DAIKIN

Application guide

Daikin HVAC Solutions for Retail

ECPEN 19-292-2

What is in this booklet?

The information in this booklet is the summary of DENV Consulting Sales team experience with discussing and developing HVAC solutions for retail customers, the majority being key accounts.

Here you will find the some solutions used and accepted by retailers in real life, as well as the answers to most common questions posed by retailers.

We hope you will find this information useful.

Sincerely yours,

Consulting Sales Section Daikin Europe

Table of contents

01. Solution matrix

How to select the right solution based on the store requirements.

01 SIMPLIFIED SOLUTION MATRIX

What kind of store do I have? Which solutions can I use?

Based on our experience in dealing with more than 30 retail chains we came to the following conclusions (see table below).

SIZE POSITION	SMALL (0-500 m²)			MEDIUM (500-1200 m²)		LARGE (>1200 m²)	
Standalone *	Split/Sky Air incl. rooftop		◎	Split/Sky incl r-top	◎	Split/Sky incl r-top	✕
	VRV		○	VRV	◎	VRV	◎
	Applied standalone		✕	Applied st-alone	✕	Applied st-alone	◎
Inside a shopping mall	Landlord services available	Split/Sky Air	○	Split/Sky Air	✕	Split/Sky Air	✕
		VRV aircooled	✕	VRV aircooled	○	VRV aircooled	○
		VRV watercooled	✕	VRV watercooled	○	VRV watercooled	○
		Applied (FCU)	◎	Applied (FCU)	◎	Applied (FCU)	◎
	Landlord services not available	Split/Sky Air	○	Split/Sky Air	✕	Split/Sky Air	✕
		VRV	○	VRV	◎	VRV	◎
		Applied st-alone	✕	Applied st-alone	◎	Applied st-alone	◎

The legend

◎ - Typical solution
○ - Occasional solution
✕ - Atypical solution

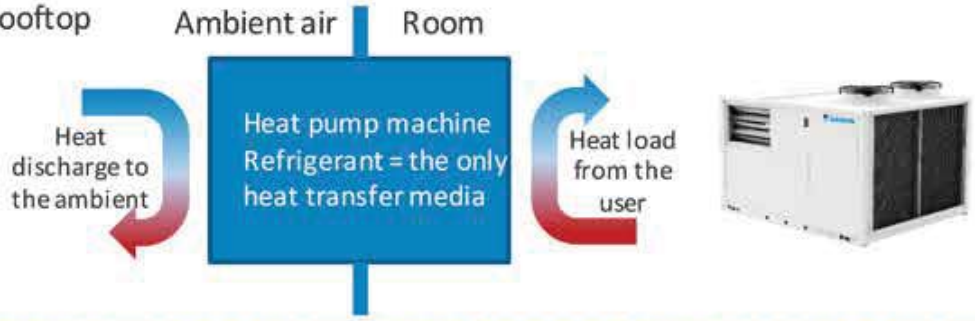
*By standalone store we understand **any location not belonging to the shopping mall** (e.g. completely standalone or high street building).
This actually means that the store must have its own engineering systems, including HVAC, **unlike shopping mall**, where different services **can be provided by the mall itself.**

01 SIMPLIFIED SOLUTION MATRIX

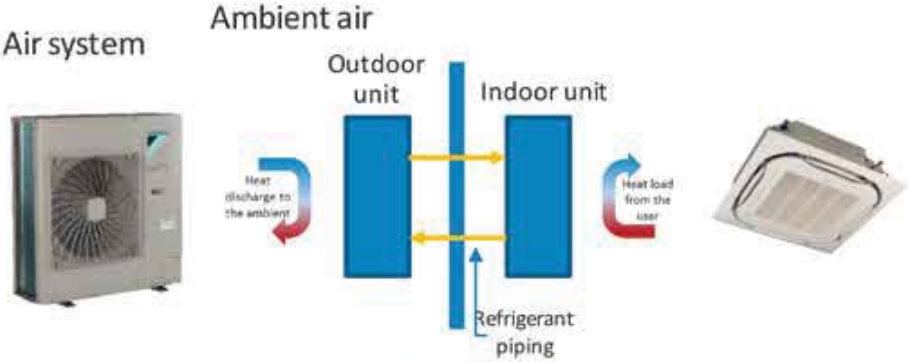
How do they work, the different climate control solutions?

DX (direct expansion systems, cooled by air)

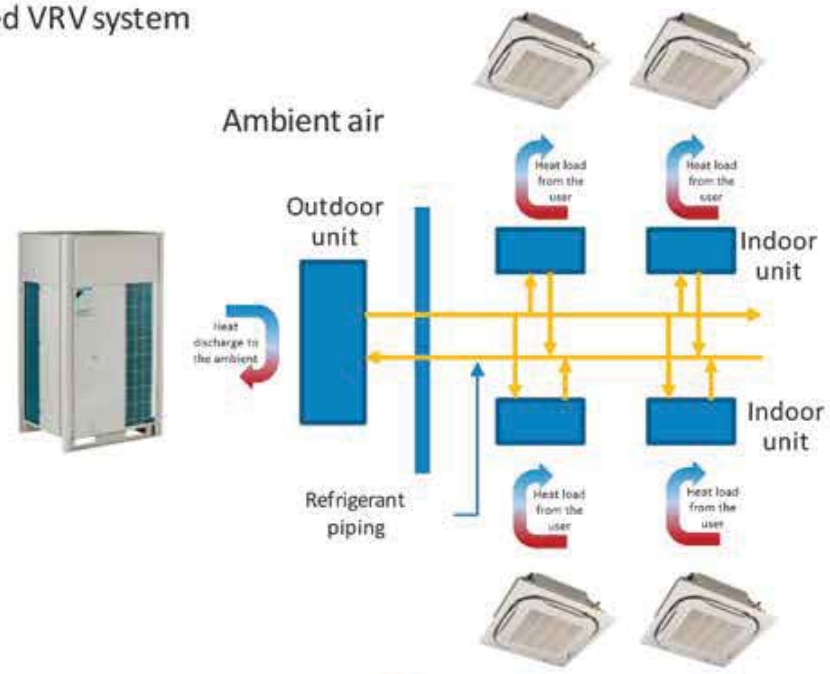
A. Monobloc/rooftop



B. Split/Sky Air system



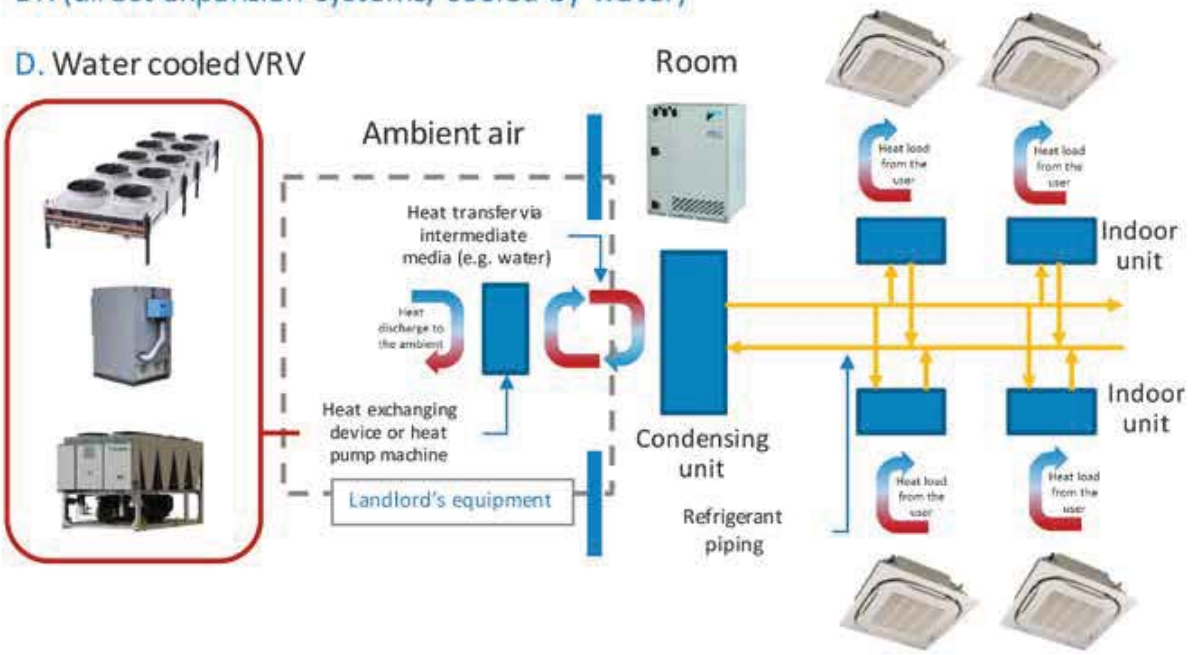
C. Air cooled VRV system



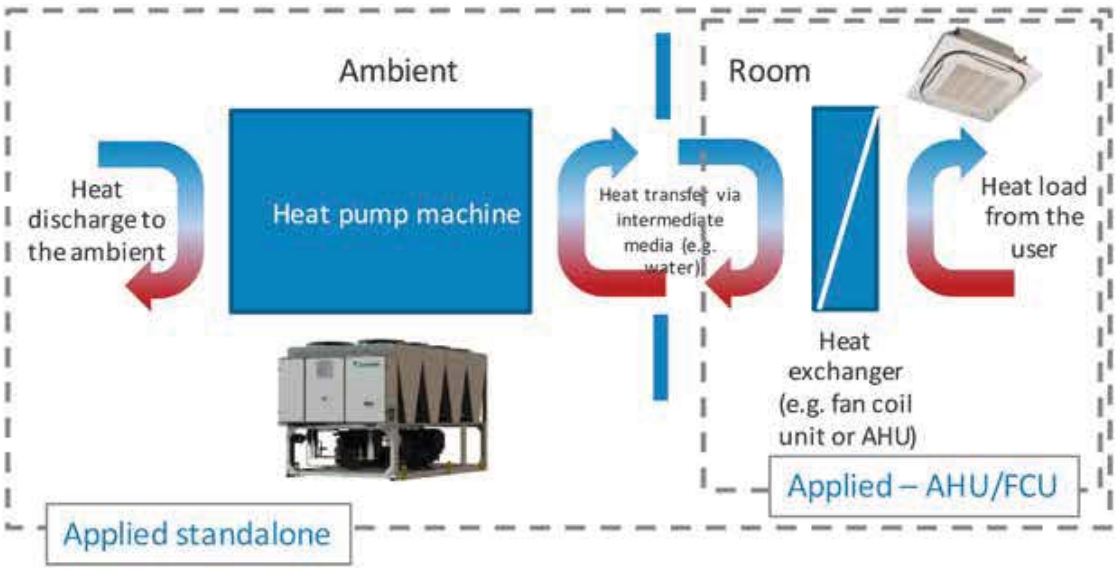
How do they work, the different climate control solutions?

DX (direct expansion systems, cooled by water)

D. Water cooled VRV



Applied (indirect expansion systems)



01 SIMPLIFIED SOLUTION MATRIX

How do I choose between different suitable solutions?

Standalone case/Shopping mall case when NO landlord's services

Select the most important features and read the number of points from the table.
Then the total of the points will give you the idea of optimal solution.

Score: 3 = best, 1 = worst

For example

Solution	Points							
Features	Capital investment (equipment per kW)	System design & installation cost/speed	Running costs	Reliability	Building aesthetics and/or permissions	End user comfort	Controls	Delivery time
Split-Sky	3	3	2	3	1	3	3	3
Rooftop	3	2	1	2	1	1	1	2
VRV	2	2	2	2	3	3	3	3
Applied	2	1	1	1	2	1	1	1

Shopping mall case, landlord's services available

Score: 3 = best, 1 = worst

For example

Solution	Points						
Features	Capital investment (equipment)	System design & installation cost/speed	Running costs	Reliability	End user comfort	Controls (possibilities + user friendliness)	Delivery time
VRV W/C	1	1	2*	2	3	3	3
Applied (FCU)	3	3	3*	2	1	1	1
Ind. DX system**	1	2	1*	3	3	3	3

*To be paid **ON TOP** of landlord's services costs.

** Some retailer prefer to have their own independent systems even in the shopping malls

02. Further understanding the solutions

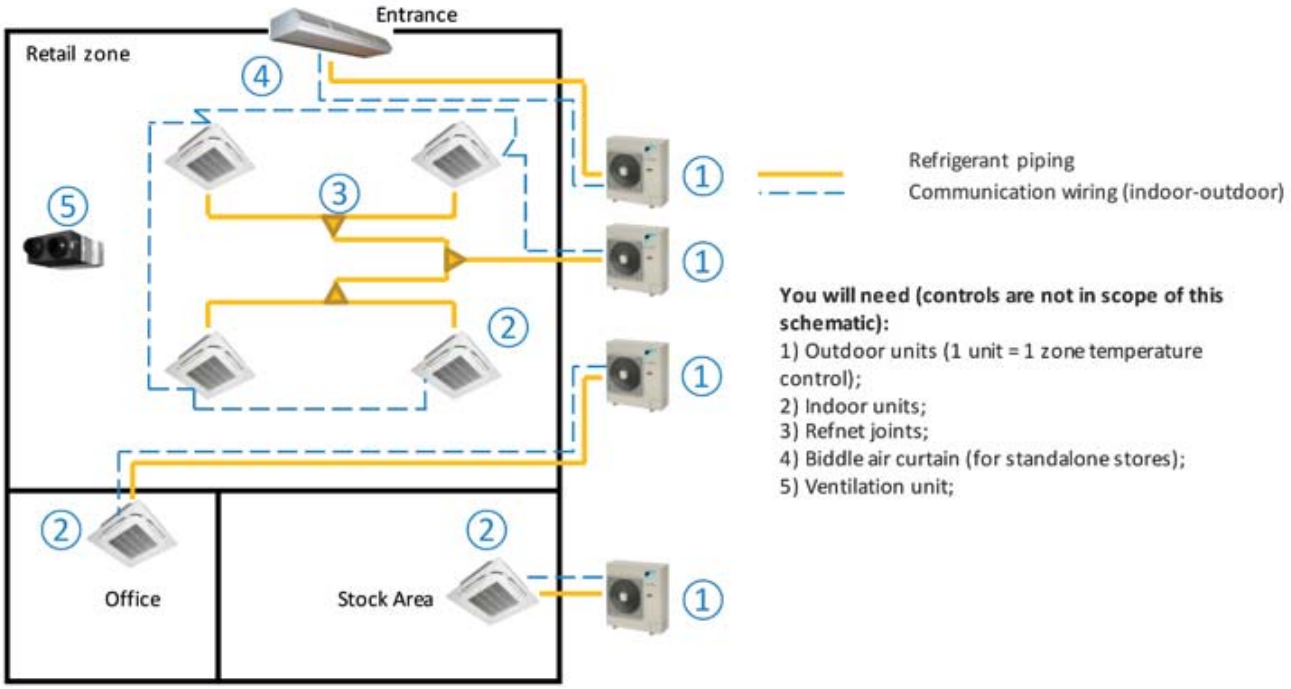
What are the components required to build up each solution?

Things to know about SKY AIR

- Standalone solution (does not require additional equipment)
- Decentralized

When?

- All cases when installation conditions are suitable
- Capacity ~3,5-25 kW (one system) -> more suitable for smaller projects



Why Sky Air?:

- Cost efficient;
- Fast to design, install and commission;
- High reliability (decentralized) and user comfort level.

To keep in mind:

- Many outdoor units, each with installation clearances -> **big outdoor installation space may be required;**
- **Piping limitations**, 50 - 85 m max from outdoor to indoor;
- Outdoor installation can be **perceived as noisy in crowded areas;**
- Although efficiency +/- the same, **needs bigger power supply size** compared to VRV solution of the same capacity.

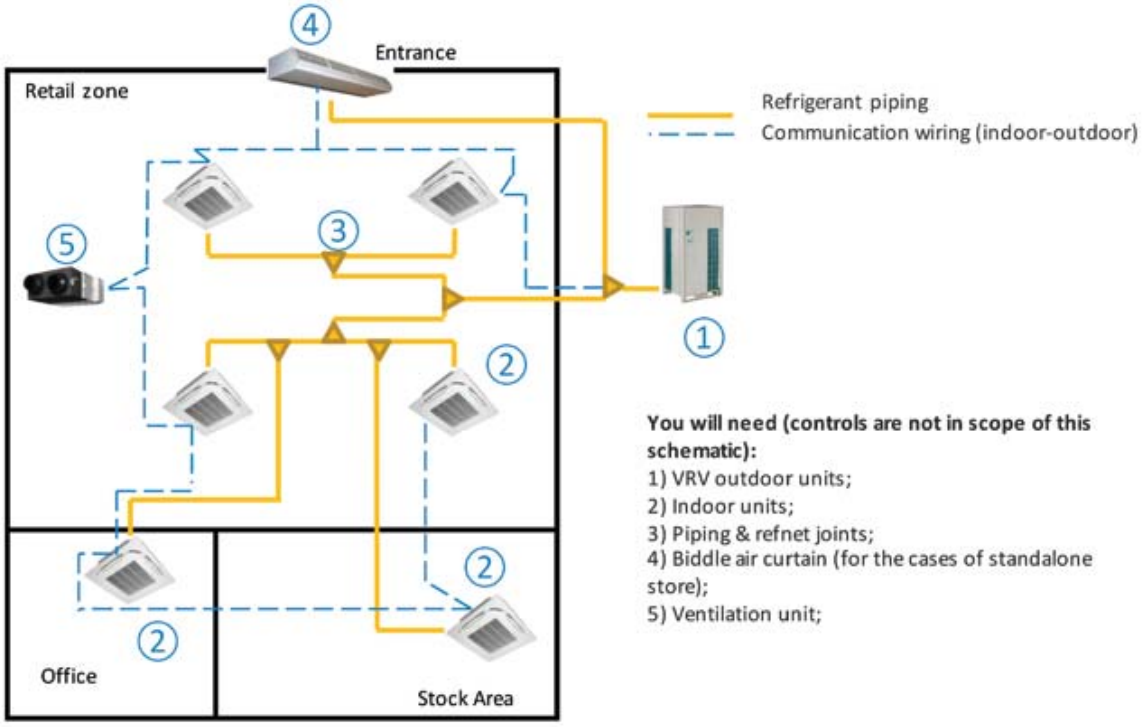
02 FURTHER UNDERSTANDING THE SOLUTIONS

Things to know about TRADITIONAL VRV AIR COOLED

- Standalone solution (additional equipment not required)
- Centralized

When?

- All cases when installation conditions are met
- Capacity ~11-150 kW (one system)



Why VRV?

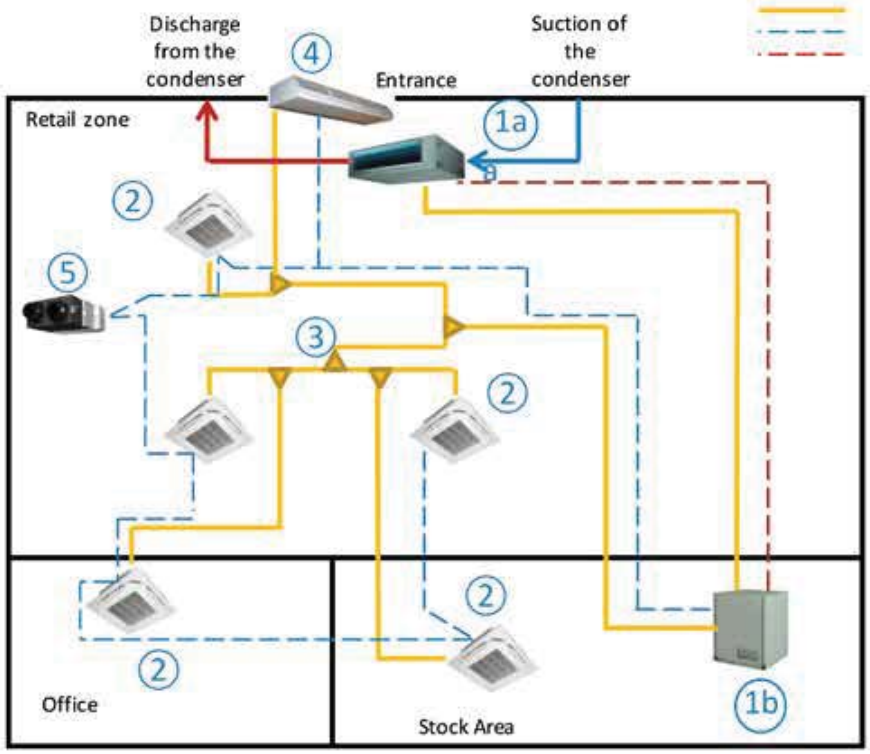
- Everything on a **single system**
- **Less outdoor units: less piping, less noise to the ambient, less maintenance**
- **Longer piping lengths**, more flexibility in outdoor units placement
- **More cost effective installation** in some cases
- Requires **smaller power supply size than similar Sky Air installation**

Things to know about VRV FOR HIDDEN INSTALLATION (VRV-i)

- Standalone, for specific installation conditions
- Centralized

When?

- For the cases of no space for outdoor unit installation (e.g. historical city center)
- Capacity ~14-22 kW (one system)



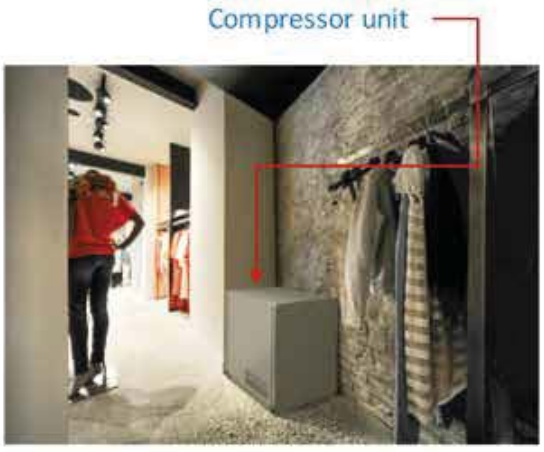
Refrigerant piping
Communication wiring (F1F2)
Communication wiring (compressor to heat exchanger units)

You will need (controls are not in scope of this schematic):

1) VRV-I compressor unit
1a) VRV-I heat exchanger unit
2) Indoor units
3) Piping & refnet joints
4) Biddle air curtain
5) Ventilation unit
6) Ducts to connect heat exchanger unit to the ambient;

1a+1b = VRV condensing unit

Installation example



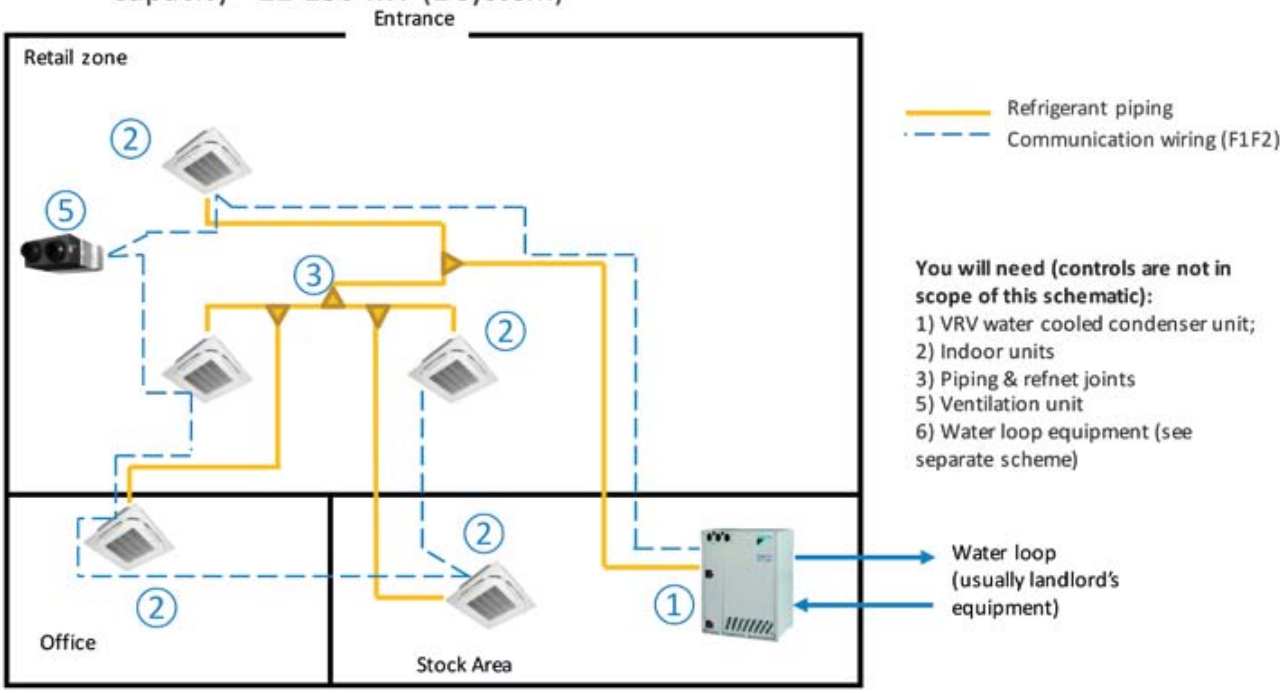
02 FURTHER UNDERSTANDING THE SOLUTIONS

Things to know about WATER COOLED VRV

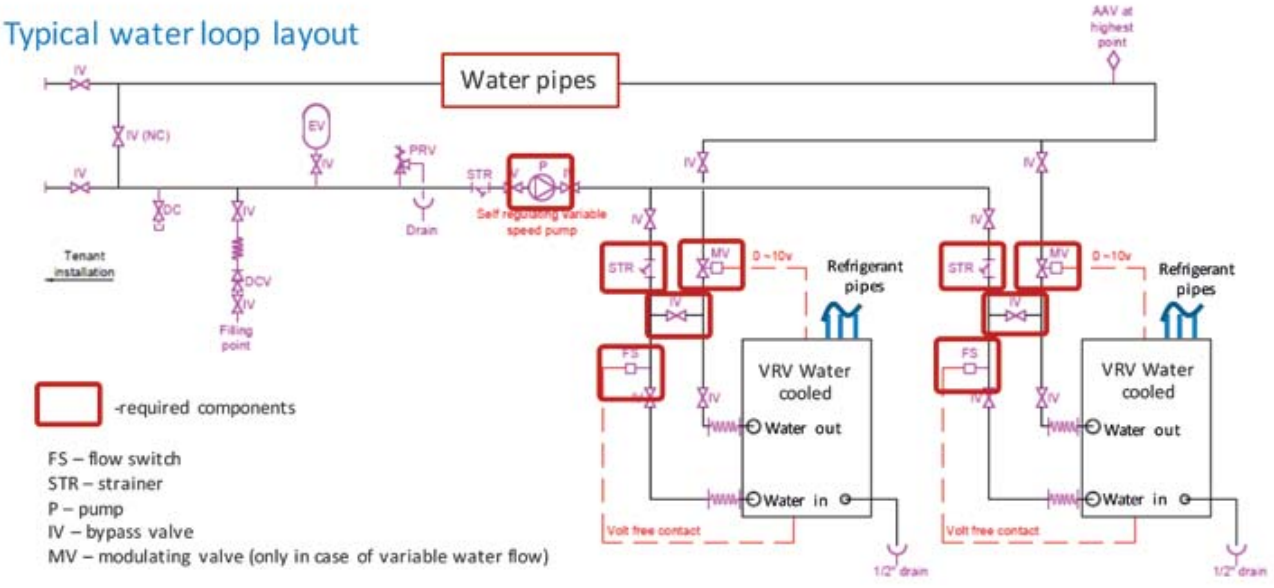
- Partially standalone, needs external water loop for operation
- Centralized system

When?

- For shopping mall locations, with existing water loop, to ensure reliable cooling/heating capacity regardless of the water loop temperature
- Capacity ~22-130 kW (1 system)



Typical water loop layout



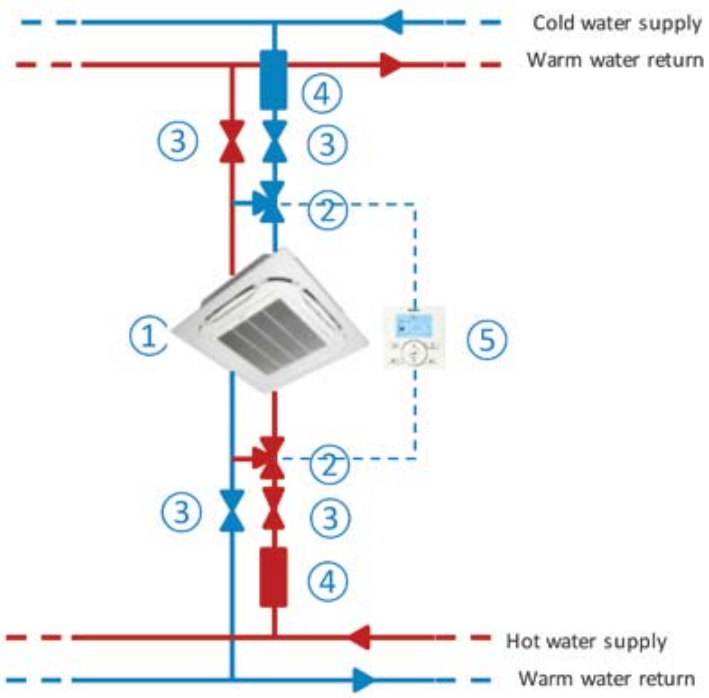
02 FURTHER UNDERSTANDING THE SOLUTIONS

Things to know about APPLIED-FAN COIL UNITS

- Water fan coil units for space cooling and heating
- Non - autonomous

When?

- Cost efficient solution for the cases of existing landlord's water loop
- When the store does not have specific comfort requirements
- Capacity ~1-20 kW (1 fan coil unit)



Communication wiring (from thermostat to control 3-way valves)

Water piping

You will need:

1) 4-pipe fan coil units (type, number, size depends on shop layout and design);
2) 3-way valves;
3) Shut-off valves (3rd party);
4) Water filters (3rd party);
5) Thermostat for temperature control;

To keep in mind:

- The capacity of a water fan coil **heavily depends on water loop temperature** (+/-1^{0}C = +/- 10% of capacity). If water loop temperature (or capacity) reliability is under question, other solutions may be more optimal
- Compared to DX solutions, fan coils of the same capacity are usually **bigger and noisier** due to lower heat exchange efficiency

Water loop usage costs

- Common practice of water loop usage costs distribution between tenants is by store area or FCU installed capacity. This means FCU running cost is +/- constant throughout the year and not load dependent, unlike DX solutions.

02 FURTHER UNDERSTANDING THE SOLUTIONS

Which indoor climate control devices should I choose?

Overall system concept	Suitable indoor devices		Options
	Shopping area	Back of house	
Split/Sky Air	Round flow cassette	Wall mounted	Presence sensor kit Self cleaning filter
	Ducted		
VRV (including watercooled)	Round flow cassette	Wall mounted	Presence sensor kit Self cleaning filter
	Ducted		
Applied – water fan coil units	Round flow cassette	Wall mounted	N/A
	Ducted		

Round flow cassette

When?
Good solution to create even temperature distribution in sales area, without high installation costs

Ducted

When?
For the cases where interior design is of primary importance

Wall mounted

When?
Cost efficient solution for back of house

Which options to consider?

Self cleaning filter kits

Round flow cassette

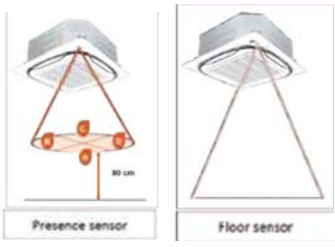
Ducted

What?
- Filters are regularly automatically cleaned with special brush, then dust is removed from the dustbox by store personnel using vacuum cleaner

When?
- Mostly for dusty environments, such as clothes stores or book stores

Why?
- Increases energy efficiency (up to 50% less yearly power consumption)
- Improves the outlook of the store (no dust marks on the ceiling)
- Maintenance cost reduction

Presence/floor temperature sensor kits



What?
- Sensor assembly detects (1) presence of people and (2) floor temperature and adjusts indoor units operation based on that.

When?
- For stores where low occupancy is foreseen
- For BOH parts of regular stores

Why?
- Increases energy efficiency (up to 30% less yearly power consumption)
- Improves customer comfort (less drafts, more even temperature distribution)

Things to know about AIR CURTAINS

Air curtain types

With electrical heating coil
To keep in mind
- Cheap and easy to install, but energy consuming solution
- Does not depend on ambient temperature

With DX coil
To keep in mind
- Consumes less energy(1/3) compared with electrical ones
- Higher investment cost
- Installation is more complicated

With hot water coil
To keep in mind
- Cost and energy efficient solution for the projects with existing hot water supply

Without heating coil
To keep in mind
- Used only for shopping mall locations to separate store ambient from common areas

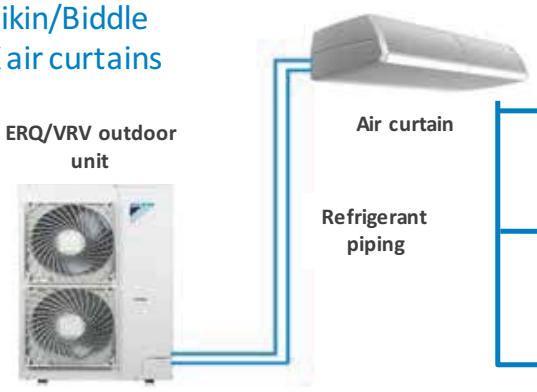
DX or electrical?
ROI calculation example

Door size: 2m x 2.7m
Operating Hours: 15 hrs/day, 7 days week.
Energy cost : EUR 0.11 /kW

	Daikin / Biddle	Electric Air curtain
Purchase Price	€ 4,090	€ 2,273
Annual Running Cost	€ 2,553	€ 7,194
Annual Energy Consumption	17,067 kWh	48,090 kWh
Annual CO2 Emissions	8,824 kg	24,863 kg

- Price difference : **EUR 1,817 (+/2 times)**
- Running Cost Saving per year : **€ 4,641**
- **PAYBACK ACHIEVED IN 1 YEAR**
- Monthly running cost saving : **€ 386**

Daikin/Biddle DX air curtains



Possible types

Free hanging
Suitable for most cases

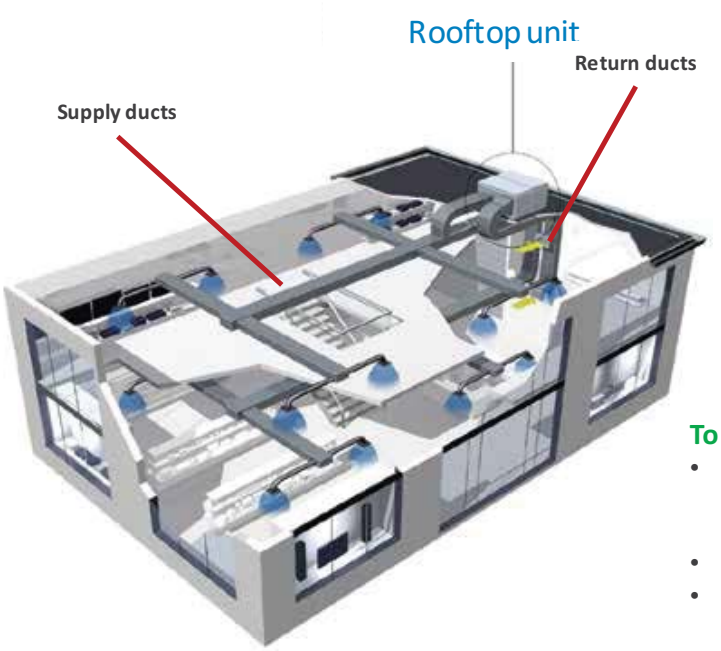
Cassette
For the cases of false ceiling

Recessed ceiling
Where fully hidden installation is required

02 FURTHER UNDERSTANDING THE SOLUTIONS

Things to know about ROOFTOP UNITS

- Cost efficient solution for large standalone stores



What is a rooftop?

- Monobloc heat pump to be installed outdoors
- Cooling/heating of the air is happening within the outdoor casing, then the air is distributed by ducts though the building
- Can be also used for fresh air supply, providing **fresh air quantity 0-100% of the airflow (settable or by CO2 sensor). The quantity of available fresh air depends on ambient conditions!**

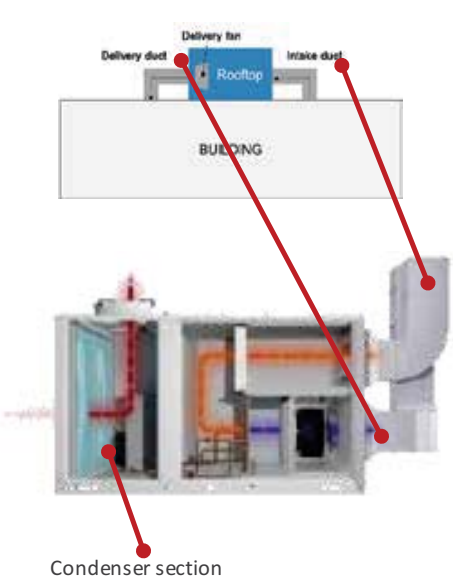
To keep in mind

- Standalone locations, with large roof area, medium to large open spaces (no small zones), e.g. supermarket
- Limited budget
- No strict requirements to the precision of temperature control or visibility of the outdoor equipment

Possible rooftop configurations

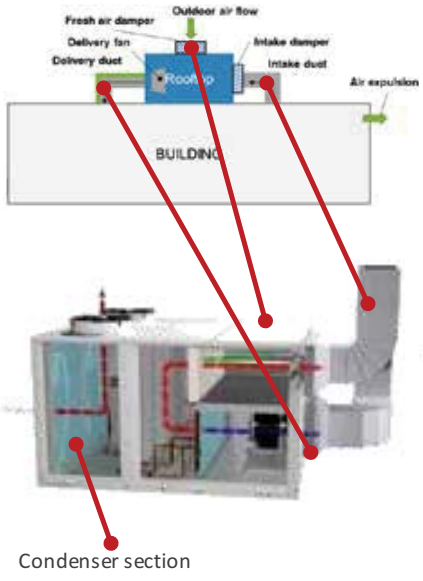
Standard

No fresh air supply



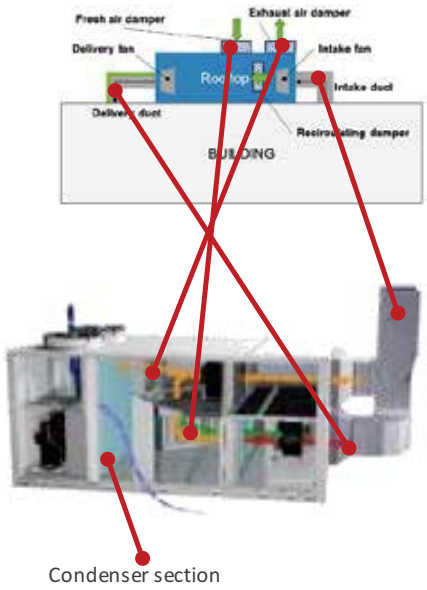
2 dampers

Fresh air, supply (separate extract required)



3 dampers

Fresh air supply and extract



03. Fresh air supply

03 FRESH AIR SUPPLY

Good to know:

- Air quality affects the comfort and well-being of people
- Fresh air is required by legislation

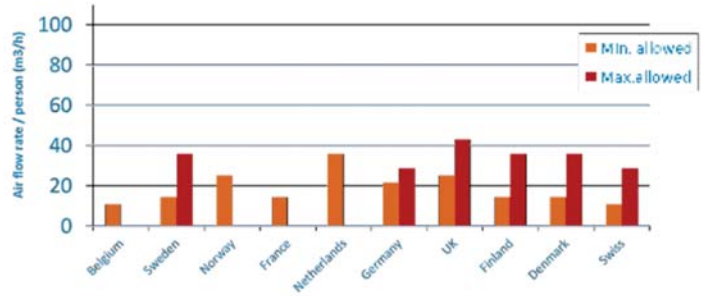
Example: According to EN13779:

Air quality	Fresh air flow per person [m³/h.pers]			
	Non smoking area		Smoking area	
	Typical range	Default value	Typical range	Default value
Excellent	>54	72	>108	144
Average	36-54	45	72-108	90
Bad	22-36	29	43-72	58
Very low	<22	18	<43	36

Does the store need mechanical ventilation?

Example: Fresh air volume requirements per country:

Source : European Commission – report N° 23



Questions to be clarified to answer this question:

- Is mechanical ventilation **legally required** in this specific country?
- What is the **required fresh air quantity** per person?
- Is only **legal minimum** required **or the store has higher comfort requirements**?

Types of mechanical ventilation systems

Centralized ventilation

- AHU (Air Handling Unit) plant for the whole building
- Mostly outdoor installation, **normally belongs to the landlord**
- **Standard case for shopping mall location**
- Big ducts, occupy a lot of space
- Store is fully dependent on landlord's equipment operation

Decentralized ventilation

- Several small AHUs per room/zone/tenant
- Standard case for standalone/high street location but can be seen in shopping mall locations as well
- Compact, usually installed in the ceiling void
- Store has independent fresh air supply
- Limited capacity (+/- 3000 m³/h max) so in case of a large FA quantity the installation can be complicated (+ many small ducts difficult to arrange)

03 FRESH AIR SUPPLY

Things to know about HEAT RECOVERY in the AHU

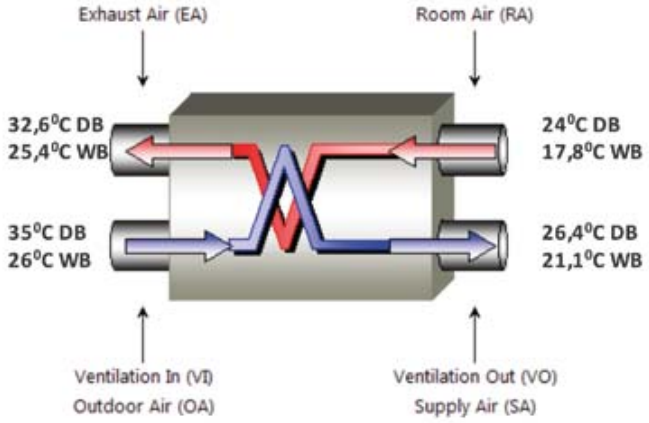
- A process of heat exchange between fresh and exhaust air in the special heat exchanger
- As a result, supply air is preheated or precooled, depending on the mode

Why ventilation with heat recovery?

Heat recovery ventilation decreases store cooling/heating loads -> A/C equipment can be downsized and consumes less energy.

	Ambient	Room
	35°C DB 26°C WB	24°C DB 17,8°C WB

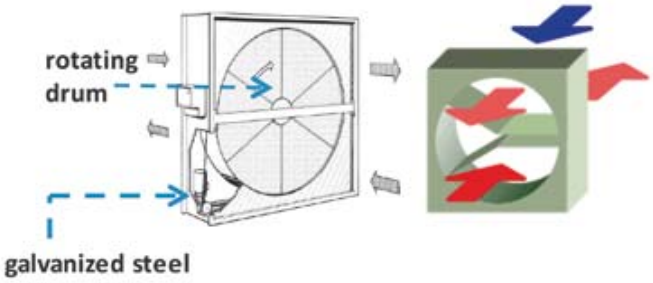
Example: 2000 m³/h of fresh air



- Cooling mode: you **save 12,7 kW** of total cooling capacity
- Heating mode: you **save 10,2 kW** of heating capacity

→ You can use e.g. 1 A/C unit less and the store will consume +/- 3 kW less electricity.

Most common recovery heat exchanger types used for heat recovery



Rotary heat recovery (heat recovery wheel)

- efficiency: up to 80%
- contamination between the two flows

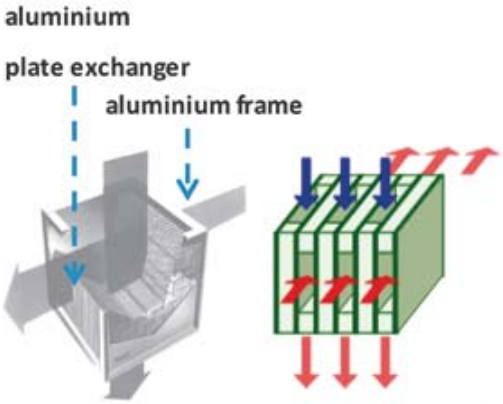


Plate heat exchanger

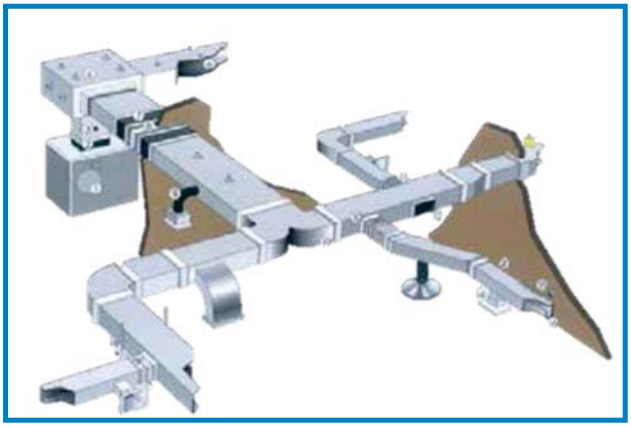
efficiency: up to 60%

- no contamination between the two flows
- maximum pressure drop 350Pa

03 FRESH AIR SUPPLY

Things to know about AIR DISTRIBUTION

- Air distribution is realized via ventilation ducts, supply and return grilles.
- Different regulation devices are foreseen in the ducts in order to balance the distribution of air.
- Poor or excessive air distribution can cause discomfort, loss of productivity and even adverse health problems



The main challenge is to dimension and select correctly these elements in order to avoid draft, noise or too expensive installation.

- Duct sizing will decrease almost linearly with reduction in air volume.
- The installed cost will not change linearly because of the labour portion.
- A 20% reduction in air volume can result in 16% overall savings in sheet metal cost.
- Less kg of steel means also fewer man-hours to install it.
- The cost of installation space has also to be evaluated: becomes interesting when false ceiling height savings may allow construction of an extra floor.

Advantages of spiral ducts towards rectangular ducts:

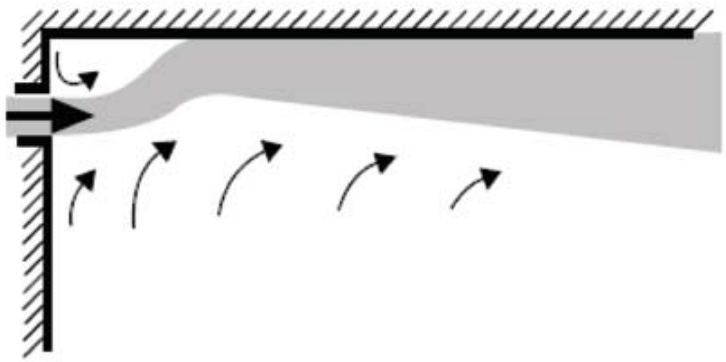
- lower pressure losses
- better sound attenuation
- 32% reduction of surface vs rectangular duct, for the same velocity
- easier design

03 FRESH AIR SUPPLY

Things to know about **AIR DISTRIBUTION**

How to position the grilles

It is very important to place the diffusers in such way so Coanda effect can be obtained.



- In the case of a wall diffuser, the distance between the air jet and the ceiling should be small, around 0,3 m.
- In case of a ceiling diffuser, the angle of distribution should be lower or equal with 45° C.

How to position the grilles - how many should I use?

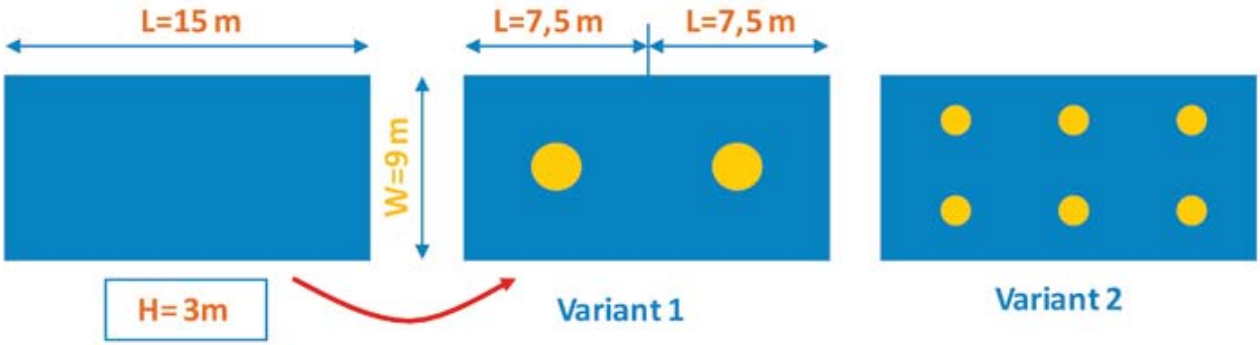
- Divide the room into squares or rectangles
- Each sq./rectangle to be served by one grille

W or L ≤ 3 * H

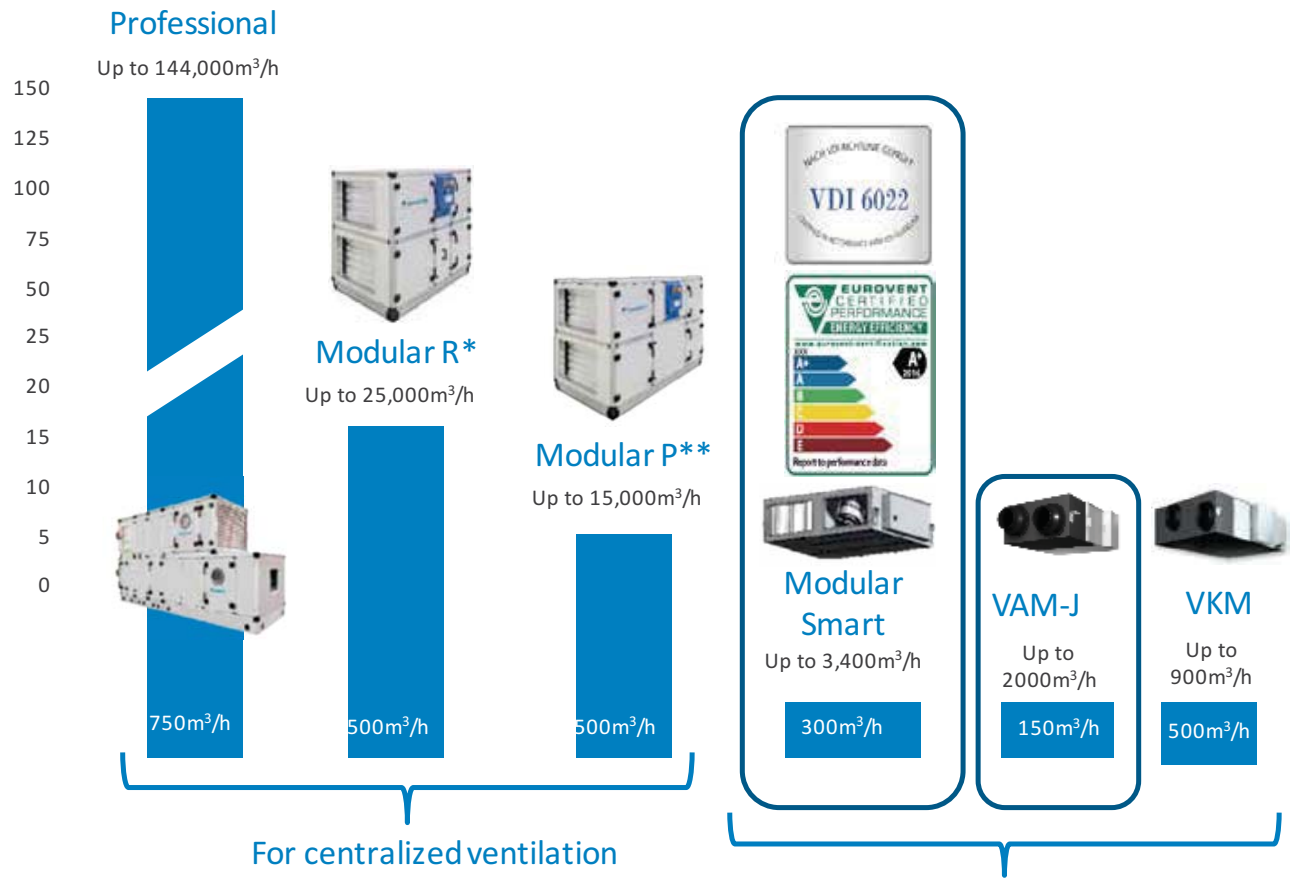
L ≤ 1.5 * W

H= height of room

W and L: dimensions of square/rectangle

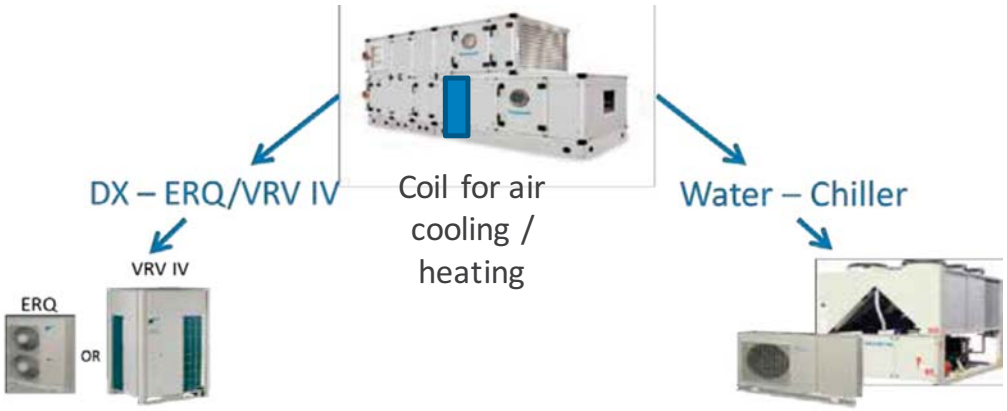


Daikin ventilation solutions portfolio (January 2019)



*Rotary heat exchanger
**Plate heat exchanger

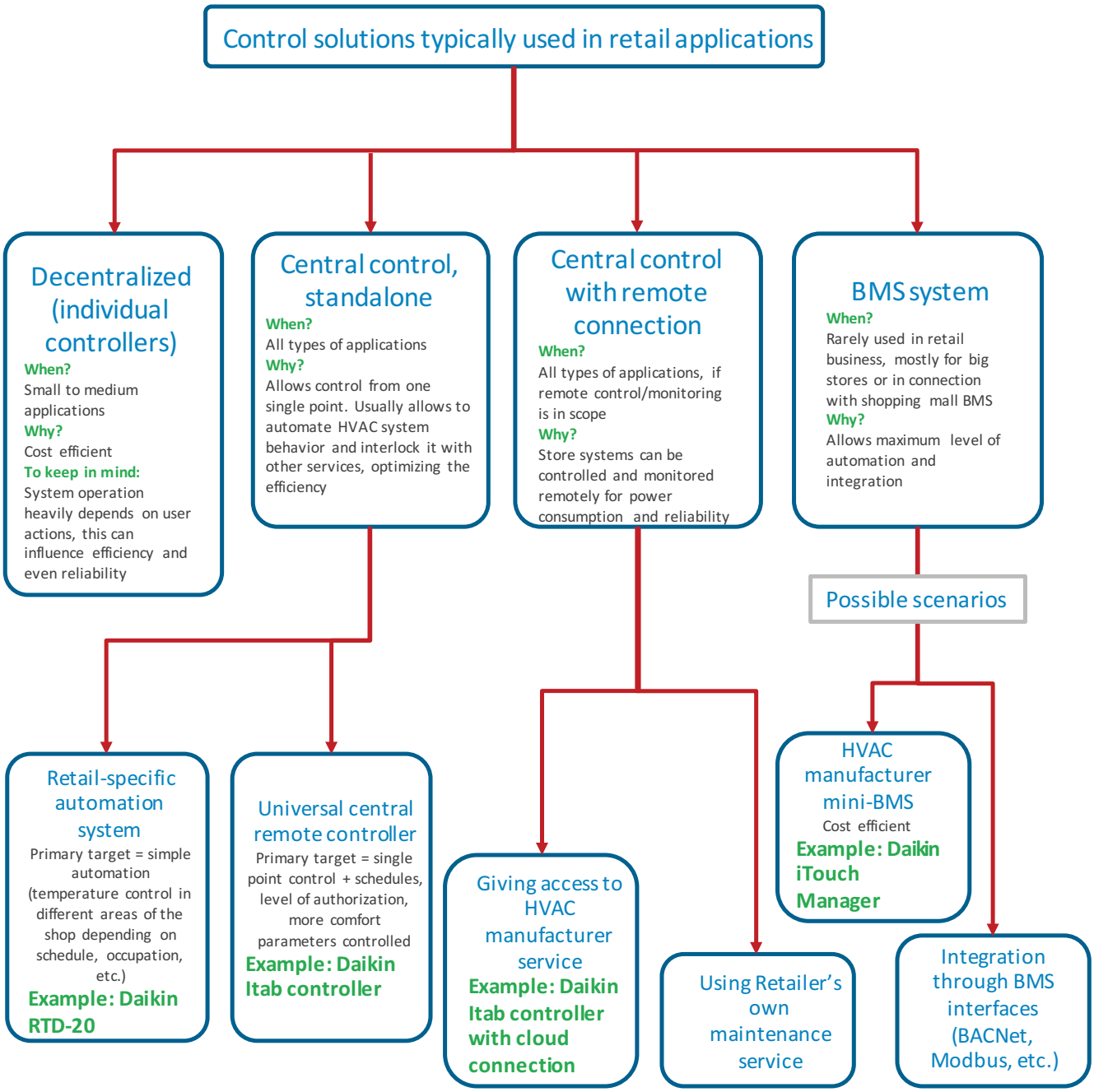
Air treatment possibilities in the AHU



04. Controls

Control schemes and strategies used in retail

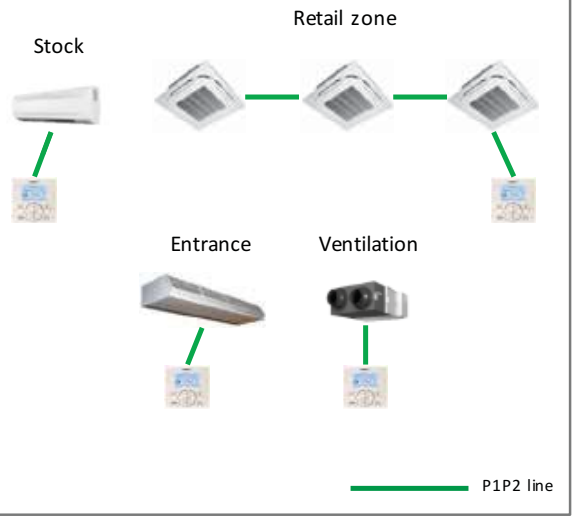
Which control solution do I need?



More details about DECENTRALIZED solution

- Individual hard wired remote controllers (1 per shop zone).

BRC073A1 (RA)
BRC1H51 (VRV/Sky Air)
= Hard wired R/C
[1 R/C for 1 indoor unit (group)]



Key benefits:

- Cost efficient and easy to install;
- Settings can be done by the shop staff.

What can be improved?

- Modern remote controllers have wide functionality and not always can be efficiently operated by shop staff
- No centralized control/monitoring is possible
- Very limited equipment operation automation possibilities

Good to know:

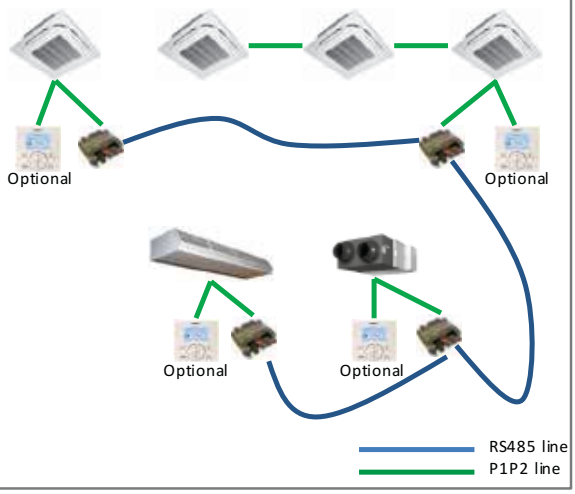
- 1 controller can control up to 16 indoor units (working in the same mode with the same set point);
- This controller is required for self-cleaning panel operation

More details about CENTRAL CONTROL, STANDALONE solution

Retail economizer for automatic control of shop zones.

Retail economizer RTD-20
= Control PCB (Modbus)
[1 gateway for 1 indoor unit (group)]

Individual hard wired controllers are optional



Key benefits:

- Automatic zone control according to the scenarios (see below);
- 3rd party equipment (PIR, fire alarm, etc.) can be integrated.

Pre-trade:

- De-stratification on start-up
- Heat/Cool protection enabled
- AC only comes on if internal temp above 26^{0}C or below 19^{0}C

Trading:

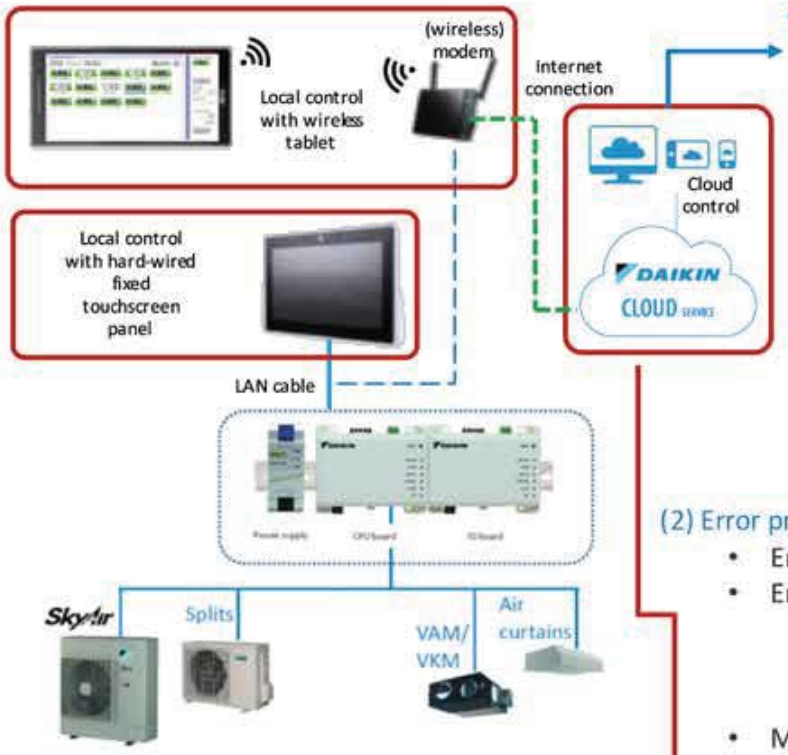
- achieving midpoint of 19-23^{0}C
- controllers locked
- heat cool clash prevented
- door curtain interlocked
- learns store patterns & heats/cools "enough" to reach set-point

Post-Trade:

- Heat/cool protection enabled
- Trade extension function

More details about CENTRAL CONTROL WITH REMOTE CONNECTION solution

Central controller with cloud service connection.



Overview:

- Local control with user-friendly tablet OR hard-wired screen
- **Online cloud control from any place of the whole shop chain.**

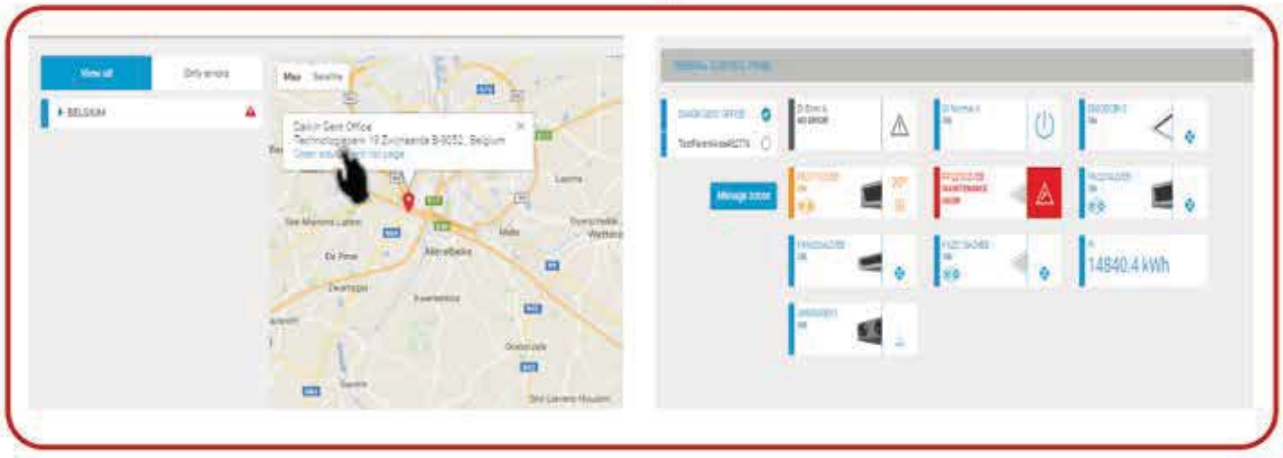
What else is available from the cloud?

(1) Energy consumption follow-up and benchmarking

- You can spot and reduce energy waste by comparing different premises
- Complies with energy monitoring and legislation, reducing running costs

(2) Error prediction & management

- Error prediction list
- Error management
  - Comments insertion
  - Progress indication
  - 30-minute operational data
- Mail notification of alarms & errors

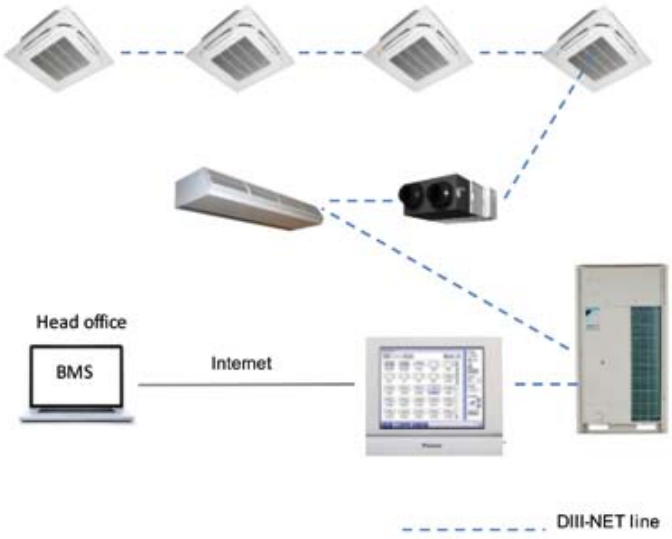


More information about CENTRAL CONTROL WITH REMOTE CONNECTION solution

- Central controller/mini BMS

Basic functionality:

- Control & monitor basic functions
- Automatic control of the air conditioning systems
- Limit freedom of shop staff to change certain settings
- Create zones within the shop



Building management functionality:

- Interlock with eg. Alarm, PIR sensor,... (BACnet or WAGO)
- Monitor energy consumption & advanced energy management (eg. Detect energy waste, compare actual consumption to planned consumption,...)
- Cross pillar integration of Daikin products & integration of 3rd party equipment
- Web control standard available for control via local or remote PC, with different access levels
- Alarm notifications via email
- Predictive maintenance with Daikin iNet service

* Not available for all the countries

Notes