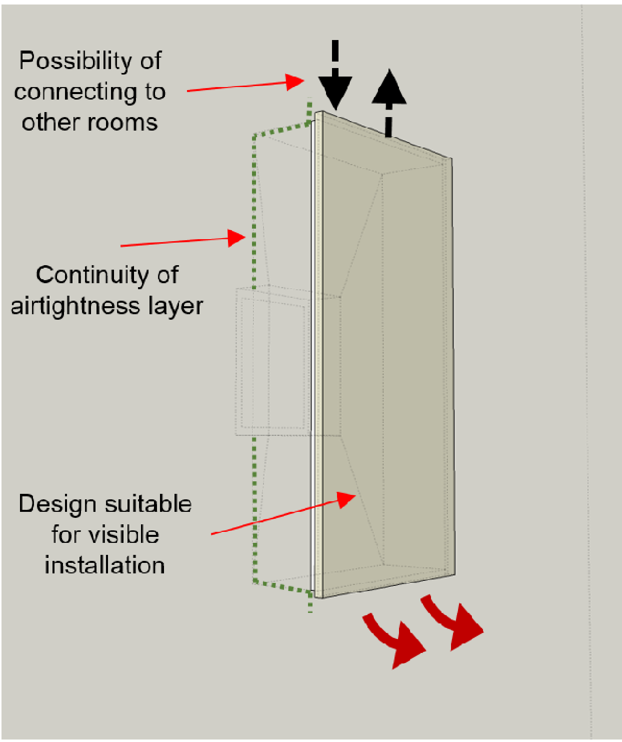
EuroPHit

D5.1.7_Wall_integrated_ventilation



INTELLIGENT ENERGY – EUROPE II

Energy efficiency and renewable energy in buildings

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EuroPHit

[Improving the energy performance of step-by-step refurbishment and integration of renewable energies]

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Technical References

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Abstract

This document is a guideline for the ventilation industry interested in developing new products for the Passive House standard. Although this is focused on the needs of step-by-step renovation, the identified areas for product development are mostly valid also for 1-step renovations or new buildings.

Ventilation systems with heat recovery are indispensable in Passive Houses. The considerably reduced ventilation heat losses due to the heat recovery system form the basis for a simplified heating system in a Passive House. Basic information on the need for ventilation (indoor air quality, health and comfort) as well as on energy efficient ventilation systems with heat recovery can be found in:

http://passipedia.passiv.de/passipedia_en/planning/building_services/ventilation

Controlled ventilation with heat recovery also plays an increasingly important role in energy efficient refurbishments due to the high savings potential and better indoor air quality. For implementation and design of the ventilation system especially for refurbishments, reference is made to [Bastian et al 2009] "Step-by-step Refurbishment Using Passive House Components".

A step-by-step refurbishment requires components to be installed quick and easy. Thereby the user should be disturbed in his usual habits as little as possible. That means the single steps of the refurbishment (the installation of the different components, the specific work steps) should be uncomplicated and easy in order to provide a smooth construction sequence. The more it is possible to combine different components and therewith different work steps, the better. Ventilation devices that are integrated in a window frame, for example, may reduce on-site work as the connection of the ventilation device to the building element is already solved with a suitable prebuilt window frame.

Furthermore, the new installation should require as little space as possible. A ventilation device that requires a technical room for installation, for example, wouldn't be a suitable solution for a step-by-step refurbishment.

The focus of components suitable for step-by-step refurbishment therefore should lay on pre-fabricated components that may simplify the onsite installation work and on space-saving components.

1 Wall integrated ventilation

Ventilation devices integrated in the facade are interesting options for a step-by-step refurbishment. After the installation of the ventilation device, the user is able to use his flat as he used to, since no additional installation room or installation area is required. The unit should provide an air flow rate of about 100 m³/h so that it is suitable for a 3-Person household or a typical 3-room flat. Façade-integrated devices currently available in the market mostly only provide air flow rates up to 50 m³/h, or even lower. With such low airflow rates, only single rooms or very small dwellings can be supplied. But the idea of such devices is a first step in the direction of the development of flat-wise, centralized, façade-integrated devices with airflow rates up to 100 m³/h.

In order to simplify the installation, one aspect is to choose components that already have a good design so that there is no need to hide the device behind a drywall. One example is given in Figure 1. Unfortunately, ventilation devices that can be treated as design elements, today, are rather the exception. Furthermore the sound level of the device needs to be low so that additional casing is dispensable.

In order to increase the consumer acceptance, the ventilation solutions in general need to be more cost efficient. A higher comfort level at lower additional costs (compared to an exhaust only ventilation system) would be the key to spread the use of ventilation with heat recovery also in refurbishments in the future.

Figure 1: Façade-integrated ventilation device with customizable design [Source: bluMartin]

1.1 Façade integration depending on the airflow range

Depending on the airflow range and specific use, the ventilation devices can be summarized in following categories:

	Air flow rate [m³/h]	**Frequent use**
Ventilation for single rooms in non-residential building	> 300	Non-residential building
Ventilation for single dwellings and single family houses: devices with optional duct connection	80 -300	Residential building
Room-wise ventilation with duct connection to a second room	40 - 80	Residential building
Room-wise ventilation: devices without any duct connection	-40	Residential building

In the following chapter, the specific design briefs for each category will be discussed.

1.2 Wall-integrated ventilation for single rooms in non-residential buildings

- Placement: Façade/ window integration
- Type of building: Non-residential building e.g. class rooms, seminar rooms
- Air flow rate > 300 m³/h
- Climatic conditions: Cold, cool temperate, warm temperate, warm

1.2.1 Description

In non-residential buildings as well exists the ambition to integrate ventilation devices, especially those devices designed for ventilation of only one room, installed into the facade in order to reduce the required installation space.

Decentralized (room-wise) ventilation devices are an interesting solution for step-by-step refurbishment of non-residential buildings (often used e.g. for ventilation of single class rooms), in order to dispense with an additional plant room. However, many available products are designed for an inside-installation with short duct connection outside. From the technical point of view there are already good devices available, however the design could be improved in order to dispense with an additional casing or false ceiling.

1.2.2 Demands

Additional to the requirements for façade integration, the following requirements depending on the specific use should be considered:

- Airtight installation concept available
- Design suitable for visible installation

1.2.3 New products

- Wall integrated centralized ventilation unit with more than 300 m³/h design airflow

1.2.4 Similar solutions

- **Lilu by Michael Tribus Architecture:**

The Passive House Designer Michael Tribus for example, uses elements of curtain wall systems for the integration of a suitable ventilation device. In Figure 5 an installation example for a class room ventilation unit is given.

Figure 2: Ventilation device for a classroom integrated in an element of a curtain wall system [Source: Michael Tribus Architecture]

1.3 Wall integrated ventilation for single-dwellings and single-family houses

- Placement: façade
- Type of building: Residential building - dwellings and single family houses, offices
- Air flow rate 80 - 300 m³/h
- Climatic conditions: Cold, cool temperate, warm temperate, warm

1.3.1 Description

Instead of large ventilation units taking up a lot of space inside the building, it is possible to integrate the heat exchanger directly into the wall. This makes intake and outlet ducts superfluous and minimalizes the space demand inside. There is also no insulation of ducts necessary inside.

The wall of a Passive House usually has a thickness of approx. 50 cm, useful space for the placement of the ventilation unit. This results in several positive effects:

- The outdoor and exhaust air intakes become an integral part of the ventilation unit. Situated directly at the facade no extra cold ducting is necessary, reducing the heat losses and otherwise costly, and time consuming installation details.
- The unit can be reduced in size because the ducts inside the unit can be much shorter. The space taken up by the unit indoors can be reduced to approx. 50x50x30cm for a 250 m3/h ventilation unit.
- These reductions in size can lead to easier installation and significant cost reduction.

1.3.2 Demands

Additional to the requirements for façade integration following requirements depending on the specific use should be considered:

- Airtight installation concept available
- Design suitable for visible installation

1.3.3 New products

- Wall integrated centralized ventilation unit with 80-120 m3/h design airflow
- Wall integrated centralized ventilation unit with 120-180 m3/h design airflow
- Wall integrated centralized ventilation unit with 180-250 m3/h design airflow
- Wall integrated centralized ventilation unit with more than 300m3/h design airflow

1.3.4 Similar solutions

- **Wall integrated unit SmartVent by Createrra**

The idea was brought up in a conversation in 2012 with Dr. Wolfgang Feist. The unit displayed above has since been created by Createrra in Slovakia first as a working prototype, and then a small series production of thirty ventilation units in cooperation with the local ventilation company Eltis. These have been tested since winter 2012/2013 in passive houses designed by Createrra.

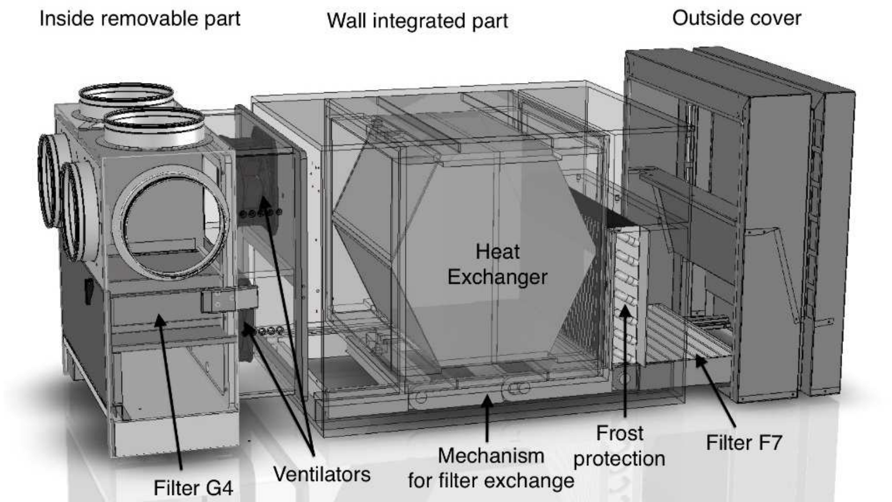

Figure 3: A schematic of the first SmartVent (Source: Createrra)

The overall design concept is fairly straight forward: One part of the unit is installed fixed in a predefined opening in the wall (in our case 50x50cm) and sealed to the airtight layer. Another part is removable, enabling access to the heat exchanger, maintenance of the ventilators and exchange of the filters. The removable element can be designed to be accessed from the inside, the outside, or even from both sides.

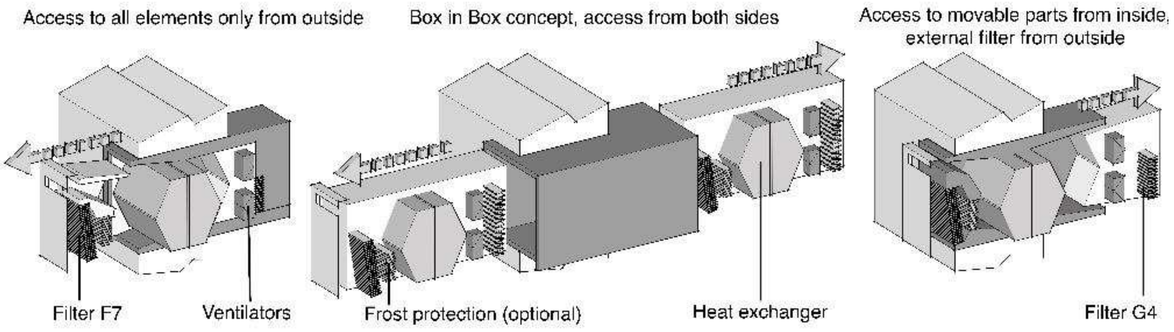

Figure 4: Concepts for accessing the removable part of the unit (Source: Createrra)

It is easier to design a removable part that can be accessed only from one side, because of the necessary airtight seals between the parts. Access from the outside could be beneficial for units installed in flats or community housing where maintenance is provided as a service.

Achieving flexibility for left and right versions

The ducting inside can be fixed to the removable part with flexible ducting (in which case it has to be detached before the unit can be opened), or it can be attached to the fixed part. Inside we need only to attach extract and supply air, reducing the need for complicated ducting. Switching the sides or adding an optional 3rd opening can provide a simple solution to creating left and right versions with the same unit.

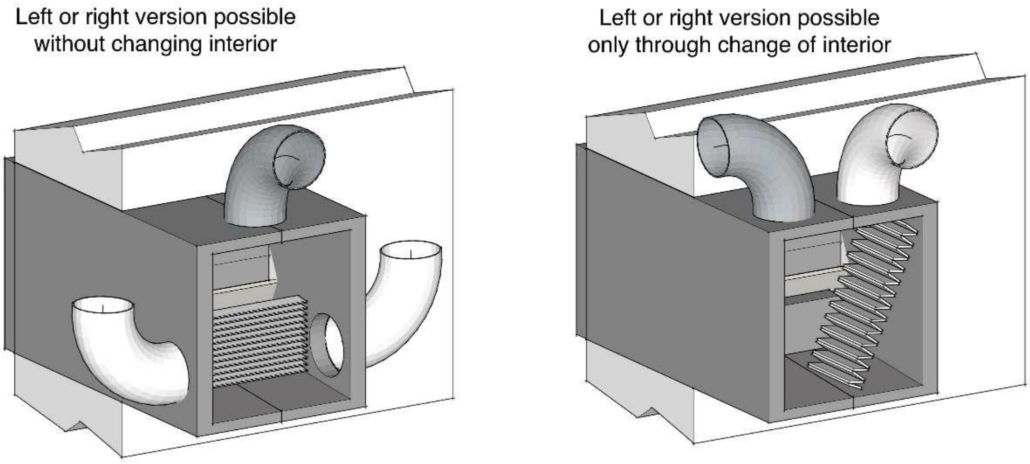

Figure 5: Left and right version (Source: Createrra)

Presently the development of another interesting concept is in process, which is shortly described below.

- **Vent4reno - Ventilation with heat recovery for renovation**

Vent4reno, a current research project of the University of Innsbruck deals with ventilation with heat recovery that is because of only a small required installation space especially suitable for renovation. The device combines fan and regenerative heat exchanger in one component, which allows a flat and compact size of the unit. Due to the moisture recovery no frost protection energy is required, which is additionally advantageous for the size of the unit.

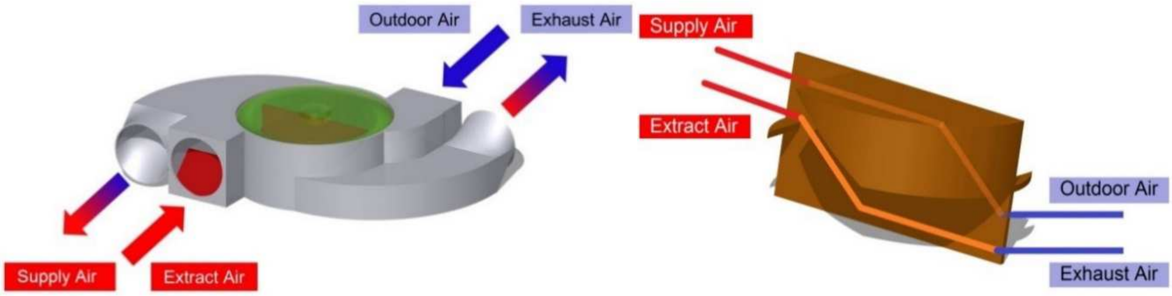

Figure 6: Heat recovery fan – combined fan and heat exchanger for facade integration [Speer14]

Through less mechatronic components, no need for frost protection and condensate drain, and high fluid mechanical and thermal efficiency, investment costs as well as installation and running costs can be reduced.

For further information about the Vent4reno project reference is made to http://www.vent4reno.eu/.

1.4 Wall integrated ventilation with duct connection for small dwellings and room groups

- Placement: Facade
- Type of building: Residential small, small dwellings or room groups
- Air flow rate 40 – 80 m³/h
- Climatic conditions: Cold, cool temperate, warm temperate, warm

1.4.1 Description

Devices available on the market do provide air flow rates up to 50 m³/h. With such air flow rates single rooms or very small dwellings can be supplied. The idea is to connect one or two supply air room to one or two extract air rooms in order to comply with the cross flow principle and use the air flow rate twice.

1.4.2 Demands

Additional to the requirements for façade integration, depending on the specific use, should be considered:

- Airtight installation concept
- Design suitable for visible installation

Deviating from the certification criteria for Passive House ventilation systems [PHI 2009] following changes to the measurement could be agreed (in accordance with PHI) for ventilation devices that are used to ventilate only a small group of rooms (e.g. one extract and one supply air room):

	Changes to be agreed
Thermodynamic measurement	For ventilation devices that are used to ventilate only a small group of rooms (e.g. one extract and one supply air room), the ducting system is assumed to be short. In this case the external pressure difference

	to be provided could be reduced accordingly. The external pressure difference to be adjusted for the thermodynamic measurements should reflect the typical installation of the respective unit.
External Leakage	Reference is made to EN 13141-8 The measurement is performed at a pressure difference of +/ 50 Pa (according to EN 13141-8) and 100 Pa (additional measurement in step with actual practice)
Internal Leakage	the measurement should be performed according to the tracer gas method described in [EN 13141-8] Alternatively the measurement could be performed based on the pressure testing method according to [EN 13141-8] with an additional measurement point at +/- 50 Pa (obligatory measurement at 20 Pa)

1.4.3 New products

- Wall integrated decentralized ventilation unit with 30-80 m3/h

1.4.4 Similar solutions

Standalone solution: As described before, the currently available products to be used in residential buildings mostly provide air flow rates up to 50 m³/h. But even at low airflow rates, there are only few devices providing good heat recovery rates. Many devices available at the market do have insufficient heat recovery rates due to small heat exchangers with only a small heat exchanger surface.

Following is a description of a positive example.

- **BluMartin freevent 100**

This device with airflow rates up to 50 m³/h (boost level up to 100 m³/h possible) is designed for ventilation of single rooms or for very small dwellings. A second room connection (e.g. duct to extract air room) allows the cross ventilation principle: the directed airflow from a supply air room to an extract air room. With a heat recovery rate of 87% at an electric power consumption of 0.26 W/m³, an efficient operation mode is provided. The good heat recovery rate is achieved with the comparatively large heat exchanger that could be realized due to the specific heat exchanger position, using the whole wall thickness.

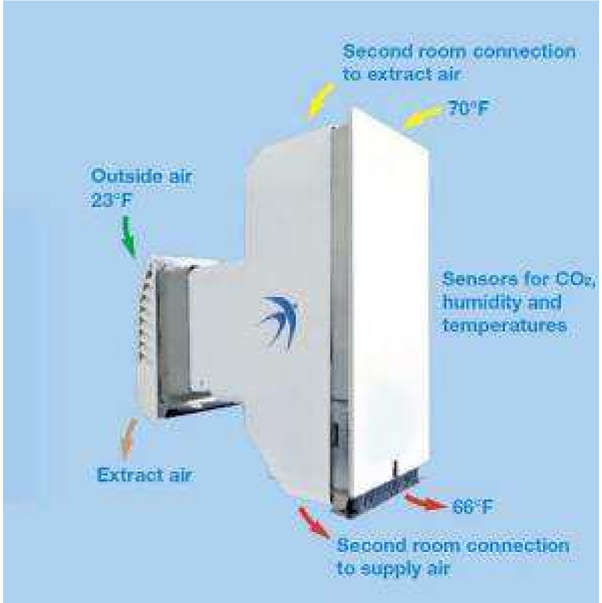

Figure 7: Facade integrated ventilation device with optional second-room-connection [Source: bluMartin]

Similar devices of other manufacturers are available at the market but not yet tested with respect to the energetic values. E.g.: the device B60 SC from Heinemann or the device CA 70 from Zehnder.

1.5 Wall integrated ventilation without duct connection for single rooms

- Placement: Facade
- Type of building: Residential single rooms
- Air flow rate - 40 m³/h
- Climatic conditions: Cold, cool temperate, warm temperate, warm

1.5.1 Description

Façade integrated devices for only single rooms is a concept that completely avoids the installation of ducts. Individual devices, situated in the respective rooms, ventilate each room separately. Depending on the specific ventilation concept, the required heat recovery rate of each device might even be higher than 75% (e.g. in case of an indoor bathroom – whereas the only way of air exchange is an extract only system). Compact heat recovery units available on the market for this purpose often do not provide sufficient heat recovery values.

1.5.2 Demands

A whole ventilation concept for an exemplary dwelling is required. In case of an indoor bathroom, for instance, an additional exhaust-only-system for the bathroom is required, which would increase the ventilation heat loss of the dwelling according to the amount of extract airflow rate (average).

The target for room-wise ventilation units is to achieve comparable ventilation heat losses to those of flat-wise centralized ventilation units with heat recovery rates of 75% (minimum hr-rate according to [PHI 2009]) for an exemplary dwelling.

- **Presence or CO2 regulated air flow:**

Air being provided to a single room is also extracted from the same room, if no extract ducts to kitchen or bath is connected. This increases the necessary amount of ventilated air. The units should thus regulate the air flow volume based on human presence or CO2 levels in order to provide the same amount of air change rate like central units.

- **Heat recovery rate > 80%.**

In order to compensate additional ventilation heat losses due to exhaust-only-system for inside bath rooms, the heat recovery ventilation devices in the single rooms must provide a heat recovery rate > 80%.

- **Airtight installation concept**

1.5.3 New products

Wall integrated decentralized ventilation unit with 20-40 m3/h, heat recovery rates > 80% providing demand control.

1.6 Demands

1.6.1 General requirements for controlled ventilation with heat recovery

The air tightness of building gets better continuously. This applies for new building as well as for energy refurbishments. Controlled ventilation becomes essential requirement for a good fresh air supply and effective moisture and pollutant removal.

Controlled ventilation with heat recovery not only provides a good indoor air quality, it also has more advantages: The heat recovery is able to reduce the ventilation heat losses by 80% and more at the same time comfortable supply air temperatures can be achieved.

In order to assure good heat recovery values and low electric power consumption at the same time, the Passive House Institute developed certification criteria described in the following table:

	Requirements
Heat recovery rate	> 75%
Electric power consumption	< 0,45 Wh/m³
Air tightness	External leakage ≤ 3% (leakage over the casing) Internal leakage ≤ 3% (leakage between different airstreams inside the unit)
Frost protection	The frost protection strategy of the device must guarantee regular operation of the device down to -15°C outdoor air temperatures (for cool temperate climate conditions) without supply air interruption or supply air reduction.
Comfort criterion	Down to outdoor air temperatures of -10°C comfortable supply air temperatures of 16.5°C must be achieved. Depending on the frost protection strategy, in some cases additional measures might be required to fulfill this requirement (e.g. supply air heater)
Hygiene	Outdoor air filter at least F7, extract air filter G4

Table 1: Requirements for controlled ventilation with heat recovery [PHI 09]

Additional to the above named criteria for controlled ventilation with heat recovery, following requirements should be fulfilled for devices integrated in the façade:

	Requirements
Acoustic inside	Corresponding to the installation room, the sound pressure level for continuous operation shouldn't exceed 25 dB(A) in living rooms and 30 dB(A) in functional areas such as kitchens or bath rooms. For demand operation the above named requirements are not obligatory. A sound pressure level of 35 dB(A) should serve as guiding value.
Acoustic outside	To be measured in order to provide adequate design values Reference is made to [TALaerm98] according to which in residential areas a sound level of 35 dB(A) at night time is recommended.
Sound reduction index	To be measured in order to provide adequate design values. To be measured in order to provide adequate design values Reference is made to [DIN 4109] according to which in noise areas of category III (61 - 65 dB) the sound reduction index of openings in the wall should be better than 30 dB
Wind pressure sensitivity	Reference is made to [EN 13141-8]: with a pressure difference of +/- 20 Pa the deviation of supply and extract air flow rate shouldn't exceed 10% of the respective higher air flow (classification S1/ EN 13141-8)
Condensate	Depending on the type of heat exchanger condensate might occur on the exhaust air side which – at low out door temperatures - might lead to icicles. This danger should be avoided by adequate measures (e.g. heat exchanger with moisture recovery or drainage).
Frost protection	Providing a good frost protection strategy is challenging especially for facade integration. Nevertheless it is a mandatory requirement for passive house ventilation however not at the demand ventilation level, but at the continuous ventilation level.

1.6.2 Advantages

- No heat losses inside
- Small space demand
- Easy installation

1.6.3 Risks

- Placement and access on façade
- Preparation of opening during construction
- Noise from ventilators
- Exchange of external filters from inside
- Frost protection
- Condensation in unit

2 Other space saving installation options for ventilation devices

Beside the possibility to integrate the ventilation device into the facade, there might be other options suitable for a step by step refurbishment as well. The general requirements are the same like for the facade integrated devices:

In order to simplify the installation, the design and the noise of the unit should be so that an additional casing could be dispensable. Additionally the units have to be cost efficient in order to increase the consumer acceptance.

Devices for flat wise centralized ventilation are already available in a variety of forms and sizes. But the sound and the design of most of the units available is still improvable.

The further development of space saving devices that can be installed in areas that are already lost for other use is desirable e.g.:

- In the bath room over the bathtub
- Devices for ceiling installation that don't need to be hidden behind a falls ceiling.

Furthermore it is desirable to simplify the installation due to a direct connection to the exterior wall or provided pre-fabricated ducting systems through the exterior wall.

List of references

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