EUROVENT
EUROPEAN INDUSTRY ASSOCIATION

EUROVENT GUIDEBOOK

AIR HANDLING UNITS

EVERYTHING YOU NEED TO KNOW ABOUT THE HEART OF A VENTILATION SYSTEM

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Figure 2:
Royal Children's Hospital in Melbourne, Australia

1. AIR HANDLING UNITS MATTER

1.1 CLEAN AIR – A BASIC HUMAN NEED

Human beings have three main basic needs: Eating, drinking, and breathing. A human can survive weeks without eating, up to one week without drinking, but can survive just a few minutes without breathing.

Air handling units (AHUs), which constitute the most important part of a ventilation and air conditioning system, are the answer to the most important but often overlooked human needs. They provide air to breath wherever this is needed in enclosed spaces.

In other words, AHUs remove polluted air from indoor spaces – either actually polluted or air that is just uncomfortably warm or cold – and replace it with clean, fresh (and sometimes humidified) air at the right temperature. They are also essential to protect building structures.

Nowadays, people spend most of their time (up to 90%) inside buildings. Our houses, offices and production plants must meet the people's need for a safe, healthy and productive environment. Fresh air supply (ventilation) plays a very important role in creating this environment. Not only are the right temperature and humidity a must, but even more so the purity of the air we breathe when we are inside.

In recent years, society has become more and more aware of the negative health effects particulate matter (PM) has. Numerous studies show a significant correlation between the yesterday's outside PM concentration and today's mortality rate. Efficient air filtration applied in AHUs allows us to reduce this risk.

Figure 3: #IAQmatters campaign

Scan the QR code to learn more about Indoor Air Quality and why it matters.

1. AIR HANDLING UNITS MATTER

1.2
INDOOR AIR QUALITY AND ENERGY EFFICIENCY

In past decades, indoor air regulations were mostly focused on minimum needs related to thermal comfort. The need for air handling and the amount of fresh air per person seemed to be in conflict with the goals of reducing energy consumption to stop global warming. In fact, efforts to reduce energy consumption did not always contribute to the design of healthy buildings.

In recent years, the European Union's Ecodesign legislation has supported solving the difficult dilemma between reducing energy consumption and creating a healthy, and productive indoor environment. Applying EU rules has led to a myriad of innovations in the manufacturing of ventilation components. Motor and fan efficiency have increased tremendously, highly efficient energy recovery components in mechanical ventilation systems were enforced by law, and cross dimensions of AHUs grew by around 30% to meet the restrictions on energy consumption of fans (SFP, Specific Fan Power). Today, all fans have to be equipped with a (multi-) variable speed drive, ensuring that demand control is easier to apply. All of this makes the AHU an essential, sustainable component for our indoor air environment.

To bring energy consumption and a healthy environment closer together, demand-controlled ventilation (DCV) has become popular in recent years. The indoor air CO_2 concentration is an important factor to control energy consumption while optimising productivity in our offices and the learning performances in our schools. The European Union Ecodesign legislation has proven to be helpful in upgrading the energy efficiency of air handling units.

1.3
APPLYING HIGH QUALITY AHUs PAYS OFF

Air handling units are essential for our health, wellbeing and performance. An AHU has to supply enough clean and fresh air to create the optimal indoor air quality (IAQ). Highly efficient fans, energy recovery systems, and controlling devices in an AHU are essential to ensure a sustainable energy consumption. Sound attenuators will diminish the noise level in the ventilation system.

Investing in well-designed air handling units, intelligent control systems (e.g. VAV), and a thorough and regular maintenance (including a regular replacement of air filters) will ultimately result in higher performances and better indoor air quality.

This Eurovent Guidebook was developed to provide you with all essential information on air handling units in a neutral and objective manner. It should enable you to better understand this highly important piece of technology, which often runs in an unnoticed manner day and night somewhere on your roof or hidden in a ventilation room. Next time you walk around your neighbourhood, it may be worthwhile having a closer look…

Figure 4:
Example of an AHU incorporated in a ventilation room

2. THE BASICS

2.1 HEART OF THE VENTILATION SYSTEM

Traditionally an air handling unit (AHU) is classified as a complex device designed to handle and condition the air processed in heating, ventilation, and air conditioning (HVAC) systems. An AHU consists of a fan or fans, and at least one other component for air processing: filter, heater, cooler, energy recovery component, humidifier, dehumidifier, or mixing section.

Every component performs a crucial function in providing a healthy and comfortable indoor climate inside a building. Therefore, AHUs are often referred to as the "heart of the ventilation system".

2.2 PAST AND PRESENT

THE BEGINNINGS OF MECHANICAL VENTILATION

The history of air handling units began back in the 1950s. Before that, ventilation components such as fans, filters and heating coils where fully integrated in the building, separated by brick walls and accessible by steel doors. Along with the boost of building sizes, mechanical ventilation became a necessity. People started to place respective ventilation components in a separate casing what gave birth to the AHU.

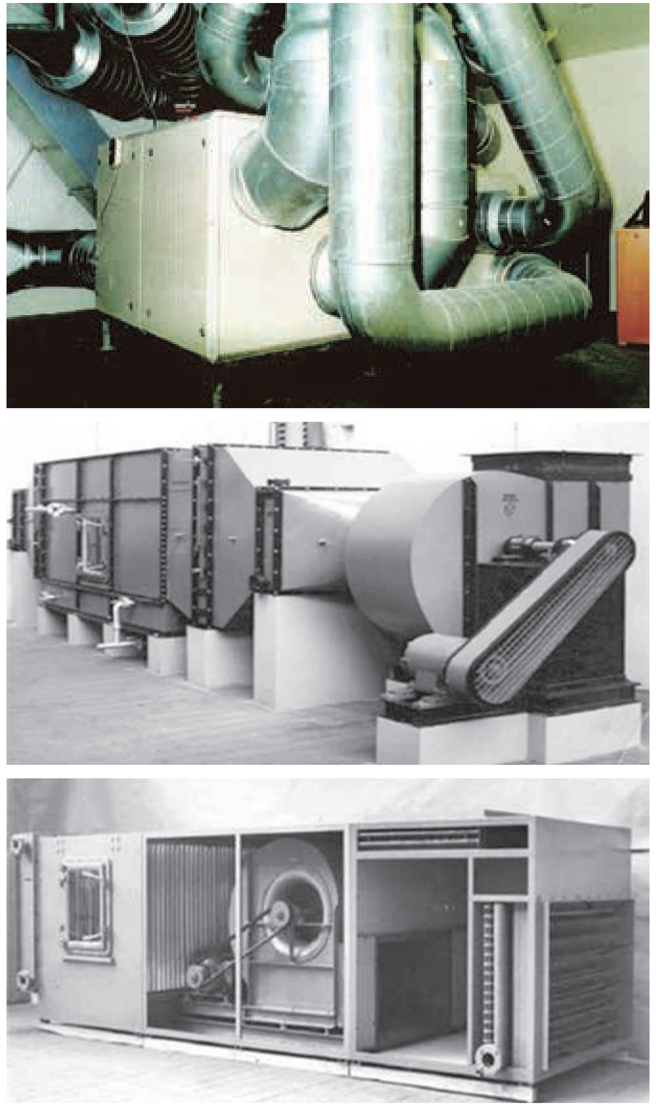

Figure 5: Impressions of past ventilation systems and AHUs

The functional design of the AHU was strongly related to the design of the building. Poorly isolated facades with a high air leakage rate and single glass windows made it necessary to circulate a high amount of air to create a comfortable, homogeneous indoor climate. In winter, AHUs recirculated the largest amount of the air – only a small part was outside air supply.

The uncontrolled infiltration through the facade into the heated building led to very low humidity indoors. Humidification of the supply air was introduced in the AHU at the beginning mostly in a way of spraying water into the ventilation system. More than thirty years later, after the oil crisis and arising out of the sick building syndrome, a decreasing number of units with recirculation is placed on the market.

To make AHUs less sensitive to lacking maintenance steam, humidifiers replaced the water sprayers. Facades became better isolated and tighter. The AHU functions turned to fully fresh air supply to people in the building. During that time, a growing energy awareness resulted in the addition of heat and moisture recovery to the AHU design. The design of ventilation systems changed in a way that supply and extract air where brought together. This facilitated the application of heat wheels and plate heat exchangers as heat recovery systems. They have become very popular and contributed towards the reduction of energy consumption and energy costs.

2. THE BASICS

THE COMPUTER ERA

The history of air handling units began back in the 1950s. Before that, ventilation components such as fans, filters and heating coils where fully integrated in the building, separated by brick walls and accessible by steel doors. Along with the boost of building sizes, mechanical ventilation became a necessity. People started to place respective ventilation components in a separate casing what gave birth to the AHU.

Figure 6: Office space in 1980

MODERN AIR HANDLING UNITS

Continuously rising requirements for modern buildings both in terms of energy efficiency and indoor air quality (IAQ), along with European Union (EU) legislation such as Ecodesign, increased the requirements for air handling units. Today, air handling units in the EU market usually consists of fans, energy recovery devices, filters, heating/ cooling elements, and a control device. Stricter energy efficiency regulations also led to higher efficiency of fans and more efficient energy recovery devices.

Figure 7:
Examples of modern air handling units

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2. THE BASICS

2.3 CLASSIFICATION

Air handling units can be classified in many ways.
The most common ones are:

By the direction of air movement:
Unidirectional or bidirectional

By their structure:
Compact or modular

By their application area:
Residential or non-residential, general or industrial ventilation

By location:
Outdoor or indoor

UNIDIRECTIONAL OR BIDIRECTIONAL

A unidirectional ventilation unit is used to move the air in one direction and usually consists of a fan, a filter, and a heating or cooling component. It is either an extract or a supply air handling unit. A bidirectional unit supplies and extracts the air inside the building.

Figure 8: Example of a bidirectional air handling unit placed in a ventilation room

COMPACT OR MODULAR

A compact air handling unit is a standardised solution, in which most ventilation components (e.g. fans, filters, energy recovery system) are installed in one casing. Thus, compact units require less installation space. Other components such as heating or cooling coils are usually installed as duct accessories.

Modular air handling units are selected for a specific project or application. They provide more flexibility in terms of structure, arrangement of components (modules), dimensions, and specialised functions (for example humidification and/or dehumidification). Each component of such a unit is fine-tuned for the ventilation system's required working point within a special AHU selection software.

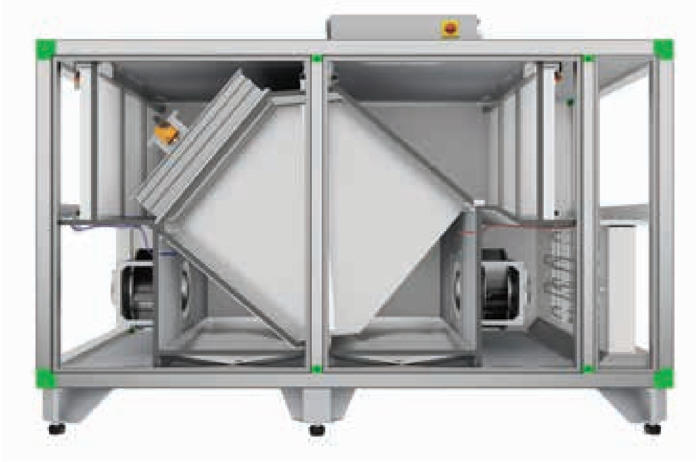


Figure 9: Examples of a compact (right) and modular (left) unit

RESIDENTIAL OR NON-RESIDENTIAL, GENERAL OR INDUSTRIAL VENTILATION

Residential units are designed for the ventilation of apartments, single or small multifamily houses. The airflow is usually limited up to 1.000 m^3/h. They tend to be less complex than non-residential units, which are designed for buildings like offices, hotels, airports or large industrial plants. Residential and non-residential air handling units have separate requirements established by EU Ecodesign regulations.

Air handling units are usually placed in auxiliary premises or outdoors (mostly on the roof). An outdoor unit should be fully watertight and the outer panel surfaces must have a corrosion-resistant coating. An indoor AHU is usually located in auxiliary premises, such as a fan room. Smaller air handling units are sometimes mounted above the ceiling.

3. APPLICATION AREAS

There are numerous applications for ventilation and air-conditioning systems. The air handling unit usually constitutes the core of each system. Some of the most important applications are summarised below.

3.1 GENERAL VENTILATION SYSTEM

The most common application where an AHU is required to provide an adequate indoor air quality is a building's general ventilation system. Office buildings, assembly halls and entertainment venues are areas where a lot of people stay. They therefore require ventilation to reduce CO_2 emitted by the people. The required airflow is usually directly linked to the number of people in the building.

3.2 DIFFERENT AREAS DEMAND DIFFERENT REQUIREMENTS

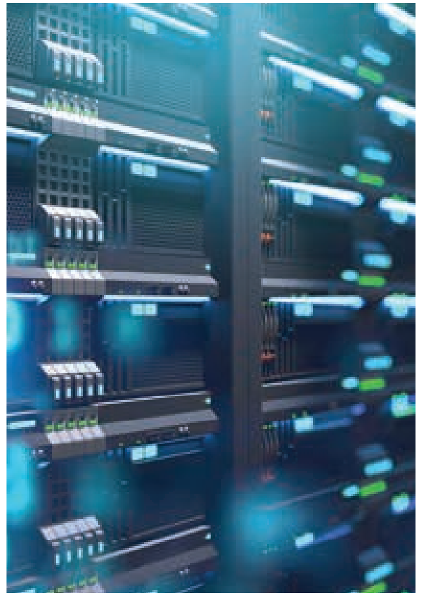
Air Handling Units are applied in different type of applications with different requirements:

Figure 10 (on pages 16, 17, 18, 19):
Various application areas of air handling units

Some applications such as airports or exhibition centres need a large air flow to reduce internal heat loads.

In museums or art galleries, AHUs are necessary to maintain a constant room climate for the exhibits. This involves a constant temperature and humidity in a certain range to protect the exhibits against premature aging.

Ventilation in a data centre is used to reduce the internal heat loads by cooling a small amount of fresh air combined with a large amount of recirculated air. In this application, the cooling function will be supported by using regenerative cooling energy (indirect adiabatic cooling) in combination with a highly efficient energy recovery system.



3. APPLICATION AREAS

Swimming pools require ventilation to reduce the air humidity in the building for comfort reason, but also to protect the building structure against humidity damages.

Marine applications such as large cruise ships must have ventilation systems to bring fresh air into the hotel rooms and entertainment areas. This has to be done not only for comfort reasons, but it is also very important to protect the indoor equipment against damages from outdoor humidity. These units have to withstand salty climate conditions.

Ventilation for medical, hospital or cleanroom environments has to keep the environment under a low particle concentration atmosphere as well as a constant temperature and humidity level. The required AHUs need to feature the high hygienic requirements design.

Pharmaceutical or chemical manufacturing plants often conduct their productions under defined cleanroom requirements.

Ventilation in all kinds of industry processes is necessary to keep all production facilities under a specified climate condition to provide a consistent product quality and a continuous production process without interceptions.

Sometimes AHUs need to manage potentially explosive atmospheres and thus require an ATEX certification.

4. FUNCTIONS AND COMPONENTS

4.1 GENERAL FUNCTIONS

The AHU's purpose is to achieve a better indoor air quality for people and/or processes. The first step is always to transfer outdoor air into the AHU. This can happen directly in case of outdoor placement or with a duct system.

Inside the AHU, the air treatment takes place. This means that particles are eliminated, and the air thermally treated for the specific application. The air is then transferred into a duct system, which distributes the air to different parts of a building.

Today, in most applications, the AHU simultaneously gathers the extract air from the building through a duct system and transports it out of the building. To save energy, high efficient energy recovery systems are being applied.

In the following, typical components of an air handling unit are introduced.

4.2 AIR FILTERS

In most parts of the world, outdoor air is always contaminated. Air filters ensure a healthy indoor air by removing harmful fine dust including pollen, bacteria, yeast and mould, along with other organic and inorganic materials. Air filters also serve to keep the air handling equipment clean. By doing so, they ensure its hygienic and efficient operation. For some applications, additional filters can be useful. This includes, for instance, filters to remove odours, grease or corrosion molecules.

Figure 11: Example of an air filter applied in AHUs

When filters are placed in AHUs, the filter bypass leakage should be as small as possible. This bypass leakage involves of two things. First, the air that passes the filter frame without streaming through the media. Second, a casing leakage downstream the filter in case of negative pressure compared to the atmosphere. Both lead to an amount of unfiltered air.

Concerning the energy efficiency of filters, two effects must be considered: The clean/initial pressure drop, and the pressure increase due to dust load in the filter. Both have a significant influence on the efficiency.
An indicator for the energy efficiency of a filter is the Energy Efficiency Class of the Eurovent Certified Performance programme for air filters.

The selection of filters depends on the outdoor air and the required indoor air quality. The most important standards are ISO 16890 (ePM1/ePM2,5/ePM10/coarse) and EN 1822 (EPA/HEPA/ULPA). Further essential information on air filters can also be found in the Eurovent Guidebook "Air filters for general ventilation" and the Eurovent 4/23 Recommendation on how to select ISO16890 rated air filters for general ventilation purposes.

Scan the QR code to download Eurovent publications for air filters while learning more about the 'Eurovent Certified Performance' programme.

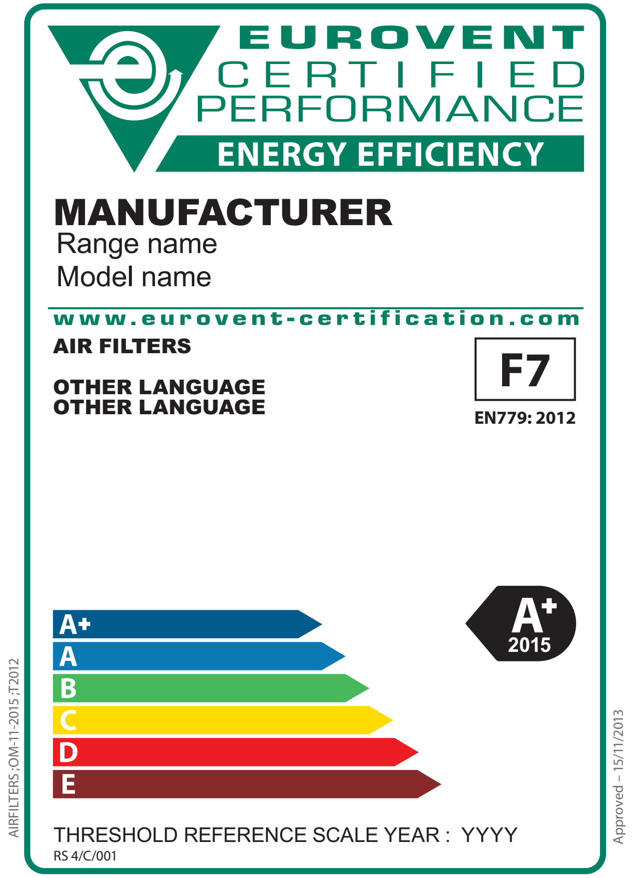


Figure 12: 'Eurovent Certified Performance' energy label for air filters

4. FUNCTIONS AND COMPONENTS

4.3
ENERGY RECOVERY COMPONENTS

During most of the year, the outdoor air temperature deviates from the necessary supply air conditions so that thermal treatment is necessary. To minimise the energy consumption of thermal air treatment, an Energy Recovery System (ERS, also commonly known as Heat Recovery System or HRS) should be applied. In fact, the installation of an ERS has been mandatory in the European Union since the Ecodesign Regulation (EU) No 1253/2014 has been in force.

An ERS transfers thermal energy from the extract air to the outdoor air. In a typical European winter, this could mean for example that the outdoor air is warmed up from -5°C to 15°C only by using the heat of the extract air which is cooled down from 22°C to 2°C. As a result, the heating demand for the heater downstream in the supply air is much lower. In summer times, the described functions work the other way around, and the ERS lowers the cooling demand.

DIFFERENT TYPES OF ENERGY RECOVERY SYSTEMS

Commonly, three different types of heat recovery systems are being applied in AHUs.

Regenerative

Figure 13: Examples of a rotary heat exchanger (left), and a matrix type regenerative heat exchanger

First, there are regenerative systems. Most of regenerators are rotary heat exchangers. A wheel rotates through both air streams and hereby transports the capacity. With rotary heat exchangers, there is always an air exchange between the outdoor and extract air. This should be considered in case of very high hygienic requirements.

Rotary heat exchangers can transport moisture so that the humidity can be recovered as well. Yet, they can also dehumidify, which has a positive impact on the cooling capacity in the summer.

Recuperative

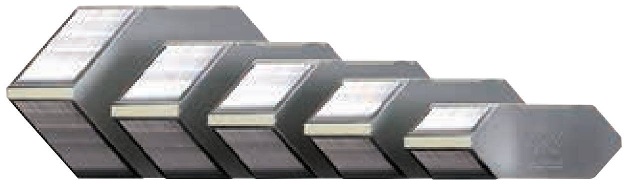


Figure 14: Example of a recuperative ERS

The second system is a recuperative system. These systems guide the outdoor and extract air to very small ducts and let both airstreams exchange the capacity with the help of the surfaces that the airstreams are passing. Normally, plate heat exchangers are used. In case of metallic or plastic heat exchangers, no moisture is transferred and in winter there can be condensate and even frost when low temperatures occur.

Some plate heat exchangers are made of permeable membranes so that moisture is transferred too. Recuperative systems have a lower cross contamination of the air streams compared to rotary heat exchangers. The humidity transfer reduces the risk of freezing and lowers the energy consumption for humidification in Winter and dehumidification in Summer.

Run-around coils

The third system keeps both air streams completely separated from each other so that cross contamination is impossible. They are called run-around coil systems. Here, the thermal capacity is transferred with a coil in the outdoor air to a water system and then brought to a coil in the extract air. A pump is necessary for circulation of the water. With run-around coil systems heat recovery can take place even if the supply and the extract air exchangers are installed in remote locations.

For all energy recovery systems, a thermal bypass facility is needed for periods in the year in which the energy recovery system is not necessary. The most important standard for the performance of heat recovery systems is EN 308.

For energy efficiency, the pressure drop of an energy recovery system shall be as low as possible to reduce energy consumption. In addition, components such as motors for rotors or pumps for run-around coils should be as efficient as possible.

In specific cases, a run around coil system can also provide higher flexibility in form of installation and save space for technical rooms in buildings.

4.4 HEATING AND COOLING COMPONENTS

Since heat recovery systems do not cover the complete cooling and heating demanded, additional components for thermal treatment are necessary. Finned water to air compact heat exchangers are commonly used.
These are connected to the central heating and cooling system of the building. Glycol can be added to avoid freezing.

It is also possible to incorporate a coil in an AHU that could be part of a refrigerant circuit. Like this, the coil will act as the evaporator or condenser, and will cool or heat the processed air. For heating, an electrical heater can be used. If a cooling coil is dehumidifying, it is recommended to use an eliminator integrated in the draining section downstream the coil.

The cooling coil can be used in two different ways.
First it can be used in a dry manner. The water content in the supply air and outdoor air is similar, no condensation takes place. Apart from the dry operation it can be used for dehumidification. Then water condensates and must be drained from the AHU with a drip tray and piping.

To increase energy efficiency, the air and water-side pressure drops of heating and cooling coils shall be as low as possible.

4.5 FANS

The components in the AHU and the duct system have a flow resistance. Therefore, a pressure drop occurs in case of air streaming through them. For air movement, a fan must increase the pressure to overcome all pressure drops.

Nowadays, direct driven, free running backward-curved fans are applied in most AHUs. Belt driven fans are barely applied due to their limited energy efficiency. Motors for fans should always be speed-controlled to ensure that only the demanded airflow is generated. This speed control can be realised with frequency converters in case of AC motors, or with a direct included control electronic in case of PM/EC-fans.

The measure of the effectiveness of a fan is the fan efficiency. Here, it is important to consider the total static efficiency of the complete system (wire-to-air approach), which combines aerodynamic and electronic effects.

In Europe, fan efficiency is regulated by the European Commission Regulation (EU) No 327/2011. The Regulation is already considering the wire-to-air approach and prevents the use of inefficient fan/motor combinations in Europe.

Figure 15: Example of an EC fan pack applied in AHUs

4. FUNCTIONS AND COMPONENTS

4.6 SILENCERS

Depending on the application area, there can be high requirements regarding the noise level. In an air handling system, noise is generated by components in the duct or the unit. The main noise emitter is the fan. It is technically advantageous to install sound reducing components close to the source.

Since the fan is a main source of noise in the AHU, silencers are often placed directly up or downstream the fan. Yet, if it occurs that noise transfers from supply to extract air or the other way around (e.g. through a heat recovery system), another position can be useful. Silencers normally consist of splitters which include an absorbing material. The sound of the impeller is reduced by the insertion loss of the specific silencer. Considering energy aspects, the pressure drop of silencers should be as low as possible.

4.7 (DE)HUMIDIFIER

In some applications, the relative air humidity is an important parameter. It needs to be controlled and maintained in defined interval values.

There are two main ways to humidify the air: With steam, or liquid water. The humidification with liquid water is an adiabatic evaporation process that collaterally cools the air. A heater is required upstream the adiabatic humidifier to secure the supply air temperature. Sometimes, the adiabatic evaporator is used as a cooler component. Steam humidifiers are more accurate and usually used more often than adiabatic evaporators.

Usually, applications requiring humidification also require dehumidification. The way to decrease the water content in the air is by using the cooling coil to cool the air in order to reach the saturated temperature. In those conditions, the air water content will condensate. Downstream the heating coil will heat up the air to the necessary supply air conditions.

4.8 MIXING SECTION

When the unit contains recirculated air, it will be the mixing chamber in which air changes from the extract unit to the supply unit side. The goal of mixing is to reach a balance between air streams that adhere to the outdoor air demand while minimising thermal treatment requirements by closely reaching the requested supply air conditions.

4.9 OTHER COMPONENTS

Indirect adiabatic cooling can be placed upstream the energy recovery system, in the extract air side. This component is only used under summer conditions. In case of humidifying the extract air, the water evaporates and therefore the extract air is cooled down. This means that it streams with a reduced temperature into the energy recovery system. As a result, the outdoor air will be cooled down to a much lower temperature after the heat recovery system than without an indirect adiabatic humidifier.

Another relevant additional component can be the use of bypass systems to reduce the air resistance through other components of a unit when not in use, as the example of Energy Recovery Systems showed.

Figure 16: Look inside an Air Handling Unit

5. ENERGY EFFICIENCY AND LIFE CYCLE COSTS

All the previously described functions and processes associated with ventilation are of high relevance for energy consumption.

As described, air treatment processes can include fans, heating, cooling, humidification, dehumidification and filtration – all of which consume energy. The annual consumption of energy to heat and cool the air is usually very large. It depends on several factors such as indoor climate requirements, ambient climate, design of the system, and the way it is operated.

The amount of power used to treat the ventilation air increases the enthalpy change (exclusive the effect of the ERS) and the air flow rate. The energy used by the fans to distribute the air increases with the airflow, pressure and efficiency of the fan and its drive system.
The total annual energy consumption is given by the sum of them.

Figure 17: Various modules of an AHU

5.1 METHODOLOGY

Since building energy is accountable for 40% of Europe's energy usage and HVAC plant energy is the largest part of that, there is plenty of reason to properly investigate how to efficiently operate a ventilation system. A methodology must be found that makes it possible to understand how energy use depends on the system design and operational strategies. The overall purpose is to find the most economical system without affecting the health of those staying in a building, or the safety and proper functioning of processes.

The main parameter in ventilation is air flow. It also has the greatest influence on the energy costs of a system. It is therefore very important to deliver the correct air flow at each moment in time, which is a task for the control system. Another consideration is space for air handling units and ducts while finding a balance between pressure drops (size-dependent) and investment costs.

Within the European Union, air handling units must fulfil the requirements of Ecodesign Regulations, which stipulate that energy recovery must be included in case of a bidirectional unit. It also defines minimum requirements for temperature efficiency.

The main energy recovery characteristic for comparison and evaluation is the dry air temperature efficiency. The usage of energy is also dependent on the climate, system design, operation, and on the heat load in the building characterised by the supply and extract air temperature. The higher the supply air temperature and the lower the extract air temperature, the greater the need of high temperature efficiency. Yet, a too high efficiency can be counterproductive due to higher pressure drops.

5.2
LIFE-CYCLE COSTS (LCC)

For most companies, the financial aspect is usually the overriding factor in steering choices and decisions. In terms of energy-saving measures, these will probably never be carried out unless they can be financially motivated. Being able to see the whole picture, instead of focusing on details and parts, should be the main denominator. This requires economic analysis in system, technology and equipment selection.

It is recommended to establish a holistic analysis, which evaluates all costs during the lifetime of the ventilation system through a Life Cycle Cost (LLC) analysis. An LCC assessment is a prediction that allows different solutions to be compared. It is based on certain assumptions and historical climate data. While it offers no guarantee of operating cost, it is a very good decision-making tool.

An LCC assessment commonly comprises the cost of acquisition (investment, installation and commissioning), energy costs for running the air handling unit and all integral auxiliary equipment, maintenance and disposal costs.

The lifetime of an air handling unit commonly lies in the range of 15-20 years. Some cost elements will occur at the outset (e.g. commissioning) and others (e.g. replacement of worn parts) may occur at various later stages of a system lifespan. It is therefore practicable, and possibly essential, to calculate a present or discounted value of the costs in order to make accurate assessments of the different solutions.

The energy cost is predominant as it can account for up to 80% of the total costs. Hence, this analysis can essentially affect a building's environmental footprint and profitability. Yet, the investment cost of an AHU with an optimised energy recovery system is likely to be higher. This highlights the conflict between building at the lowest price and reaching the lowest life cycle cost of a building.

Another important issue to be considered is the possible impact of each air handling unit on other investment elements. Many functions in the unit are related to other HVAC components (e.g. energy recovery is related to boiler capacity and water chiller performance and the associated distribution systems). Consequently, a more expensive unit with a better energy recovery performance will reduce the investment for thermal energy supply. In the same breath, a more costly, larger unit with highly efficient fans might decrease the investment for electric power supply. All these investment interactions shall be considered in the LCC calculation.

Figure 18: Installation of an AHU on a roof

6. CONTROL SYSTEM

A factory fitted intelligent control system will enable the AHU to fulfil the mentioned requirements. Experience gained on fundamental characteristics about the AHU are transferred into intelligent integrated control functions by the manufacturer. On top of that, pre-configured controls that take into account the exact specifications of the air handling unit enable a quick and reliable commissioning.

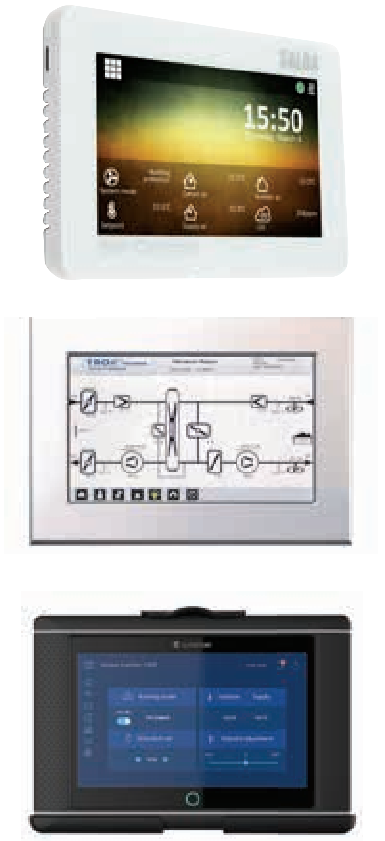


Figure 19: Examples of a digital AHU control interfaces

6.1 INFLUENCE OF AN AIR HANDLING UNIT CONTROLLER ON THE OVERALL EFFICIENCY

The factory fitted intelligent control system commonly includes many functions to optimise the overall energy performance, as well as functions to monitor and control efficiency-critical parts of the ventilation system. Without such an intelligent control system, it would be practically impossible to prove that energy efficient components such as heat exchangers and fans are also working in an efficient manner.

6.2 COMPONENTS IN AN AIR HANDLING SYSTEM THAT CAN BE COMBINED USING A CONTROLLER

It generally possible and useful to combine the controller of an AHU with other local controllers in rooms or zones of a building. Such a system controller ensures that the components and air handling units are working together in the most efficient way.

Demand controlled ventilation adjusts the level of air to the room's actual needs. This means that a high indoor air quality can be achieved while, at the same time, the energy consumption kept at a minimum. The system controller will ensure that the fans inside the AHU are running at the lowest possible speed, ensuring the smallest possible energy consumption.

A zone unit with its controller will use the primary air from the air handling unit to heat or cool it to the required temperature level of the connected room or rooms. The communication between the zone controller and the AHU's controller is crucial to adapt the primary air to the demands on the different zones. This ensures an energy optimised operation of the complete air handling system.

6.3 THE IMPORTANCE OF BUILDING MANAGEMENT INTERFACES

Figure 20: Example of a Building Management Interface

When a building management system (BMS) is implemented, it is crucial that this system can communicate with the factory mounted control system of the air handling unit. To make this possible, the air handling unit controller is typically equipped with a building management interface. The most important protocols used today for this purpose are BACnet or Modbus, which both can be offered for serial communication with a RS485 interface or by using TCP/IP communication.

With this interface, the BMS is able to receive all the important actual values and statuses like alarms and operation messages. Yet, it can also change set point and unit modes to influence the behaviour of the AHU to its demands.

By using a factory fitted intelligent control system for the air handling unit, a reliable and energy efficient operation of the air handling unit is guaranteed. The interface gives the BMS the required functionality to support the user, without influencing the reliability and energy efficiency of the air handling system.

7. DESIGN AND SELECTION

When designing and selecting air handling units, several aspects have to be considered.

7.1 AIR FLOWS

The desired air flow to be handled by the unit into and out of the building gives an idea of the size and capacity of the unit. To minimise air flow resistance, a larger cross-section area is preferred as it reduces the air velocity through the unit.

7.2 DIMENSIONS AND MODULARISATION

The length of the AHU should accommodate enough room for filters, heat exchangers, access sections for maintenance and fans. It is also critical to avoid condensation in filters and on other surfaces. At the same time, the building may set limits to the unit size. Depending on available space in the plantroom, several AHU sizes and cross sections are necessary to be able to select a suitable AHU that fits both physically and delivers the right performance.

Detailed 3D or BIM representations of the unit design can be used in the planning and designing of buildings and ventilation systems. An important aspect of an AHU is the possibility to have it delivered in modules to enable transport into the building through narrow doors and elevators. The size of the AHU in terms of external dimensions enabling transport with standard trucks without having the need of expensive special transports.

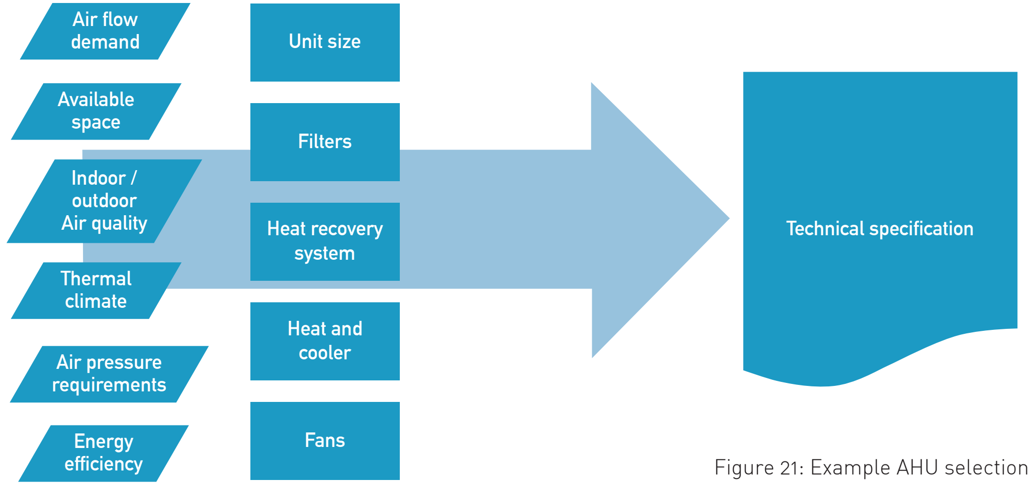


Figure 21: Example AHU selection scheme

7.3 FANS AND ENERGY RECOVERY

Design features like proximity of the fan impeller to the surrounding interior surfaces of the air handling unit for example may influence the fan efficiency.

To be able to select a fan with an optimal duty point, different fan impeller sizes are needed for each AHU size to optimise the unit. Belt driven fans most often require more maintenance than direct driven fans due to the belt drive and the wearing of it. The calculated value of the internal specific fan power (SFPint) is the ratio between the pressure drop over internal ventilation components and the efficiency of the fan and should be kept low for energy efficiency.

The total energy efficiency of the building is on the other hand strongly dependent on the efficiency of the heat recovery from the exhaust air stream to the supply air stream - especially in a colder climate. For that reason, the type, choice and design of heat exchangers involve a trade-off between pressure drop and thermal efficiency. This is included in the "Eurovent Certified Performance" Energy Efficiency Class.

In a warmer climate, the use of cooling recovery reduces the amount of cooling power required when ventilating with 100% outside air, especially when using enthalpy recovery for latent cooling power. In this case, it is required to have a thermal by-pass to use free-cooling when the conditions are favourable.

7.4 FILTERS

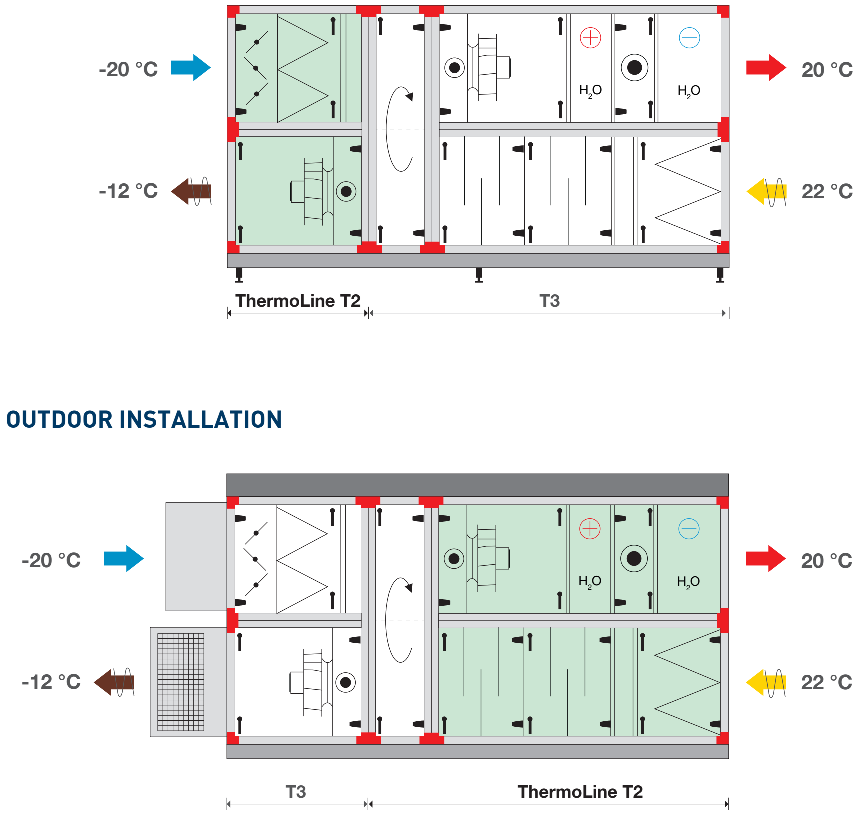
With the ISO 16890 filter standard, the focus can be put on smaller particles proven dangerous to human health. Maintenance intervals depend on the dust holding capacity of the filters and are adjusted by monitoring the pressure drop.

The use of the AHU cross section area to fit as much filter area as possible enables a high dust holding capacity and thus longer filter change intervals. Floor panels in filter sections used in corrosive climates should be designed with appropriate material (e.g. stainless steel or suitable coating) as corrosive condensate could build up in the filters and come in contact with the floor panels.[1]

1 Not only in corrosive atmospheres, should the floor panels be made of stainless steel. When using bag filters the movement on the bags, over a long-term period, will remove the protection of the floor panels internal metal sheet.

7.5 CASING

INDOOR INSTALLATION



OUTDOOR INSTALLATION

Figure 22: Different casing on different units

The mechanical strength of the casing is critical for the reliability of the air handling unit. Panels and frames are designed to withstand maximum fan pressure without exceeding deflection limits. Air tightness of the casing is critical for the efficiency of the ventilation system. Depending on the design, the casing leakage rate is limited, both for positive and negative pressure.

The AHU's casing is thermally insulated to reduce the thermal transmittance to within limits according to the desired class. To further reduce the heat loss and to prevent local condensation on casing surfaces, thermal bridging in the casing is also limited.

When the AHU is installed, having a small temperature difference between ambient air and the airflow temperature, the need for casing with low thermal transmittance is not as high as when installed with a large temperature difference. The casing of the AHU will reduce the radiated noise of the fan inside the AHU.

One other aspect of casing design is corrosion resistance. The installation in different environments including, for instance, close to the sea, process industry and pool applications requires a high grade of corrosion classes.

7.6 INSTALLATION

Figure 23: Example of an outdoor installation

When installed outdoors, aspects such as UV resistance, corrosion resistance (especially in coastal areas) are of high importance. Weather louvres and exhaust hoods should be designed and arranged to avoid short-circuiting between the outdoor- and exhaust air streams.

Noise emerging from a ventilation unit should not reach disturbing levels. Both the sound insulation of the casing as well as the in-duct sound power are specified for air handling units.

Mechanical safety and fire protection requirements, including material properties according to standards, are to be met by the design. Depending on the environment for where the unit is designed to work, materials with suitable corrosion resistance should be used. Harmful substances should be avoided.

7.7 HYGIENE

Hygienic air handling units put special requirements on planning, manufacture and shipment as well as on the design of the unit. Care is to be taken concerning the choice of inner surface materials and the arrangement of fans, filters and cooling coils with sloping drip trays to ensure proper condensate water drainage, to avoid condensation and biological contamination. Sealing of pockets and gaps to avoid dirt accumulation. There are general requirements for inspection, maintenance and cleaning and especially regarding filter maintenance.

8. CERTIFICATION

Due to ever-increasing environmental challenges, most of the global community is focused on improving energy efficiency, and thus to reducing the carbon footprint and air pollution.

Depending on how complex a system is, the running costs associated with ventilation and cooling can amount up to 30% of total expenses incurred by the building users. Efficiency of air handling and air transport processes is the key parameter regarding the energy consumption attributable to ventilation and air conditioning. These tasks are performed by air handling units.

8.1 THE IMPORTANCE OF ACCURATE DATA

Air handling units are usually very complex devices comprising numerous essential components. Moreover, they are often tailor-made and not mass produced.

Designers of HVAC systems must meet tight energy performance requirements implemented in building codes. Their energy calculations are based on data provided by AHU manufacturers. Even slight variances between actual and declared energy performance can result in essential differences of real energy consumption, and consequently in the energy performance of a building and its running cost.

This is why the reliability of declared performance data is crucial for business and product investment decisions.

8.2 EUROVENT CERTIFIED PERFORMANCE

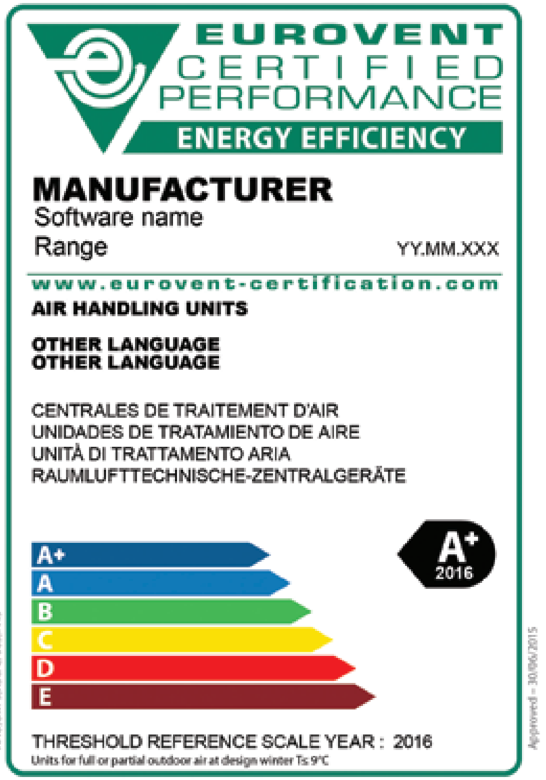


Figure 24: The "Eurovent Certified Performance" Energy Label for AHUs

Participation in the certification programmes provided by Eurovent Certita Certification offers a solution for fair competition and reliable data. Eurovent Certita Certification is a major accredited third-party certification body for HVACR products. Among its 40+ programmes, it operates globally renowned and applied "Eurovent Certified Performance" programme dedicated to air handling units.

This programme does not come down to a simple performance test. Quite the contrary, it comprises much more:

- Evaluation of selection software consistency and accuracy,
- Periodic factory audits verifying whether products are manufactured in line with declared technology,
- Periodic real unit and model box performance tests.

This comprehensive procedure guarantees customers that products perform as declared. Furthermore, the certification assessment includes the energy efficiency label, helping planners, installers and end-users to select the most suitable product for their application. In addition, it can be extended with the evaluation of hygienic properties classification as an option.

Besides obvious benefits for the end-users, the certification provides numerous advantages to the manufacturers and contributes to a level-playing field. The major benefits can be summarised as follows:

- Increasing consumer confidence,
- Fair market comparison through easy access to performance data of all certified products,
- Reducing need for customer witness test,
- Enhancing the product brand.

Figure 25: AHU inside a ventilation room

Scan the QR code to learn more about "Eurovent Certified Performance"

9. STANDARDS

9.1 CEN COMMITTEES

In Europe, the standardisation committee CEN is responsible for standards. The most important technical committees for AHUs within CEN are

- CEN/TC 156: Ventilation for buildings, and
- CEN/TC 110: Heat exchangers.

Standards remain voluntary and there is no legal obligation to apply them.

Figure 26: Logo of the European Committee for Standardization (CEN)

Figure 27: Simple animation of a ventilation system within an office building

9.2 HARMONISED STANDARDS

Different to the past, one of the main objective of standards today is to provide the industry with the right tools in order to ensure compliance with legislation (e.g. European Union Ecodesign). The European Commission, for instance, mandates CEN to prepare technical standards facilitating compliance with essential requirements.

That said, several HVAC standards are to be harmonised for compliance with Ecodesign legislation. Examples of standards that were in the process of being revised while drafting this Guidebook are:

- CEN/TC156 (Ventilation for buildings)/WG5: EN13053 – Rating and performance for units, components and sections
- CEN/TC110 (Heat exchangers)/WG6: EN308 – Test procedures for establishing performance of air to air and flue gases heat recovery devices

9.3 EN 13053 AND EN 16798

Purchaser of air handling units, especially planners and executing companies have to apply international valid standards such as EN 13053 and EN 16798.

The EN 13053 "Ventilation for buildings - Air handling units - Rating and performance for units, components and sections" is one of the most important standards with regard to ventilation systems. This standard determines requirements for central air conditioning devices in non-residential buildings (air volume larger than 250 m^3/h) as for example energy recovery, air speed and power consumption.

EN 16798 "Energy performance of buildings - ventilation for buildings" constitutes a rather new series of standards (issued in November 2017). It is split into 18 parts and includes, next to specifications concerning the energy performance of buildings, detailed specifications for the ventilation of buildings.

Within EN 16798, the important AHU standards as EN 15251 and EN 13779 were redesigned, harmonized and merged. As the standard contains, for instance, guidelines for aspects of designing an AHU, filter requirements, and energy recovery specification, it is of high important for planners, installers, operators and manufacturer alike.

9. STANDARDS

9.4
EN 1886, EN 308, ISO 16890

Manufacturers advise their customers and have to apply internationally recognised standards. Some of the most important, besides the already mentioned, are EN 1886, EN 308 and ISO 16890.

EN 1886 covers the "Mechanical performance". This guideline was developed for the clear purpose of defining the mechanical properties of a central air conditioning device. Some specifications impact casing air leakage (L1, L2, L3) or the thermal insulation (T1, T2, T3, T4, T5).

EN 308 describes "Test procedures for establishing performance of air to air and flue gases heat recovery devices". It defines the laboratory audit process to determine the rating of air-to-air energy recovery devices or of devices which recover the warmth out of flue gases of heating systems in buildings.

The global ISO 16890 standard "Air filters for general ventilation" includes the testing and classification of HVAC air filters. In Europe, it replaced the formerly applied EN 779 "Classification of particular air filters". The main difference to EN 779 is that the new norm focuses on the possibility of a filter to catch different particle sizes in a dangerous area. Therefore, the new norm includes, based on tests of the effectiveness of filters, 49 new filter categories instead of 9 in EN 779. In July 2018, the ISO 16890 will replace the EN 779.

Figure 28: Example of an AHU with integrated heat pump section and refrigeration circuit controls

Scan the QR code to download the latest version of Eurovent Recommendation 4/23 on how to select EN ISO 16890 rated air filter classes for general ventilation applications

9.5
EUROPEAN UNION ECODESIGN

The European Union Directive 2009/125/EG (Energy-related Products Directive), also commonly known at Ecodesign Directive, defines minimal requirements for energy-related products. The Ecodesign Directive's objective is the reduction of energy consumption and the CO_2-emission rates as well as an increase of the overall share of renewable energies. This Directive applies for all products placed on the market within the European Economic Area (EEA). Exports from the European Union are not affected by this Directive.

The Ecodesign Directive is implemented through product-specific Regulations, which are directly applicable in all EU countries. Of relevance for AHUs is the EU Regulation No 1253/2014 'Ventilation Units', which sets requirements concerning the energy efficiency of AHUs.

It should also be noted that components within a product can also be subject to a Regulation. That said, all fans applied in AHUs must comply with EU Regulation No 327/2011.

9.6
NATIONAL LEGISLATION AND GUIDELINES

All the described standards and the Ecodesign Regulation 1253/2014 form the normative basis for planning, construction and conception of air handling units in non-residential buildings.

Additionally, each market participant has to consider national standards. Examples include DIN 1946-4 in Germany, or the quite similar Austrian version ÖNORM H 6020 – to name just a few. They regulate the minimum requirement of AHUs to reduce the microbial contamination in hospitals or surgeries.

10. THE EUROPEAN AHU INDUSTRY

10.1 MANUFACTURERS

Europe is home to more than 100 manufacturers of air handling units, ranging from small family-owned companies that tend to focus on a particular country or region within a country, to large multinationals active across the globe. The majority of manufacturers can be found in Northern and Central Europe. The large number of manufacturers reflects the traditionally strong ventilation focus across Europe.

10.2 CONSTANT THRIVE FOR INNOVATION

Over the past years and decades, legislative measures such as the European Union's Energy Performance of Buildings Directive (EPBD) and Ecodesign Regulations have set ever-stricter requirements on the building as a whole as well as on individual products incorporated in a building system such as air handling units.

The need to increase energy recovery and to decrease operating cost of air handling units, for instance, has played a significant role in propelling the European air handling units market. It has also led to new heights in product innovation and quality, which made air handling technology from Europe globally known and respected. All of this goes hand in hand with an increasing awareness on indoor air quality and life cycle cost aspects, which further drives the market and its players.

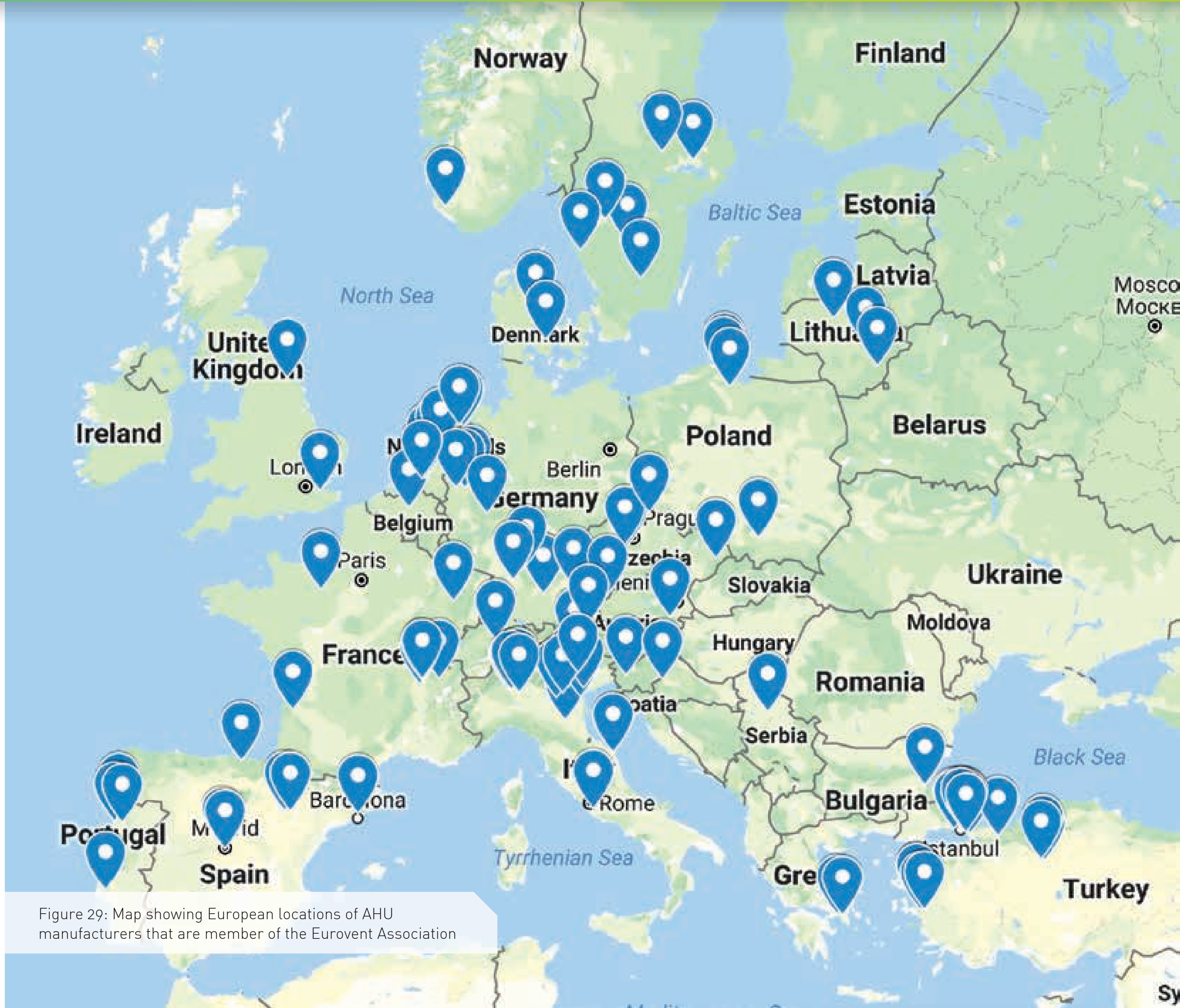


Figure 29: Map showing European locations of AHU manufacturers that are member of the Eurovent Association

10. THE EUROPEAN AHU INDUSTRY

10.3 MARKET SIZE

The European Union (EU) is one of the largest markets for air handling units worldwide. According to Eurovent Market Intelligence, the AHU market in EU in 2017 saw 180.000 sold units and a total market value of 1.56bn EUR with. This constitutes a growth of 10% in market value compared to the previous year. The three largest AHU markets in the EU were Germany (400m EUR), Northern Europe (320m EUR), and the United Kingdom (240m EUR).

Scan the QR code to learn more about Eurovent Market Intelligence.

10.4 EUROVENT AND AHUs

Since its foundation in 1958, the Eurovent Association has been closely linked with air handling units. Eurovent and its members are playing a major role in jointly developing forward-thinking, European-wide standards and industry recommendations. They are actively accompanying and shaping legislative developments such as Ecodesign.

In the early 1990s, Eurovent members have also set up the "Eurovent Certified Performance" programme for air handling units with the goal to ensure a level-playing field by allowing customers to compare performance values verified by a third party. Today, this programme is well known and applied across the globe.
Close to 150 manufacturers are certifying their air handling units with Eurovent. All certification programmes are managed by Eurovent Certita Certification in Paris, which is an independent subunit of the Eurovent Association.

Figure 30: Members of the Product Group "Air Handling Units" (PG-AHU, in the past known as: PG6C) during the 2016 Eurovent Summit in Krakow, Poland, and in 1983 in Knokke-Heist, Belgium

Within the Eurovent Association, the Product Group "Air Handling Units" (PG-AHU) represents all air handling unit manufacturers that are member of the association.
This also includes non-certified manufacturers, as the certification programmes are organised independently from association activities. PG-AHU is the largest grouping of its kind worldwide. Within the Product Group, manufacturers are, for instance, developing industry standards, define legislative positions, monitor the market, and discuss recent development of general relevance.
It members meet at least twice a year in changing locations throughout Europe.

Scan the QR code to learn more about Eurovent's Product Groups

10.5
SELECTED EUROVENT PUBLICATIONS

In the following, a selection of important Eurovent publications of relevance for air handling units is being provided.

Air Handling Units

- Eurovent 6/2 - 2015: Recommended code of good practice for the interpretation of Directive 2006/42/EC on machinery concerning air handling units
- Eurovent 6/12 - 2013: Eurovent air handling units energy efficiency class
- Eurovent 6/8 - 2005: Recommendations for calculations of energy consumption of air handling units
- Eurovent 6/14 - 2000: Hygienic aspects in air handling units
- Eurovent 6/4 - 1996: Thermal test method for induction units
- Eurovent 6/7 - 1986: Guide for maintenance of air handling plant
- Eurovent 6/5 - 1985: Safety regulations for electricity
- Eurovent 0/1 - 1980: Symbols and units of physical quantities in the field of air handling and heating techniques

Air Filters

- Eurovent 4/23 - 2018: Selection of EN ISO 16890 rated air filter classes
- Eurovent 4/21 - 2016: Energy Efficiency Evaluation of Air Filters for General Ventilation Purposes
- Eurovent 4/10 - 2005: Method of testing air filters used in general ventilation and recommended classification
- Eurovent 4/19 - 2015: Updated Industry Recommendation concerning Public Enquiries for Air Filters

Energy Recovery Components

- Eurovent 17/11 - 2015: Guidelines for Heat Recovery

Certification

For the most recent 'Eurovent Certified Performance' reference documents (e.g. rating standards, operational manuals), please visit www.eurovent-certification.com

Scan the QR code to access the Eurovent publication database

Figure 31: The Eurovent Association head office in Brussels, Belgium

11. ABOUT THIS GUIDEBOOK

This guidebook is the result of a project of the Eurovent Product Group 'Air Handling Units'. It is aimed to provide everyone dealing with air handling units (in whichever form) with an unbiased, hands-on, and thought-through compendium on this very important piece of technology.

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Figure 32: Installation of an AHU on an industrial facility

11. ABOUT THIS GUIDEBOOK

11.2 THE EUROVENT ASSOCIATION

Eurovent is Europe's Industry Association for Indoor Climate (HVAC), Process Cooling, and Food Cold Chain Technologies. Its members from throughout Europe, the Middle East and Africa represent more than 1.000 companies, the majority small and medium-sized manufacturers. These account for a combined annual turnover of more than 30bn EUR, employing around 150.000 people within the association's geographic area. This makes Eurovent one of the largest cross-regional industry committees of its kind. The organisation's activities are based on highly valued democratic decision-making principles, ensuring a level-playing field for the entire industry independent from organisation sizes or membership fees.

Eurovent's roots date back to 1958. Over the years, the Brussels-based organisation has become a well-respected and known stakeholder that builds bridges between manufacturers it represents, associations, legislators and standardisation bodies on a national, regional and international level. While Eurovent strongly supports energy-efficient and sustainable technologies, it advocates a holistic approach that also integrates health, life and work quality as well as safety aspects. Eurovent holds in-depth relations with partner associations around the globe. It is a founding member of the ICARHMA network, supporter of REHVA, and contributor to various EU and UN initiatives.

Eurovent possesses two subunits. With Eurovent Certita Certification (ECC), it majority owns an independent product performance certification company based in Paris, which holds the EN ISO/IEC 17065:2012 accreditation certificate – fulfilling highest independency, reliability and integrity standards. Open to any manufacturer, it is known for its globally-recognised 'Eurovent Certified Performance' mark. Activities are complemented by Eurovent Market Intelligence (EMI), the association's second independent unit. Its EMEA-wide data sets are frequently being used to support the development of legislation in the EU and beyond.

EUROVENT
EUROPEAN INDUSTRY ASSOCIATION

Scan the QR code to learn more about the Eurovent Association.

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Figure 33: Example of a modular AHU

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