

Clivet. Change things

ZEPHIR³



The complete packaged
Primary Air supply System with
thermodynamic energy recovery

CLEAN AIR. Fundamental. But less and less available.

Everyday we consume

1 kg of food

3 litres of liquid

More than **10.000** litres of air

And more often **we**
cannot choose

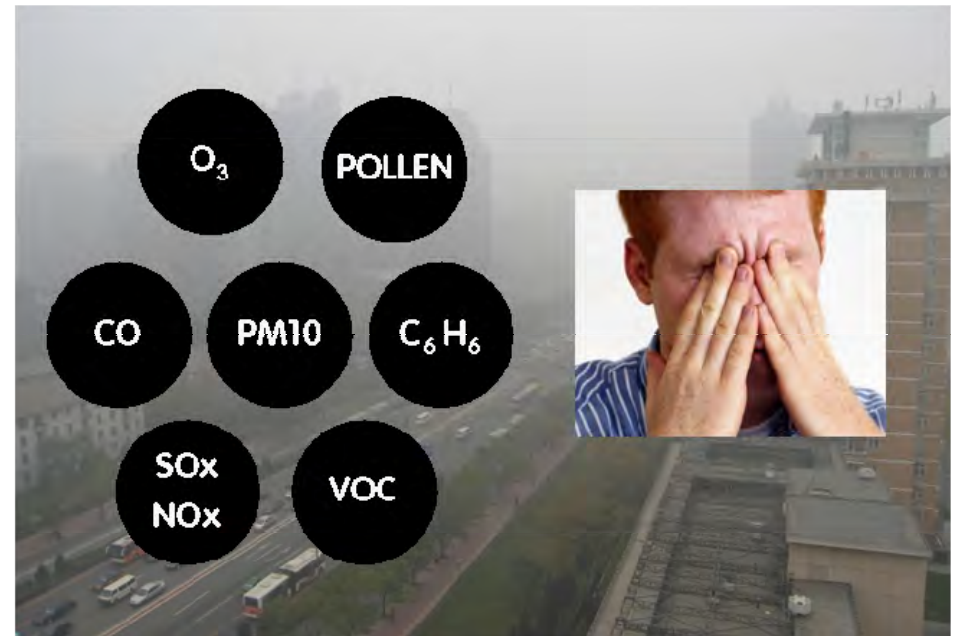
CLEAN AIR. Fundamental. But less and less available.

- ▶ 90% of our time → Spent indoors
- ▶ Air quality = threatened by pollutants

✓ Indoors



✓ Outdoors



AIR RENEWAL. Determines the comfort level in buildings.

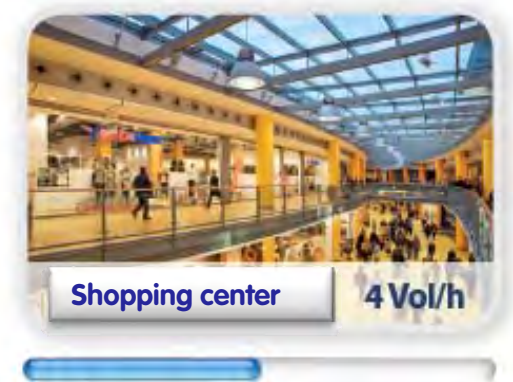
The role of Primary Air.

- ▶ Extraction of stale air
- ▶ Filtration of outdoor air
- ▶ Required temperature and humidity



The quantity depends on the application.

- ▶ Hospital = 20 x residential



AIR RENEWAL. Determines the comfort level in buildings.

Primary Air today.

Even more important

Modern construction methods:

- ▶ Virtually sealed housing
- ▶ Risk of accumulation of pollutants

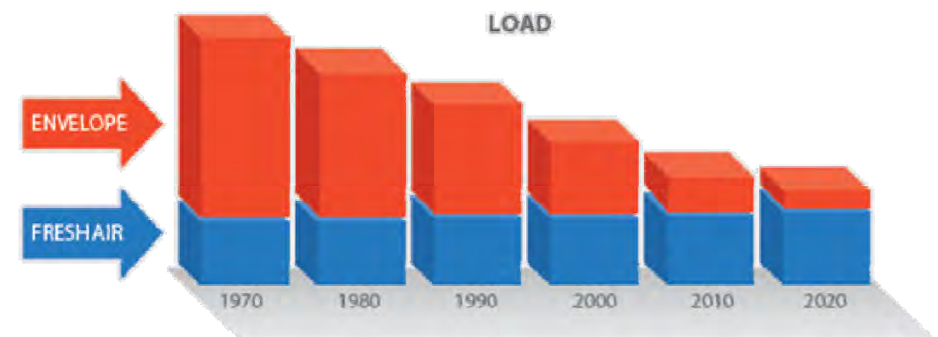


Primary Air costs.

More and more.

Highly insulated housing

- ▶ Renewal loads = exceed 60% of the overall requirements
- ▶ Renewal costs = one of the main for the operating systems



PRIMARY AIR YESTERDAY. Difficult to achieve. And to manage.



Bespoke systems.

Focus on costs and time control.

Intrusive.

Less space in the building.

Complicated integration.

Design and commissioning time.

PRIMARY AIR YESTERDAY. Difficult to achieve. And to manage.



1. Bespoke systems

Focus on costs and time control.

Traditional systems:

- ▶ Air Handling Units
- ▶ Heating and cooling systems, fluid distribution networks, pumps, control systems
- ▶ Chosen separately and then assembled, calibrated and tested on site

PRIMARY AIR YESTERDAY. Difficult to achieve. And to manage.



2. Intrusive.

Less space in the building.

- ▶ Entire building laden with machines, pipes, electric feed and control lines, air distribution ducts
- ▶ Takes up space that could be used for productive activities
- ▶ Designers and operators are challenged to integrate everything

PRIMARY AIR YESTERDAY. Difficult to achieve. And to manage.



3. Complicated integration.

Design and commissioning time.

- ▶ The system success and reliability depends on the proper functioning of its individual components and their effective interaction.
- ▶ This requires careful design of the control system, an efficient performance and a costly calibration to achieve and then maintain the desired result.

PRIMARY AIR YESTERDAY. Difficult to achieve. And to manage.

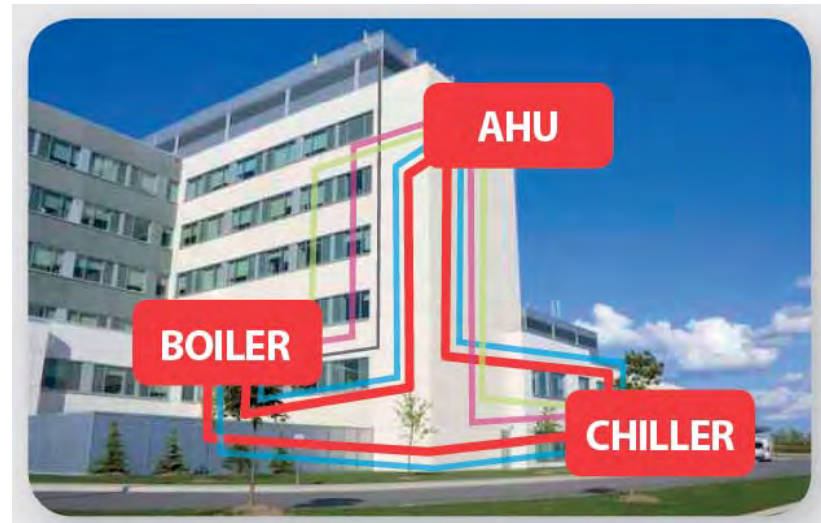


High Energy costs.

Auxiliary consumption costs.

In traditional systems heating and cooling capacity is produced centrally:

- ▶ It must be transferred to the AHU by hot and chilled water
- ▶ The consumptions for pumping, storage and heat losses reduce the actual seasonal efficiency



PRIMARY AIR YESTERDAY. Difficult to achieve. And to manage.



Passive recovery systems.

Higher consumption.

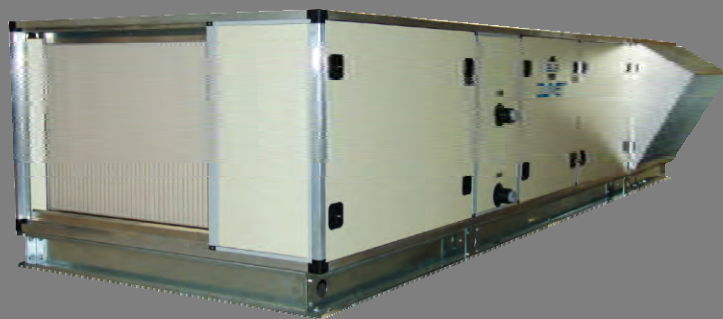
Capacity of the passive exchangers depends largely on the operating conditions

- ▶ It decreases until it reaches zero in conditions other than design
- ▶ The increased fan power due to high pressure drop remains constant instead
- ▶ The fan energy consumption increases
- ▶ Less-than-expected net energy recovered
- ▶ Risk of contamination between the air flows



CLIVET INVESTS IN PRIMARY AIR. For more than 10 years.

The first **ZEPHIR system** was launched in 2002



CLIVET INVESTS IN PRIMARY AIR. For more than 10 years.

The first **ZEPHIR system** was launched in 2002



Since then we have gained a wealth of **experience**

We have developed an **advanced and reliable technology**

ZEPHIR³. A REVOLUTION IN PRIMARY AIR

The whole Primary air plant in a single stand-alone System

The active thermodynamic circuit produces capacity amplifying the energy contained in the exhaust air

Extracts and expels the stale air from the space and recovers its thermal energy

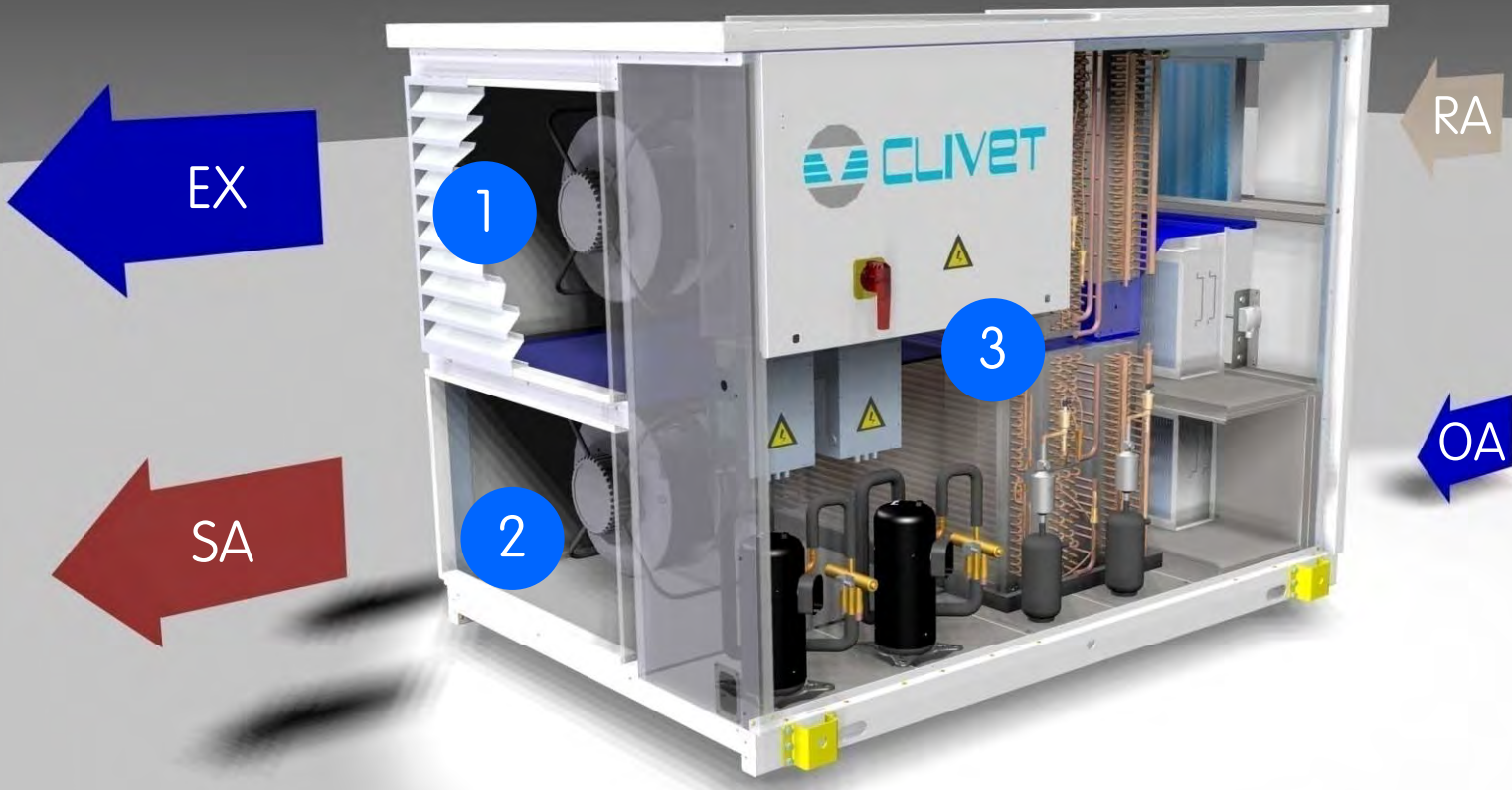
It supply Primary Air purified and air-conditioned

It operates with 100% outdoor air



100% CLIVET TECHNOLOGY. The Primary Air system, industrialised.

- 1. AIR RETURN AND EXHAUST SECTION WITH ENERGY RECOVERY
- 2. FRESH AIR HANDLING AND INLET SECTION
- 3. THERMODYNAMIC INVERTER AND MANAGE AND CONTROL ELECTRONICS SECTION



EX. Exhaust air RA Return air
SA. Supply air OA Outdoor air

100% CLIVET TECHNOLOGY. The Primary Air system, industrialised.

Heat pump technology.

Single system annual cycle

Electric reversible heat pump **systems** are the heart of the Clivet's specialised system solutions

- ▶ Single system for the whole **annual cycle**
- ▶ Efficiency increases further during the most frequent **part load operation**
- ▶ Annual saving **of up to 50%** compared to traditional systems.



100% CLIVET TECHNOLOGY. The primary Air system, industrialised.

Qualified proposal.

It does not use fossil fuels

ZEPHIR³ has full electric operating

- ▶ **No gas** or other fossil fuels
- ▶ **No direct emissions** into the atmosphere
- ▶ **No heating stations**, chimneys, explosion safety devices and regular servicing
- ▶ Further **savings**



SIMPLIFIES THE SYSTEM. More value for the building. And for users.

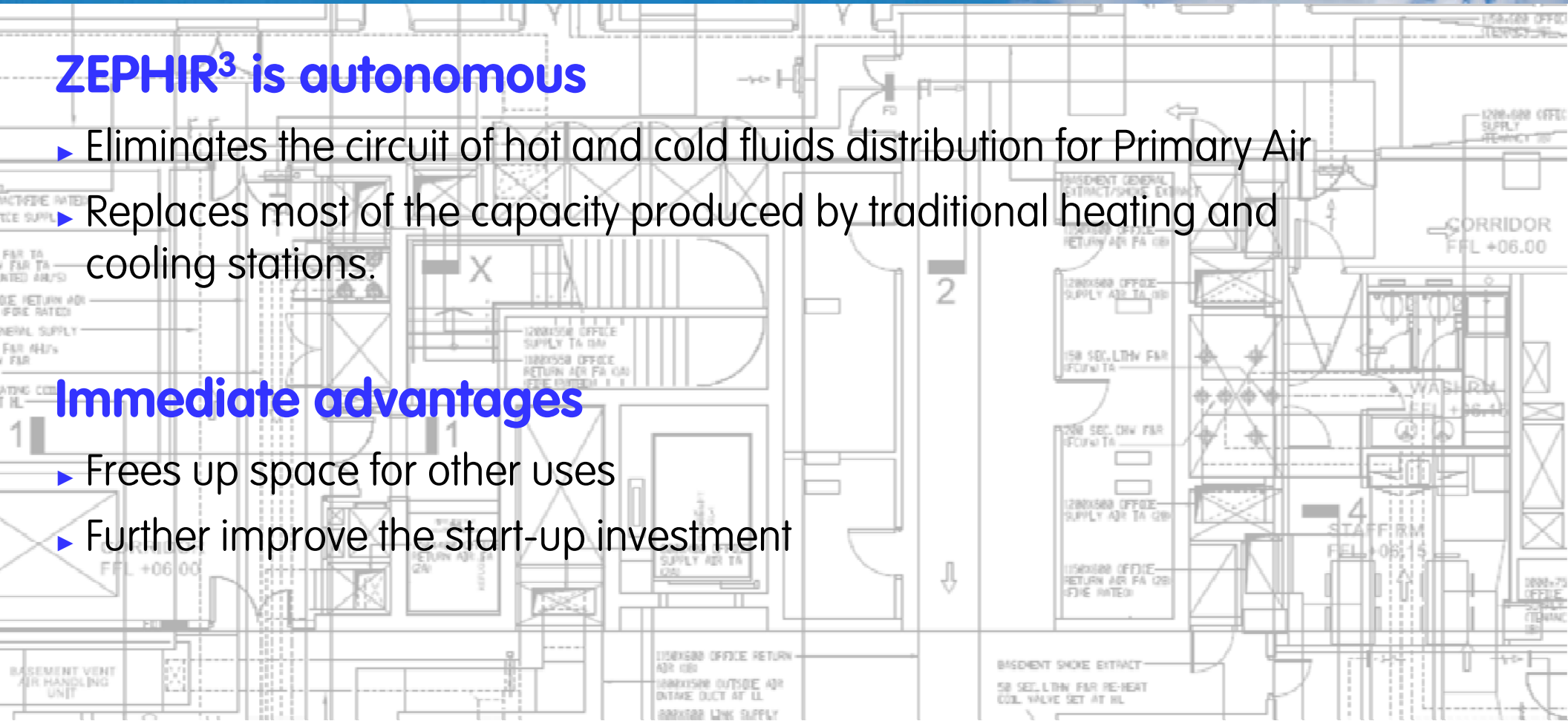
Maximum integration

ZEPHIR³ is autonomous

- ▶ Eliminates the circuit of hot and cold fluids distribution for Primary Air
- ▶ Replaces most of the capacity produced by traditional heating and cooling stations.

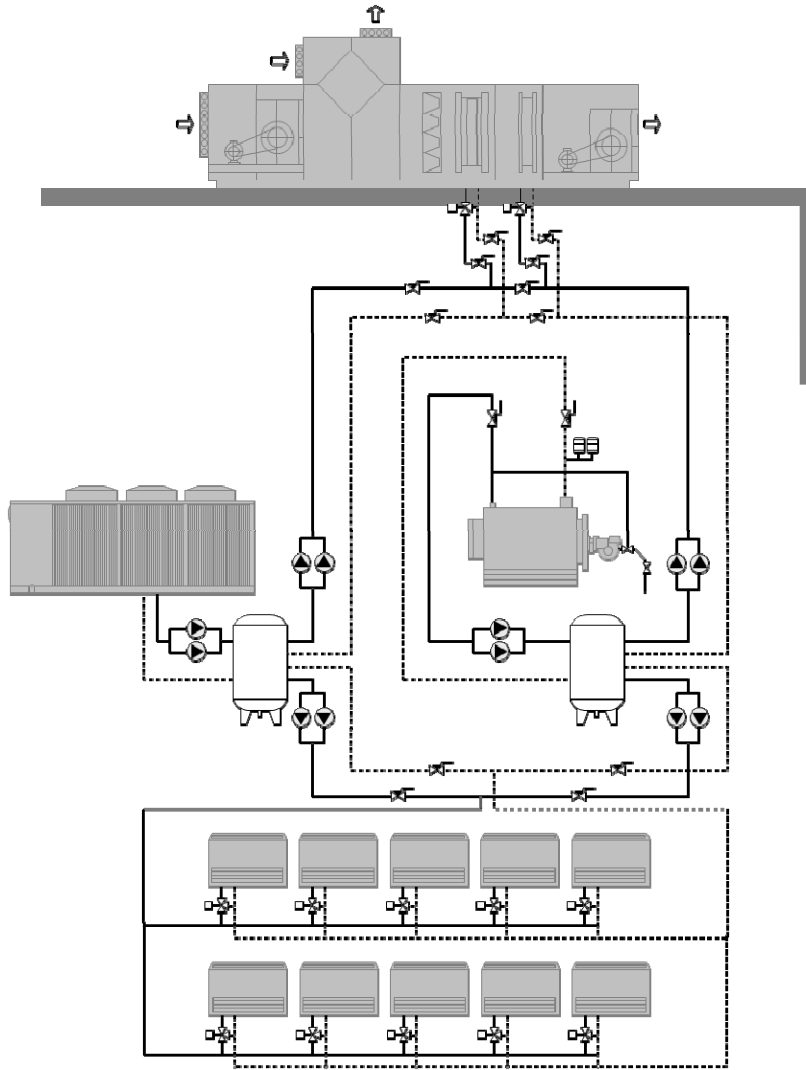
Immediate advantages

- ▶ Frees up space for other uses
- ▶ Further improve the start-up investment



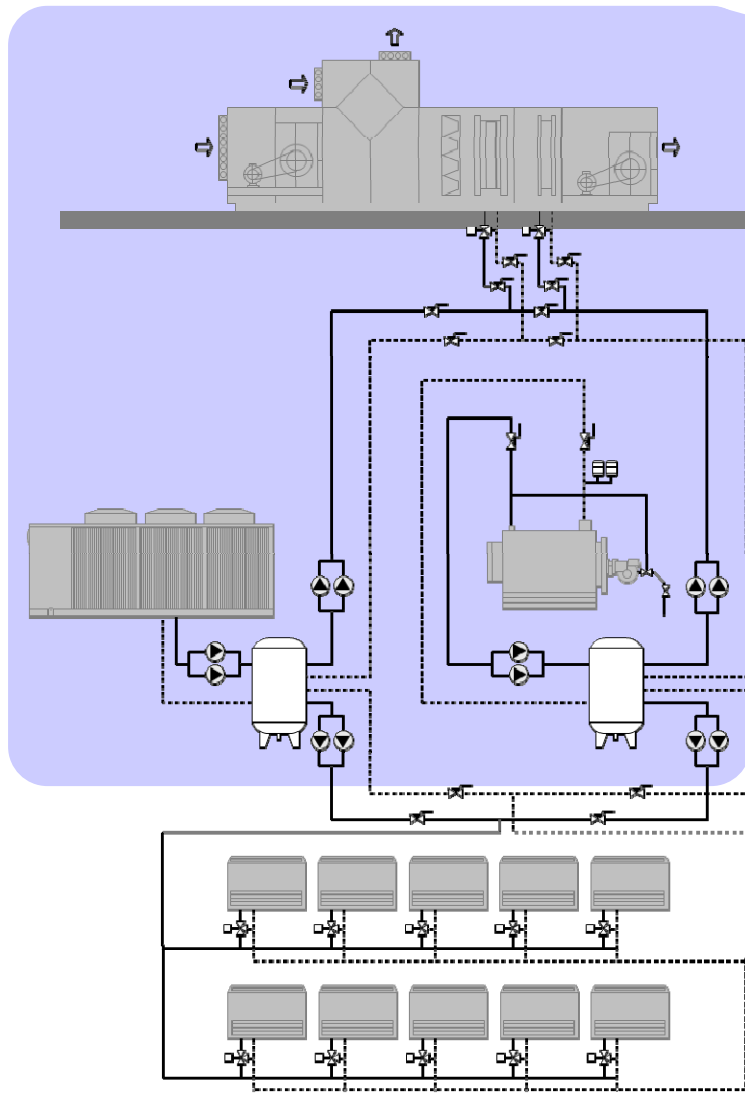
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TRADITIONAL SYSTEM

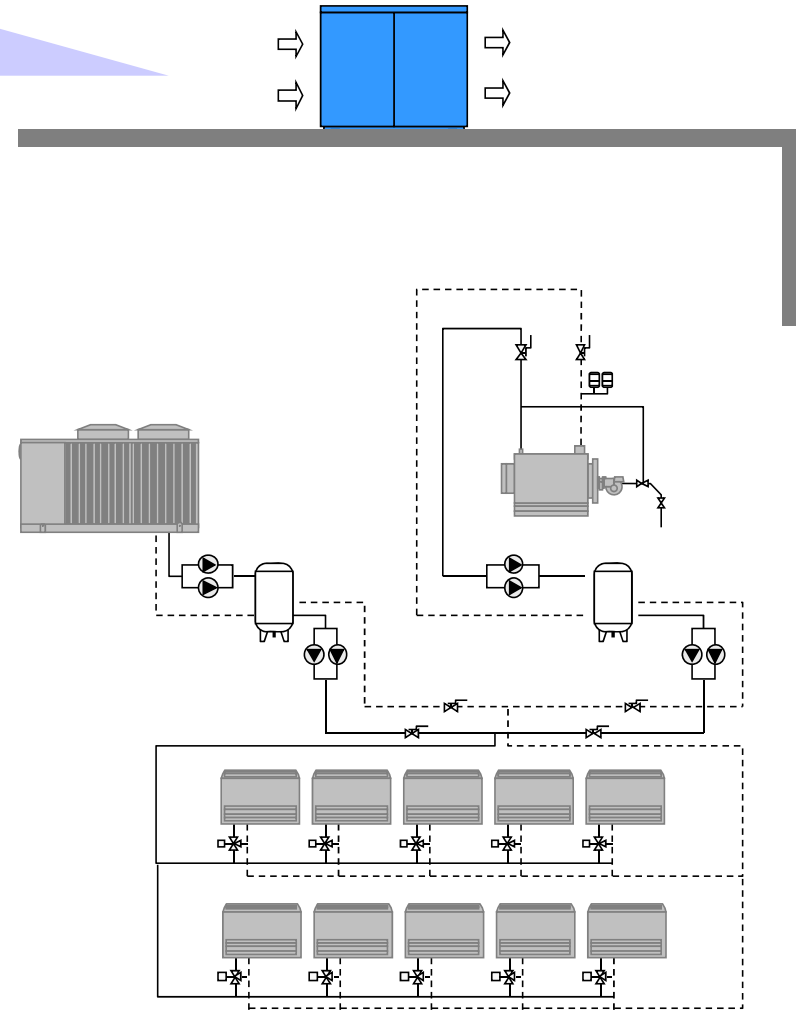


SIMPLIFIES THE SYSTEM. More value for the building. And for users.

TRADITIONAL SYSTEM

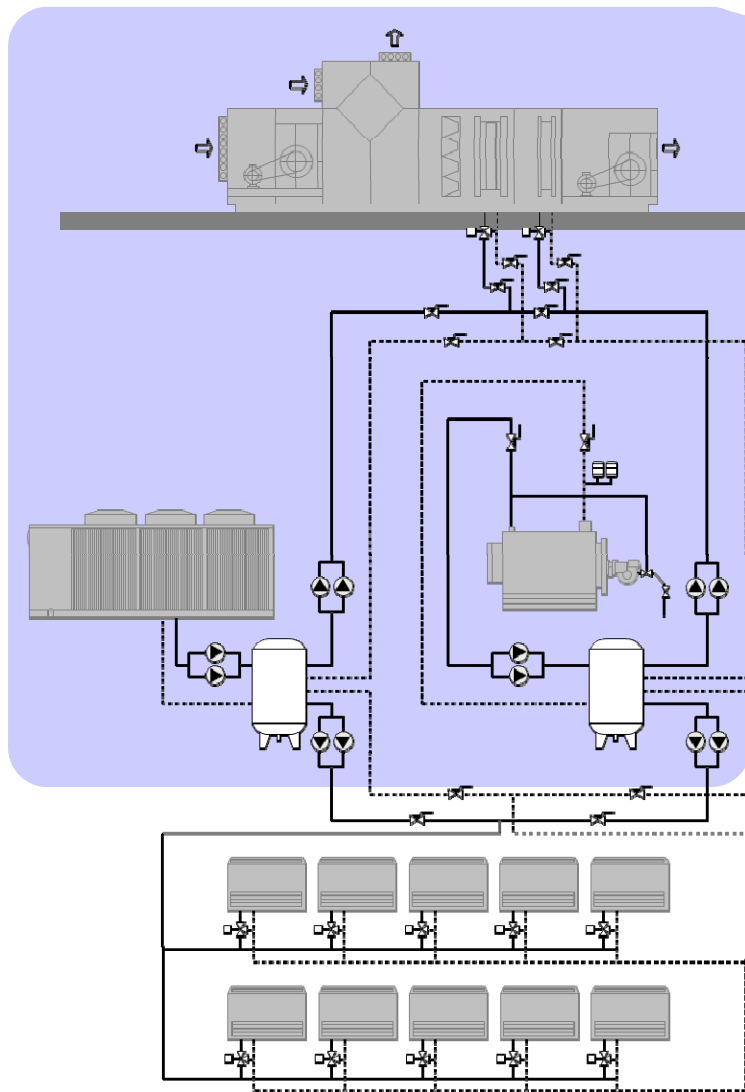


SYSTEM WITH ZEPHIR³

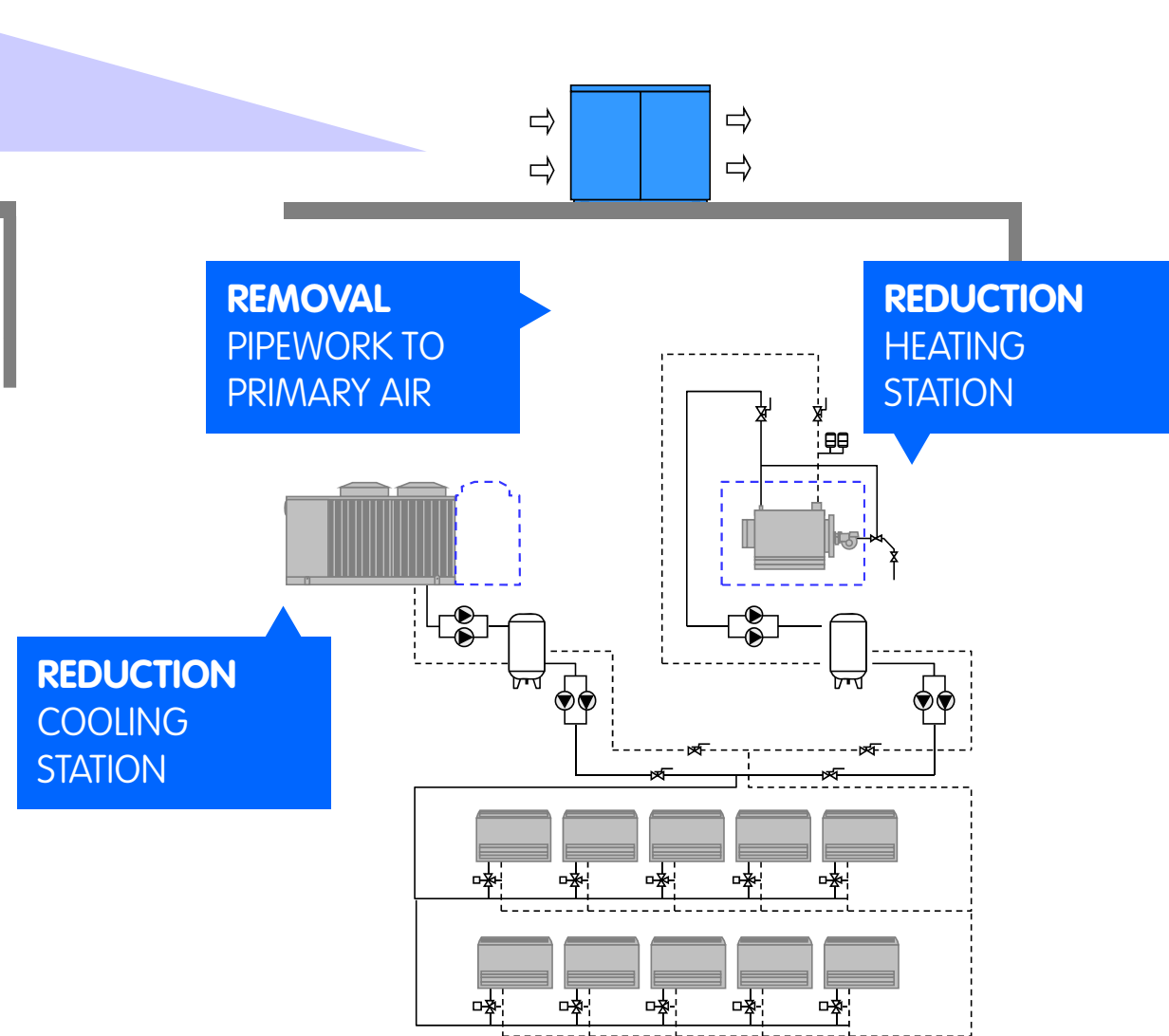


SIMPLIFIES THE SYSTEM. More value for the building. And for users.

TRADITIONAL SYSTEM



SYSTEM WITH ZEPHIR³



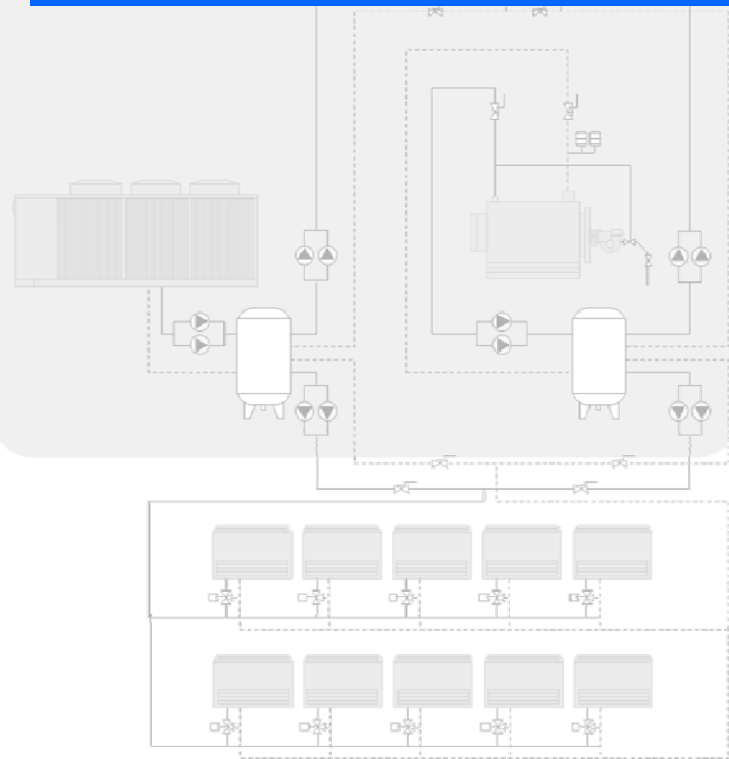
SIMPLIFIES THE SYSTEM. More value for the building. And for users.

IMPIANTO CONVENZIONALE

IMPIANTO CON ZEPHIR³

Elimination of liquid system for Primary Air.

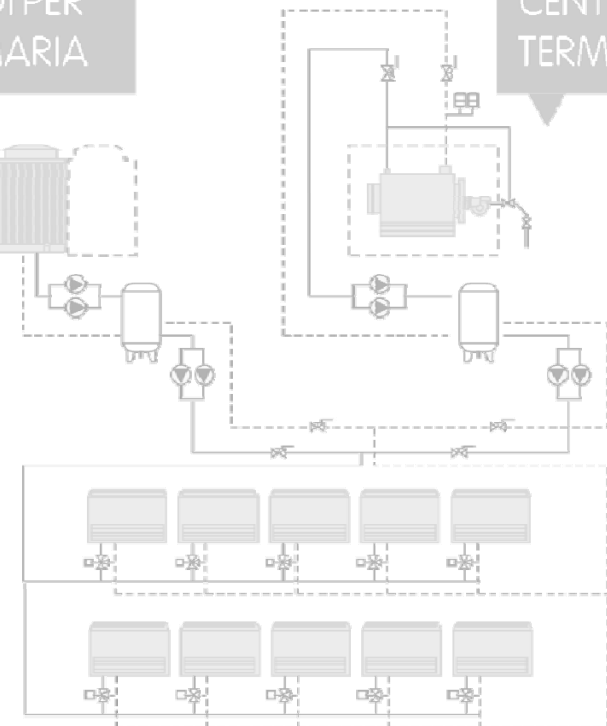
There is non necessary piping and thermal insulation, pumping stations and storage tanks, controls, shafts, installation and testing works



RETE FLUIDI PER
ARIA PRIMARIA

CENTRALE
TERMICA

RIDUZIONE
CENTRALE
FRIGORIFERA



SIMPLIFIES THE SYSTEM. More value for the building. And for users.

IMPIANTO CONVENZIONALE

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Elimination of liquid system for Primary Air.

There is non necessary piping and thermal insulation, pumping stations and storage tanks, controls, shafts, installation and testing works

RETE FLUIDI PER

CENTRALE

Cooling and heating reduction.

Traditional heating and cooling stations are required only for the secondary local air-conditioning system:

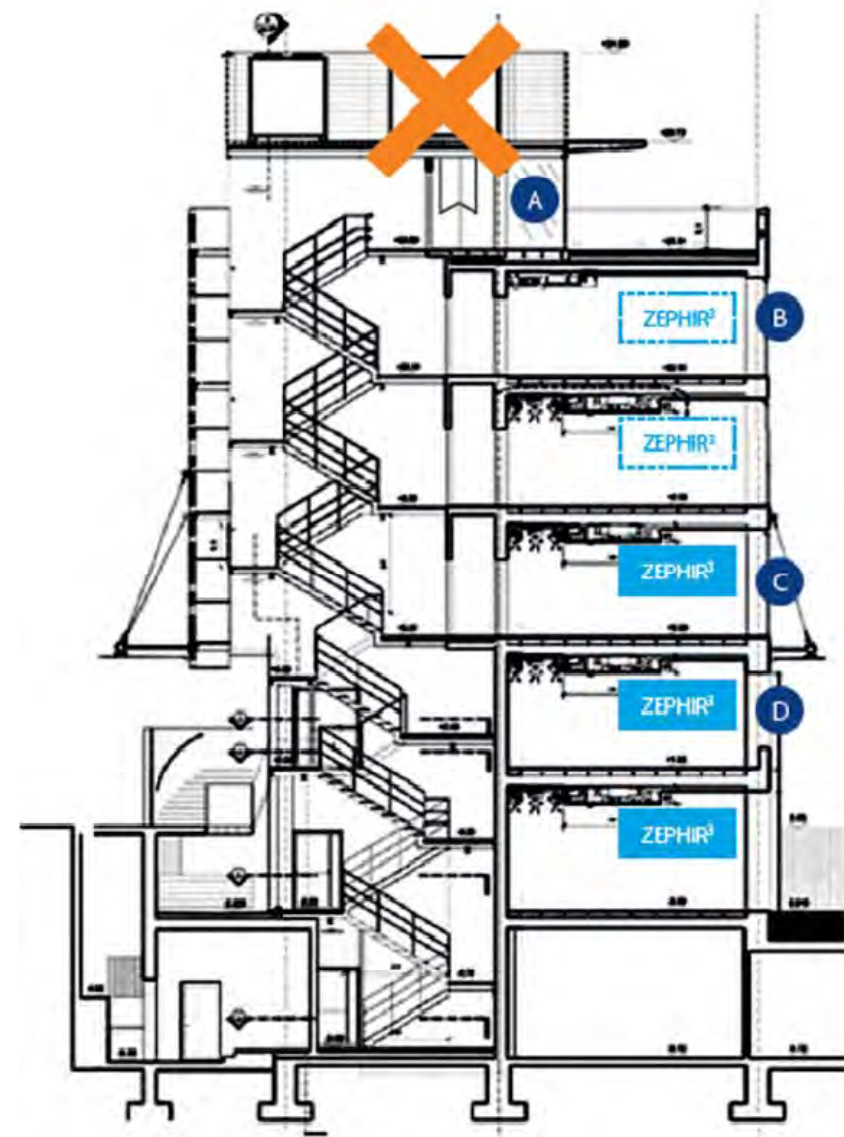
- ▶ have compact size and low start-up costs
- ▶ are activated only for limited times and in severe ambient conditions
- ▶ produce lower direct energy consumption, that is electricity and fossil fuels
- ▶ produce lower auxiliary energy consumption for pumping, losses and thermal inertia of the fluid distribution network.

DECENTRALISED SYSTEM. Flexible of investment and installation.

Location of the Primary Air system

ZEPHIR3 makes it easier to split the primary air system into similar areas of the building

- ▶ Further increase of efficiency as it produces energy locally, only when and where it is required
- ▶ Further increase of the comfort because the unit successfully adapts to the different loads
- ▶ Modular design, therefore simpler



DECENTRALISED SYSTEM. Flexible of investment and installation.

Advantages

A. Frees up space

No need for large-size central ductworks for supply and return air

B. Spread out investment over time

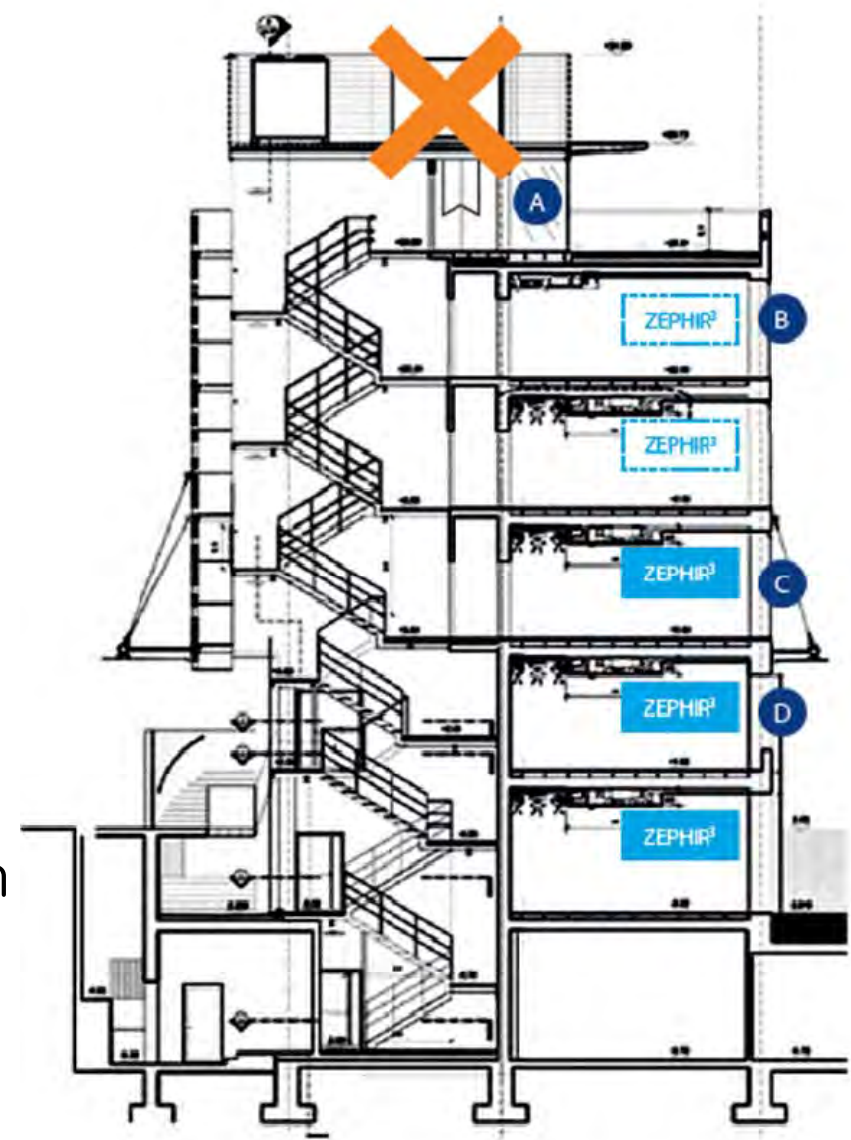
Purchase only as the areas become occupied

C. Best architectural integration

Smaller capacity modules are easier to position

D. More durable

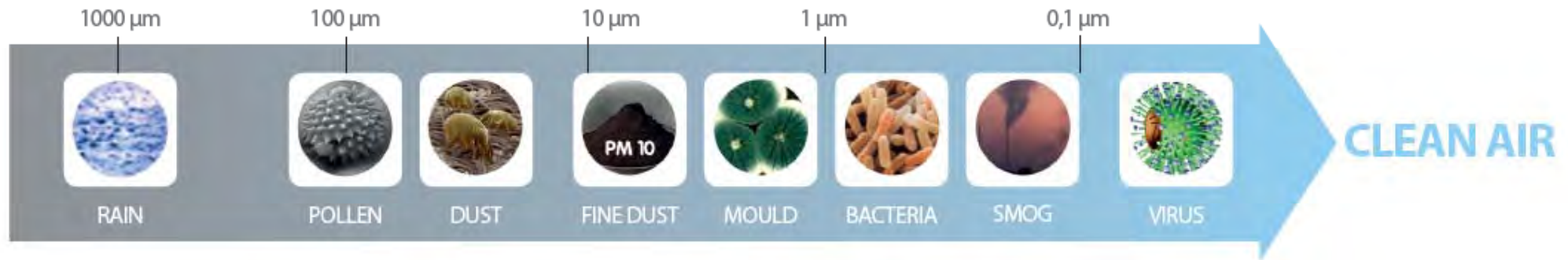
It can be easily installed indoors, sheltered from the bad weather



HIGH AIR QUALITY. Purification and Comfort while Saving.

99% pure air.

- ▶ The ZEPHIR³ electronic filters are effective on smoke, dust particles especially PM10, PM2,5, PM1, viruses and bacteria
- ▶ Higher air quality even in the most polluted urban areas.



Continuous humidity control

- ▶ Cooling: constantly dehumidifying via the thermodynamic circuit
- ▶ Heating: steam humidification optional

Continuous extraction of exhaust air

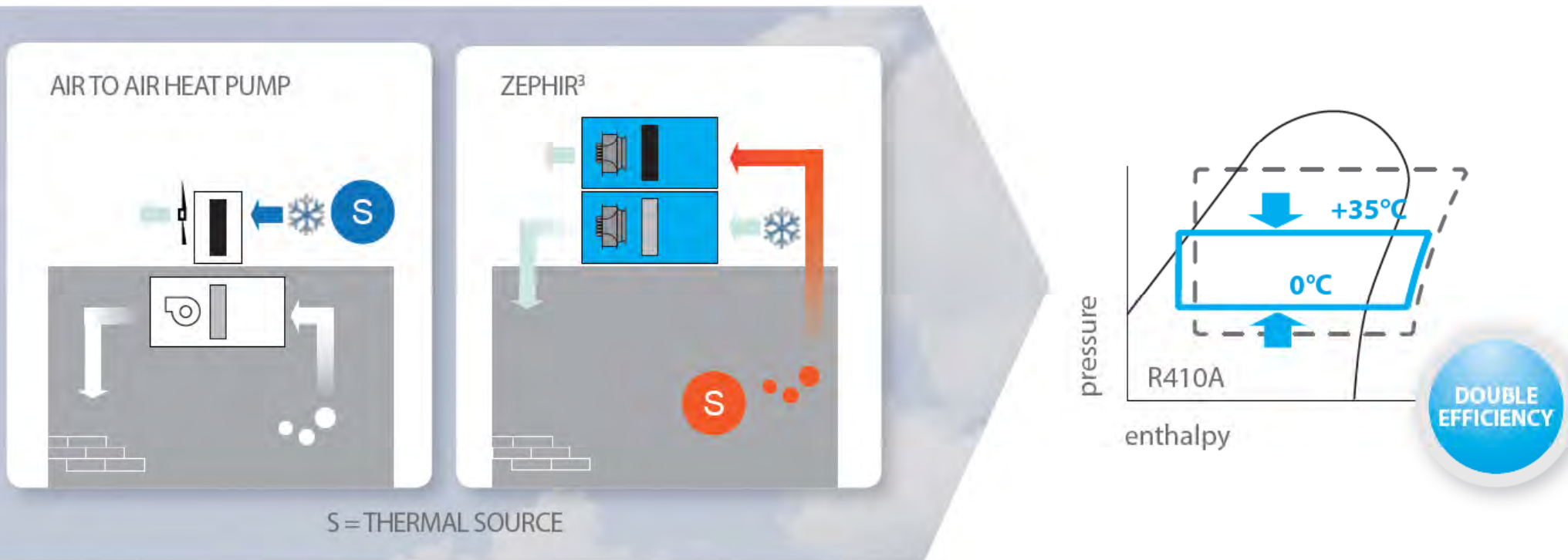
- ▶ Removal of pollutants
- ▶ No cross flow contamination

HIGH ENERGY EFFICIENCY Production at low energy consumption.

1. Exhaust air as a favourable thermal source stable over time.

It halves the energy required for the compressors

- ▶ Higher evaporation/Lower condensation
- ▶ Up to 50% less power consumption by the compressors



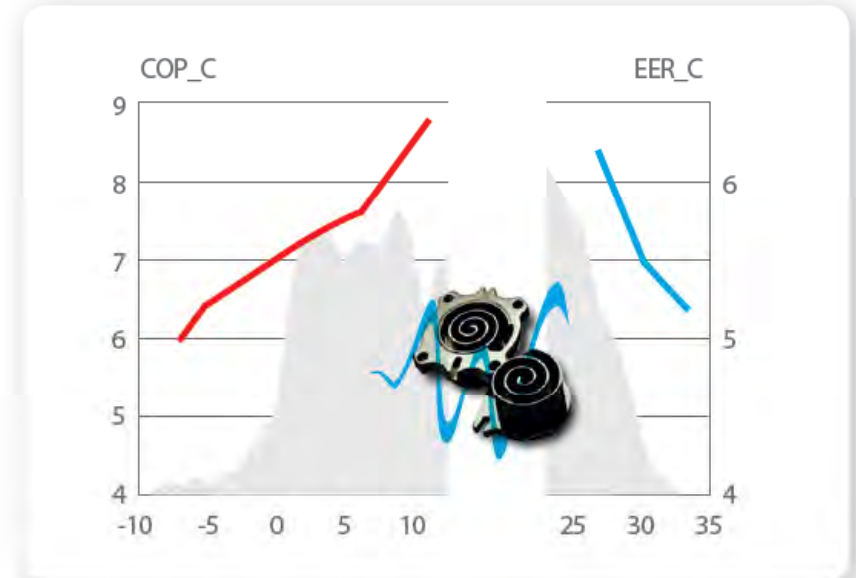
HIGH ENERGY EFFICIENCY Production at low energy consumption.

2. Continuous capacity control.

Very high seasonal efficiency

ZEPHIR³ supplies only the energy actually required.

- ▶ Increased efficiency at partial load which is the most used condition.
- ▶ The annual consumption of primary energy is reduced by 50% compared with traditional systems.



3. Dynamic Free-cooling

Great savings on management costs.

With these ZEPHIR³ feature:

- ▶ It intakes fresh and clean outdoor air without the compressors activation
- ▶ It cools the spaces free of charge for a considerable amount of hours of operation
- ▶ It's even more effective in buildings with high space loads

4. Re-heat free of charge

It recovers the heat from hot gas.

During dehumidification:

- ▶ It eliminates the energy cost to pump and store hot water from the heating station or the heat recovery on
- ▶ The energy efficiency of the thermodynamic circuit further increases due to favourable condensation
- ▶ Accurate modulating control of the supply temperature

5. High efficiency air circulation

Because the ventilation is always on.

Electronically controlled motor directly coupled to the reverse blade impeller.

- ▶ Eliminates inefficiencies, wear and maintenance of traditional belt and pulley transmissions.
- ▶ As standard they are equipped with a "soft start" function, which drastically reduces the inrush current and further limits the electric consumption of the system
- ▶ At the same performances level, ZEPHIR³ saves up to 30% compared with traditional ventilation systems.



6. Efficient recovery

Ventilation not reduced.

- ▶ The ZEPHIR³ thermodynamic recovery eliminates the high pressure drops of passive recovery which in traditional systems requires more power for ventilation. This higher electrical consumption in an annual cycle often loses the savings on the recovered energy.



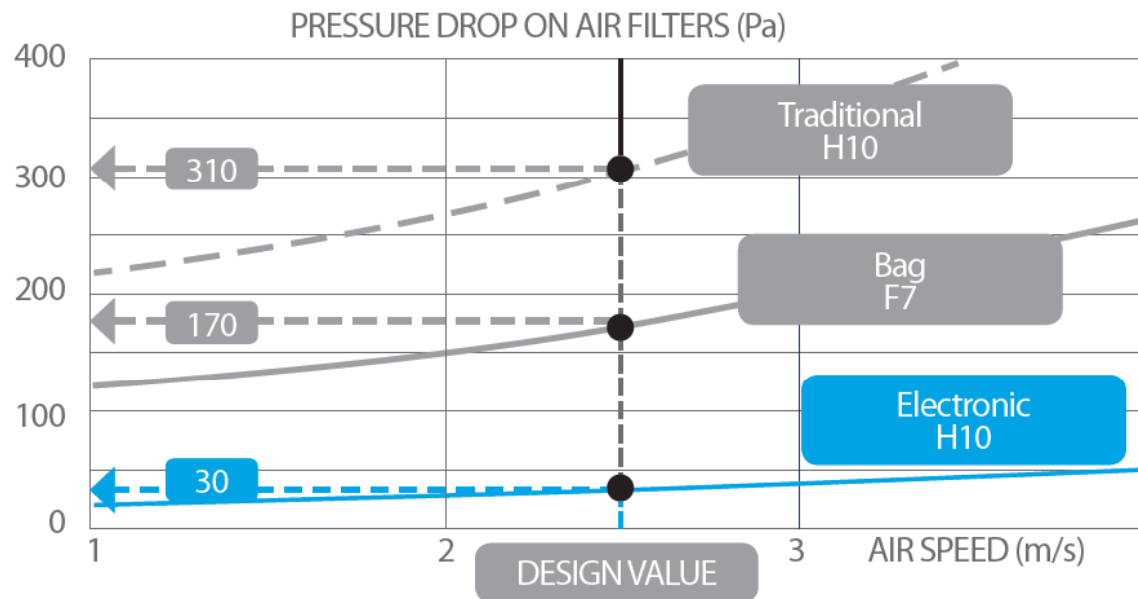
HIGH ENERGY EFFICIENCY Top ventilation technology. No waste.

7. No waste filtration

High efficiency purification only.

High efficiency electronic filters

- ▶ Equivalent to the traditional H10
- ▶ Negligible pressure drop
- ▶ Saving on ventilation above 10% compared with conventional filters



8. Constant or variable air flow

Constant: just the amount required.

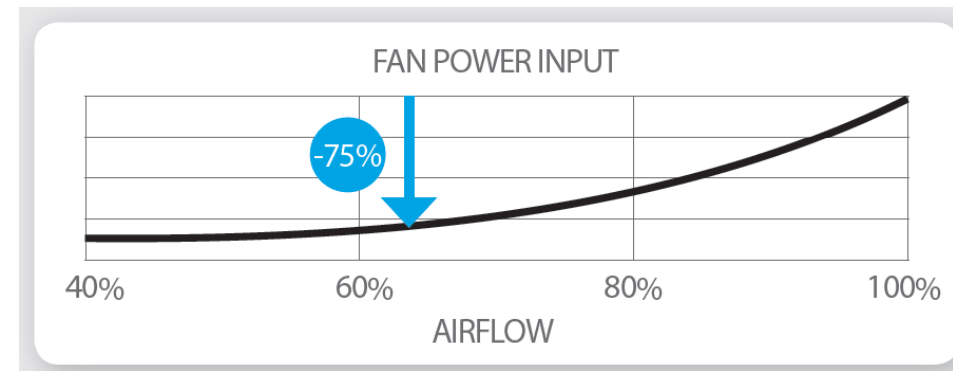
The nominal air flow set on the display

- ▶ Simplified system calibration and testing
- ▶ Constant air flow, by adjusting the fan speed
- ▶ For all air diffusion systems that cannot support variations in air flow, as in the majority of induction and chilled beam systems

Variable: the quantity required only.

It can automatically reduce the air flow in accordance with the actual crowding detected by the CO₂ probe

- ▶ Further increase of energy saving for air handling.
- ▶ Suitable also for other pollutants such as tobacco smoke, formaldehyde, cooking odours (VOC, Volatile Organic Compounds).

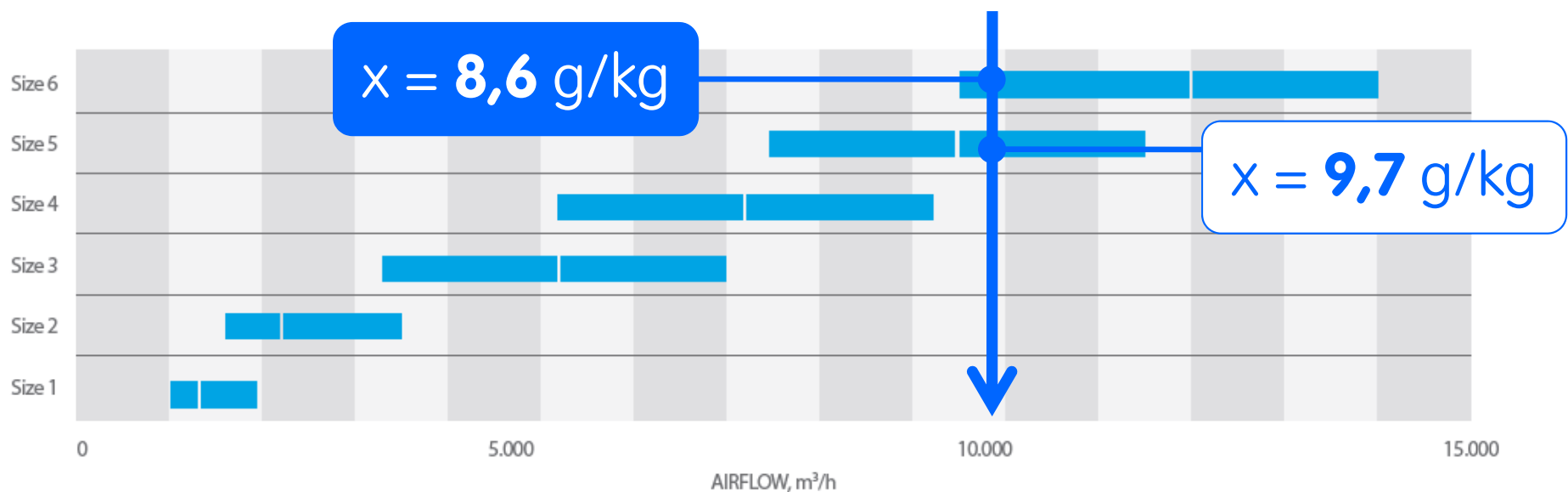


UNIVERSAL SYSTEM. In different climates and system types.

Always the right choice

Simplified design.

- ▶ The primary air flow depends on the the building features and its use.
- ▶ The capacity required for the air handling depends on both the outdoor air conditions and the secondary air conditioning system.
- ▶ The ZEPHIR³ air flow can be chosen accurately for each model (Size).
- ▶ Two models with the same air flow differ from heating and cooling capacities of the thermodynamic circuit, thus from the different supply conditions.



ADDS VALUE TO THE BUILDING. Cost-effectively.



Greater comfort and reduced CO₂ emissions

Improves the energy rating of the building.

- ▶ ZEPHIR³ increases comfort in buildings, reduces the consumption of primary energy, and reduces CO₂ emissions by up to 50% compared with traditional systems.
- ▶ It makes an important contribution by improving the energy rating of the building and thus increasing its market value.

Incredible saving in the Total Life Cycle Cost

In the initial investment, operation and maintenance.

- ▶ The system choice depends on the sustainability of the building operation and the welfare of the people who will live in the building, for the duration of its operating life.
- ▶ ZEPHIR³ simplifies the system and increases overall efficiency. Total capital cost is competitive, and it provides savings in system management which results in greater cash flow over the years.



CLIVET IS INVOLVED IN
THE PROMOTION
OF SUSTAINABLE BUILDING
AND
IS AN ORDINARY MEMBER OF
GBC ITALY

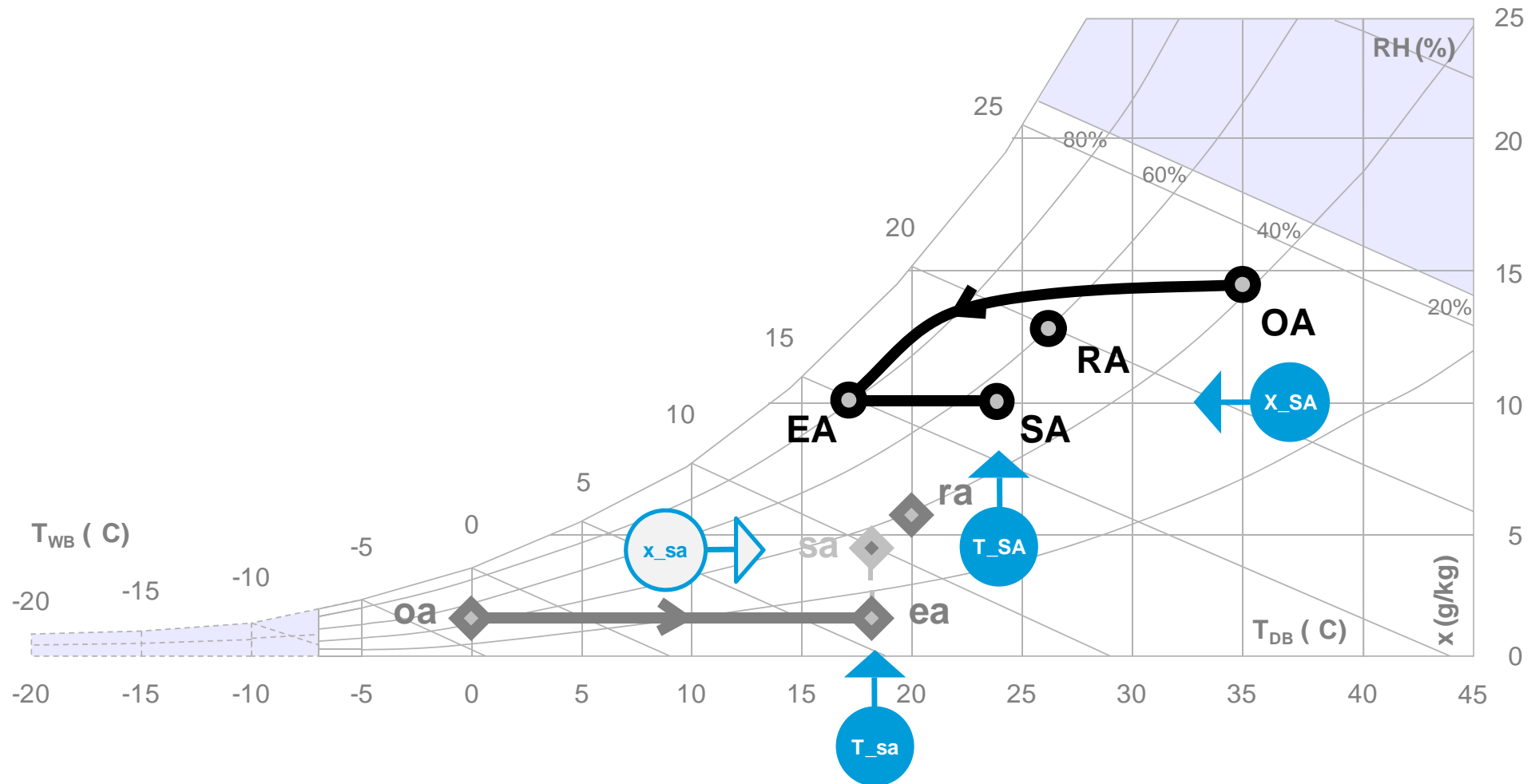
OPERATION WITH CONSTANT SUPPLY CONTROL (CS)

When the room loads are handled by the secondary system

- ▶ Exploits part of the ZEPHIR³ usable capacity
- ▶ Operation does not depend on space conditions
- ▶ Accurate regulation of air flow conditions
- ▶ Common in centralized systems
- ▶ Humidity supply control in summer operation
- ▶ The same system can serve multiple spaces of the building, with different requirements (for example with different exposure)
- ▶ Ideal in installations with induction or Chilled Beam

OPERATION WITH CONSTANT SUPPLY CONTROL (CS)

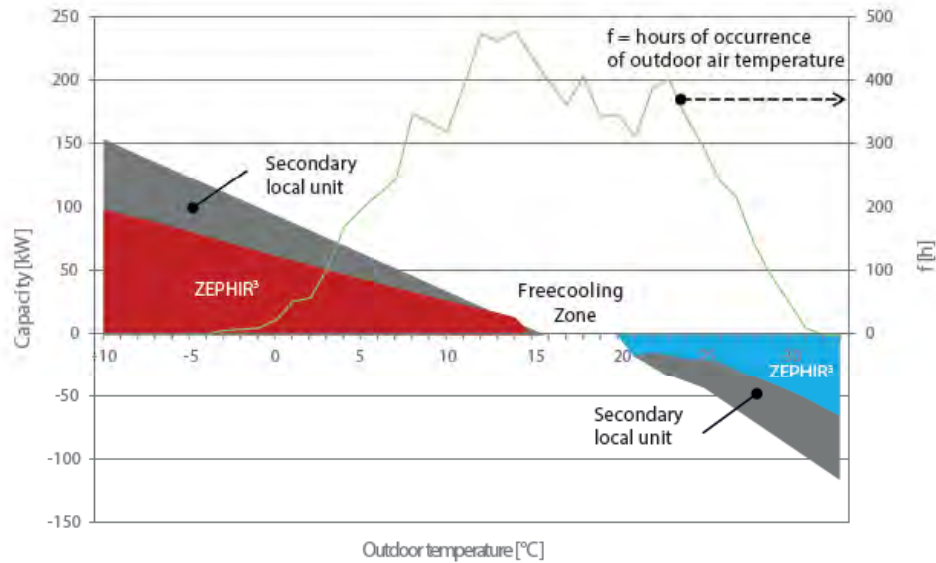
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OPERATION WITH CONSTANT SUPPLY CONTROL (CS)

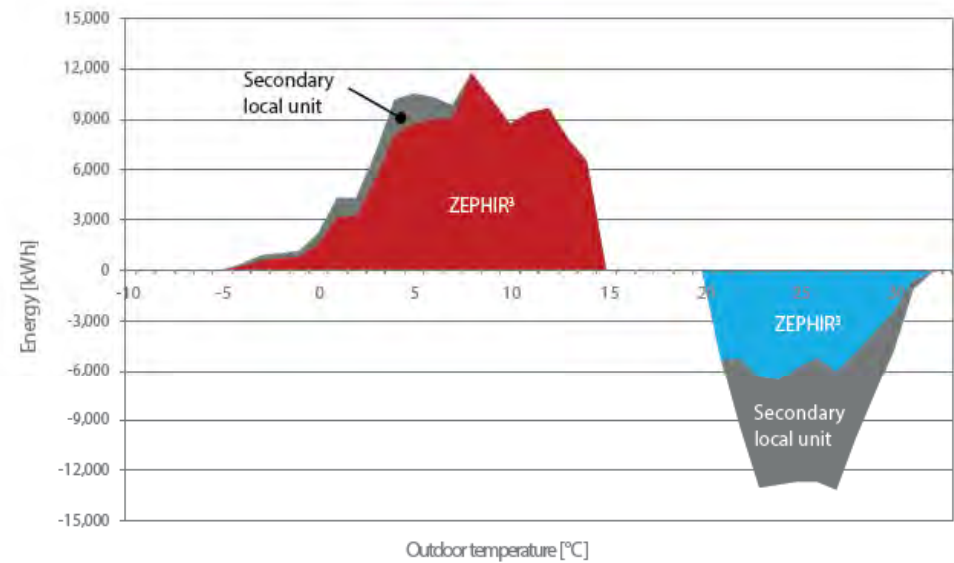
Case study. Hospital building in Rome

HEAT LOAD DISTRIBUTION



Data refer to the use in a Hospital building, operating in continuous cycle operation. 24 hours a day for 365 days a year. Location: Rome, Italy. Source of climate data: U.S. Department of Energy. ZEPHIR3 Size 5 system, nominal air flow 9.500 m³/h

THERMAL LOAD DISTRIBUTION

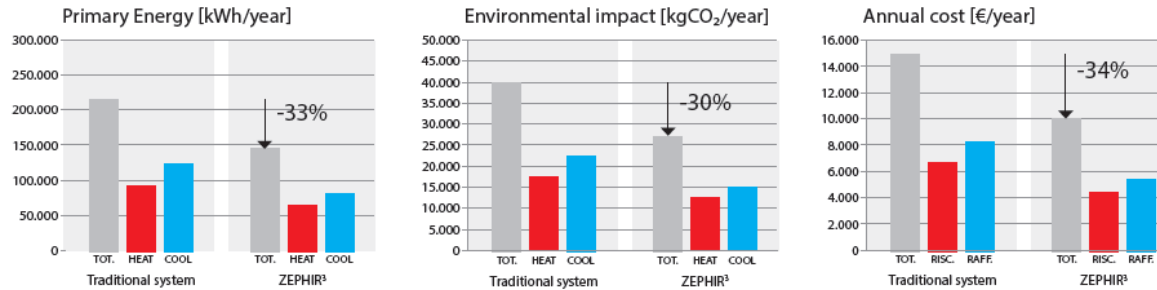


Location	ZEPHIR ³ Thermal energy heating ratio	ZEPHIR ³ Thermal energy cooling ratio
ROME	91%	51%
LONDON	86%	57%
VALENCIA	94%	52%

OPERATION WITH CONSTANT SUPPLY CONTROL (CS)

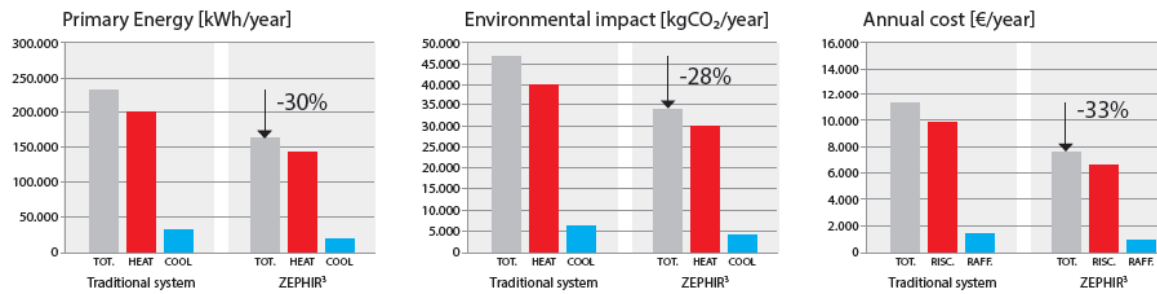
Case study. Energy analysis

ROME



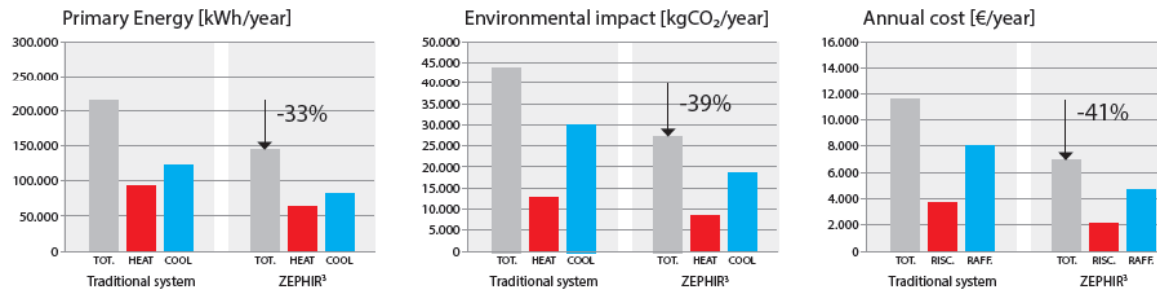
Methane gas cost 0,7 EUR/Nm³ - Electric energy cost 0,15 EUR/kWh

LONDON



Methane gas cost 0,5 EUR/Nm³ - Electric energy cost 0,10 EUR/kWh

VALENCIA



Methane gas cost 0,6 EUR/Nm³ - Electric energy cost 0,10 EUR/kWh

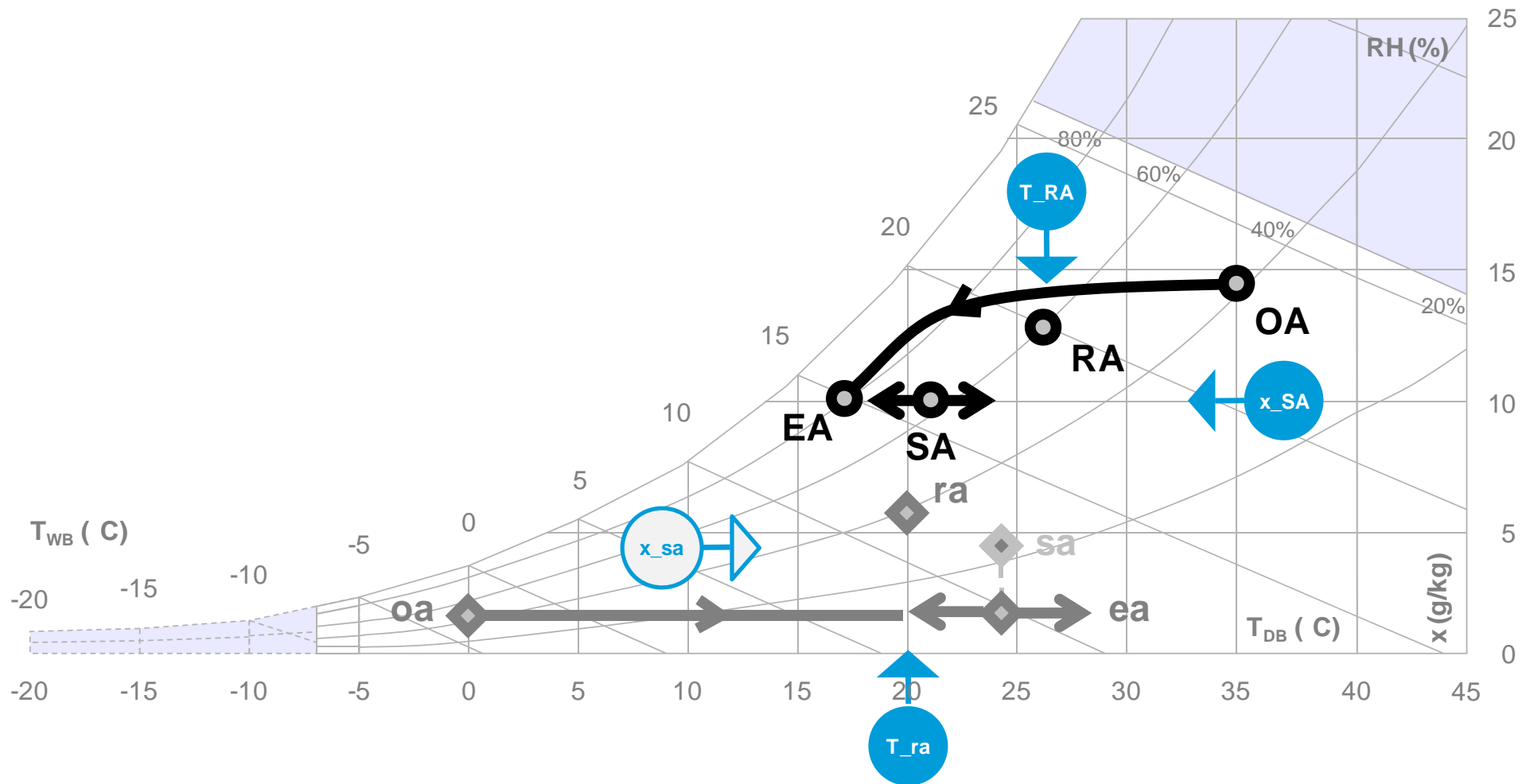
OPERATION AT MAXIMUM AVAILABLE CAPACITY (MC)

To maximise the heating and cooling capacity of the ZEPHIR³

- ▶ Operation also depends on space conditions
- ▶ It satisfies most of the building load
- ▶ It reduces the capacity required from secondary local units
- ▶ Ideal also for applications on multiple spaces with similar loads
- ▶ Humidity supply control in summer operation
- ▶ It allows to benefit from decentralising primary air

OPERATION AT MAXIMUM AVAILABLE CAPACITY (MC)

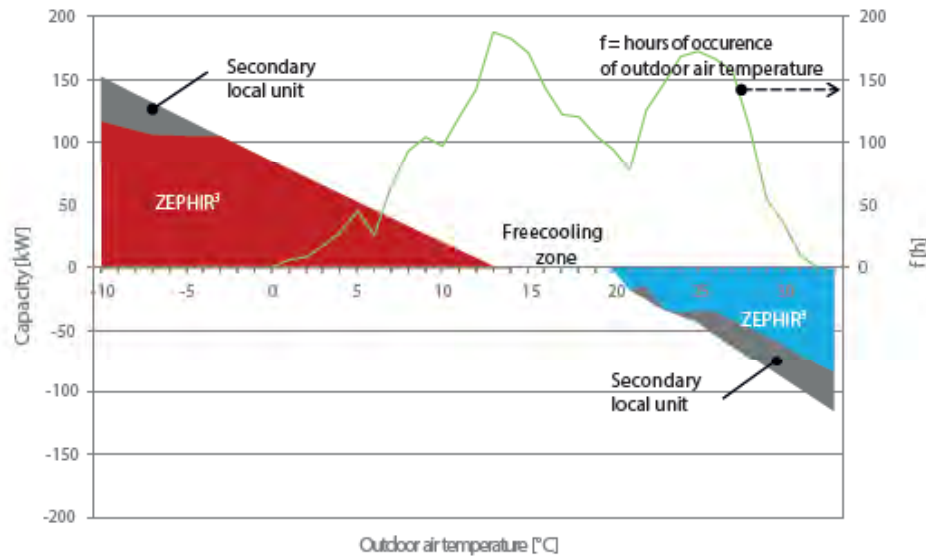
To maximise the heating and cooling capacity of the ZEPHIR³



OPERATION AT MAXIMUM AVAILABLE CAPACITY (MC)

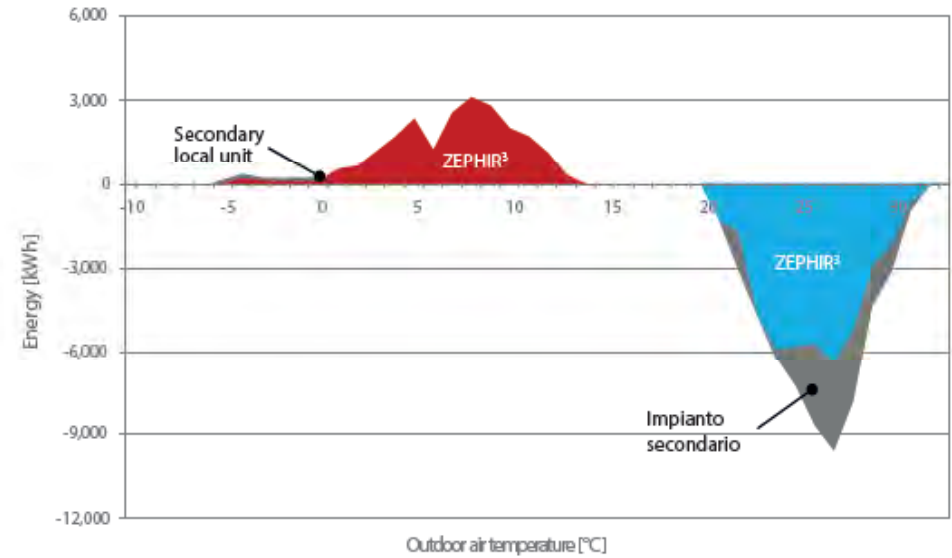
Case study. Office building in London.

HEAT LOAD DISTRIBUTION



Data refer to the use in an Office Building, operating at discontinuous cycles. 12 hours a day for 260 days a year. Location: Rome, Italy. Source of climate data: U.S. Department of Energy.

THERMAL ENERGY DISTRIBUTION

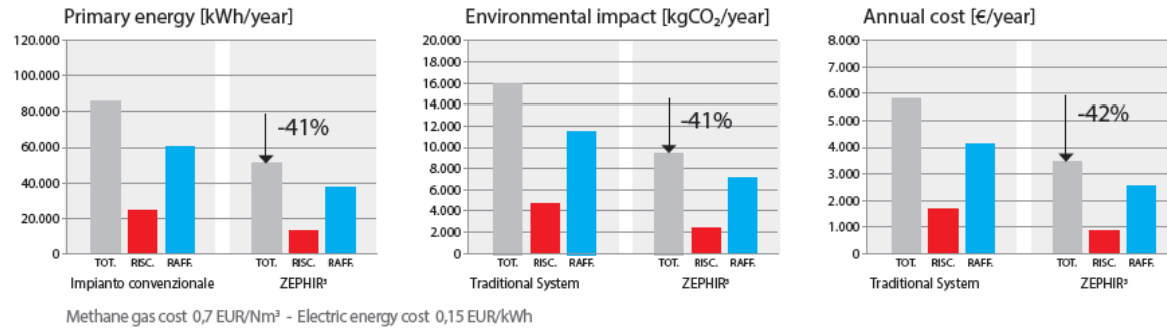


Location	ZEPHIR³ Thermal energy heating ratio	ZEPHIR³ Thermal energy cooling ratio
ROME	98%	74%
LONDON	97%	83%
VALENCIA	99%	73%

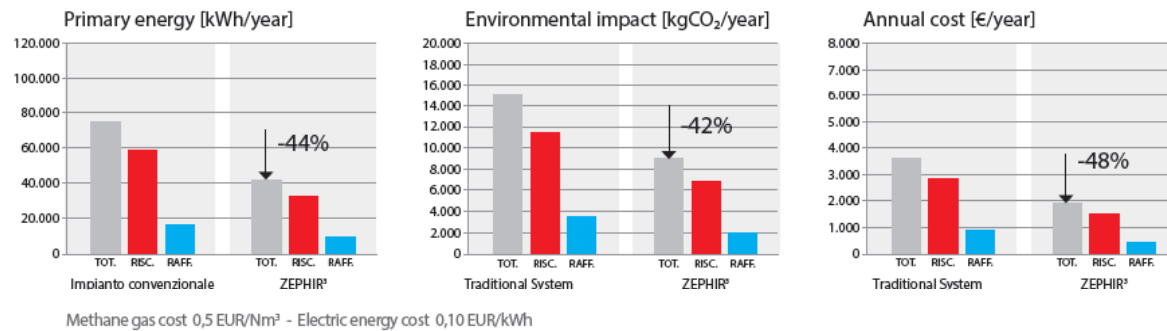
OPERATION AT MAXIMUM AVAILABLE CAPACITY (MC)

Case study. Energy analysis

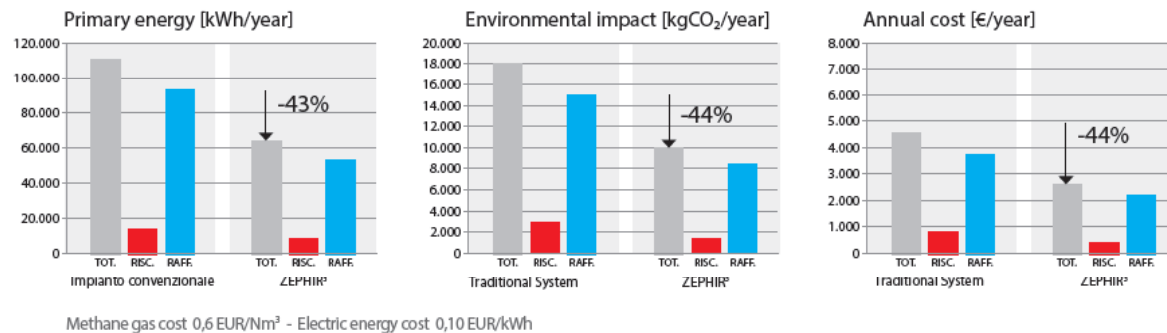
ROME



LONDON



VALENCIA



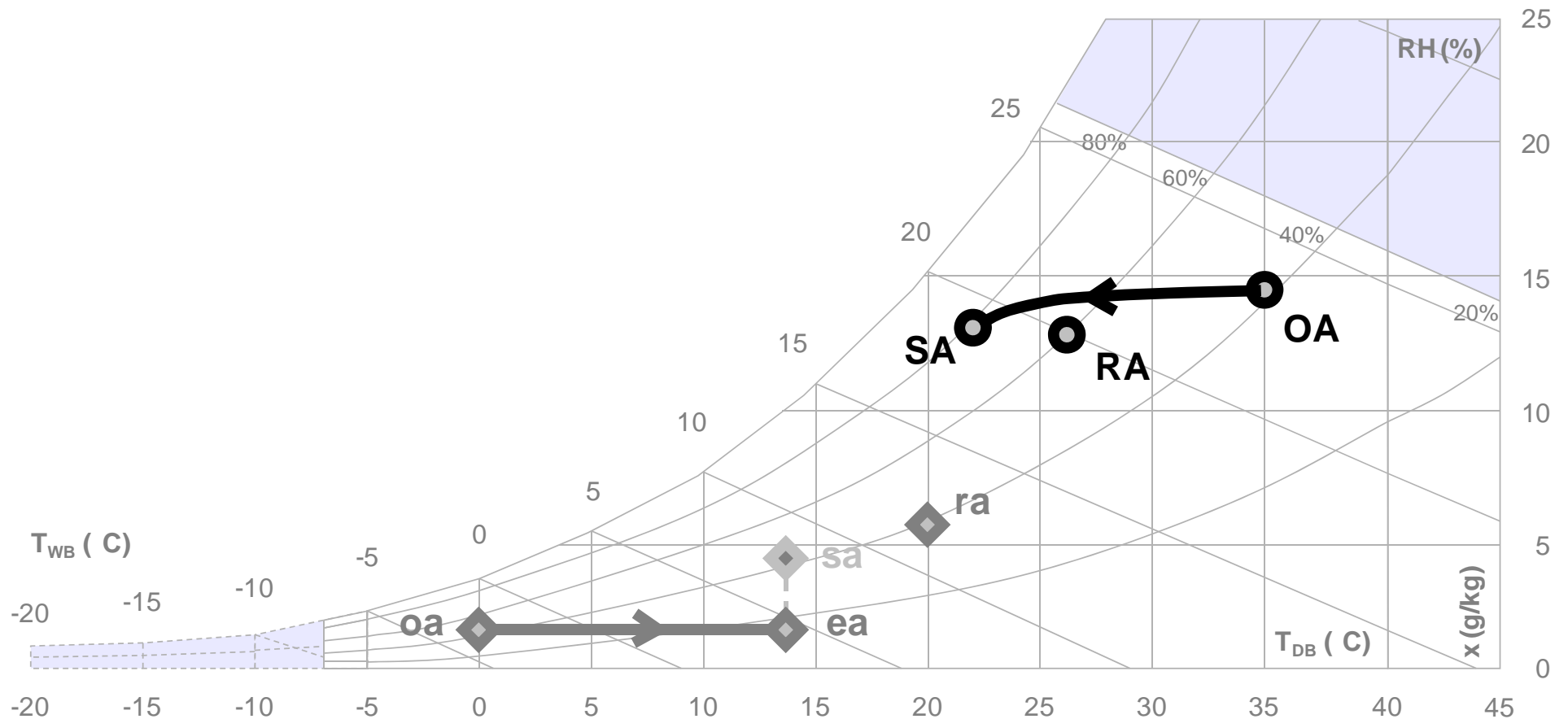
OPERATION WITH HIGH AIRFLOW (HA)

When ZEPHIR³ operates as an active thermodynamic recovery system and the secondary local system controls space conditions.

- ▶ Common conditions for shopping Malls
- ▶ Air handling is completed by the secondary local units.
- ▶ Extensive use of Free-cooling
- ▶ Operation does not depend on space conditions
- ▶ Secondary air units controls humidity supply in summer operation
- ▶ Primary air is delivered to intake of secondary local units

OPERATION WITH HIGH AIRFLOW (HA)

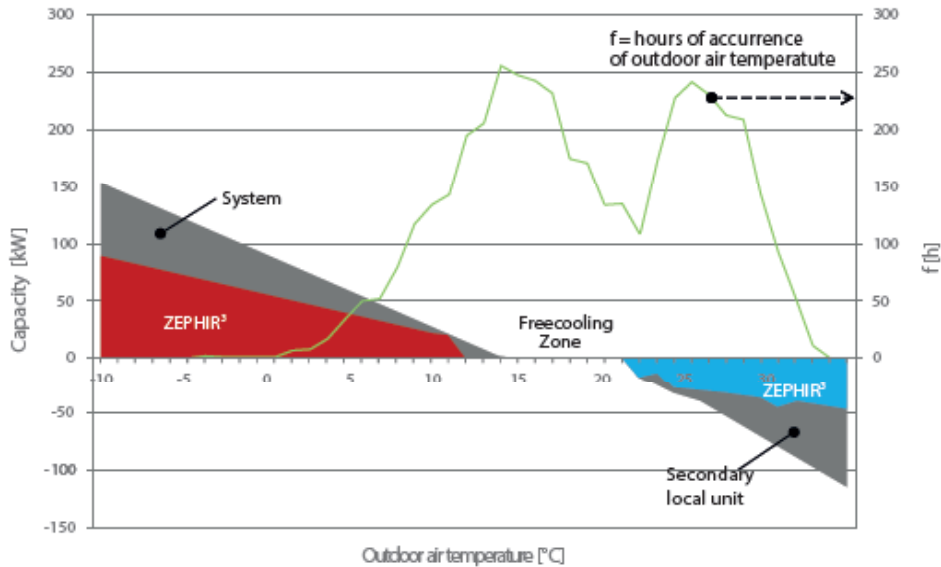
When ZEPHIR³ operates as an active thermodynamic recovery system and the secondary local system controls space conditions.



OPERATION WITH HIGH AIRFLOW (HA)

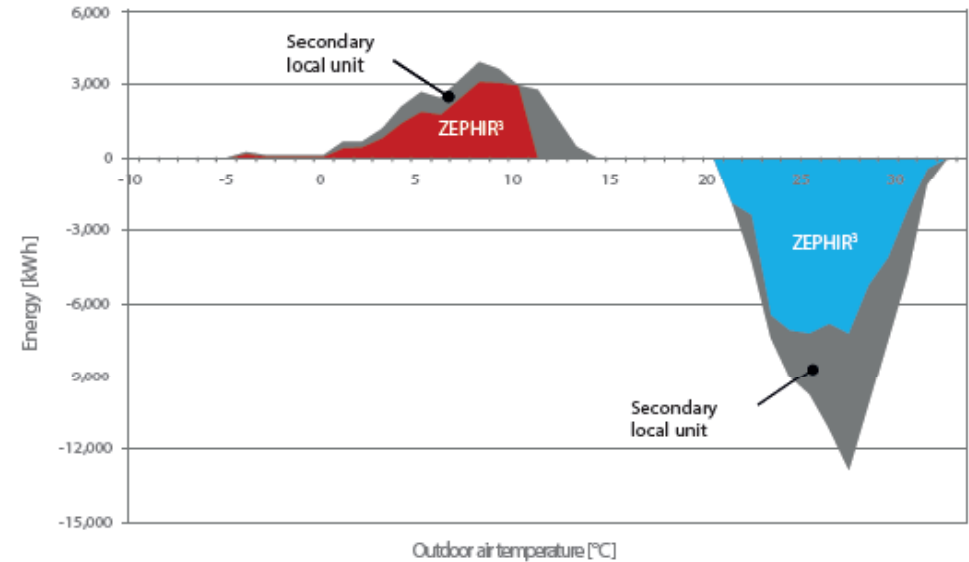
Case study. Shopping Mall in Rome.

HEAT LOAD DISTRIBUTION



Data refer to the use in a shopping mall, operating at discontinuous cycles.
 12 hours a day for 365 days a year.
 Location: Rome, Italy.
 Source of climate data: U.S. Department of Energy.

THERMAL ENERGY DISTRIBUTION

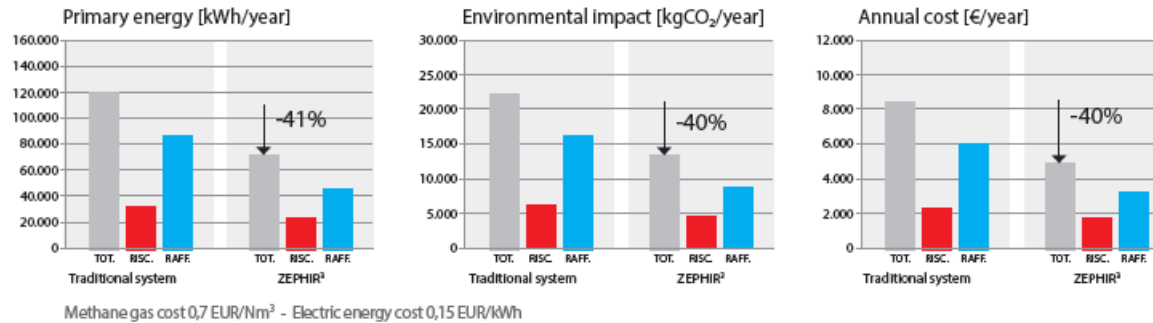


Location	ZEPHIR ³ Thermal energy heating ratio	ZEPHIR ³ Thermal energy cooling ratio
ROME	63%	66%
LONDON	67%	73%
VALENCIA	61%	59%

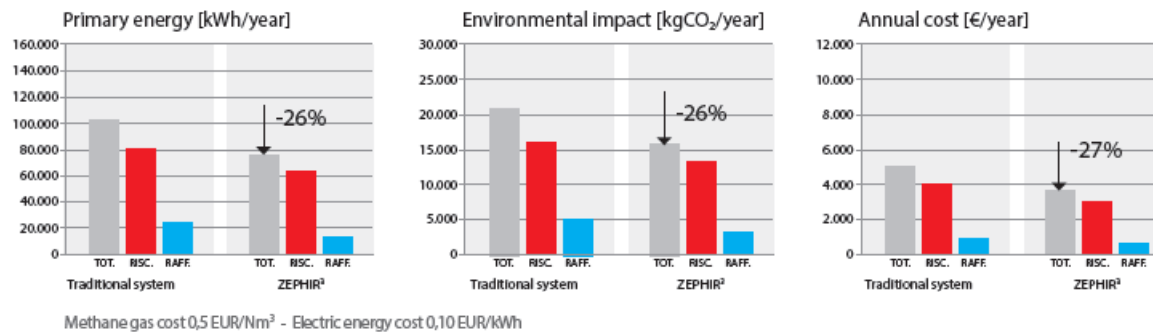
OPERATION WITH HIGH AIRFLOW (HA)

Case study. Energy analysis

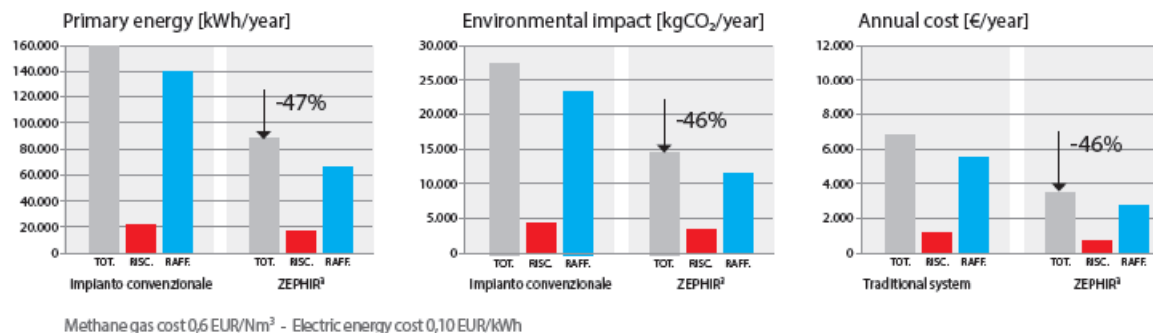
ROME



LONDON



VALENCIA

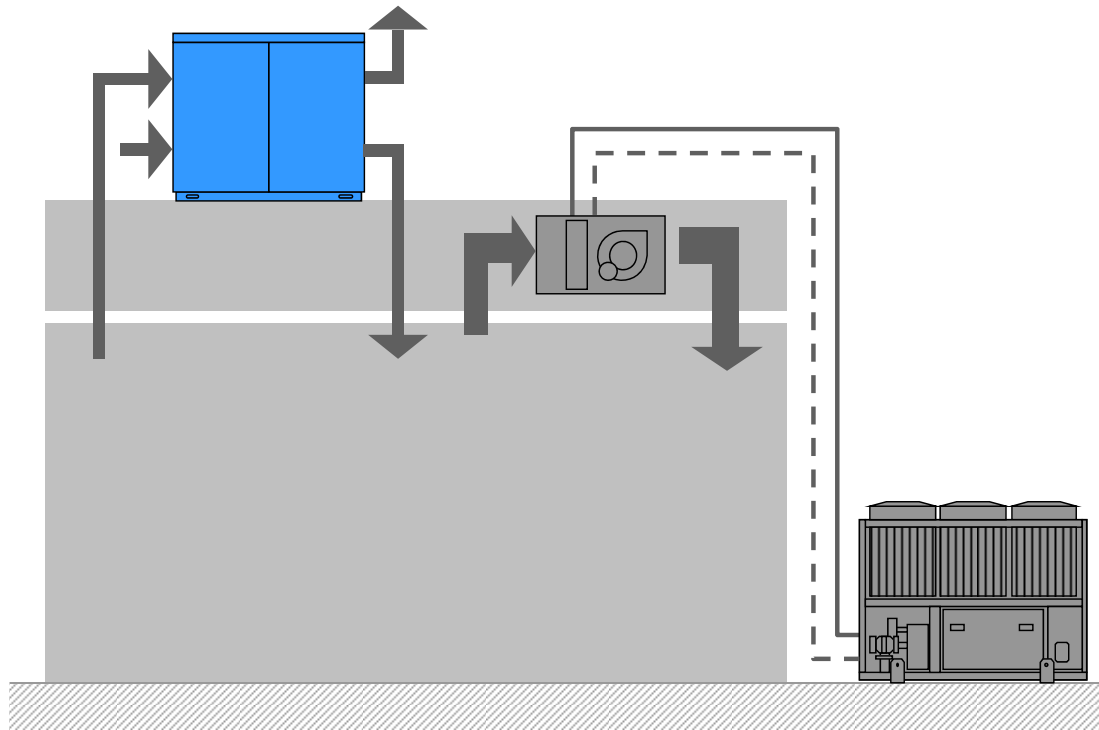


ADVANTAGES OF THE DIFFERENT SYSTEM TYPES

Mixed system → Terminal units + Primary air

1

- ▶ Terminals = with dehumidification
- ▶ Primary air = direct supply to the space
- ▶ System → **Greatly simplified**



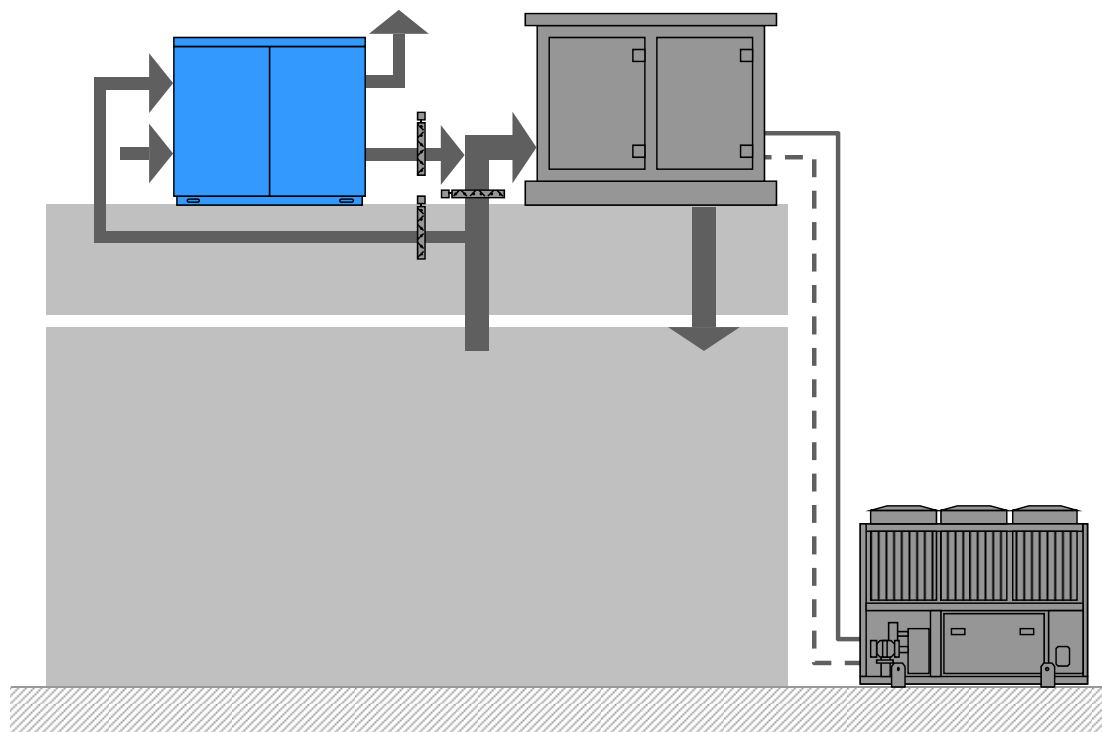
Simplified perspective of system compatibility

ADVANTAGES OF THE DIFFERENT SYSTEM TYPES

2

Perfect for redevelopment

- ▶ Upgrade to current standards/laws on air renewal
- ▶ Upgrade to current standard/laws on **heat recovery**
- ▶ **Without intrusive operations** to the system



Simplified perspective of system compatibility

ADVANTAGES OF THE DIFFERENT SYSTEM TYPES

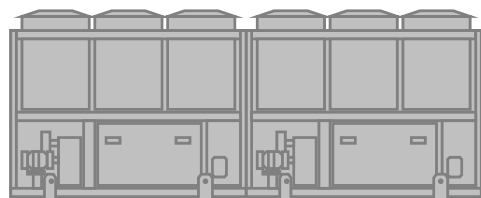
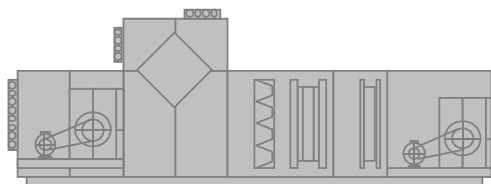
Mixed systems → chilled beam + Primary air

3

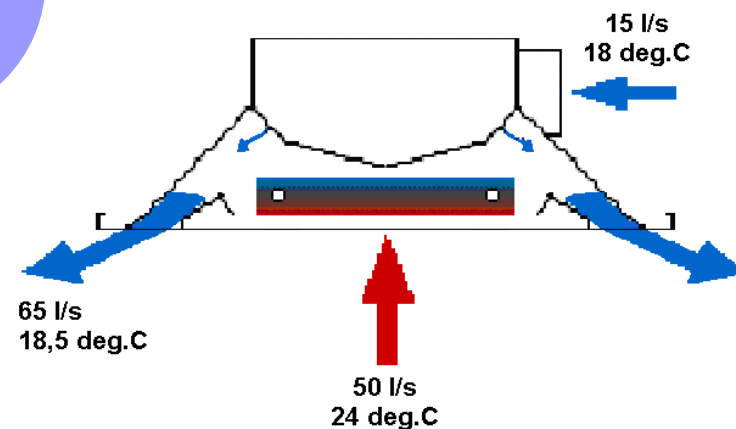
In traditional systems

- ▶ Dehumidification is carried out in the AHU
- ▶ The refrigerated water is produced at 7°C by the **chiller**
- ▶ Chilled water is then **mixed** on the beams near 18°C

CHILLER
OPERATION
7°C



BEAM
OPERATION
18°C

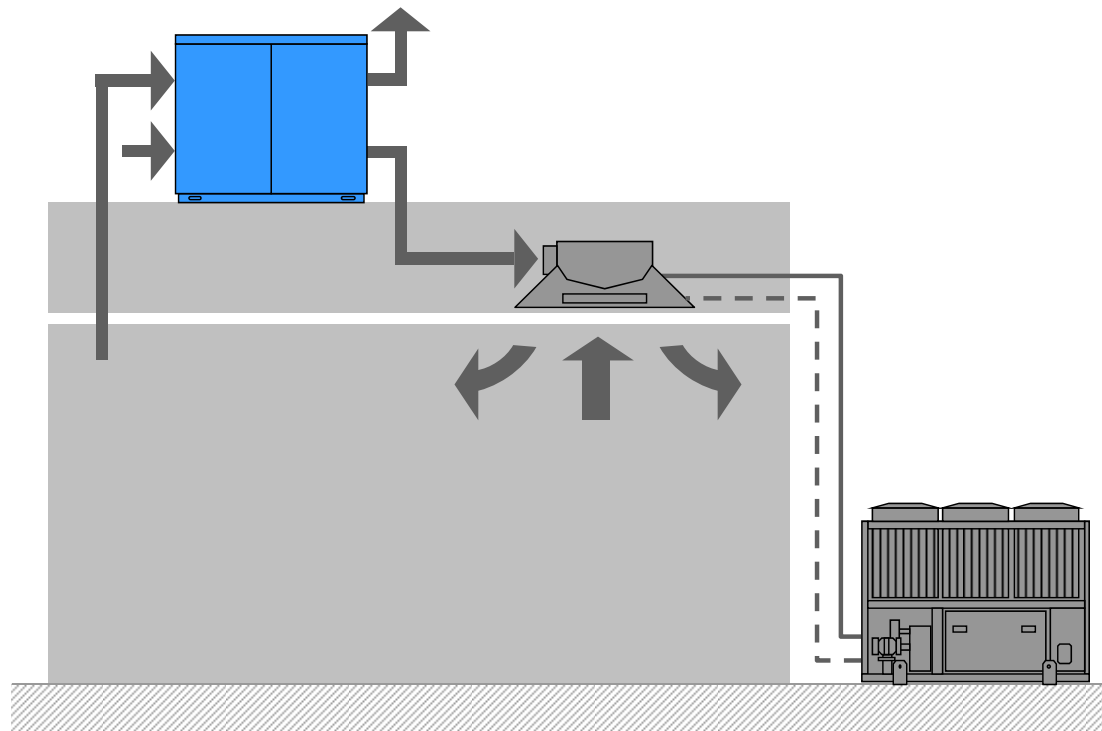


ADVANTAGES OF THE DIFFERENT SYSTEM TYPES

ZEPHIR³ with chilled beams

3

- ▶ Correct induction → **Constant air flow**
- ▶ **Fluid produced only for the beams** = e.g. 18°C summer



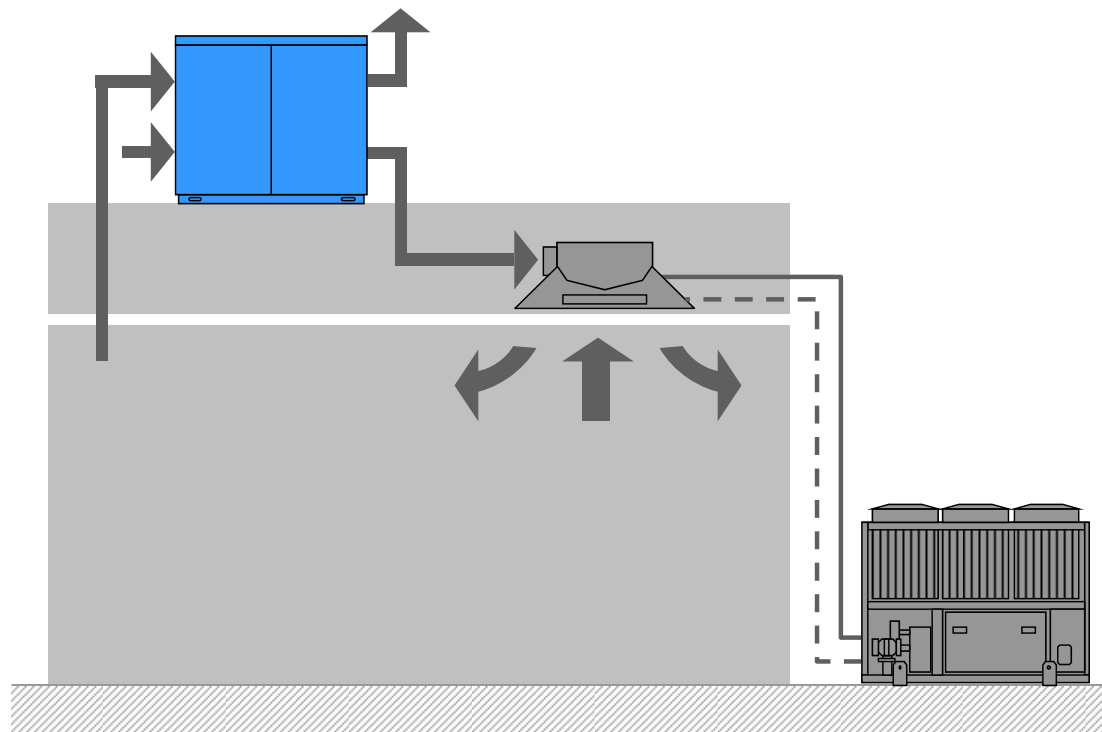
Simplified perspective of system compatibility

ADVANTAGES OF THE DIFFERENT SYSTEM TYPES

3

ZEPHIR³ with chilled beams

- ▶ Correct induction → **Constant air flow**
- ▶ **Fluid produced only for the beams** = e.g. 18°C summer
- ▶ Chiller → **Power reduction -20%** **Efficiency + 30%**



Simplified perspective of system compatibility



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