Eurovent Industry Recommendation / Code of Good Practice

Eurovent 20/2 - 2025

Ventilation systems in new and renovated residential buildings in support of the recast EPBD goals

First Edition

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This Eurovent Industry Recommendation / Code of Good Practice supersedes all of its previous editions, which automatically become obsolete with the publication of this document.

Modifications

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Modifications as against	Key changes
1st edition	Current document

Preface

In a nutshell

This document presents an overview of mechanical ventilation technologies for good IAQ in new and renovated residential buildings, which support the objectives of the recast EPBD. It discusses various systems in the context of their suitability for different applications and explains the importance of controls in achieving the goals. The document also serves to present the industry's position on the transposition of the ventilation-related provision of the Directive. It is primarily aimed at policymakers and experts implementing the recast EPBD into the national building legislation of Member States.

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This document was published by Eurovent and was prepared in a joint effort by participants of the Product Group 'Residential Ventilation Systems' (PG-RVS), which represents a vast majority of manufacturers of these products active on the EMEA market. Particularly important contributions have been provided (in alphabetical order of the last name) by Ann-Sofie Andersson, Xavier Boulanger, Jaroslav Chlup, Jan Deklerck, Wolfgang Grassler, Henning Gronbaek, Anneli Halfvardsson, Quentin Liebens, Pedro Ruiz, Igor Sikonczyk, Harald Svedung, Wolfgang Tanzer and Arie Veldhuijzen.

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List of abbreviations used

BAC	Building Automation and Control
DCV	Demand Control Ventilation
DHW	Domestic Heat Water
EHA	Exhaust Air (airflow leaving the extract air treatment system and discharged to the atmosphere). Alternatively, the term *Exhaust air outlet* is used
ETA	Extract Air (airflow leaving the treated room and entering the air treatment system). Alternatively, the term *Exhaust air inlet* is used
HRV	Heat Recovery Ventilation
HRS	Heat Recovery System
IAQ	Indoor Air Quality
ODA	Outdoor Air (airflow entering the system from outdoors before heat recovery) Alternatively, the term *Supply air inlet* is used
RVS	Residential Ventilation System
RVU	Residential Ventilation Unit
SUP	Supply Air (airflow entering the treated room after heat recovery) Alternatively, the term *Supply air outlet* is used
VAV	Variable Air Volume (device)
VU	Ventilation Unit
VOC	Volatile Organic Compounds

1 Foreword

This document presents an overview of mechanical ventilation system technologies for providing good IAQ in residential buildings at minimised energy consumption.

It is primarily aimed at policy makers and experts implementing the recast EPBD (Directive 2024/1275) into the national building legislation of Member States, as a guide to technically and economically available technologies and designs solutions that support objectives of the Directive, whose related provisions relevant to the scope of this document are discussed in Chapter 2.

Eurovent strongly advocates that harmonised implementation of the Directive by all Member States should result in common IAQ and ventilation requirements across the EU, in order to exploit the potential of optimised and standardised technologies to achieve its objectives. The lack of consistent requirements between Member States can lead to barriers and the need to adapt products to different markets, making them more costly and the objective of the Directive less economically feasible.

Eurovent considers it crucial that the following issues, which are the focus of this document, are thoroughly addressed in the transposition of the Directive by Member States.

1.1 Significance of Indoor Air Quality (IAQ)

The importance of Indoor Air Quality (IAQ), which is a key part of indoor environmental quality, has been thoroughly proven scientifically. Poor IAQ impairs the comfort and well-being of building occupants as well as can be harmful to their health. This is particularly important for residential buildings, where inhabitants spend much of their time resting, sleeping and performing other domestic activities.

Poor IAQ directly affects individuals but also entails implications and financial costs for the society and economy. While for individuals, poor IAQ can mean headaches, fatigue, trouble concentrating, bad sleep quality up to respiratory and cardiovascular diseases, for the society and economy, it means increased healthcare spendings, increased absence rate at work, reduced productivity of the European workforce or decreased learning performance of European students.

Consequently, the statutory requirements for good indoor air quality must not be neglected, even though the benefits may not be directly and easily quantifiable and may, on the contrary, be overshadowed by readily achievable savings in investment and operating costs, compromising IAQ as a result.

1.2 Mechanical ventilation - the solution for good IAQ, energy optimalisation and safety

To ensure good indoor air quality, an appropriate ventilation system is necessary.

While natural ventilation[1] is an option for some building types and climates, in practice, mechanical ventilation is the suitable solution for most applications. This is because only mechanical ventilation can provide fully controlled and adjustable air exchange in ventilated spaces, regardless of the indoor and ambient conditions. With the available technologies, electricity consumption by fans is very low

[1] According to prEN 12792:2025 'Ventilation for buildings – terminology', it is ventilation whose operating principle is based solely on the effect of wind and the stack effect. Open windows can be used for natural ventilation, if they are purpose-made.

and negligible in the building's energy balance, which enables the highest energy performance requirements to be easily met. The smart controls adjust airflow rates to the actual demand, further reducing electricity and thermal energy consumption. Where applicable, bidirectional systems minimise by means of heat recovery, the consumption of thermal energy to heat or cool the outdoor air used for ventilation, which is not possible with natural ventilation, where this energy is provided by other systems (space heating/cooling) without any recovery. Furthermore, mechanical ventilation systems can protect the indoor environment from outdoor air pollution (by properly selected air filtration), which is not feasible with natural ventilation either.

1.3 Imperative to provide IAQ in renovated residential buildings

Refurbishments limited to improving thermal performance (facade insulation and replacement of windows) always result in increased airtightness of the building, meaning further deterioration of IAQ and the well-being of its occupants. In other words, funds and subsidies spent on renovations limited to thermal performance will make for increased social and economic costs indicated in Section 1.1.

While applying a suitable ventilation system in new residential buildings is feasible and common, it is usually more challenging in old buildings requiring retrofitting.

The EU building sector is one of the largest energy consumers in Europe, responsible for more than one-third of the energy-related emissions. More than 70% of permanently occupied floor area in the EU is residential, while 75% of the building stock has poor energy performance. To meet the EU Climate target plan, the renovation rate must be doubled by 2030. The Renovation Wave Strategy, which is supported by the recast EPBD aims to achieve this goal.

It is crucial to ensure that major renovations, which involve substantial construction works, are not limited to improving thermal performance, but include, at the same time, the installation of an adequate mechanical ventilation system. If a ventilation system to provide good IAQ is not installed during other construction works, it may not be technically or economically feasible to install it at a later stage. Furthermore, this can result in sick building syndrome (SBS) in a residential building after renovation.

1.4 Mechanical ventilation for safety due to transition to flammable refrigerants

On top of reasons for mechanical ventilation arising from the recast EPBD, there is another aspect that cannot be overlooked, given that cooling of dwellings is usually indispensable in warm climates.

The transition road map of the F-Gas regulation, to reduce the use of fluorinated refrigerants, and the introduction of the new safety requirements of the standard EN IEC 60335-2-40:2022 (ED7) and others (prEN378_2027), will increase the amount of A2L refrigerants that can be used in residential air conditioning and heat pumps in rooms, and also allow the use of refrigerants like A3, even in split systems, in the future, both to be used in new buildings and renovation buildings.

Within the residential sector, this means that from now to 2050, when the actual split air conditioning or heat pump installed in the room will have to be substituted, it will be done by a split system with flammable refrigerant inside (for example A2, A2L o A3).

Taking into consideration that natural ventilation does guarantee suitable air exchange, in many existing buildings, it will be critical to guarantee a minimum constant ventilation airflow through mechanical ventilation to add protection to the user, not only to dilute the refrigerant in case of a refrigerant leak, but as a general safety measure. This means that ensuring mechanical ventilation in residential buildings with cooling or space heating systems containing refrigerants is highly recommended.

2 Ventilation-related provisions of the recast EPBD

The subject matter of the Directive 2024/1275 explicitly refers to indoor environment quality requirements and cost-effectiveness, while the definition of a building in Article 2(1) clearly indicates that energy used by a building is used to condition the indoor environment. In this context, the energy efficient HVAC technical building systems, including ventilation, play a key role in implementing the objectives of the Directive.

The following sections of this chapter discuss and comment on the provisions of the Directive relating to ventilation in residential buildings and link to more detailed chapters providing further information.

2.1 Indoor environmental quality and national IEQ standards

Article 2(66) provides a definition of IEQ and Article 13(4) requires Member States to set requirements for the implementation of adequate indoor environmental quality standards in buildings.

The IEQ definition of the Directive refers to indoor conditions that influence the health and well-being of its occupants, which include parameters relating to the temperature, humidity, ventilation rate and presence of contaminants. The presence of contaminants and relative humidity are generally considered to be determinants of indoor air quality (IAQ), whereas the ventilation systems discussed in this document, and the ventilation rate, which is the main indicator of their performance, play a key role in providing IAQ.

The subject literature lists almost 40 different air quality indicators, while in practice, only a few of them are the most relevant, and technically and economically feasible, for continuous monitoring and regulation of the IAQ. Regarding ventilation in residential buildings, these include in particular the indoor CO_2 concentration and relative humidity. Another significant pollutant - the concentration of indoor particulate matter (PM2.5 and PM10) – can be ensured at an adequate level by using appropriate air filters in areas where limit concentrations of PM in ambient air are exceeded.

At present, the standards for IAQ requirements and the related ventilation rates to provide it differ among Member States. Furthermore, some Member States have not yet implemented any statutory requirements for IAQ and minimum ventilation rates.

Eurovent considers it crucial that the harmonised implementation of the Directive by all Member States should result in the consistent IAQ and minimum ventilation rates requirements across the EU, based on the existing European standardisation framework (CEN EN standards) and taking into account the relevant parameters that are technically and economically feasible to be monitored and regulated.

This is fundamental because:

- All EU citizens have the right to the same 'good' indoor air quality, regardless of the country they live in.
- Only an EU-harmonised approach to the IAQ requirements will enable exploiting the potential of EU HVAC industry products, optimised against the same standard in terms of cost-effectiveness and performance, making the objective of the Directive to secure IEQ economically feasible.

The existing European standardisation framework for IAQ and ventilation rate requirements are discussed more in detail in respectively in Section 3.

2.2 Minimum energy performance with regard to ventilation

Article 5(1) states that the minimum energy performance requirements to be set by Member States both for new, as per Article 7(6), and existing buildings undergoing major renovation, as per Article 8(3), shall take account of optimal indoor environmental quality. This means that energy for ventilation to provide good indoor air quality should be properly considered in the energy performance assessment of a building.

In new, well-thermally insulated and airtight buildings, the share of energy required for effective indoor air exchange in the total energy balance of a building can be significant, and the aim should be to reduce this energy consumption by applying the most energy-efficient ventilation systems.

A guide to available ventilation technologies that minimise energy consumption while ensuring optimal indoor air quality, along with recommendations for their appropriate application depending on building type and other considerations, is presented in Chapter 4. Determinants of the energy consumption of residential ventilation systems and ways to reduce it are discussed in Chapter 6, and Chapter 7 explains smart control systems for further energy savings.

With existing residential buildings undergoing major renovation, installing an energy-efficient ventilation system for good IAQ may be more challenging than in new buildings due to a number of technical constraints. The relevance of different ventilation systems for renovation purposes is discussed in more detail in Annex I.

2.3 IAQ monitoring

Article 13(5) requires all new non-residential buildings as of 2030 to be equipped with measuring and control devices for the monitoring and regulation of indoor air quality. It also leaves freedom to Member States to set such requirements for residential buildings.

If this requirement were to be implemented also for residential buildings, in the opinion of Eurovent members, monitoring and regulation of all IAQ parameters in residential buildings is not economically feasible. The parameters that should be monitored and controlled are CO_2 in living rooms and bedrooms, and relative humidity in wet rooms[2].

2.4 Technical systems in residential buildings

Article 13(11) requires that, where technically, economically and functionally feasible, new and undergoing major renovation residential buildings are equipped as of 2026 with the following:

a) *the functionality of continuous electronic monitoring that measures systems' efficiency and informs building owners or managers in the case of a significant variation and when system servicing is necessary.*

[2] Proposed modifications and guidelines for implementation of Article 11a 'Indoor environmental quality' in EPBD draft. REVHA, EUROVENT, NVG, 2023

Eurovent position on the national transposition of Article 13(11)(a)

Implementation of this functionality is economically and technically feasible in all residential buildings by:

- Indicating the operation of the ventilation system,
- Notifying of the need to replace.

Controls of the residential ventilation system may also be capable of continuous monitoring and reporting its efficiency without the need for a separate BAC system.

c) a capacity to react to external signals and adjust the energy consumption.

Eurovent position on the national transposition of Article 13(11)(c)

Eurovent requests that ventilation systems should be exempted from this requirement in order not to interfere with the necessary continuous ventilation operation to provide IAQ and to avoid the risk of disrupting antifreeze protection systems.

3 European standards for IAQ and ventilation requirements

Comprehensive guidance on IAQ requirements, in both residential and non-residential buildings, and technical specifications for the design of ventilation systems are provided in the well-established European Standard EN 16798-1- *Indoor environmental input parameters for design and assessment of energy*. It is equivalent to the international standard ISO 17772-1 but in addition, it includes national annexes to complement country-specific requirements where needed.

EN 16798-1 forms a solid basis for IAQ requirements in national regulations implementing the recast EPBD provision.

4 Mechanical ventilation systems for residential buildings

Mechanical ventilation systems must be present in all dwellings, whatever the type of dwelling and construction method. Construction methods are very diverse, especially as the life span of a building is well over 50 years and the variety of solutions available in the market increases every year, particularly with a view to renovation.

All major and common system types, which can be built using typical (mass-produced) RVUs are listed in Table 1, with a breakdown by category:

- Category A for detached, semi-detached and terrace houses
- Category B for apartment buildings

A recommendation on the suitability of different systems for retrofitting, depending on the climate, is provided in the last column of the table. It is based on the technical and economic feasibility of installing the system in renovated buildings and energy efficiency.

Detailed information on each system, including recommendations for their applicability depending on the building type and suitability for retrofit purposes, is provided in Annex I.

Residential building	Type	System description and functionality	Recommended for retrofit by climate		
			cold	avg.	warm
	A1	mechanical exhaust air system with air inlet / infiltration			
	A2	mechanical supply air and exhaust air system with central heat/moisture recovery (counterflow or rotary heat exchanger)			
	A3	mechanical supply air and exhaust air system with central heat/moisture recovery and additional air to air heat pump system			
	A4	mechanical supply air and exhaust air system with local heat/moisture recovery (counterflow or push-pull heat exchanger)			
	B1-C	mechanical exhaust air system with a central ventilation unit and air inlet / infiltration			
	B1-L	mechanical exhaust air system with local ventilation units and air inlet / infiltration			
	B2	mechanical exhaust air system with local heat recovery (air to water heat pump system) to produce DHW and with air inlet / infiltration			
	B3	mechanical supply air and exhaust air system with heat/moisture recovery unit per dwelling (counterflow or rotary heat exchanger)			
	B4	mechanical supply air and exhaust air system with heat/moisture recovery unit per dwelling and additional air to air heat pump system			

Table 1. Overview of RVS types and recommendations on their suitability for retrofitting (based on the technical and economic feasibility of installing the system in renovated buildings and energy efficiency).

Regardless of the type, each ventilation system comprises a number of components such as extract and supply fans, heat recovery ventilation unit and ductwork. Each of these components features specific technical parameters that affect the operation and performance of the entire system, both in terms of energy and comfort, as well as aspects such as hygiene and ease of maintenance. An overview of the properties of the system components to be considered in the design and construction of ventilation in residential buildings is presented in Annex II.

5 Energy savings by using mechanical ventilation instead of natural ventilation

As explained in Section 1.2, mechanical ventilation systems are usually the most suitable solution in residential buildings. In addition to providing appropriate IAQ, they ensure significant energy savings compared to natural ventilation. This is because mechanical systems provide only the necessary amount of ventilation air in a controlled manner, and the air exchange in the building is lower than with natural ventilation, where air enters the interior in an uncontrolled manner, including infiltration. This results in a reduction of energy needed to heat the ventilation air, even in systems without heat recovery. For systems with heat recovery, the savings are even higher. The savings in heating energy outweigh the additional electricity consumption of the fans.

A plausible and general method for assessing energy savings in residential buildings resulting from using mechanical ventilation in place of natural ventilation is set out in Regulation (EU) 1254/2014[3]. In addition to savings in energy to heat ventilation air and extra electricity consumption by fans, it also considers the way how the ventilation system is controlled, i.e. how effectively it adjusts its capacity to the actual and current demand.

According to this method, annual energy consumption to heat air in the case of natural ventilation, expressed in kWh per 1 m^2 of a dwelling, amounts to:

- 49 kWh/m^2/a for an average climate, which translates to 123 MWh for a 100 m^2 flat over 25 years,
- 96 kWh/m^2/a for a cold climate, which translates to 240 MWh for a 100 m^2 flat over 25 years.

In turn, the annual energy savings for ventilation that can be achieved thanks to mechanical ventilation are presented in Diagram 1.

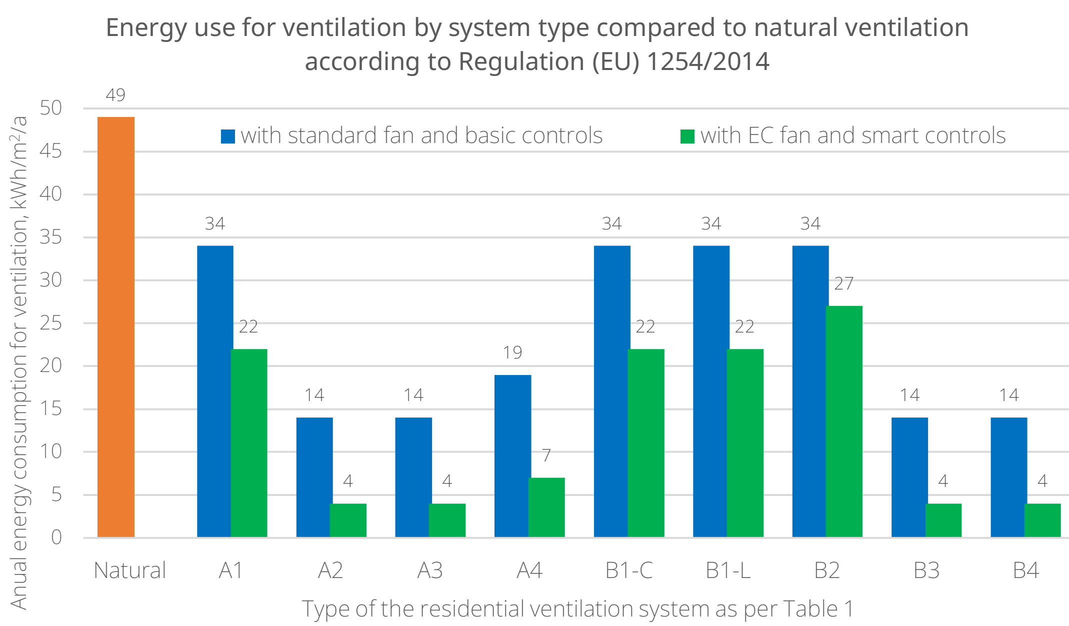

Diagram 1. Energy consumption for ventilation by system type compared to natural ventilation for an average climate.

[3] AEC, AHS and SEC values as per Annex VIII to Commission Delegated Regulation (EU) no 1254/2014

The diagram shows the energy consumption in an average climate by different systems as listed in Table 1 compared to natural ventilation. The energy consumption of each system is shown depending on the type of fan and controls used. In other words, it shows a difference between a ventilation unit equipped with a standard fan and basic control system, and a unit equipped with a high-efficiency EC fan and smart controls adjusting its performance to the actual demand. For systems with heat recovery, the difference between a standard and very high efficiency is also considered.

As can be seen in the graph, energy savings by using mechanical ventilation instead of natural ventilation can be very high and lead to a reduction in energy consumption of over 90%. The key features of residential ventilation systems impacting the reduction of energy use are discussed more in detail in the following two sections.

6 Energy consumption by residential ventilation systems

The building sector accounts for approximately 40% of the EU's overall energy consumption and 36% of the EU's energy-related emissions of greenhouse gas[4]. 75% of buildings in the EU have poor energy performance and require renovation, while more than 70% of permanently occupied floor area is residential.

Particularly for renovations, mechanical ventilation systems limit thermal losses and optimise heating and cooling needs, thereby improving the overall energy performance of a building. In fact, buildings fitted with a mechanical ventilation system can reduce energy needs by between 15 and 26% [5].

Thus, residential ventilation systems (RVS) play a crucial role in maintaining indoor air quality (IAQ) while ensuring high energy performance of buildings. Nevertheless, they do consume energy themselves.

The key features for optimised energy consumption while ensuring good IAQ and building's energy performance are the following:

Efficient Fans: The fans within RVS are significant components influencing energy consumption. By utilising energy-efficient fan technologies such as EC (electronically commutated) motors, RVS can achieve substantial energy savings compared to traditional AC motors. EC motors offer variable speed control, allowing the system to adjust fan speed according to ventilation requirements, thus reducing energy wastage during low-demand periods.

Heat Recovery Systems (HRS): Integrating HRS into RVS enables the recovery of heat from exhaust air, which can then be transferred to incoming fresh air. This heat exchange mechanism significantly reduces the energy required to condition incoming air to comfortable indoor temperatures, particularly during extreme weather conditions. The average efficiency of the heat exchanger is around 80%. The following technologies are the most representative ones: rotary heat exchanger and plate heat exchanger. Nowadays, the energy recovery can also be ensured by a heat pump, using the exhaust air as a heating source. This technology can be coupled with a water tank to provide domestic hot water.

Advanced Controls: Another key factor for optimising energy consumption and matching it to actual demand, as well as taking advantage of the high efficiency of fans and heat recovery is the control system, discussed in the next chapter.

[4] *Energy Performance of Buildings Directive, 2010*

[5] *French administration energy efficiency certificate for demand-controlled ventilation based on humidity (calculation methodology: fiche BAR-127)*

7 Controls of residential ventilation systems

Control systems of mechanical ventilation in residential buildings are pivotal in optimising energy consumption while maintaining IAQ. Smart ventilation controls can monitor IAQ in individual rooms and manage the operation of all system elements in a way that minimises energy consumption to maintain the required IAQ levels. In other words, smart controls adjust the performance of the ventilation system to the actual demand, which can be related to the presence of occupants, generation of indoor pollutants (e.g. moisture) or outdoor conditions. The important features of smart ventilation controls are outlined in the following sections.

7.1 Demand Control Ventilation (DCV)

DCV is a control strategy that continuously monitors IAQ and occupancy to adjust ventilation rates based on the real-time demand, optimising energy consumption by only ventilating spaces when necessary, without compromising IAQ. The system uses sensors, typically CO_2 and humidity, to monitor the presence of people in habitable areas and the relative humidity of utility rooms.

The significant difference in energy consumption between a DCV system and a constant airflow system is shown in Figure 1.

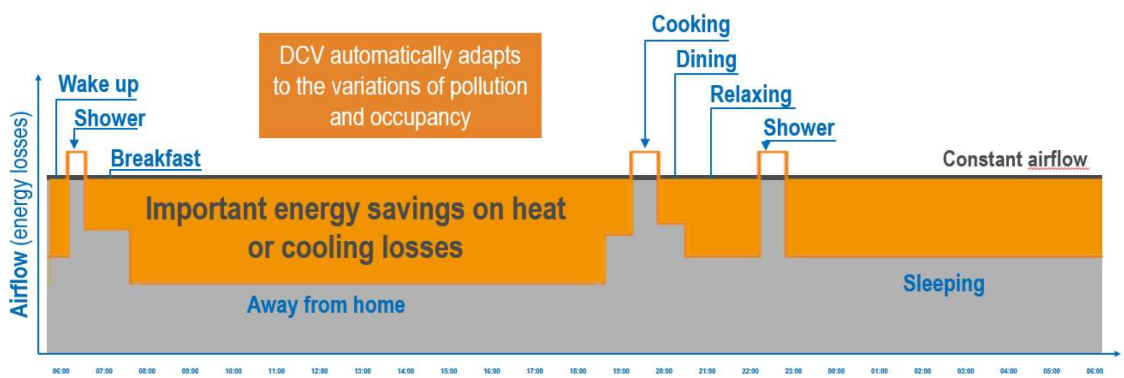

Figure 1. Potential savings in electricity (fans) and thermal energy (heating and cooling with a DCV system compared to a constant airflow system.

When the occupants are away from home or sleeping the airflow will be automatically adjusted or reallocated into the relevant room. This reduces the electricity consumption by fans and accordingly the thermal energy demand for heating or cooling the ventilation air.

A study[6] published in the framework of the AIVC 2014 presents the results of 20 years of in-situ monitoring in the residential field, including the impact on the energy losses. Comparing with the constant airflow in the French regulatory reference, the DCV system demonstrates a statistical reduction in airflow, resulting in heating energy savings. The measured average airflow savings for this project have been evaluated at 30%.

7.2 IAQ monitoring – quality of sensors

The measurement accuracy of IAQ sensors (in principle CO2 sensors), particularly for low-quality and low-cost sensors, can be very low. This in turn, may result in poor IAQ control and low performance of

[6] Demand Control Ventilation, 20 years of in situ monitoring in the residential field, Jean-Luc Savin

DCV systems, making energy savings deceptive. Therefore, measurement accuracy requirements should be laid down. This type of requirement is already in place, for example, in Belgium[7] and the Netherlands[8].

7.3 Defrosting control

Particularly in cold climates, heat recovery exchangers in bidirectional RVUs are prone to freezing at low outdoor temperatures. If no appropriate defrost control strategy is applied, this phenomenon can cause a significant increase in energy consumption and malfunction of the unit. There are different defrosting control strategies available, including very advanced and effective ones. It is crucial to ensure in cold climates that the applied control strategy minimises the impact of frosting on energy consumption.

7.4 Focus on the optimised systems approach

RVS technologies available on the market are oriented towards a complete system approach, meaning that one supplier can oftentimes offer all elements comprising the ventilation system, including ventilation units and all components of the integrated control system for the monitoring and regulation of indoor air quality. The integrated control system is optimised at the development stage, as well as factory tested and configured. This significantly facilitates and reduces the cost and time of installation and commissioning. It also gives more confidence in effective system operation with optimised energy consumption while maintaining IAQ.

8 Residential ventilation systems and sustainable buildings

A significant, if not the largest part, of the energy used in the life cycles of buildings, as well as that of greenhouse gas emissions, is related to the use-phase. Installing a modern and energy-efficient ventilation system during the renovation of older buildings often reduces ventilation costs while always improving indoor air quality and the well-being of occupants.

The performance parameters of the energy labelling regulation for residential ventilation units are defined partially by comparison of the net ventilation rate adjusted for heat recovery and demand control to a reference natural ventilation rate. This may be to date the most fair, simply defined and available data relevant for avoided emissions in the use phase in a general residential building life cycle scenario. Energy consumption that aims to enable a fair comparison of different products and to support an informed choice when making investment decisions, considering all costs and environmental impacts.

The annual heat saving in an average European climate as defined by the energy labelling Regulation 1254/2014 made by a bidirectional residential ventilation unit with efficient heat recovery and demand control in comparison to the reference natural ventilation is in most cases significant compared to the footprint of the material used for its construction and the energy used during manufacturing of the unit. CO_2 footprint from manufacturing and installation of a heat recovery mechanical ventilation system may thus be covered by the first year of use in some building scenarios.

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[7] Royal Decree of 7 February 2024 - CO_2 meters (https://www.health.belgium.be/en/royal-decree-7-february-2024-co2-meters)

[8] Requirements for CO_2 sensors for elementary schools in the Dutch building conde (Artikel 3.5 | Bouwbesluit Online)

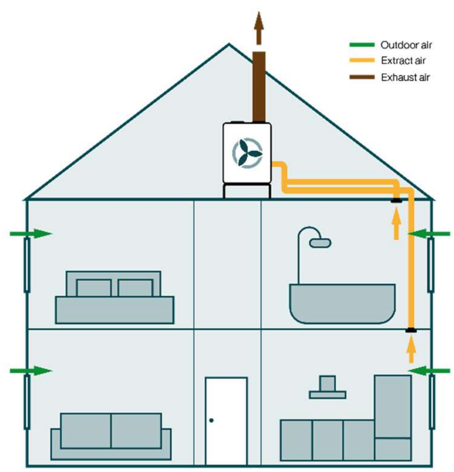
Annex I – Main residential ventilation system types

This Annex presents common and general types of mechanical ventilation systems for residential buildings and comprehensively discusses their properties and suitability for various applications.

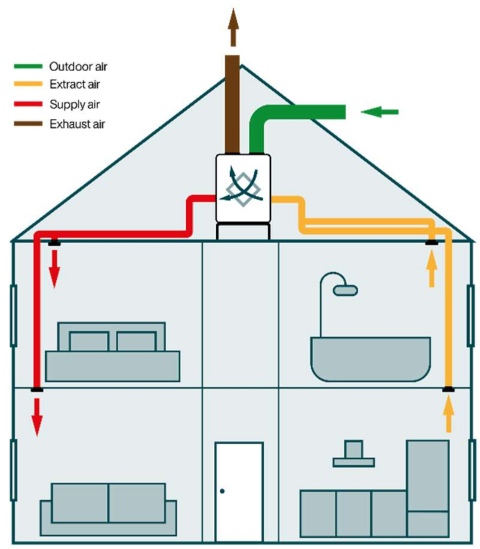
System A1

<table>
<tr><td colspan="2">General system description (characteristic)
The system consists of a central ventilation unit that extracts air through a duct system from all 'wet' rooms: kitchen, bathroom and toilets. Air is usually supplied through window grilles in the living areas.

Advantages: Investment cost and electricity consumption are limited. no filter change needed.

Drawbacks: Heat losses during the heating season, especially in cold climates. No filtration of outdoor air, which is particularly adverse in locations with poor outdoor air quality.</td><td>System scheme

</td></tr>
<tr><td>Aspects for application in New Buildings
- Fits for detached and semi-detached housings.
- Requires planning and installation of ducts to wet rooms.
- Windows to equip with grilles for fresh air supply.</td><td colspan="2">Aspects for application in Renovation
- Relatively easy to apply for renovation because ducts have to be installed only to wet rooms.
- Windows should be fitted with grilles for outdoor air supply.</td></tr>
<tr><td colspan="3">Additional information
- Typical annual energy savings[3] for ventilation per 1 m^2 of dwelling compared to airing (i.e. opening windows and no mechanical ventilation system) for average climate range from 15 $kWh/m^2/a$ for a RVU with a standard fan and basic controls to 27 $kWh/m^2/a$ for a RVU with an EC fan and smart controls. This translates into a reduction in energy use for ventilation by 31% to 55%.
- Can be combined with IAQ sensors, e.g. CO_2 to monitor and control IAQ and reduce energy consumption by adjusting airflow to the actual demand (DCV).
- Can also be connected to motorless range hoods, depending on national regulations.</td></tr>
</table>

System A2

General system description (characteristic)	System scheme
The system consists of a central heat recovery unit that extracts air through ducts from all wet rooms (kitchen, bathroom and toilet) and supplies outdoor air to the habitable areas (living room and bedrooms). Through the heat exchanger in the unit, the supplied outdoor air is warmed by the extracted indoor air; the air flows are separated. *Advantages*: Heat losses through ventilation remain limited, especially in cold climates. In hot periods/hot climates, the unit can recover cold. Supply air may be filtrated to prevent the outdoor PM pollutants from entering the interior. *Drawbacks:* Requires higher investment.	

Aspects for application in New Buildings	Aspects for application in Renovation
- Fits for detached and semi-detached housings. - Requires planning and installation of ducts to wet and habitable rooms.	- More difficult to apply for renovation because ducts must be installed to all rooms. - If an exhaust system was already installed it can be extended to this system under conditions.

Additional comments

- Typical annual energy savings[3] for ventilation per 1 m^2 of dwelling compared to airing (i.e. opening windows and no mechanical ventilation system) for average climate range from 35 kWh/m^2/a for a RVU with standard fans and basic controls to 45 kWh/m^2/a for a RVU with EC fans and smart controls. This translates into a reduction in energy use for ventilation by 71% to 92%.
- For good indoor air quality and proper, energy-efficient system operation, air filters need to be changed regularly.
- Can be combined with IAQ sensors, e.g. CO_2 to monitor and control IAQ and reduce energy consumption by adjusting airflow to the actual demand (DCV).
- Several types of heat exchangers can be used: heat recovery only or heat + moisture recovery. Adding moisture recovery is an advantage in dry climates (e.g. winter mountain climate).
- Can also be connected to motorless range hoods, depending on national regulations.

System A3

General system description (characteristic)

The system consists of:

- a central unit with heat recovery and a heat pump for heating and cooling air,
- a duct system with extraction of air from all wet areas (kitchen, bathroom, toilet) and supply of outdoor air to the habitable areas (living room, bedrooms).

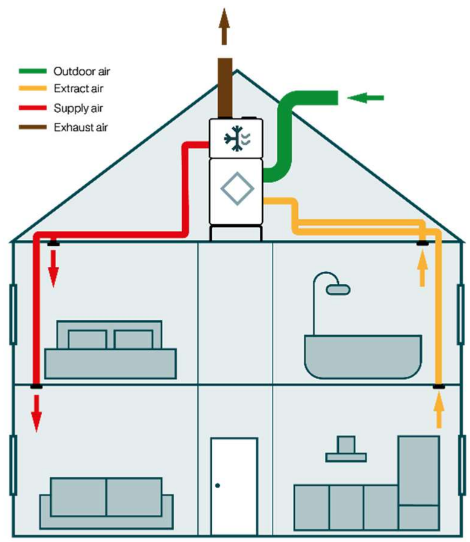
Through the heat exchanger in the unit, the supplied outdoor air is warmed by the extracted indoor air.

The heat pump in the unit ensures that, if required, the supply air to the dwelling is further heated (in winter) or cooled (in summer).

Advantages: Heat losses through ventilation remain limited, especially in cold climates. Possible to have cooling in hot periods or hot climate. For NZEB houses this system can cover heating, cooling and ventilation (no hydronic heating needed.). Supply air is filtrated to prevent the outdoor PM pollutants from entering the interior.

Drawbacks: Requires higher investments, additional electricity consumption for active cooling.

System scheme



Aspects for application in New Buildings

- Fits for detached and semi-detached housings.
- Requires planning and installation of ducts to wet and habitable rooms.

Aspects for application in Renovation

- Application is difficult. Can only conditionally be applied in case of deep renovation: ducts must be installed to all rooms.

Additional comments

- Typical annual energy savings[3] for ventilation per 1 m^2 of dwelling compared to airing (i.e. opening windows and no mechanical ventilation system) for average climate range from 35 $kWh/m^2/a$ for a RVU with a standard fan and basic controls to 45 $kWh/m^2/a$ for a RVU with EC fans and smart controls. This translates into a reduction in energy use for ventilation by 71% to 92%. Further energy savings for heating are provided by the heat pump.
- For good indoor air quality and proper, energy-efficient system operation, air filters need to be changed regularly.
- Can be combined with IAQ sensors, e.g. CO_2 to monitor and control IAQ and reduce energy consumption by adjusting airflow to the actual demand (DCV).
- Use of heat exchangers with moisture recovery will improve cooling efficiency and lower energy cost.
- Supply ducts must be insulated.

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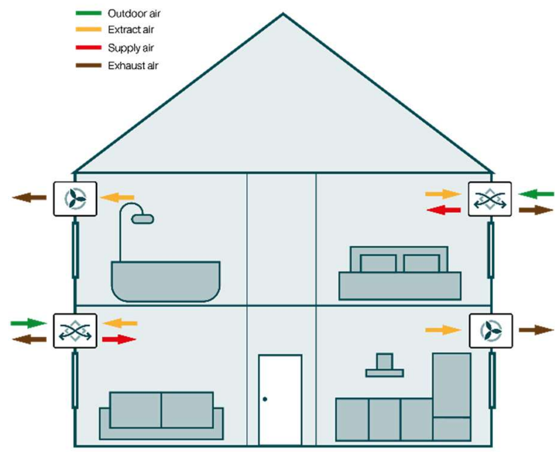
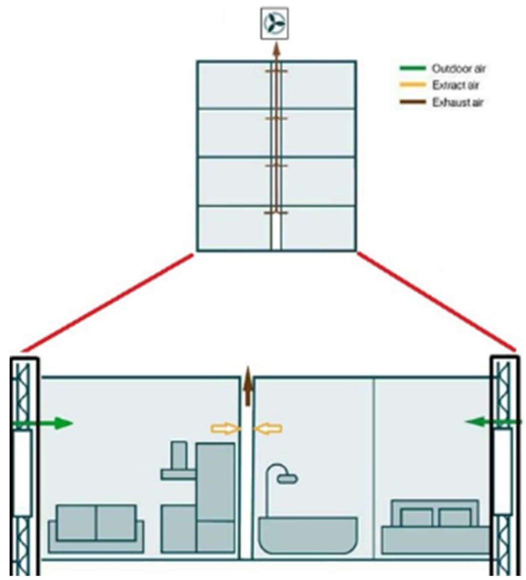
System A4

<table>
<tr>
<td>General system description (characteristic)
The system comprises of a number of local heat recovery units mounted in the outer wall of living areas, usually living room and/or bedroom.

The wet rooms are ventilated with small exhaust fans.

Advantages: Heat losses through ventilation remain limited, especially in cold climates. No need to install ventilation ducts. Ventilation units may be equipped with air filters to prevent the outdoor PM pollutants from entering the interior (except for push-pull units)</td>
<td>System scheme

</td>
</tr>
<tr>
<td>Aspects for application in New Buildings
- Fits for detached and semi-detached housings.
- Energy-wise, it is less efficient than central heat recovery (A2) because exhaust fans are also required.</td>
<td>Aspects for application in Renovation
- Good use for renovation, easy to install as no ducts are needed.
- No condensate drain required for units with heat and moisture recovery exchanger, often referred to as ’enthalpy exchanger’.</td>
</tr>
<tr>
<td colspan="2">Additional comments
- Typical annual energy savings[3] for ventilation per 1 m^2 of dwelling compared to airing (i.e. opening windows and no mechanical ventilation system) for average climate range from 30 $kWh/m^2/a$ for a RVU with basic controls and one fan which alternately exhausts and supplies air (‘push-pull’) to 42 $kWh/m^2/a$ for a RVU with two EC fans and smart controls. This translates into a reduction in energy use for ventilation by 61% to 86%.
- For good indoor air quality and proper, energy-efficient system operation, air filters need to be changed regularly (except for push-pull units).
- Can be combined with IAQ sensors, e.g. CO^2 to monitor and control IAQ and reduce energy consumption by adjusting airflow to the actual demand (DCV).
- Several types of heat exchangers can be used: heat recovery only or heat + moisture recovery.
- There are local units with one fan only that alternates between supply and exhaust; the heat is exchanged in a ceramic element. These units are commonly referred to as ‘push-pull’ units.</td>
</tr>
</table>

System B1-C

General system description (characteristic)	System scheme
There is one central ventilation unit per building or per group of flats in the multi storey building. Air from wet areas is extracted through grilles directly into a collective vertical shaft*, and when needed, through a small additional ductwork within the apartment. The central ventilation unit on the roof exhausts the air through a collective shaft. Outdoor air is supplied through window grilles. *Advantages*: low investment cost per apartment. Compared to the B1-L system, noise level indoors is lower because the fan is installed outside the dwelling. *Drawbacks*: Heat losses during heating season, especially in cold climates. No filtration of outdoor air, which is particularly adverse in locations with poor outdoor air quality.	

Aspects for application in New Buildings	Aspects for application in Renovation
- Fits for multi-story buildings. - Requires planning and installation of ducts to wet rooms. - Windows to equip with grilles for air supply.	- Relatively easy to apply for renovation. - A collective duct to the roof must be available. - Requires installation of ducts to wet rooms. - Windows should be fitted with grilles for air supply.

Additional information
- Typical annual energy savings[3] for ventilation per 1 m^2 of dwelling compared to airing (i.e. opening windows and no mechanical ventilation system) for average climate range from 15 $kWh/m^2/a$ for a system with a roof fan and basic controls to 27 $kWh/m^2/a$ for system with an EC roof fan and smart controls. This translates into a reduction in energy use for ventilation by 31% to 55%. - Can be combined with IAQ sensors, e.g. CO_2 to monitor and control IAQ and reduce energy consumption by adjusting airflow to the actual demand (DCV). - Can also be connected to motorless range hoods, depending on national regulations. * According to building regulations in some Member States, extract air systems from kitchens and bathrooms/toilets cannot be combined in multi-family dwellings. In such cases, system B1-C requires separate collective ducts (shafts) for kitchens and bathrooms/toilets.

System B1-L

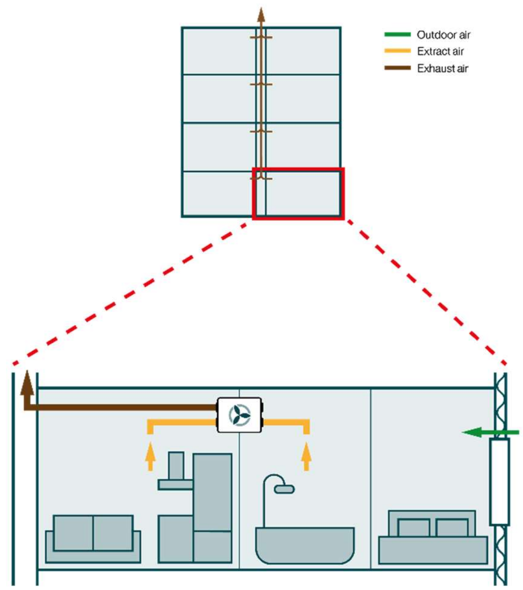
General system description (characteristic)

There is one ventilation unit per apartment in the multi storey building. Through a small ductwork within the apartment*, the air from wet areas is extracted. The ventilation unit exhausts the air through a collective duct to the roof. Outdoor air is supplied through window grilles.

Advantages: low investment cost per apartment.

Drawbacks: Heat losses during heating season, especially in cold climates. No filtration of outdoor air, which is particularly adverse in locations with poor outdoor air quality.

System scheme



Aspects for application in New Buildings

- Fits for multi-story buildings.
- Requires planning and installation of ducts to wet rooms.
- Windows to equip with grilles for air supply.

Aspects for application in Renovation

- Relatively easy to apply for renovation.
- A collective duct to the roof must be available.
- Requires installation of ducts to wet rooms.
- Windows should be fitted with grilles for air supply.

Additional information

- Typical annual energy savings[3] for ventilation per 1 m^2 of dwelling compared to airing (i.e. opening windows and no mechanical ventilation system) for average climate range from 15 $kWh/m^2/a$ for a RVU with a standard fan and basic controls to 27 $kWh/m^2/a$ for a RVU with an EC fan and smart controls. This translates into a reduction in energy use for ventilation by 31% to 55%.
- Can be combined with IAQ sensors, e.g. CO_2 to monitor and control IAQ and reduce energy consumption by adjusting airflow to the actual demand (DCV).
- Can also be connected to motorless range hoods, depending on national regulations.

* According to building regulations in some Member States, extract air systems from kitchens and bathrooms/toilets cannot be combined in multi-family dwellings. In such cases, system B1-L requires separate collective ducts (shafts) for kitchens and bathrooms/toilets.

System B2

General system description (characteristic)

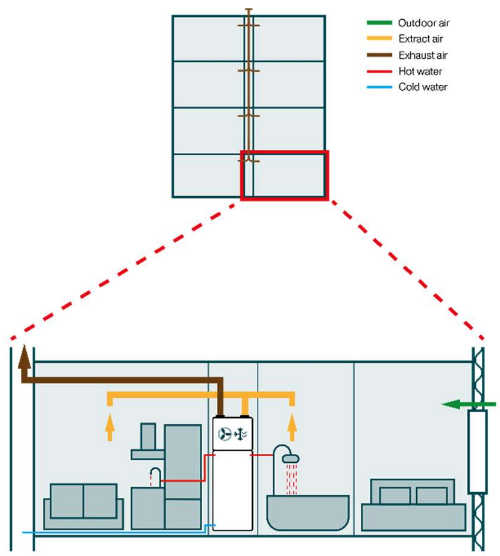
There is one exhaust unit with an integrated heat pump for DHW per apartment in the multi storey building.

- This unit extracts air through ducts from all wet rooms (kitchen, bathroom and toilet)
- With the heat in the exhaust air, domestic hot water is produced using an integrated heat pump.
- The domestic hot water is stored in a storage tank.

Advantages: The energy in the exhaust air is used to produce domestic hot water.

Drawbacks: domestic hot water supply is relatively limited. The ventilation air volume should not be too low. No filtration of outdoor air, which is particularly adverse in locations with poor outdoor air quality.

System scheme



Aspects for application in New Buildings

- Requires higher investment; suits homes that are not heated with a gas (combi) boiler.
- Requires limited floor space in the technical or wet room
- Requires planning and installation of ducts to wet rooms.
- Windows to equip with grilles for air supply

Aspect for application in Renovation

- Relatively easy to apply for renovation because ducts have to be installed only to wet rooms.
- A collective duct to the roof must be available.
- Windows should be fitted with grilles for air supply
- Requires limited floor space in technical/wet room.
- Water supply system must be adapted.

Additional information

- Typical annual energy savings[3] for ventilation per 1 m^2 of dwelling compared to airing (i.e. opening windows and no mechanical ventilation system) for average climate range from 15 $kWh/m^2/a$ for a RVU with a standard fan and basic controls to 22 $kWh/m^2/a$ for a RVU with an EC fan and smart controls. This translates into a reduction in energy use for ventilation by 31% to 45%. Further energy savings for DHW production are provided by the heat pump.
- Typical capacity of the storage tank is 100 – 300 litres, most common 150 - 200 litres
- The water in the storage tank should be regularly heated to min 60°C to rule out legionella.
- According to building regulations in some Member States, extract air systems from kitchens and bathrooms/toilets cannot be combined in multi-family dwellings and require separate collective ducts (shafts) for kitchens and bathrooms/toilets. This prevents using system B2.

System B3

General system description (characteristic)

There is one heat recovery ventilation unit per apartment that extracts air through ducts from all wet rooms (kitchen, bathroom and toilet) and supplies outdoor air to the living areas (living room and bedrooms). Through the heat exchanger in the unit, the supplied outdoor air is warmed by the extracted indoor air. The air flows are separated.

The ducts for the outdoor air and the extract air are connected to:

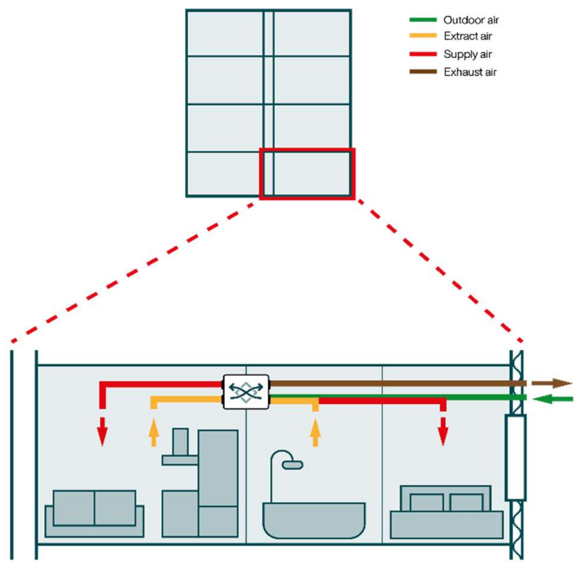
- an air inlet and outlet grid in the façade (system scheme I)
- or via collective ducts to the roof (system scheme II)

However, such a ductwork design is not allowed by building codes in some Member States (see additional comments).

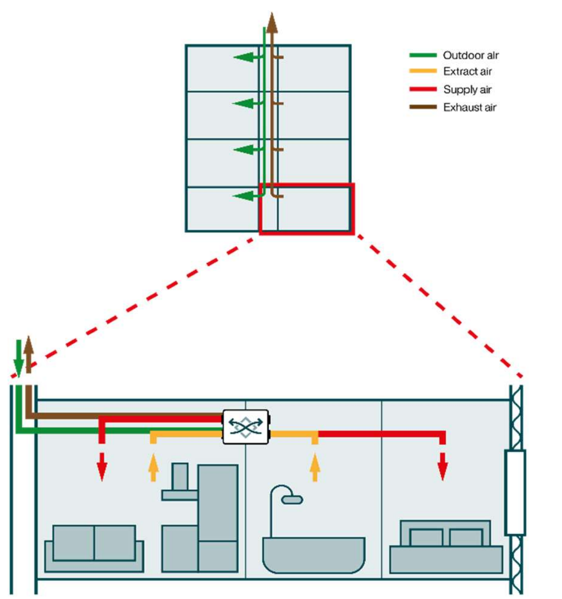
Advantages: Heat losses through ventilation remain very limited, especially in cold climates. In hot periods/hot climates, the unit can recover cold. Supply air may be filtrated to prevent the outdoor PM pollutants from entering the interior.

Drawbacks: Requires higher investment; Design not allowed or very difficult to implement according to building regulations of some Member States.

System scheme I



System scheme II



Aspects for application in New Buildings

- Fits for multi-story buildings.
- Requires planning and installation of ducts to wet and habitable rooms.

Aspects for application in Renovation

- More difficult to apply for renovation because ducts must be installed to all rooms.
- If an exhaust system was already installed it can be extended to this system under certain conditions.
- Some units / systems can also be mounted outdoor on a balcony.

Additional comments

- Typical annual energy savings[3] for ventilation per 1 m^2 of dwelling compared to airing (i.e. opening windows and no mechanical ventilation system) for average climate range from 35 $kWh/m^2/a$ for a RVU with standard fans and basic controls to 45 $kWh/m^2/a$ for a RVU with EC fans and smart controls. This translates into a reduction in energy use for ventilation by 71% to 92%.
- For good indoor air quality and proper, energy-efficient system operation, air filters need to be changed regularly.
- Can be combined with IAQ sensors, e.g. CO_2 to monitor and control IAQ and reduce energy consumption by adjusting airflow to the actual demand (DCV).
- Can also be connected to motorless range hoods, depending on national regulations.
- Several types of heat exchangers can be used: heat recovery only or heat + moisture recovery. Adding moisture recovery is an advantage in dry climates (e.g. winter mountain climate).
- Can also be connected to motorless range hoods, depending on national regulations.
- According to the current building regulations in some Member States, extracting air from kitchens and bathrooms/toilets cannot be combined in multi-family dwellings. As the extract air from all wet rooms mixes in the ventilation unit, the System scheme II cannot be used. On the other hand, the minimum distances required between inlet/outlets in the façade or to windows may prevent the practical implementation of this system both for new buildings and renovations.

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System B4

General system description (characteristic)

There is one system per apartment:

- Heat recovery ventilation and a heat pump for heating and cooling air
- a duct system with extraction of air from all wet areas (kitchen, bathroom, toilet) and supply of outdoor air to the habitable areas (living room, bedrooms).

Through the heat exchanger in the unit, the supplied outdoor air is warmed by the extracted indoor air.

The heat pump in the unit ensures that, if required, the supply air to the dwelling is further heated (in winter) or cooled (in summer).

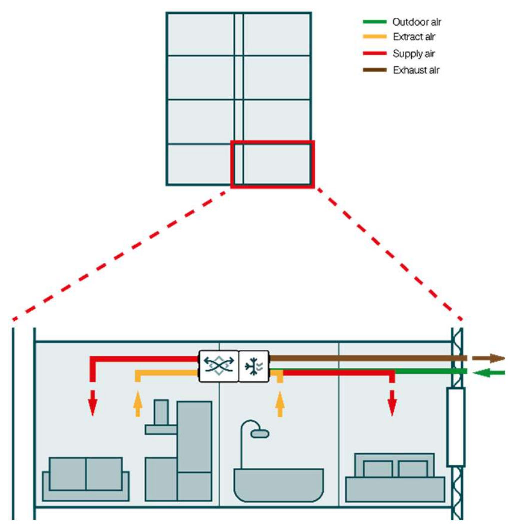
The ducts for the outdoor air and the extract air are connected to:

- an air inlet and outlet grid in the façade (system scheme I)
- or via collective ducts to the roof (system scheme II)

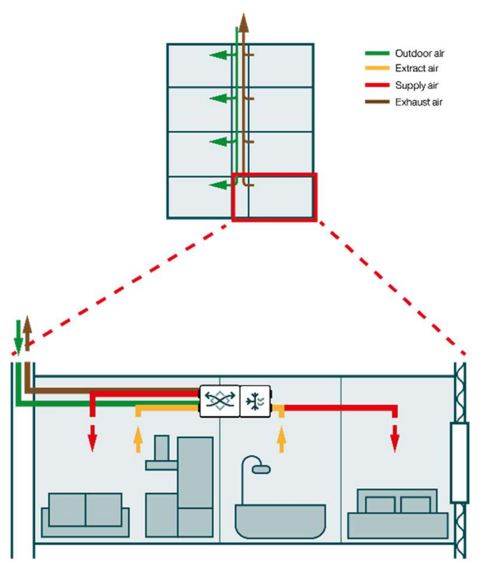
Advantages: Heat losses through ventilation remain limited, especially in cold climates. Possible to have cooling in hot periods or hot climate. For NZEB houses this system can cover heating, cooling and ventilation (no hydronic heating needed.). Supply air may be filtrated to prevent the outdoor PM pollutants from entering the interior.

Drawbacks: Requires higher investments, additional electricity consumption for active cooling. Design not allowed or very difficult to implement according to building regulations of some Member States (see additional comments).

System scheme I



System scheme II



Aspects for application in New Buildings

- Fits for multi-story buildings.
- Requires planning and installation of ducts to wet rooms.

Aspect for application in Renovation

- More difficult to apply for renovation because ducts must be installed to all rooms.
- If an exhaust system was already installed it can be extended to this system under certain conditions.
- Some units / systems can also be mounted outdoor on a balcony.

Additional comments

- Typical annual energy savings[3] for ventilation per 1 m^2 of dwelling compared to airing (i.e. opening windows and no mechanical ventilation system) for average climate range from 35 kWh/m^2/a for a RVU with a standard fan and basic controls to 45 kWh/m^2/a for a RVU with an EC fan and smart controls. This translates into a reduction in energy use for ventilation by 71% to 92%. Further energy savings for heating are provided by the heat pump.
- For good indoor air quality and proper, energy-efficient system operation, air filters need to be changed regularly.
- Can be combined with IAQ sensors, e.g. CO_2 to monitor and control IAQ and reduce energy consumption by adjusting airflow to the actual demand (DCV).
- Can also be connected to motorless range hoods, depending on national regulations.
- Several types of heat exchangers can be used: heat recovery only or heat + moisture recovery. Adding moisture recovery is an advantage in dry climates (e.g. winter mountain climate).
- Can also be connected to motorless range hoods, depending on national regulations.
- Supply ducts should be insulated.
- According to the current building regulations in some Member States, extract air from kitchens and bathrooms/toilets cannot be combined in multi-family dwellings. As the extract air from all wet rooms mixes in the ventilation unit, the System scheme II cannot be used. On the other hand, the minimum distances required between inlet/outlets on the façade or to windows, may prevent the practical implementation of this system both for new buildings and renovations.

Annex II – Key features or ventilation system components

Table 2 provides an overview of parts and components of residential ventilation systems, their key features affecting energy efficiency and the overall quality of system operation and maintenance.

System part	System component	Component features	Comments
Extract ventilation	Unit	- Strength (stiffness, toughness) - Accessibility (easy service)	The extraction box/unit extracts air from so-called wet rooms: kitchen, bathroom, toilet. The extracted air is exhausted to the outside.
	Fan	- Capacity (airflow /pressure) - Power consumption - Noise emission	
Heat recovery ventilation	Unit	- Strength (stiffness, toughness) - Tightness (air leakage external/internal) - Thermal insulation (heat loss, condensation) - Accessibility (easy service)	Casing of the residential ventilation unit holds the main components together, so it should be strong and well thermally and acoustically insulated. Also, it should be airtight to avoid the extract air going to the supply air or elsewhere. Easy access for service enables proper operation during its lifetime.
	Heat Recovery Exchanger	- Heat recovery efficiency (temperature) - Moisture recovery efficiency (humidity) - Pressure drop (energy consumption) - Tightness (internal leakage) - Acoustic insulation (noise reduction)	The Heat recovery exchanger is an essential component of an efficient residential ventilation system, saving the majority of energy losses during ventilation. Some of the exchangers can also recover humidity, further improving the health and comfort of people in the building. A quality heat/moisture exchanger is highly thermally efficient, with a low pressure drop and minimal internal air leakage between supply and exhaust.
	Supply and exhaust fans	- Capacity (airflow /pressure) - Power consumption	Both the supply and exhaust fans are the most important elements of the RVS moving the air through the ductwork and other components. It costs energy therefore fans should be efficient with low energy

System part	System component	Component features	Comments
		- Noise emission	consumption for reaching nominal airflow volume. Fans are the main source of noise emissions, so they should run quietly so as not to disturb residents.
	Filters	- Air purity (filtration class, IAQ) - Pressure drop (energy consumption) - Tightness (filter bypass leakage) - Protection of downstream components against dust (clogging) - Filter class (quality)	The supplied outdoor air is filtered in an HRV unit with a supply filter to remove dust and pollen. It is possible to use supply filters that also filter out fine dust. The return air is filtered in the HRV unit to keep the unit internally clean. The two filters should be cleaned or replaced periodically. The recommended filter class is the following: Extract side ePM10 60%, Supply side ePM1 50%
	Bypass Frost protection	Heat recovery control (summer free-cooling, frost protection) Reduction supply air Frost-preheater (on/off – modulating)	The bypass in the HRV unit allows the operation of the heat exchanger to be switched off. It may be needed to supply outdoor air directly to the interior, for example if it is cold outside in summer and hot inside.
Peripheral devices	pre-heater, post-heater, post-cooler, cooker hood	Air heating/cooling (cover ventilation heat loss/gain, thermal comfort for people) Connection Control / valve	Supply air heater/cooler within the RVS keep thermal comfort inside the building covering heat losses/gains caused by ventilation. Pre-heater protects heat recovery exchanger against freezing during extreme winter conditions.
Air distribution Ductwork supply/exhaust	Sound attenuator tubes/pipes/ manifolds	Acoustic attenuation (noise reduction) - Pressure drop (energy consumption) - Strength (resistance to deformation) - Tightness (no air losses and noise)	Sound attenuators reduce noise in ducts coming from fans to keep humans indoor undisturbed by RVS operation. Duct system consumes energy in pressure drop form during ventilation. It should be designed short as possible with large cross-sectional areas and with minimum obstacles as sharp elbows. Duct should be rigid to

System part	System component	Component features	Comments
	Air inlets, Air outlets	- Thermal insulation (heat loss, condensation) - Pressure drop (energy consumption) - Noise level	withstand pressure differences without deformation and airtight for transportation of air to the destination without losses along the air path. With different temperatures between air inside and outside, the duct must be thermally insulated to avoid heat loss and water condensation. Terminal devices serve for a proper air supply distribution inside a ventilated room, with low pressure loss and low additional noise.
Controls	User control (switch and app) sensors (CO_2, VOC, humidity presence) Demand control (central, zone, local)	Temperature control (thermal comfort) monitoring temperature, humidity, IAQ, presence Airflow control (automatic Demand control ventilation)	Measurement and control system of the RVU plays a key role in energy efficient operation of the whole RVS. Smart airflow control provides air only when and where is really needed based on measurement of IAQ parameters (CO_2, presence, humidity). Additionally control system can adjust air temperature for thermal comfort of people in building.

Table 2. Crucial properties of parts and components of residential ventilation systems.

Annex III – Relevant articles of Directive 2024/1275

Article 2(66) - DEFINITIONS
'indoor environmental quality' means the result of an assessment of the conditions inside a building that influence the health and well-being of its occupants, based upon parameters such as those relating to the temperature, humidity, ventilation rate and presence of contaminants.

Article 5(1) – SETTING MINIMUM ENERGY PERFOMANCE REQUIREMENTS
Minimum energy performance requirements shall take account of optimal indoor environmental quality, in order to avoid possible negative effects such as inadequate ventilation, as well as local conditions and the designated function and the age of the building.

Article 7(6) – NEW BUILDINGS
Member States shall address, in relation to new buildings, the issues of optimal indoor environmental quality, adaptation to climate change […]

Article 8(3) – EXISTING BUILDINGS
Member States shall address, in relation to buildings undergoing major renovation, the issues of indoor environmental quality, adaptation to climate change […]

Article 13(4) – TECHNICAL BUILDING SYSTEMS
Member States shall set requirements for the implementation of adequate indoor environmental quality standards in buildings in order to maintain a healthy indoor climate.

Article 13(5) – TECHNICAL BUILDING SYSTEMS
Member States shall require non-residential zero-emission buildings* to be equipped with measuring and control devices for the monitoring and regulation of indoor air quality. In existing non-residential buildings, the installation of such devices shall be required, where technically and economically feasible, when a building undergoes a major renovation. Member States may require the installation of such devices in residential buildings.

*Zero-emission building = new public buildings (from 2028), all new buildings (from 2030).

Article 13(11) – TECHNICAL BUILDING SYSTEMS
Member States shall lay down requirements to ensure that, where technically, economically and functionally feasible, from 29 May 2026, new residential buildings and residential buildings undergoing major renovations are equipped with the following:

c) the functionality of continuous electronic monitoring that measures systems' efficiency and informs building owners or managers in the case of a significant variation and when system servicing is necessary;
d) effective control functionalities to ensure optimum generation, distribution, storage, use of energy and, where applicable, hydronic balance;
e) a capacity to react to external signals and adjust the energy consumption.

Member States may exclude single-family houses undergoing major renovations from the requirements laid down in this paragraph where the costs of installation exceed the benefits.

Annex IV – Detailed examples of some system types design

SYSTEM A1 – mechanical exhaust air system with air inlet / infiltration

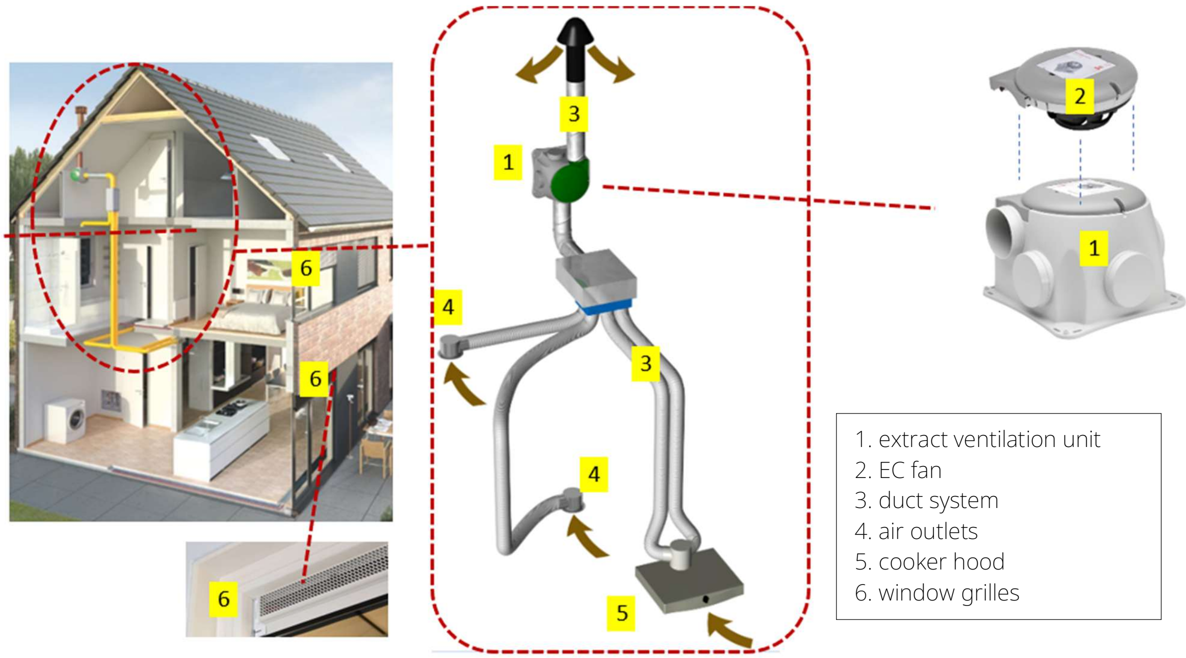


Figure 2. System A1 ©Zehnder

General comments on good practice.

- Extract ventilation unit (1) – extracting air from ‘wet rooms’: kitchen, bathroom and toilet. It is important that the unit can be easily accessible for service and maintenance.
- EC fan (2) has higher efficiency compared to other fan types. Importantly, it can be easily cleaned.
- Duct system – impacts energy used due to pressure drop. It should be designed short as possible with large cross-sectional areas and with minimum obstacles as sharp elbows and similar.
- Air outlets (4) in ‘wet’ spaces, kitchen, bathroom and toilet. They should feature low pressure drop.
- Cooker hood (5) in the kitchen. In some countries, the HRV unit has a separate air connection for the cooker hood so that the extracted air is discharged through this hood directly to the outside and not through the heat recovery exchanger.
- Window grilles (6). There are many different types. It is desirable to apply window grilles that regulate automatically so that wind pressure on the facade does not cause problems. cleaning should be possible.

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SYSTEM A2 - mechanical supply air and exhaust air with heat/moisture recovery

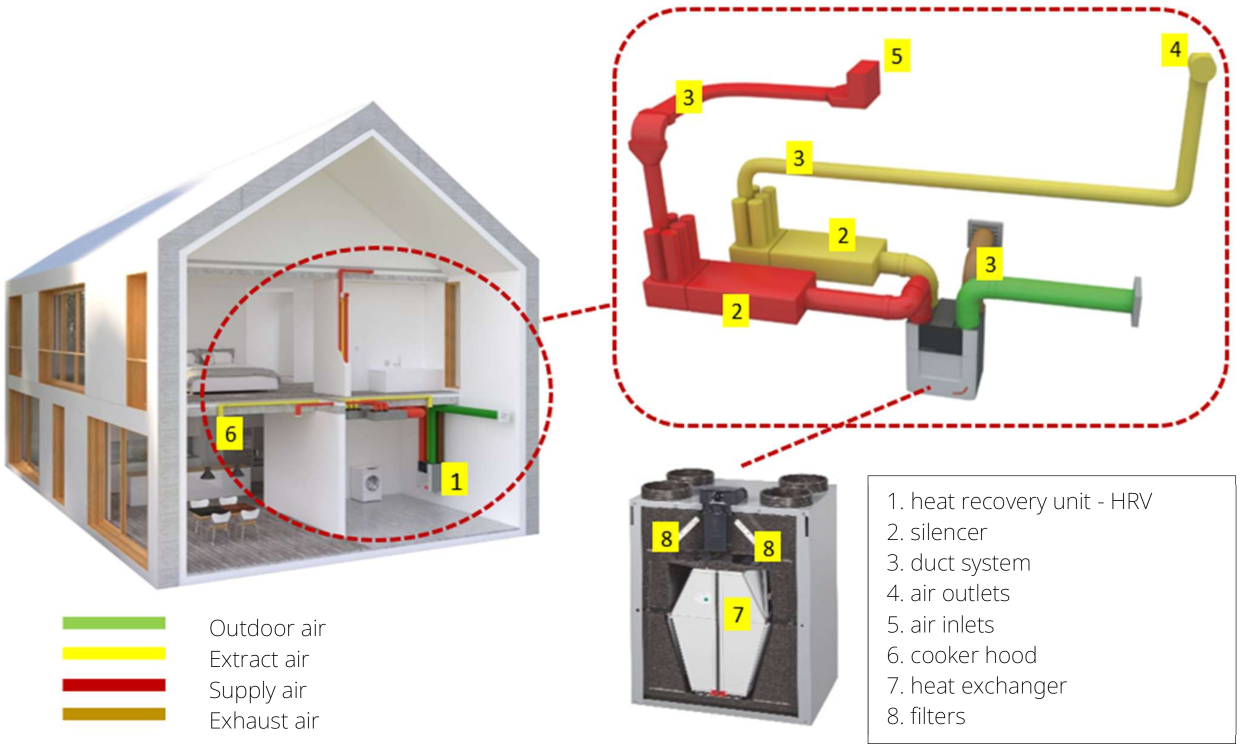

Figure 3. System A ©Zehnder

General comments on good practice.

- Heat recovery unit (1). Unit's casing holds the main RVU components together, so it should be strong and well thermally and acoustically insulated. Also, it should be airtight to avoid the extract air from going to the supply air or elsewhere. Easy access for service enables proper operation during its lifetime.
- Silencers (2) reduce noise in ducts coming from fans to keep occupants indoors undisturbed by RVS operation.
- Duct system (3) consumes energy in pressure drop form, during ventilation. So, it should be designed as short as possible with large cross-sectional areas and with minimum obstacles as sharp elbows and similar. Duct should be rigid to withstand pressure differences without deformation and airtight transportation of air to final destination without losses along air path. In case of different temperatures between the air inside and outside duct should be thermally insulated to minimise heat loss and water condensation.
- Air inlets (4) in 'wet' spaces, kitchen, bathroom and toilet. Preferably, of low pressure drop.
- Air outlets (5) in 'habitable spaces. Preferably with low pressure drop, good induction, draught-free and low noise level.

- Cooker hood (6) in the kitchen. In some countries, the HRV unit has a separate air connection for the cooker hood so that the extracted air is discharged through this hood directly to the outside and not through the heat exchanger.
- Heat recovery exchanger (7) is an essential component of efficient RVS, saving the majority of energy losses during ventilation. Some exchangers can also recover humidity, improving the health and comfort of occupants in the building. A quality heat/moisture exchanger is highly thermally efficient, with low pressure drop and minimal internal air leakage between supply and exhaust.
- Filters (8). The supplied outdoor air is filtered in the HRV unit with a supply filter to remove dust and pollen. It is possible to use supply filters that also remove fine dust. The return air is filtered in the HRV unit to keep the unit internally clean. The two filters should be cleaned or replaced periodically.

SYSTEM A3 - mechanical supply air and exhaust air with heat/moisture recovery and additional air to air heat pump

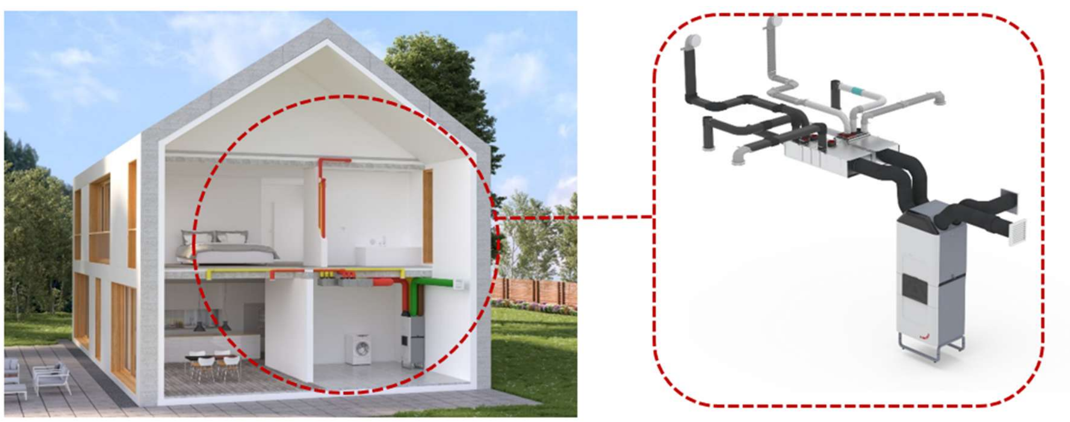

Figure 4. System A3 ©Zehnder

General comments on good practice.

- Same as for system A2.
- The difference is in the ventilation units which additionally incorporate an air-to-air heat pump for heating and cooling the supply air.

SYSTEM B3 – Local heat recovery ventilation unit in each flat

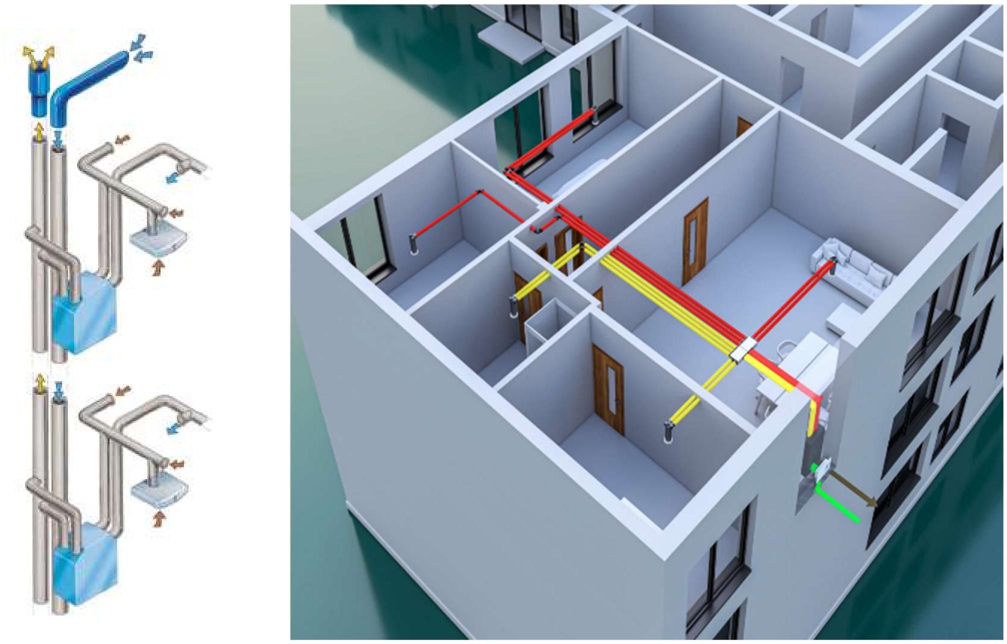

Figure 5. System B3. With local units connected to common shafts for outdoor and extract air (left), with a unit, air intakes and air outlets on the facade (right) ©Pichler

About Eurovent

Eurovent is the voice of the European HVACR industry, representing over 100 companies directly and more than 1.000 indirectly through our 16 national associations. The majority are small and medium-sized companies that manufacture indoor climate, process cooling, and cold chain technologies across more than 350 manufacturing sites in Europe. They generate a combined annual turnover of more than 30 billion EUR and employ over 150.000 Europeans in good quality tech jobs.

Mission

Eurovent's mission is to bring together HVACR technology providers to collaborate with policymakers and other stakeholders towards conditions that foster fair competition, innovation, and sustainable growth for the European HVACR industry.

Vision

Eurovent's vision is an innovative and competitive European HVACR industry that enables sustainable development in Europe and globally, which works for people, businesses, and the environment.

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