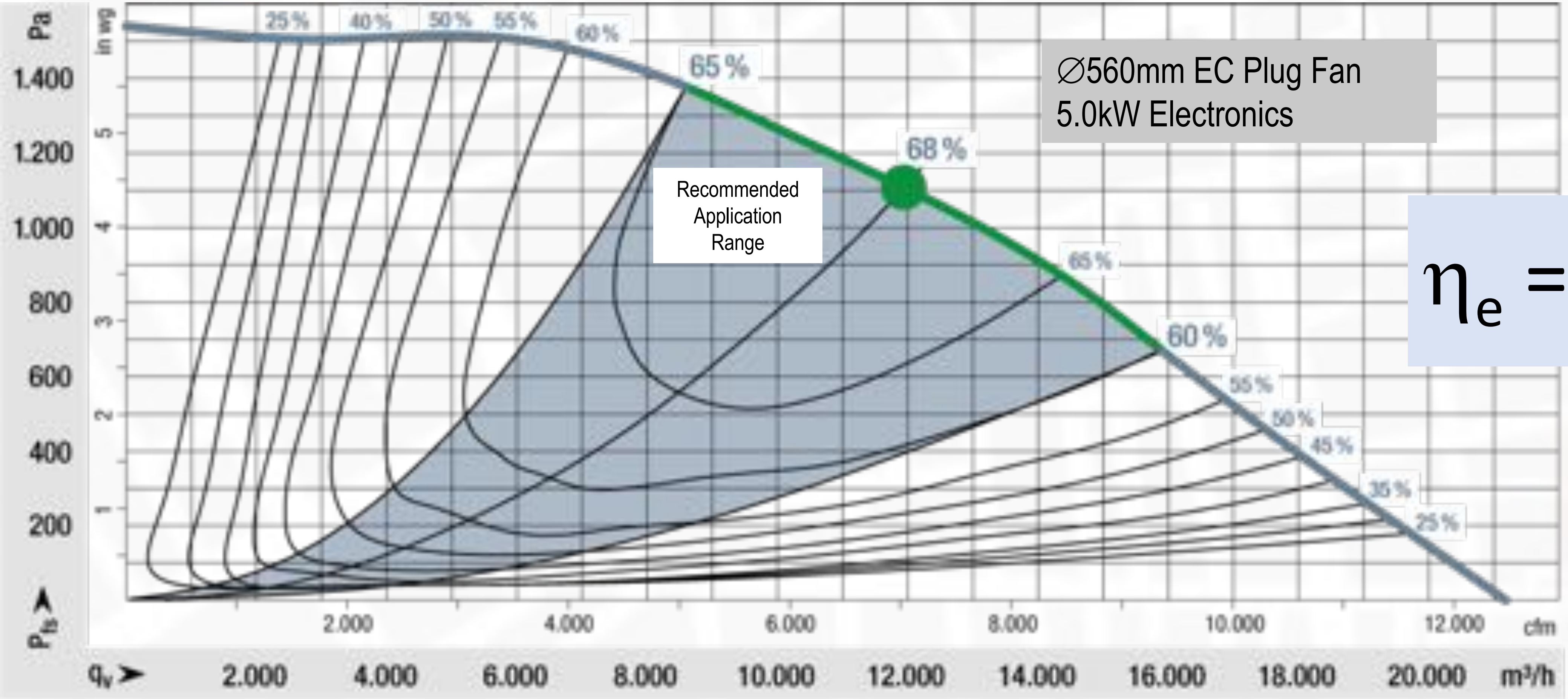
High Performance



Low Noise

Backward-Curved Impeller Design

Fan Efficiency (η_e)



$$\eta_e = \frac{q_v.qf}{p_i}$$

Backward-Curved Impeller Design

Fan Efficiency (η_e)

Multiple Fans Operated in Parallel

Fan Array/Grid Concept

- "FANWALL Technology"
  - Registered Trademark of Huntair
  - Certain Control Elements Patented

- High Air Flows/Reduced Footprint
- Built-in Redundancy
- Optimum Air Distribution
- Noise Reduction
- Higher Efficiency

Summary

- EC Plug Fans – “Plug-and-Play” Air Movement Systems
- High Energy Efficiency
- Maintenance-Free, Long Service Life
- Integrated Controls and Network Capabilities
- Fan Efficiency (η_e) – The True Measure of Fan Performance

- Fan Array Applications – Additional Performance Benefits

Upgrading to EC Fans

James Cooper
Product Manager
ebm-papst UK

Upgrade Process

1. Site Survey
2. Estimate savings
3. Metered trial Installation
4. Site roll-out

Case Studies

UBS Datacentre, Ernst & Young HQ, M&S Condenser, Birmingham Airport

UBS Datacenter
Upgrade Process

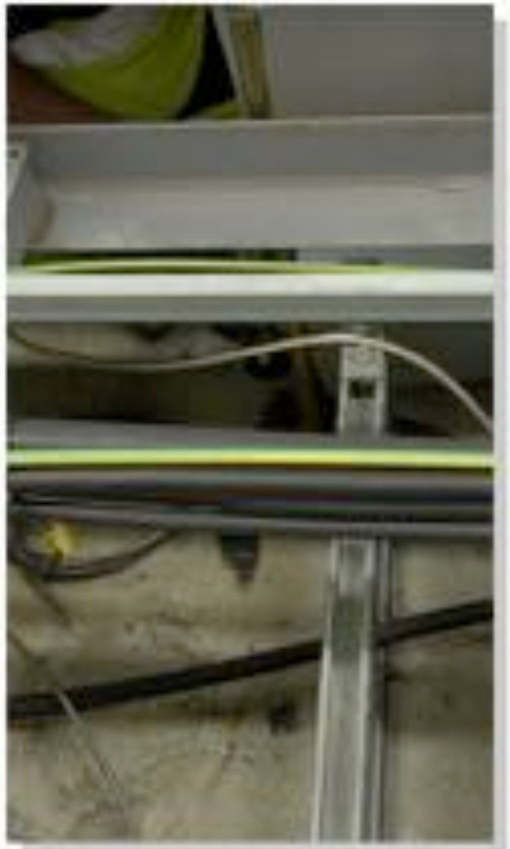
76 CRAC Units in total (2 manufacturers)

- 39 Liebert 14UC units
- 21 Liebert 10UC units
- 16 Stulz CCD900CW
- Equipment Age: 2006
- Control Strategy measuring return air temperature

Site Considerations

- Only one unit off at any one time
- Live data centre environment
- Protection of site operatives
- Restricted site access
- Equipment protection
- Work scheduled for a 4 month period
- Access to 3 data halls at one time

Under floor restrictions



Contamination Protection

Liebert 14UC measurements

Triple fan system – Ziehl Abegg direct drive AC centrifugal fans

AC fans: Absorbed power @ 100% 10.48kW
Absorbed power @ 80% 6.18kW

EC fans: Absorbed power @ 100% 5.36kW
Absorbed power @ 80% 3.8kW

Liebert 10UC measurements

Twin fan system – Ziehl Abegg direct drive AC centrifugal fans

AC fans: Absorbed power @ 100%
7.2kW
Absorbed power @ 80%
5.2kW

EC fans: Absorbed power @ 100%
4.4kW
Absorbed power @ 80%
2.9kW

Stulz CCD900CW measurements

Twin double inlet blowers – belt drive

<u>AC fans:</u> Absorbed power @ 100%
5.4kW

<u>EC fans:</u> Absorbed power @ 100%
4.3kW
Absorbed power @ 80%
2.2kW

Stulz unit upgrade – floor mounted

Belt Driven Fans

Removal of Fan Assay

Suspended Fans within

Floor Void

EMERSON
Network Power

Project Paybacks

Liebert 14UC

- 39 units
- **49% energy saving**
- Total annual energy cost saving £175k
- Annual Carbon reduction 261 tonnes
- Annual CO_2 reduction 957 tonnes
- Payback 1.04 years

Liebert 10UC

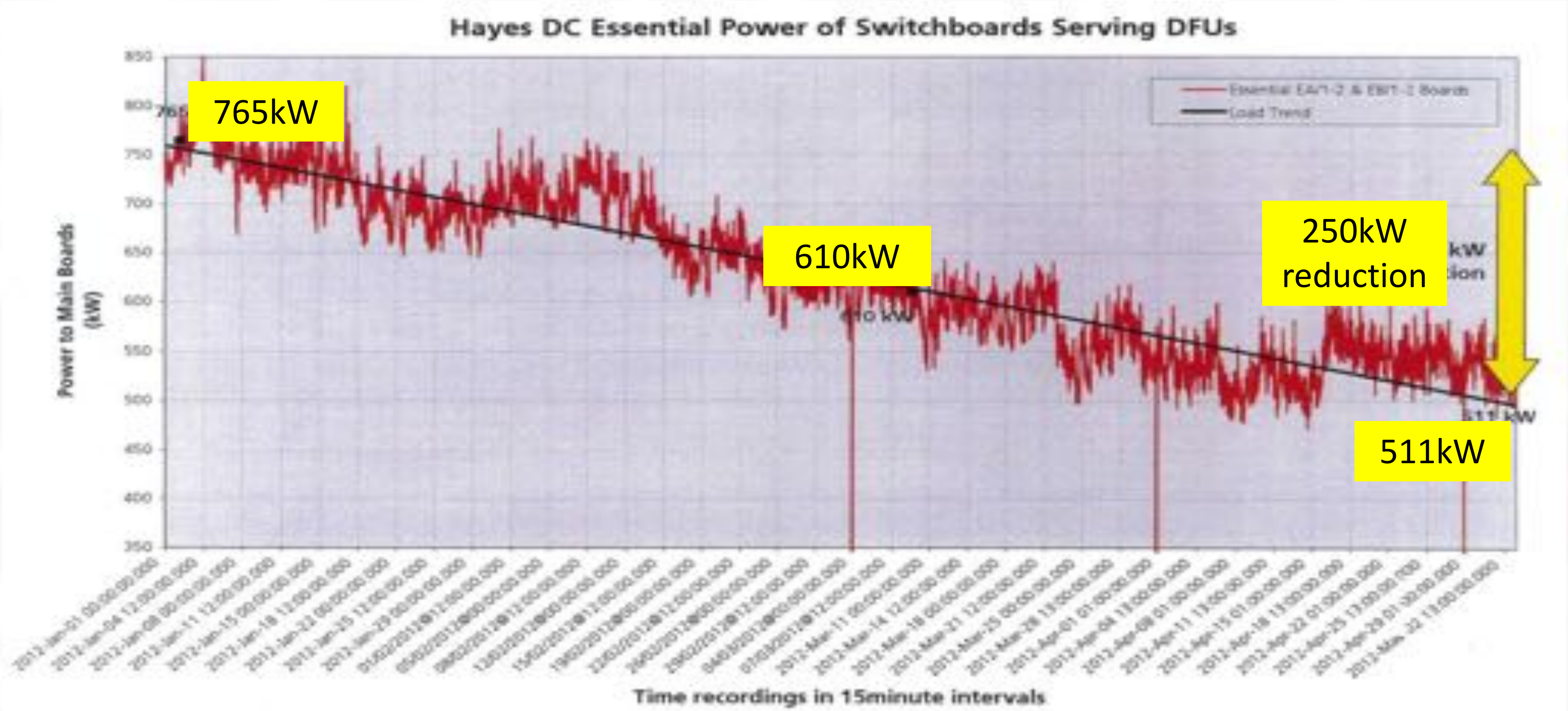
- 21 units
- **39% energy saving**
- Total annual energy cost saving £52k
- Annual Carbon reduction 77 tonnes
- Annual CO2 reduction 281 tonnes
- Payback 1.4 years

Project Paybacks

Stulz CCD900CW set to 80% speed control

- 16 units
- **59% energy saving**
- Total annual energy cost saving £45k
- Annual Carbon reduction 67 tonnes
- Annual CO_2 reduction 245 tonnes
- Payback 1.48 years

Power Graph in Upgrade Period



Company HQ Building, London
Fan Coil Units

Aims:

- Reduce energy consumption of HVAC equipment
- Reduce maintenance
- Increase controllability

Scope:

- 10 floor building
- Total ~ 1200 FCU's

Problem with existing FCU's

- AC fan motors, coming to end of life
- Poor speed control function
- No monitoring

Case Study – Fan Coil Units

<u>AC Fan Decks</u>
49 FCU's / wing each floor.   Total ~ 1200 units

2 sizes of FCU
- Small (208)
- Large (212)

4 speed settings (manual)

<u>EC Fan Decks</u>

Small unit -   (2 x D3G133)
Large unit -   (3 x D3G133)

Variable speed control – Via 0 – 10v

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Case Study – Fan Coil Units

Trial - Floor 2 east wing

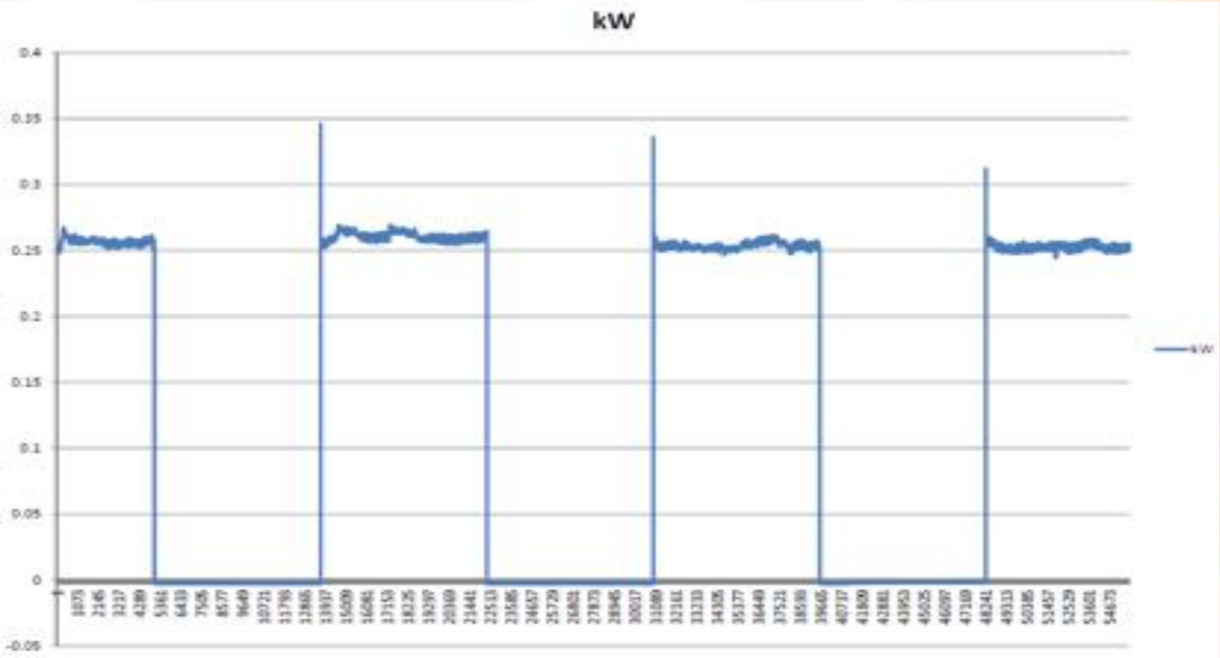
FCU Installation:

Case Study – Fan Coil Unit

<u>Measurements</u>

- Single Fan coil was measured for 1 week prior to fitting EC fans
- This showed that a constant power draw was maintained during running hours.
- Average ~ 250w

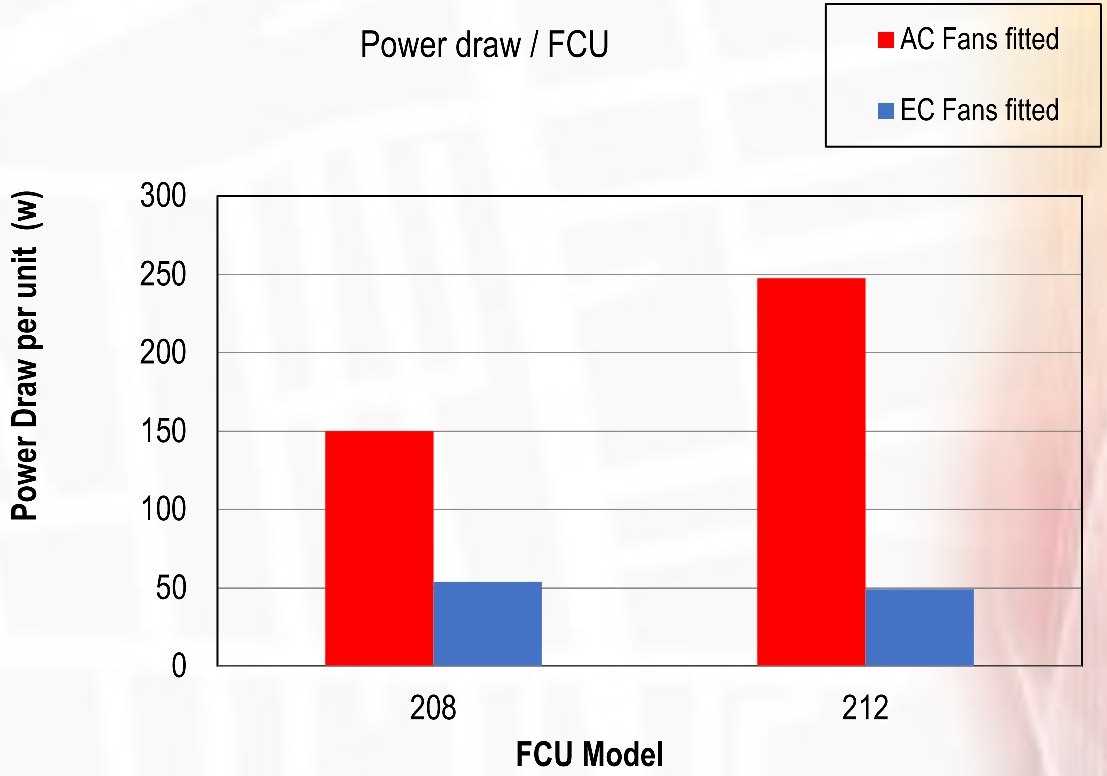
<u>Power measurements before – 212 model</u>



Case Study – Fan Coil Units

Spot Measurements taken on individual FCU's before and after the EC fans fitted.

	Large unit	Small Unit
AC fan deck (W)	247	150
EC fan deck (W)	49	54
Saving (W)	198	96
% saving	**80%**	**64%**



Case Study – Fan Coil Units

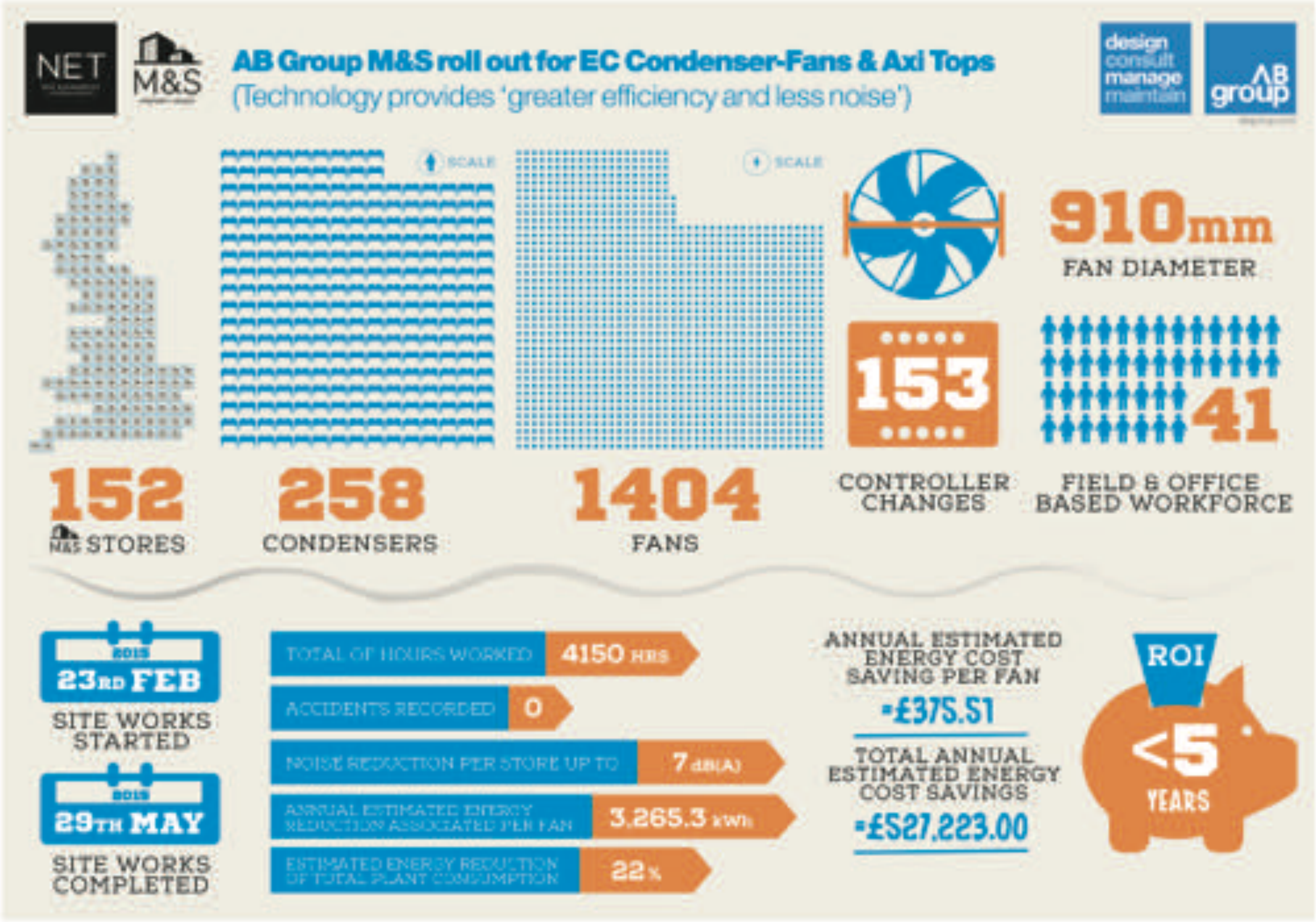
Forecast Annual savings:

Operating Hours:
12h/day, 260d/year

Energy Cost: £0.085 / kWh
CRC cost: £15.60 / t

	Floor 2 East Wing	Total Building
Qty of Units	49	1200
Run time (hrs / year)	3,120	3,120
AC fan deck (kW)	10,066	246,514
EC fan deck (kW)	2,506	61,371
Annual Savings		
% Saving	75%	75%
Power kWh	23,587	577,641
Power (£)	£2,000	£49,000
CRC (£)	£194	£4,800
Total Financial Saving	**£2,194**	**£53,800**
CO_2 (T)	12	303
C (T)	3	83

M&S Condenser Upgrade



NET
M&S
AB Group M&S roll out for EC Condenser-Fans & Axi Tops
(Technology provides 'greater efficiency and less noise')
design consult manage maintain
AB group
SCALE
SCALE
910mm
FAN DIAMETER
153
41
152
M&S STORES
258
CONDENSERS
1404
FANS
CONTROLLER CHANGES
FIELD & OFFICE BASED WORKFORCE
2015
23RD FEB
SITE WORKS STARTED
2015
29TH MAY
SITE WORKS COMPLETED
TOTAL OF HOURS WORKED
4150 HRS
ACCIDENTS RECORDED
0
NOISE REDUCTION PER STORE UP TO
7 dB(A)
ANNUAL ESTIMATED ENERGY REDUCTION ASSOCIATED PER FAN
3,265.3 kWh
ESTIMATED ENERGY REDUCTION OF TOTAL PLANT CONSUMPTION
22%
ANNUAL ESTIMATED ENERGY COST SAVING PER FAN
=£375.51
TOTAL ANNUAL ESTIMATED ENERGY COST SAVINGS
=£527,223.00
ROI
<5
YEARS

Residential AHU application with VRV

Utpal Joshi

Head – VRV DX consulting Sales

Daikin Middle East

Agenda

1. F/AHUs in Residential sector
2. System build up of F/AHU + VRV combination
3. Design Precautions
4. Case study : 500 MBR Villas with integrated FAHU
5. Popularity of VRV in residential sector

AHUs in Residential Sector
Case Study

FAHU use

FAHU

Traditionally FAHUs are used in building to supply Treated fresh air to meet Building Codes, they are either

Connected to Chilled water

or DX outdoor units

Issues faced

- Chiller or Dx supplied by one party
- AHU by Specialist supplier
- Controls by 3rd party
- Integration is difficult for Contractor
- Owner / operator faces difficulty in maintenance

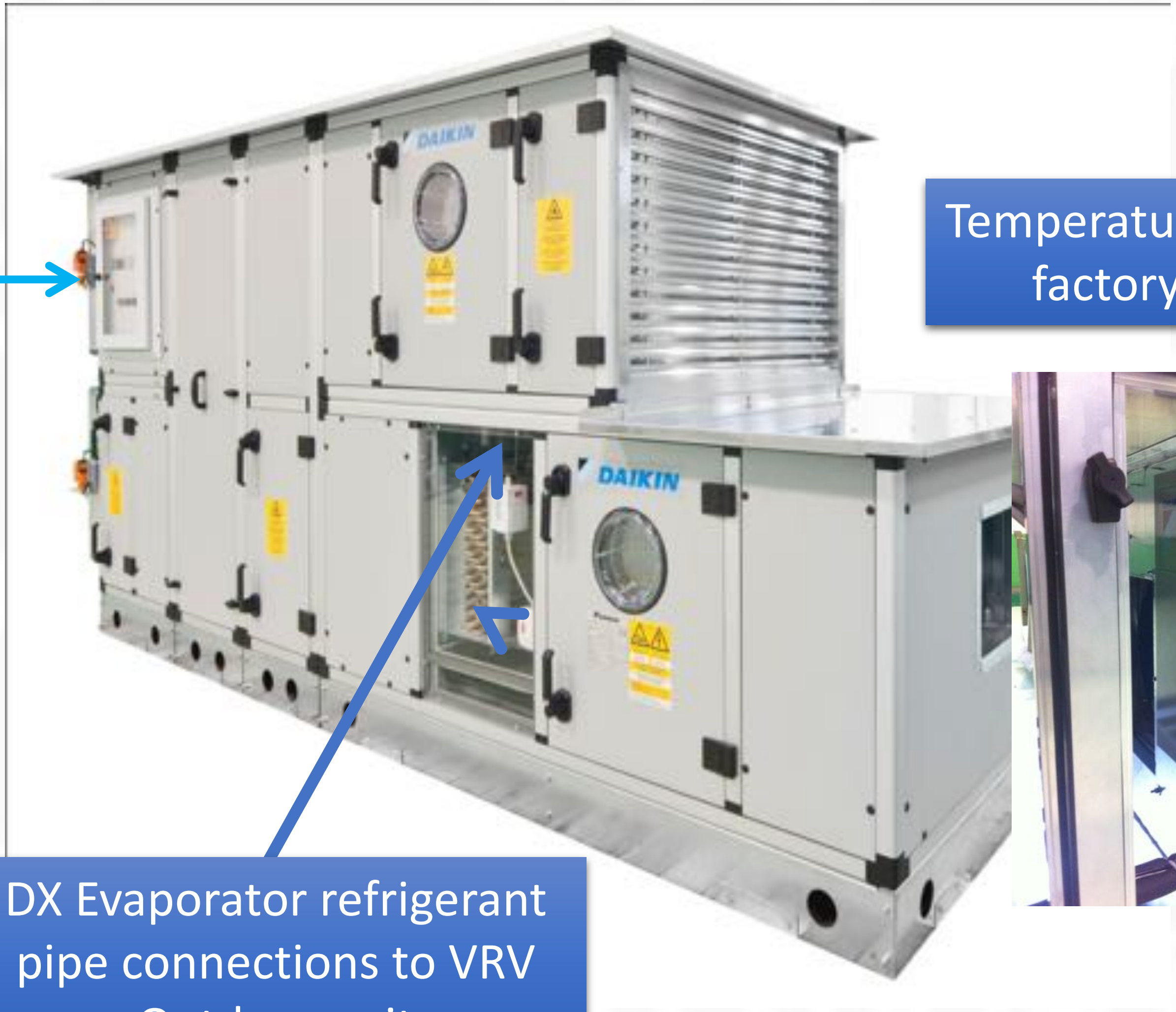
Solution?

- One supplier Supplying complete system FAHU, Condensing unit and controls
- Engineered products to meet High Ambient conditions
- Energy Efficient Heat recovery options

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Plug & Play



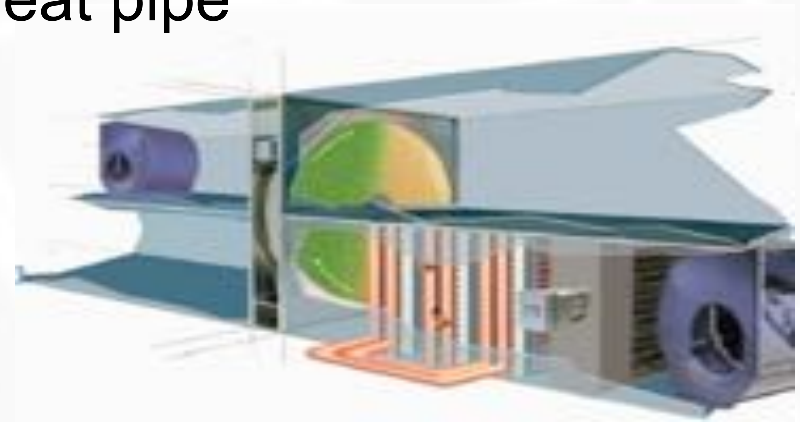
Integrated Electrical Control Panel

Temperature Sensors factory fitted

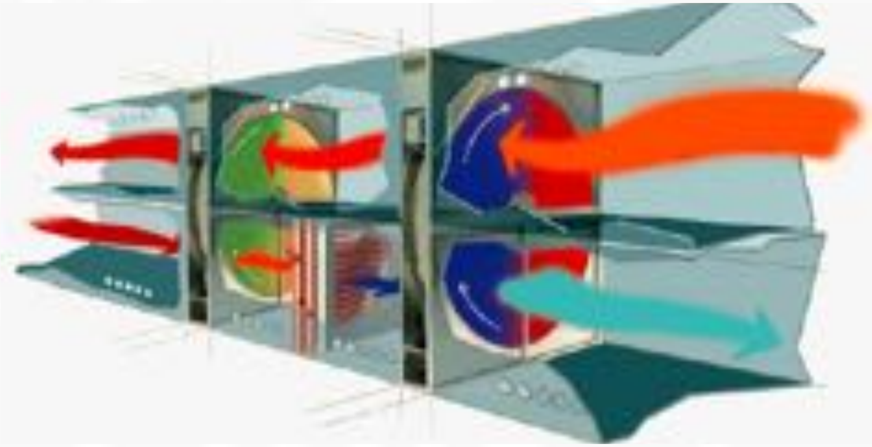
DX Evaporator refrigerant pipe connections to VRV Outdoor unit

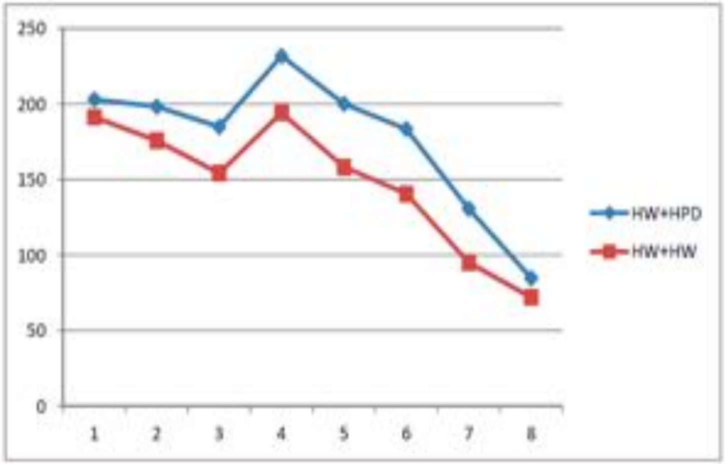
FAHUs - Choices

- FAHU with Heat recovery + HS Heat pipe

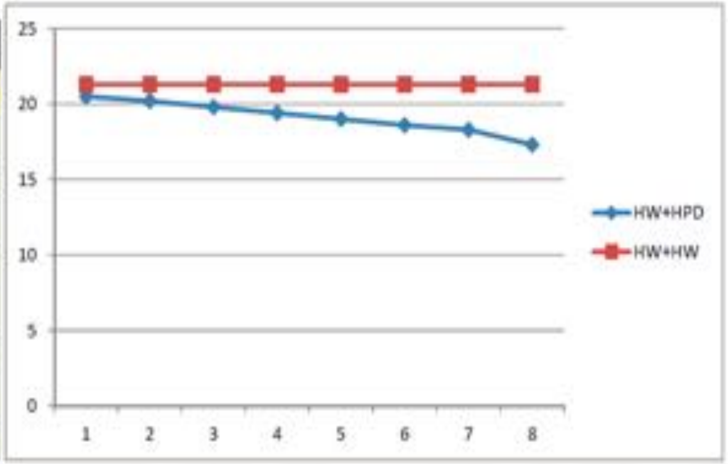


- More efficient – Double Heat Wheel





COOLING COIL CAPACITY	
HW+HPD	HW+HW
203	191.3
198.3	175.8
184.9	154.2
231.8	194.2
200.1	158.4
183.4	140.6
130.7	95
84.7	72



SUPPLY TEMP	
HW+HPD	HW+HW
20.5	21.3
20.2	21.3
19.8	21.3
19.4	21.3
19	21.3
18.6	21.3
18.3	21.3
17.3	21.3

- DX (Direct Expansion) Condensing Units
- More efficient – VRV Condensing units

Item	DX	VRV
Air Flow	15000 l/s	15000 l/s
Model	ERAD	RXYTQ16
Cooling Cap	343 kW	350
kW	149.9	110.1
Run hrs Per month	480	480
Elec Rate	0.38	0.38
Running Costs	27342	20082.24
Savings Per month	-7260	

Approx. 100 TR DX v/s VRV Running cost comparison

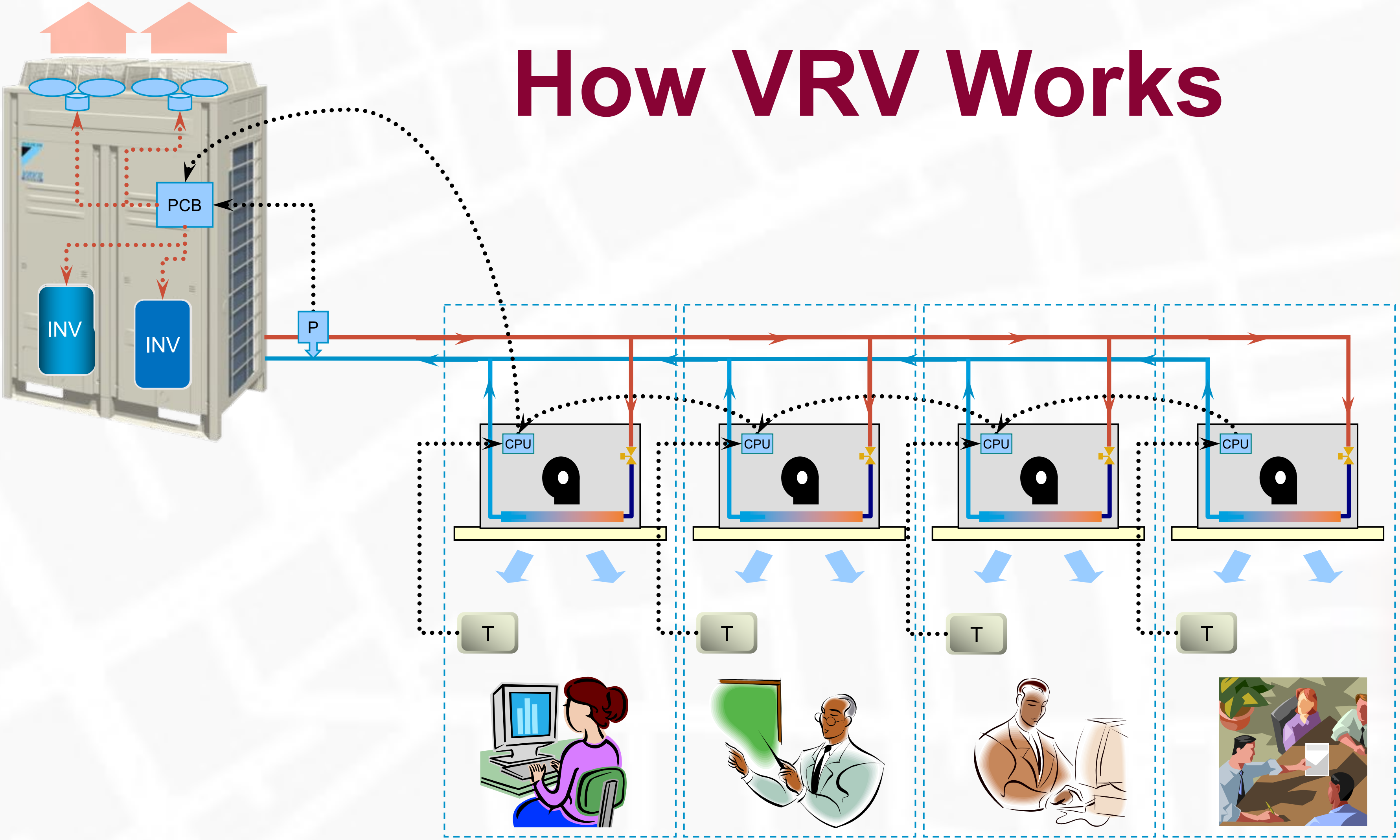
Design Precautions

Design Precautions

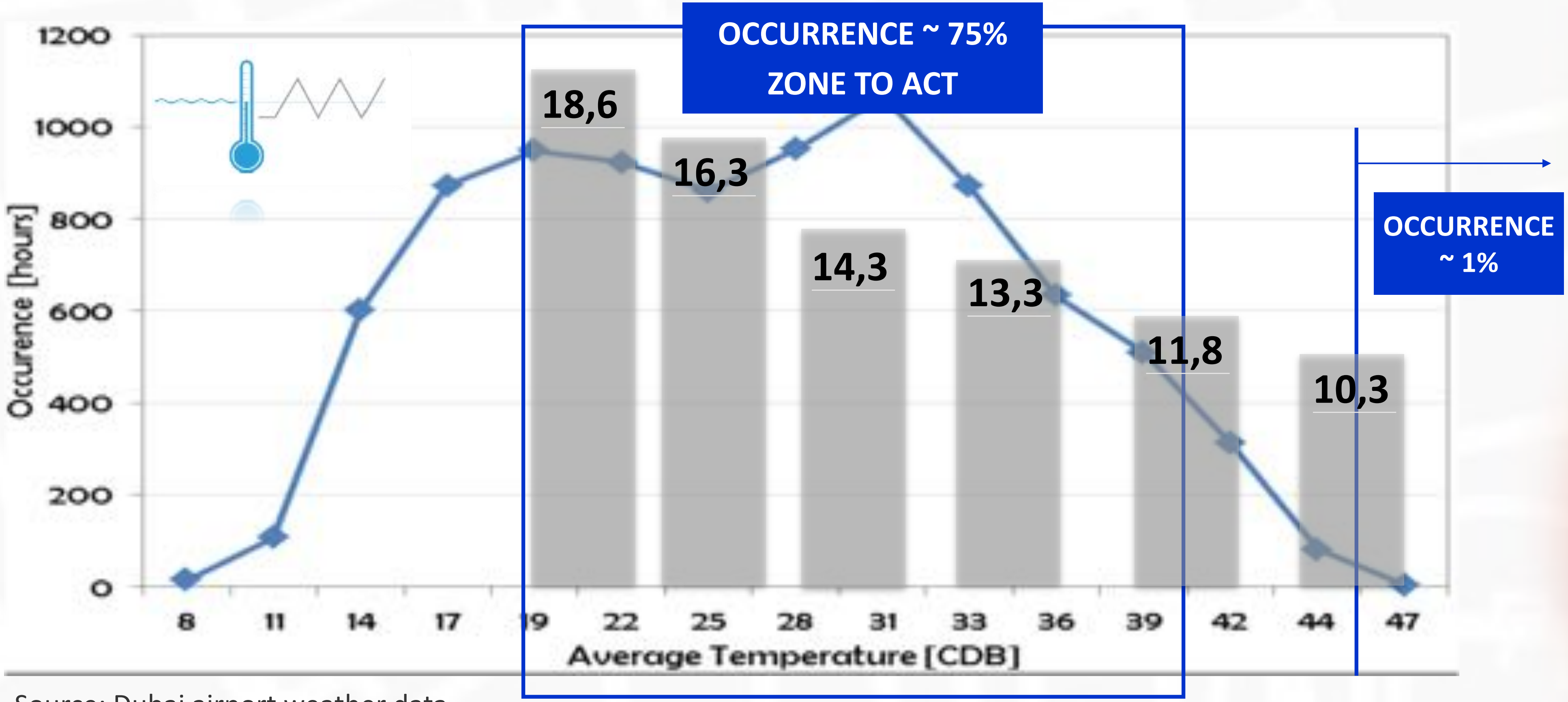
- Always use Electronic Exp Valve, No Thermostatic Exp. Valves
- For space planning of Outdoor units (per 10 TR)
- 1 m^2 Foot Print + 1 m^2 Service space = 2 m^2
- DM is asking for Winter selection for FAHU at 34 /32C – Please select Outdoor at 46/29 and cross check the capacity at 35 with winter selection to avoid oversizing
- Energy Efficient Heat recovery options – Double heat wheel
- VRV Outdoor unit is expensive option but ROI is 1-2 years so take wise decision.
- Always ask for Plug-n Play solution where one supplier is supplying the full system.

System build up of F/AHU + VRV combination

How VRV Works

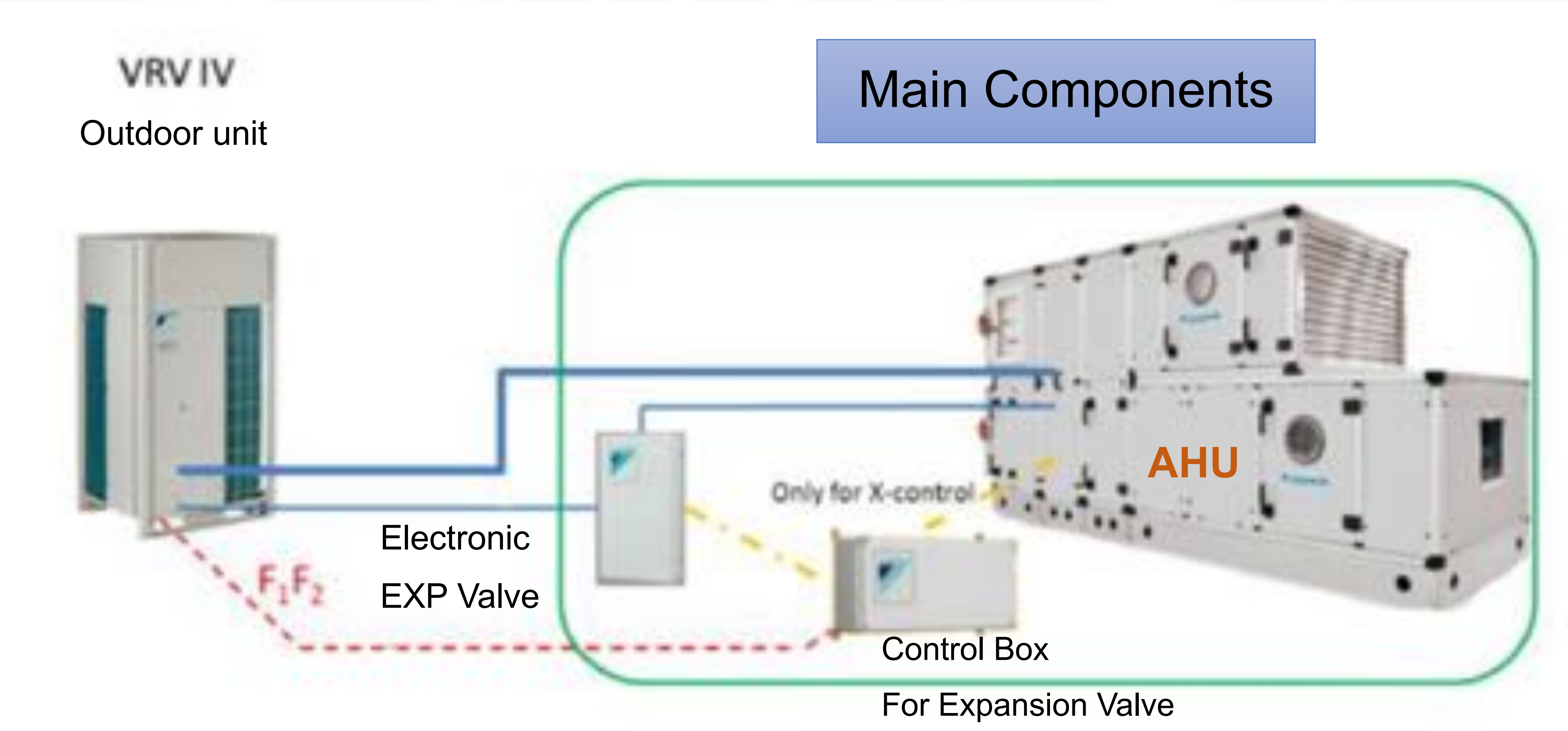


Seasonal Efficiency
Real life operating conditions

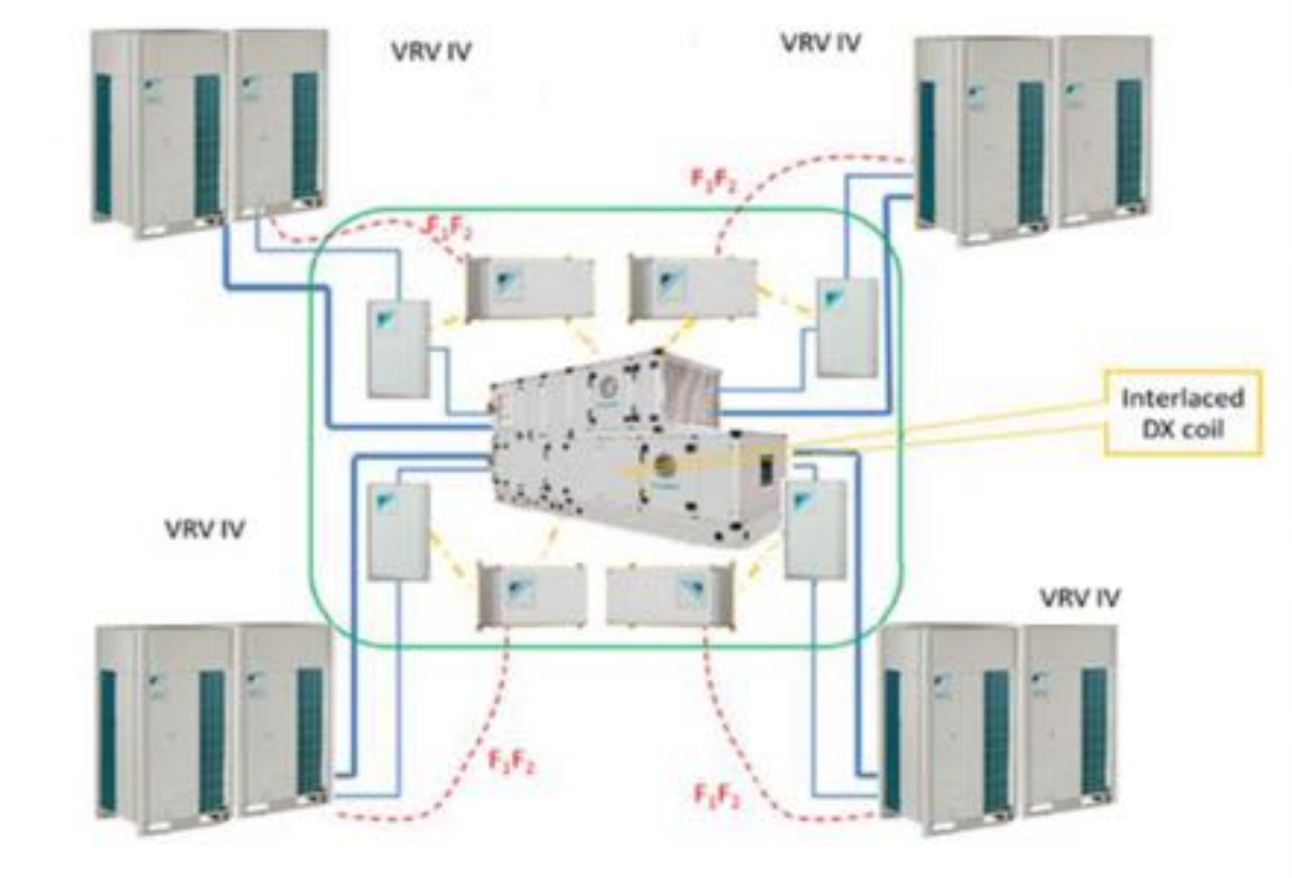


Source: Dubai airport weather data

High-ambient VRV with AHU / FAHU



Bigger configuration



Recommended Configuration

- 240 kW Max (96 HP)
- 4 interlaced coils
- 60 kW per Electronic Expansion Valve/circuit
- Needs controller per expansion valve
- Use EC fans
- Plug n Play

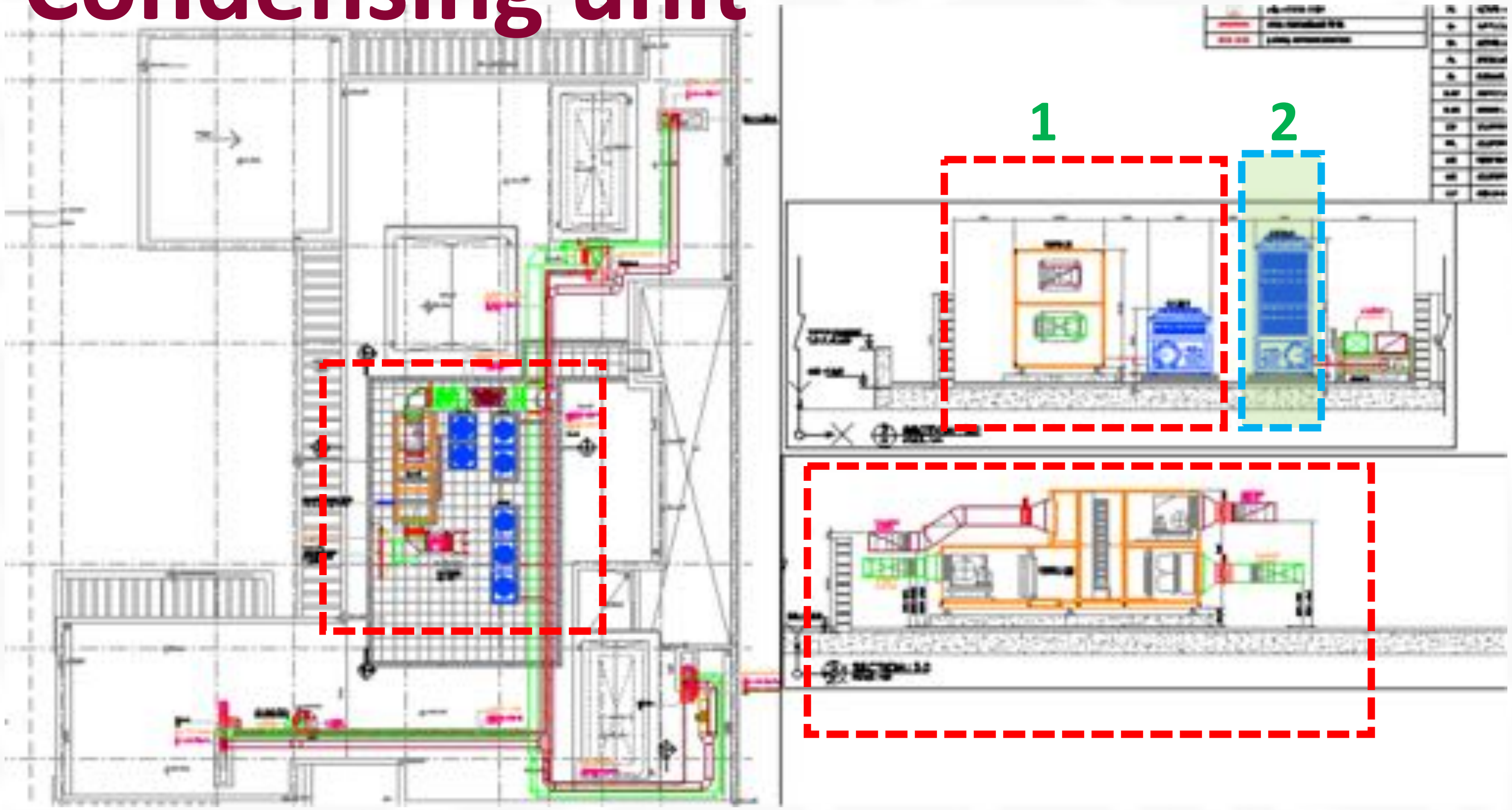
Case study:
500 MBR Villas with integrated FAHU

500 Villas At MBR City

Villa Configuration

- 422 m2 Villa
- 56 kW
- 24 HP (2 ODU system)
- 12 indoor + FAHU 400 Lps
- Home Automation
- No Daikin Theromostat

Traditional FAHU system with dedicated Condensing unit



Two separate systems

Case Study: MBR City

Original Design

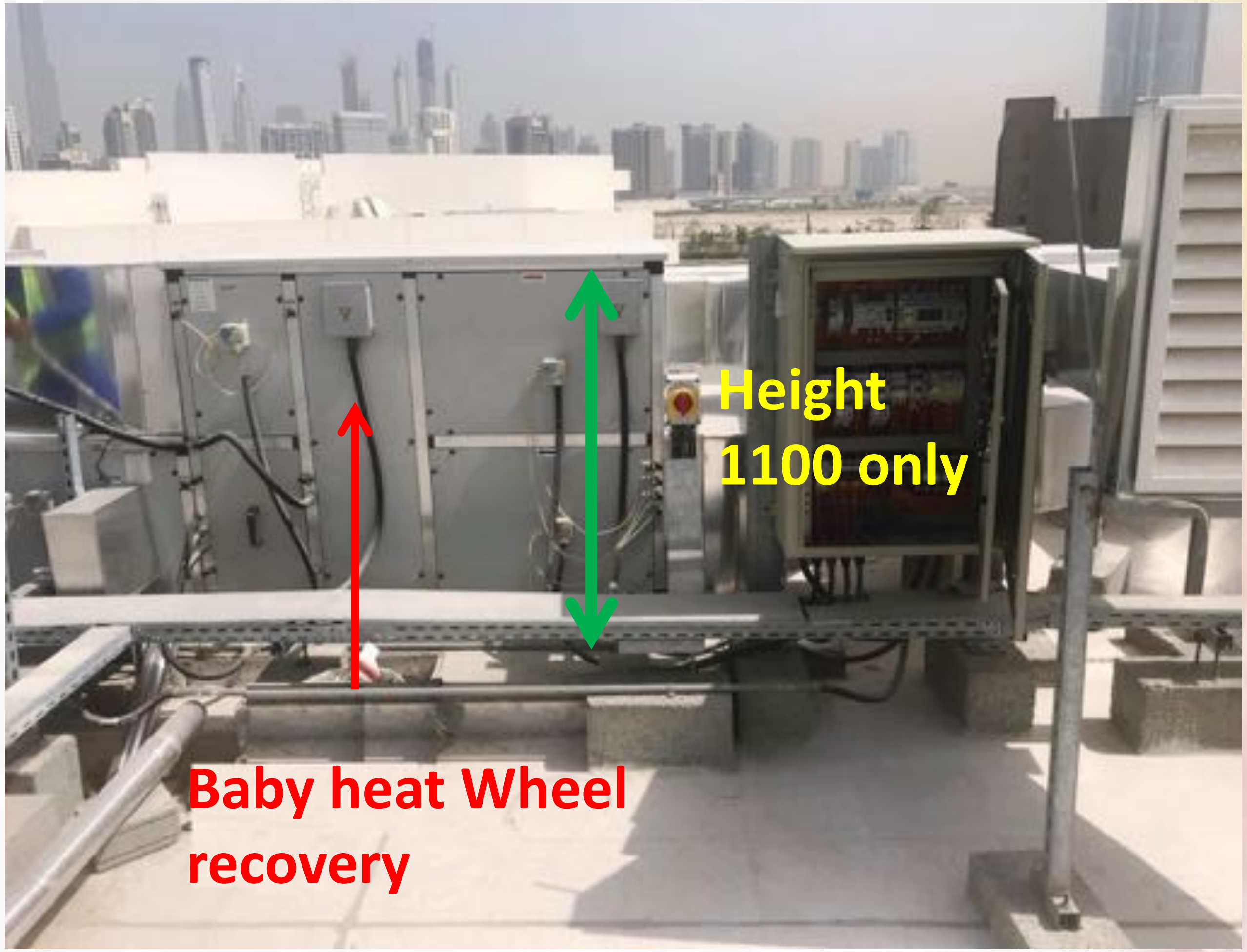
- Villas were Designed earlier on two Packaged unit serving each floor
- Fresh air was added to each packaged unit
- No heat recovery of exhaust
- EER les than 3.0
- Each room control was difficult with use of VA

Improvements

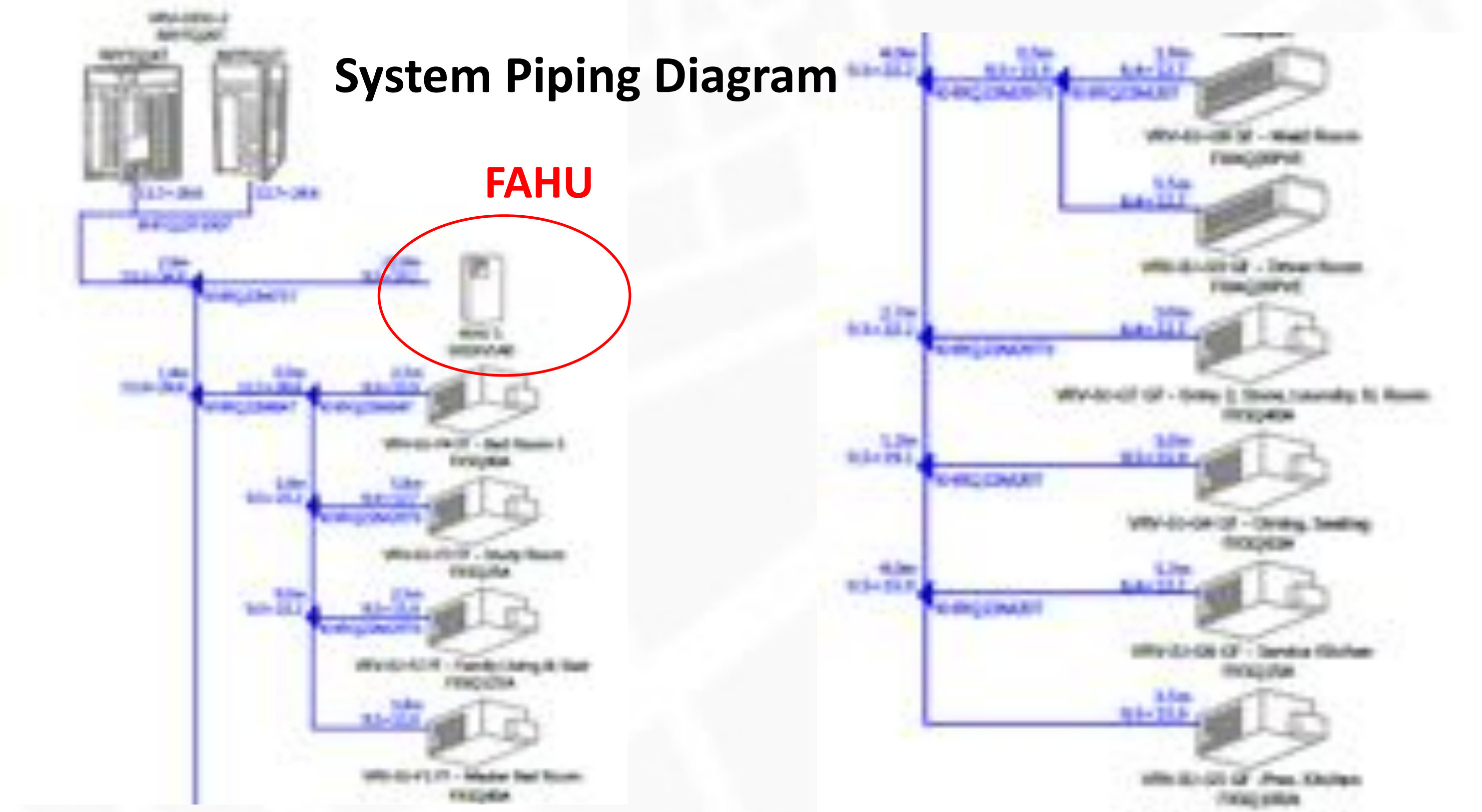
- Villas AC design was changed to VRV system with separate indoor unit for each room
- Two outdoor in roof only
- Special Fresh Air handling unit (height 1100mm) with baby heat wheel recovery + HS heat Pipe was introduced
- Integration with Home automation without thermostat.

FAHU with heat recovery

Control
& Elec Panel



System Piping Diagram



Index	Villa Detail		VRV Unit Detail		Specified VRV Ind		Selected VRV Indoor Unit Capacity								Selected VRV Outdoor Unit Capacity			
	Type	Qty (Nos)	Unit Reference	Outdoor Ref	TH (kW)	SH (kW)	Supply	TH (kW)	SH (kW)	ESP range (Pa)	Model No.	Type	Dimentions WXHXD (mm)	Power Input (W)	Total C	Model No.	Dimentions WXHXD (mm)	Weight (kg)
1	M5A	8	VRV-IU-G1	VRV-ODU-1	7.7	5.7	383	7.8	5.8	30-150	FXSQ80	Ducted	1000x245x800	0.121	28.7	RXYTQ16T	1240x1685x765	310
2			VRV-IU-G2		3.3	2.6	208	3.9	3	30-150	FXSQ40	Ducted	700x245x800	0.092				
3			VRV-IU-G3		2.6	1.9	158	3.2	2.4	30-150	FXSQ32	Ducted	550x245x800	0.045				
4			VRV-IU-G6		0.8	0.7	83	2	1.7	---	FXAQ20	Decorative	795x290x238	0.019				
5			VRV-IU-G7		1	0.9	83	2	1.7	---	FXAQ20	Decorative	795x290x238	0.019				
6			VRV-IU-F1		4.4	3.6	253	4.9	3.7	30-150	FXSQ50	Ducted	700x245x800	0.095				
7			VRV-IU-F2		2.9	2.3	158	3.2	2.4	30-150	FXSQ32	Ducted	550x245x800	0.045				
8			VRV-IU-F3		3.9	3.4	253	4.9	3.7	30-150	FXSQ50	Ducted	700x245x800	0.095				
9			VRV-IU-F6		3.4	2.9	208	3.9	3	30-150	FXSQ40	Ducted	700x245x800	0.092				
10			VRV-IU-G4	VRV-ODU-2	3.3	2.3	208	3.9	3	30-150	FXSQ40	Ducted	700x245x800	0.092	22.4	RXYTQ10T	1240x1685x765	233
11			VRV-IU-G5		2.7	2	158	3.2	2.4	30-150	FXSQ32	Ducted	550x245x800	0.045				
12			VRV-IU-F5		3	2.6	208	3.9	3	30-150	FXSQ40	Ducted	700x245x800	0.092				
13			VRV-IU-F4		2.2	1.8	108	2.5	1.8	30-150	FXSQ25	Ducted	550x245x800	0.041				
14			FAHU-1		9.45	-	n/a	9.9	n/a		680 X740							

Technological Breakthrough:

One Refrigerant system having two different Refrigerant Temperature (Indoor unit and FAHU at Different Temperature)

Risk Mitigated with heat recovery and HSHP and with special factory settings change.

Popularity of VRV in residential sector

Subtitle, additional information

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

VRV projects

VRV has successfully covered small, medium and large scale project answering to the customer needs.

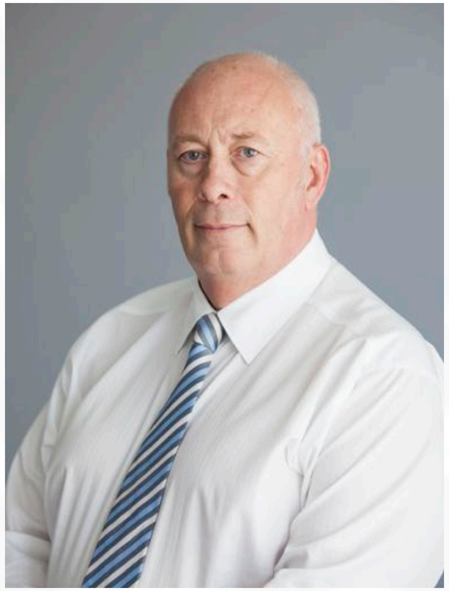
What are the needs of Customer?

- Simple Solution
- Low DEWA Bills
- Easy to install
- Flexible spacing

- VRV + FAHU by one Company
- 1.2 kW/TR peak Load (0.75NPLV)
- Plug n Play + copper piping
- Flexible spacing of outdoors

Large VRV Projects with FAHU

Eurovent Certified Performance
Air Handling Units



Brian Suggitt
Chairman
Eurovent Middle East

Eurovent Certification

- Eurovent Certification certifies the performance ratings of air-conditioning and refrigeration products according to European and international standards.

- The objective is to build up customer confidence by leveling the competitive playing field for all manufacturers by increasing the integrity and accuracy of the industrial performance ratings.

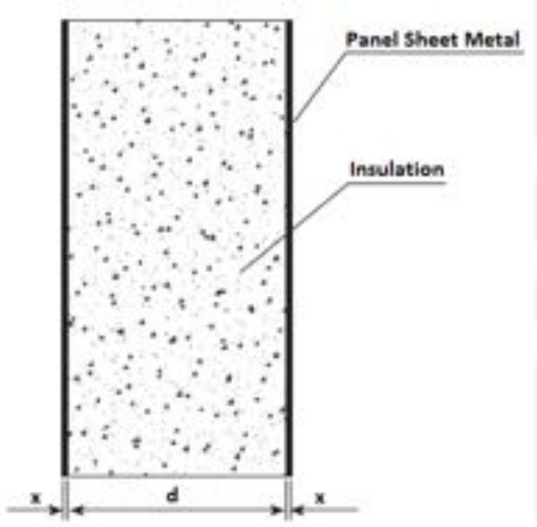
Eurovent Certification

Please note!

- ECP tests and verifies the performance of a product
- Always check back with the database of Eurovent Certification to make sure the product holds a valid certification
- Eurovent Ratings give you an indication of the efficiency of a product
- ECP does NOT equal a quality mark!

AHU Certification Criteria

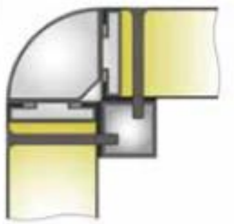
Thermal Transmittance			
Class	Heat Conduction Coefficient W/m²K	Panel Quality	Condensation Risk
T1	U≤0,5	Highest	Very Low
T2	0,5<U≤1,0	High	Low
T3	1,0<U≤1,4	Medium	Medium
T4	1,4<U≤2,0	Low	High
T5	Not Required	Very Low	Highest



- Test Result based on Heat Conduction Coefficient of Panels
- Depends on panel thickness, insulation material and panel sheet thickness.

AHU Certification Criteria

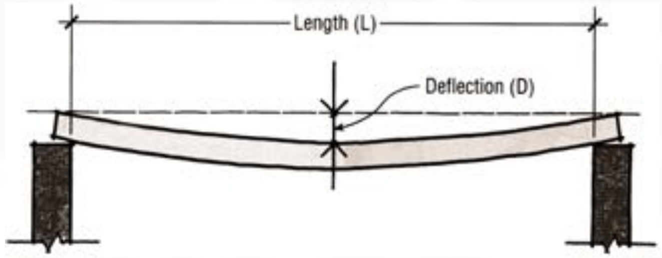
Thermal Bridging Factor			
Class	Thermal Bridging Factor k_b	Panel Quality	Condensation Risk
TB1	$0{,}75 \le k_b < 1$	Highest	Very Low
TB2	$0{,}60 \le k_b < 0{,}75$	High	Low
TB3	$0{,}45 \le k_b < 0{,}60$	Medium	Medium
TB4	$0{,}30 \le k_b < 0{,}45$	Low	High
TB5	Not Required	Very Low	Highest



- Test result is based on weakest point, where there is maximum thermal leakage.
- If the metal-metal contact between inside and outside of the unit is prevented, the bridging factor therefore increases.

AHU Certification Criteria

Casing Strength		
Class	Maximum Deflection mm/m	Resistance to Max. Fan Operating Pressure
D1(M)	4	Yes
D2(M)	10	Yes
D3(M)	Not Required	Yes



- Maximum deflection after a test pressure of ±1000 Pa
- The remaining deflection after a test pressure of ±2500 Pa must be less than 2 mm.

AHU Certification Criteria

Casing Air Leakage			
Class	Maximum Leakage (-400 Pa) $L \times s^{-1} \times m^{-2}$	Maximum Leakage (+700 Pa) $L \times s^{-1} \times m^{-2}$	
L1	0,15	0,22	
L2	0,44	0,63	
L3	1,32	1,90	

- Sections working under negative pressure tested at test pressure of -400 Pa
- Sections working under positive pressure tested at test pressure of +700 Pa
- NOTE : the air leakage test is undertaken immediately after the casing strength test

AHU Certification Criteria

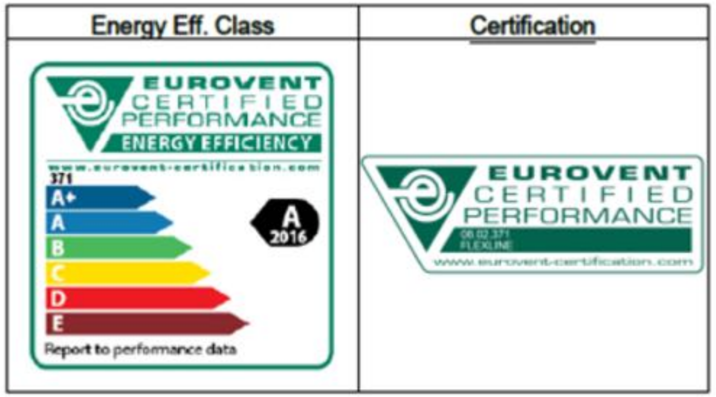
Filter By-pass Air Leakage					
Class	G1-F5	F6	F7	F8	F9
Bypass Leakage Factor %	6	4	2	1	0,5

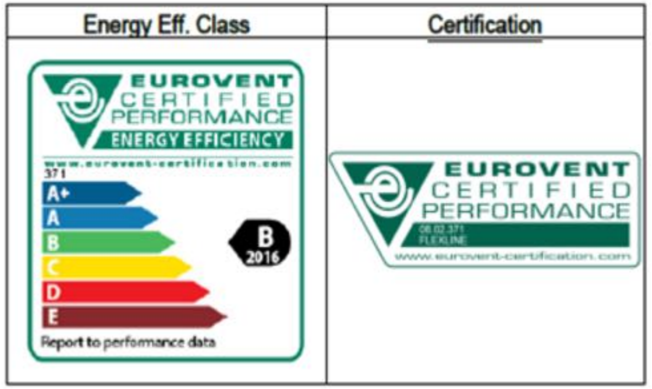
- Shows the bypass air ratio that is not filtered and leaked through filter sides
- Usable filter class must be equal or above this class

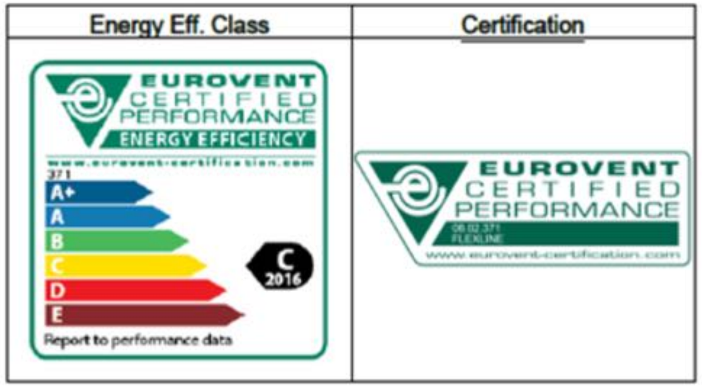
Energy Efficiency Reference Chart

CLASS	All Units	Units for full or partial outdoor air at design winter temperature ≤ 9°C		
	Velocity	Heat recovery system		Fan Efficiency Grade
	v_{class} [m/s]	η_{class} [%]	Δp_{class} [Pa]	$NG_{ref\text{-}class}$ [-]
A+ / A+ϛ / A+↑	1.4	83	250	64
A / Aϛ / A↑	1.6	78	230	62
B / Bϛ / B↑	1.8	73	210	60
C / Cϛ / C↑	2.0	68	190	57
D / Dϛ / D↑	2.2	63	170	52
E / Eϛ / E↑	No calculation required			No requirement

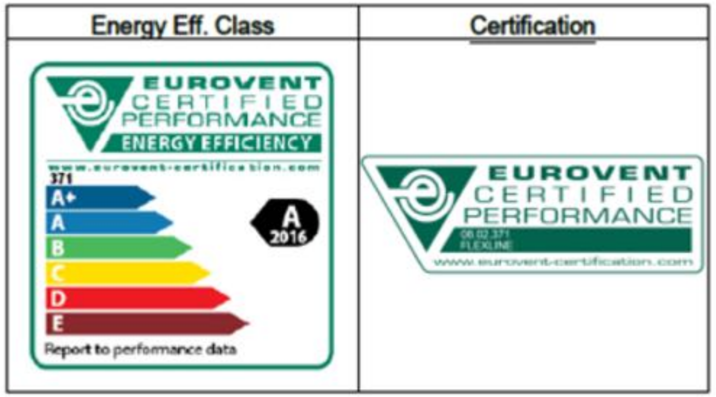
Illustration of AHU Energy Efficiency Label

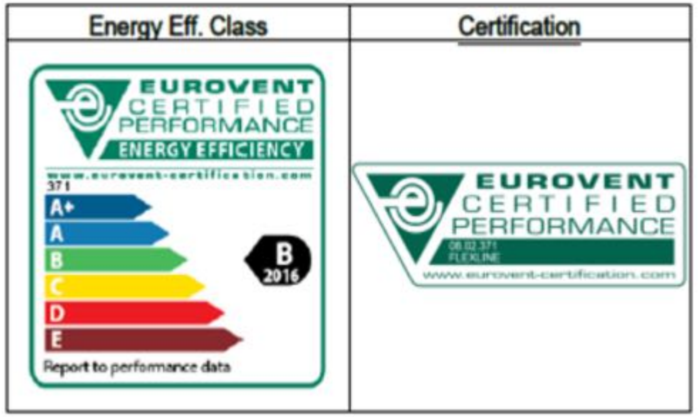






Dynamic Rating System





Watch out for the year!

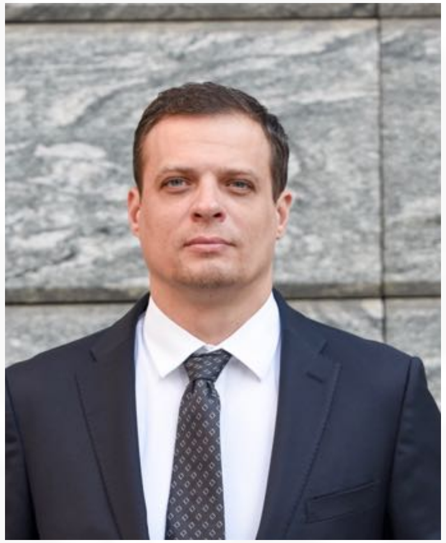
Summary

- Certification Schemes help you to select and rely on products
- Certification Schemes are complex and need to be fully understood to make the right use of them
- Safety, Quality, Performance, Fire Safety and many other aspects are certified by different bodies and different schemes
- Certificates loose their validity after a certain period
- Always cross check with the certifying body!

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Moderated Discussion



Markus Lattner
Director
Eurovent Middle East

Workshop Partners

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Media Partner

climate control MIDDLE EAST

KEY PERSPECTIVES ON THE REGION'S HVACR INDUSTRY

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Hotel Partner

Le MERIDIEN

Thank you!