

## AWP 150

### Introduction

#### Definition and criteria of the 3-litre house

A 3-litre house is a building in which the heating requirement is so low, that you can dispense with a conventional heating system, without any loss of comfort levels. In Germany, this is the case of a heating warmth energy parameter according to PHPP or DIN 4108-6 under 30 kWh/m<sup>2</sup>a based on the living area. This corresponds to a maximum heating load of 20 W/m.

#### What singles a 3-litre house out?

Many measures have to be taken to designate a house as a 3-litre house. These can be divided into 4 groups:

- 3-litre houses have high-quality heat insulation
- Air-tight building envelope
- Windows are triple-glazed and have 2 coatings.
- A building technology system for controlled domestic ventilation with high efficiency heat recovery.

#### Air-tight construction:

The building envelope must be air-tight, using suitable sealing measures.

There are 2 reasons for this:

- Cold air can enter through joints in the envelope. This can result in draughts, local cool spots, and in general uncontrolled heat loss. In buildings with controlled domestic ventilation, leaks in the outside shell will not only result in significant increases in heat loss, but can put in question the functioning of the entire ventilation system.
- If warm room air flows to the outside through a joint, this will not only result in a loss of heat, but may also cause extensive damage to the building through condensation.

#### Special windows:

The most problematic areas for thermal installation are the windows. The parameter for the insulation characteristics of windows is the heat transmission coefficient (known as the U value), which gives the heat transmission in W/m<sup>2</sup>K.

The Thermal Insulation Ordinance of 1995 prescribed that all new houses and renovations must have double pane thermal insulation glazing with U values from 1.2 W/m<sup>2</sup>K to 1.6 W/m<sup>2</sup>K.

#### Building technology system:

No exchange of air with the outside air occurs because of the previously described air-tight building envelope. Therefore an active ventilation system is necessary for exchanging the air. If the air extraction is not controlled, a substantial quantity of heating energy will be lost to the atmosphere with the outgoing air which cannot be used anymore.

The building technology system supplies air to the house and extracts stale air from the house in a controlled way, using fans. In order to achieve heat recovery, the exhaust air flow is fed through a heat pump, where the heat is extracted from the exhaust air.

Controlled domestic ventilation prevents the spreading of odours and humidity and instead enables sufficient air to be exchanged to ensure health and comfort without heating energy being lost.

- Fans supply and extract the required air quantities regardless of the weather.
- The air flows from the least contaminated areas into the most contaminated areas.

### Building technology system for low-energy and 3-liter houses

#### Building technology system requirements

Building technology system requirements can be divided into 2 sections:

- Controlled domestic ventilation

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### ■ Dispensing with conventional central heating with burner technology

#### Controlled domestic ventilation

Controlled domestic ventilation is distinguished by providing constantly high room air quality. This means that the room air which may be polluted by steam, odours or even pollutants, is continuously replaced by outside air. The measure of the pollution of the room air is its CO<sub>2</sub>- content, because in general all other pollutants are present in proportion to this. A CO- proportion of less than 0.1 volume percentage is considered comfortable at an outside air CO-volume percentage proportion of 0.036.

Type of activity	Exhaled CO <sub>2</sub> [m <sup>3</sup> /h]	Required quantity of supply air [m <sup>3</sup> /h]
Sleeping, resting	0,01	17 to 21
Reading, watching TV	0,015	20 to 26
Working at a desk	0,02	32 to 42
Housework	0.03 to 0.04	55 to 72
DIY activities	0.05 to 0.08	90 to 130

In order to ensure that the CO<sub>2</sub> content in the room air is always below the limit of 0.1 volume percentage, an air exchange rate of between 0.3 l/h and 0.5 l/h must be achieved.

In addition to the extraction of odours and pollutants, any steam in the room air must be extracted, as otherwise this can result in considerable structural damage e.g. the build-up of mould, being caused by condensation in air-tight insulated houses. An air exchange rate of between 0.3 l/h and 0.5 l/h is also essential here.

	Release of water vapour in domestic areas [g/h]
Potted plants	10 to 20
Bath	approx. 1100
Shower	approx. 1700
Meal preparation	400 to 800
Dish washer	approx. 200
Washing machine	200 to 350
Person asleep	40 to 50
House work	approx. 90
Heavy-duty activities	approx. 175

#### Dispensing with conventional central heating with burner technology

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The previously described controlled domestic ventilation in passive houses, however, makes sense only when the thermal loss caused by this ventilation system is minimal. A high-efficiency heat recovery system is used, which in most cases, is sufficient to feed enough reclaimed heat energy to the heating equipment, in order to achieve the required room temperature. This principle of heat recovery, if it is correctly implemented, makes a conventional heating system with burner technology unnecessary in a low-energy house - this is replaced by a modern combination of thermal insulation, heat recovery and electrical re-heating.

### Hot water preparation

The exhaust air pump provides hot water, which is collected in the integrated tank. If the hot water heating does not have to be supplied with heating energy, the heat pump can use the available heat to heat up the supply air in the ventilation system. A building technology system with a combination of heat pumps of the AWP...S model series and solar collectors can provide a large portion - if not all - of the hot water requirements in a 3 litre house.

### Implementation in the AWP exhaust air heat pump

The MAICO AWP exhaust air heat pump provides an optimum way of fulfilling the previously described requirements.

The AWP is a complete system with heat recovery for use in good low-energy and 3 litre houses. It is used for central air extraction and decentral ventilation, as well as for central hot water preparation and the entire heat supply for the heating system.

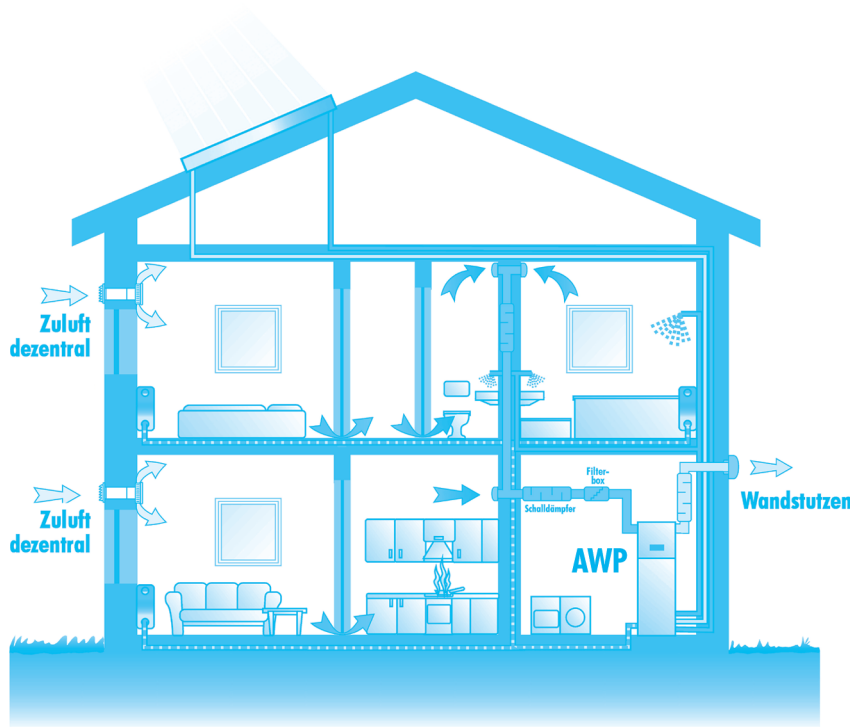
The entire system can be divided into several sections, made up of different components:

- AWP exhaust air heat pump with hot water storage tank
- Control unit
- Duct system, filter box, sound absorber...
- Solar collector (when using the AWP...S product group)

The function can be explained in the following way:

The stale room air is extracted from the kitchen, bathroom and WC and brought through a duct system into the exhaust air heat pump. There, heat energy is extracted from the exhaust air by an air-water heat pump. This heat energy is transferred to the heater/hot water system. Afterwards the cooled exhaust air leaves the building as outgoing air.

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In the case of very low outside temperatures or a very high heat requirement, the exhaust air heat pump covers the residual heat requirement of the heating system using a built-in auxiliary electric heater (electrical re-heating).

Fresh outside air replaces it via supply air elements in the outside wall of the building, replacing the stale air that was removed via the heat pump. In this way, just enough air as is required for a hygienic air exchange comes into the house.

This principle ensures, on the one hand, the required air exchange rate of 0.5 l/h when the duct system and the exhaust air heat pump are correctly laid out and, on the other hand, that the heating and hot water system is actually operated using the heat energy removed from the exhaust air due to the highly efficient heat recovery. Therefore, a central heating system with conventional burner technology is unnecessary in low-energy houses with the AWP exhaust air heat pump. In this case, the power output exceeds the electrical energy that is used to operate the heat by a factor of approx. 4, i.e. the working index at a heater forward flow temperature of 35°C is 3.8 to 4 for the AWP.

The components of the AWP are implemented by the built-in control unit in an energy-efficient manner. Amongst other things, the control unit is used to set the required room temperature, the operating mode (summer or winter operation) or other user-defined functions, such as reduced night-time levels.

Using these settings, the forward flow temperature is automatically adjusted by the control unit, depending on the outside temperature. The temperature is monitored using a sensor on the outside wall of the building.

The exhaust air heat pumps of the AWP...S product group are designed to be combined with solar collectors to prepare hot water. The medium heated in the collectors is pumped into an additional heat exchanger in the hot water storage tank, where it radiates its heat energy. As a result, only a small amount of electrical re-heating is required in hot water preparation.

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### Detailed presentation of AWP

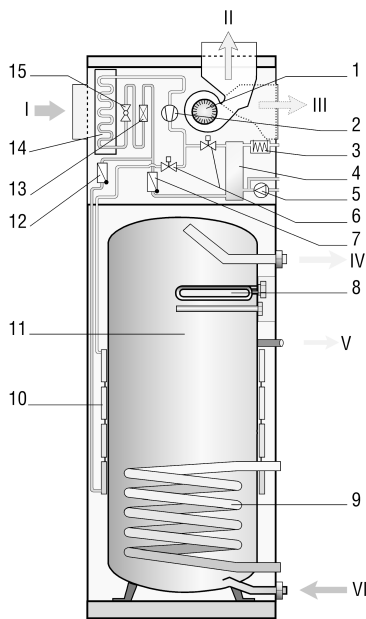
Currently, there are 2 variants of AWP exhaust air heat pumps: Firstly, there is the AWP... variant, which consists of a heat pump and a hot water storage tank; secondly, there is the AWP...S solar variant, with an additional heat exchanger for connecting to solar collectors.

Each variant is available in 2 models that differ in the efficiency of the heat pump that is used:

- The AWP 150 and AWP 150 S have a 1.5 kW heat pump for good low-energy houses from 100 m<sup>2</sup> to approx. 150 m living space.
- The AWP 200 and AWP 200 S have a 2.1 kW heat pump for good low-energy houses from 150 m<sup>2</sup> to approx. 190 m living space.

The quoted living space dimensions are based on experience. There can be variations in individual cases, caused by the corresponding heating requirement.

1 - Exhaust fan



- 2 - compressor
- 3 - electrical re-heating, heater
- 4 - condenser, heater
- 5 - circulation pump
- 6 - change over valves
- 7 - non-return valve
- 8 - electrical heating element, hot water
- 9 - heat exchanger
- 10 - condenser, hot water
- 11 - hot water tank

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- 12 - non-return valve
- 13 - collective drier
- 14 - vaporiser
- 15 - expansion valve
- I - exhaust air
- II - outgoing air
- III - outgoing air (option)
- IV - hot water
- V - circulation

Type	With/without solar connection	Minimum living space [m <sup>2</sup> ]	Minimum volumetric flow [m <sup>3</sup> /h]	Lower limit of use [°C]	Max. hot water temperature [°C]	Air volume [m <sup>3</sup> /h]	Hot water storage tank [l]	Coolant
AWP 150	without	100	125	15	60	50 to 200	303	134a
AWP 200	without	150	175	15	60	100 to 280	303	134a
AWP 150 S	with	100	125	15	60	50 to 200	290	134a
AWP 200 S	with	150	175	15	60	100 to 280	290	134a

VI - cold water

An overview of the most important technical data of the 4 AWP is provided in the following table (further technical data can be found on page 21):

### Layout of the suitable exhaust air heat pump

Please take note of the following in the layout:

The basis for the layout is the standard heating requirement in accordance with DIN EN 12831 (previously DIN 4701).

### General view

Depending on the extent of the standard heating requirement, the heat pump is capable of covering the heating requirement by itself to a certain outside temperature. If the outside temperature is lower, the integrated electrical auxiliary heater is automatically switched on.

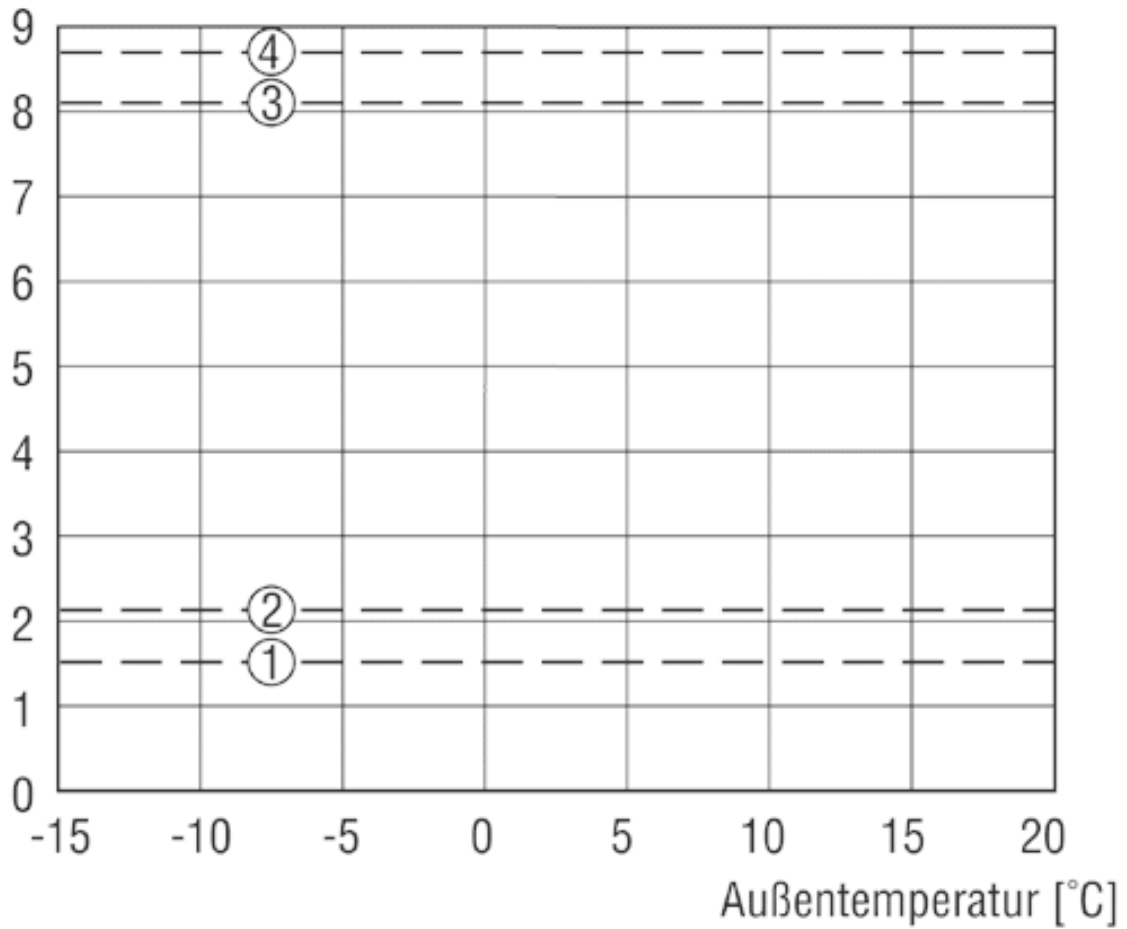
Generally, an economical area of application of the AWP 200 / AWP 200 S for a standard heating requirement of up to a 6.0 kW results from this power performance; for the AWP 150 / AWP 150 S, it is up to 5.0 kW. These areas of application assume an average heat pump tariff. If conditions differ, a different assessment must be carried out according to the layout table and an energy cost appraisal is recommended.

When laying down the air amount, you should note that a minimum air amount is required for the effective operation of the heat pump (AWP 150/150 S 125 m<sup>3</sup>/h or AWP 200/200 S 175 m<sup>3</sup>/h).

① AWP 150 and 150 S

**AWP 150**

Wärmepumpenleistung [kW]



- ① AWP 200 and 200 S
- ② AWP 150 and 150 S with electrical re-heating
- ③ AWP 200 and 200 S with electrical re-heating

Location	Normal outside temperature [°C]
Berlin	-14
Bremen	-12
Dortmund	-12
Frankfurt	-12
Hamburg	-12
Hannover	-14
Kassel	-12

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Location	Normal outside temperature [°C]
Cologne	-10
Leipzig	-14
Munich	-16
Nuremberg	-14
Stuttgart	-12

### Layout example

The lower layout limit for the practical operation of the AWP is at 72% coverage.

Given: a residential building in Frankfurt with a standard heating requirement of 6 kW according to DIN 4701. The hot water distribution system consists of an underfloor heater with a 35/30 layout (35°C forward flow temperature at a normal outside temperature of -12°C).

The layout diagram shows that the heat requirement curve (5) crosses curve 1 (AWP 150 / AWP 150 S) at approx. 8 C and curve 2 (AWP 200 / AWP 200 S) at approx. 6 C.

For the use of AWP 200 and AWP 200 S, this means that if the heat pump is used in Frankfurt, it attains a coverage of approx. 0.78, i.e. the heat pump can cover 78% of the annual required heating. The remaining part is covered directly by the integrated electrical auxiliary heater.

For AWP 150 and AWP 150 S, the coverage for this example is only approx. 0.66, i.e. the proportion of direct electrical heating is approx. 34%. This system configuration is not recommended.

Other factors contributing to the coverage include the volume flow, the exhaust air temperature, the sealing factor of the house and the maintenance of the supply air filters.

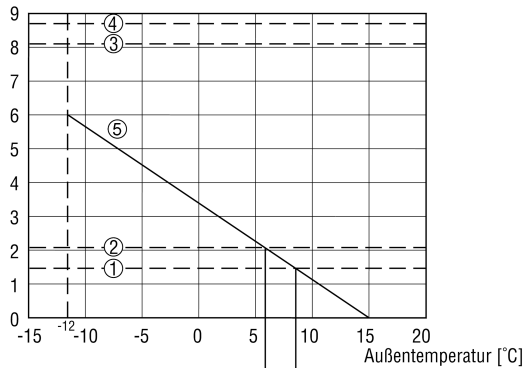
Hot water preparation is covered mainly - in general solely - by the heat pump. The coverage of the heat pump depends on the required amount and the temperature of hot water.



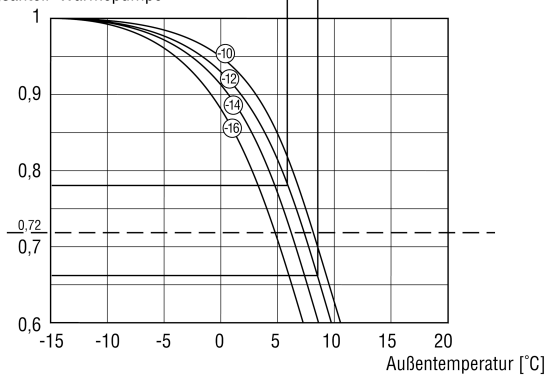
## AWP 150

### Detailed information regarding the construction of the units

Wärmepumpenleistung  
[kW]



Deckungsanteil Wärmepumpe

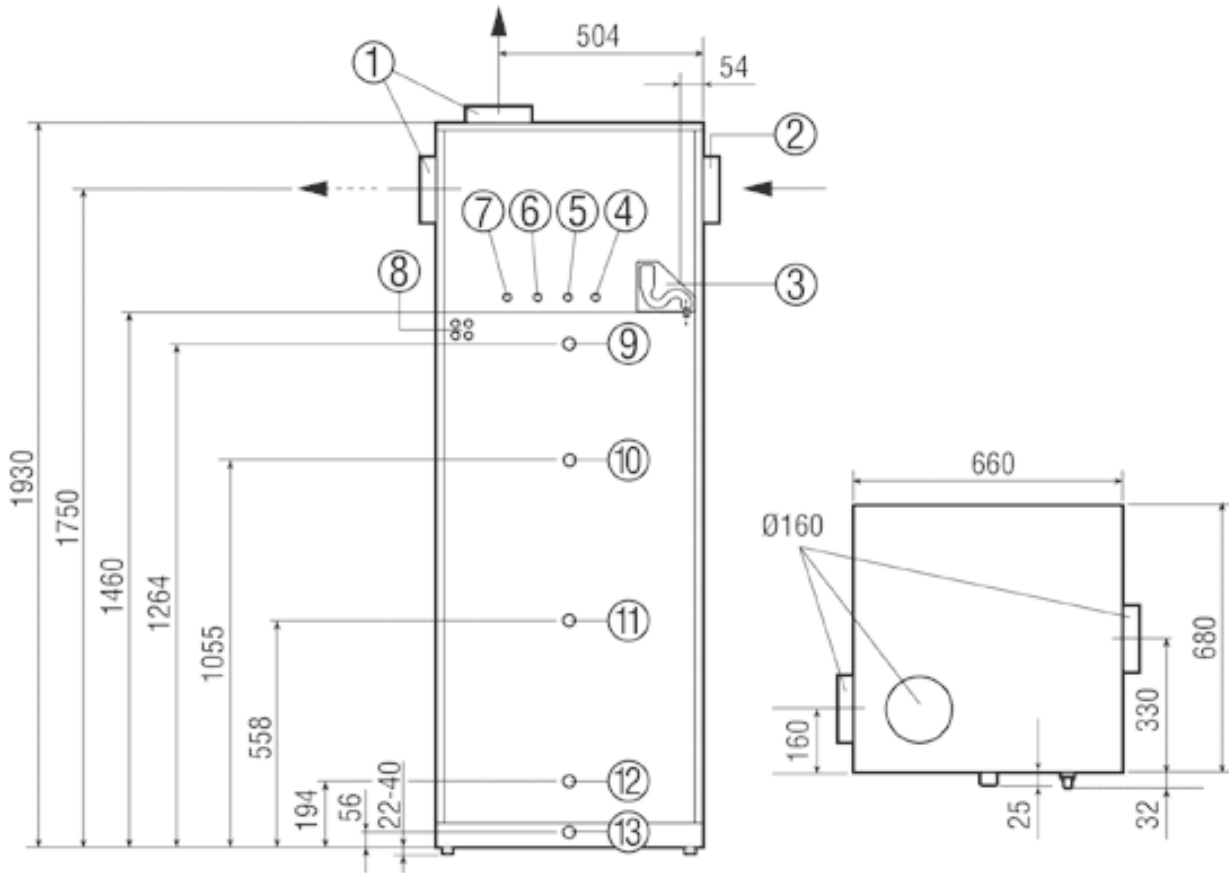


### Housing

The housing consists of silver sheet steel plates and covers the heat pump and the hot water storage tank. A fold-out service aperture is located on the top of the front side. It permits access to the heat pump.

The connections for the duct system can be found on the left-hand (exhaust air) and top (outgoing air) sides of the housing. Alternatively, the outgoing air duct can also be connected on the right-hand side of the housing.

**AWP 150**



**Exhaust fan**

DC fans are used as standard with all AWP exhaust air heat pumps. Significant energy savings are made due to their high efficiency. In addition to this, the quiet running characteristics and the linear speed control are important advantages with these fans. Voltage is supplied using a power supply unit that is specially designed for these fans and is also optimised for maximum efficiency.

The exhaust air fan can be adjusted to the planned volume flow, based on the pressure loss in the duct system. This occurs when making the presettings of the unit during commissioning. The minimum volume flow is also preset at this time.

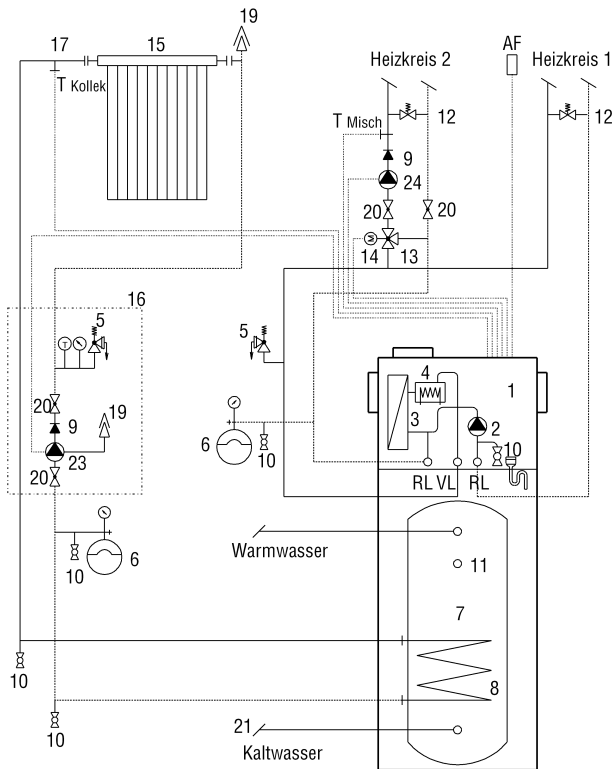
If the compressor is running - i.e. when the heat pump is in operation - the fan automatically switches to the set minimum volume flow (AWP 150 - 125 m<sup>3</sup>/h or AWP 200 - 175 mh).

**Fan characteristic curve at maximum speed**

**Solar panels**

The solar control unit, the collector sensor and the pump activation are integrated into solar variants AWP 150 S and AWP 200 S. The heat exchanger has a transfer area of 1.3 m<sup>2</sup>. The maximum tank temperature is 65°C.

Note:



Please take note of the manufacturer's control functions. If necessary, use the controller prescribed by the collector manufacturer.

- 1 - ventilation unit with heat pump
- 2 - circulation pump, heater
- 3 - condenser of the heat pump
- 4 - electrical re-heating
- 5 - safety valve
- 6 - expansion tank
- 7 - service water reservoir
- 8 - heat exchanger
- 9 - non-return valve
- 10 - filling and drainage cock
- 11 - circulation connection
- 12 - overflow valve
- 13 - mixing valve
- 14 - servomotor for mixing valve
- 15 - solar collector
- 16 - compact solar installation
- 17 - collector sensor
- 19 - ventilation
- 20 - stop valve
- 21 - safety group acc. to DIN 1988

## AWP 150

23 - solar circulation pump

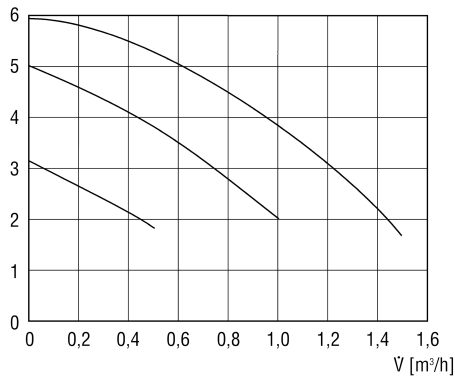
24 - circulation pump, mixer circuit

AF - external sensor

VL - forward flow

RL - return flow

Förderhöhe [m]



### Circulation pump

The heating volume flow is to be set according to the layout of the heat distribution system using the 3 steps of the circulation pump.

### Control unit

The AWP exhaust air heat pump is controlled by the built-in control unit.

The control unit is located in the central unit. The user settings are entered here and the different components, such as the fans, heat pump etc., are controlled and monitored. The various functions can be called up at the press of a button:

This includes different summer and winter operating modes, independent programmable daily programs for temperature reductions and air quantities and various setting options.

At the same time, the control unit acts as a control monitor for the user, as the current status can always be called up and fault messages can be displayed.

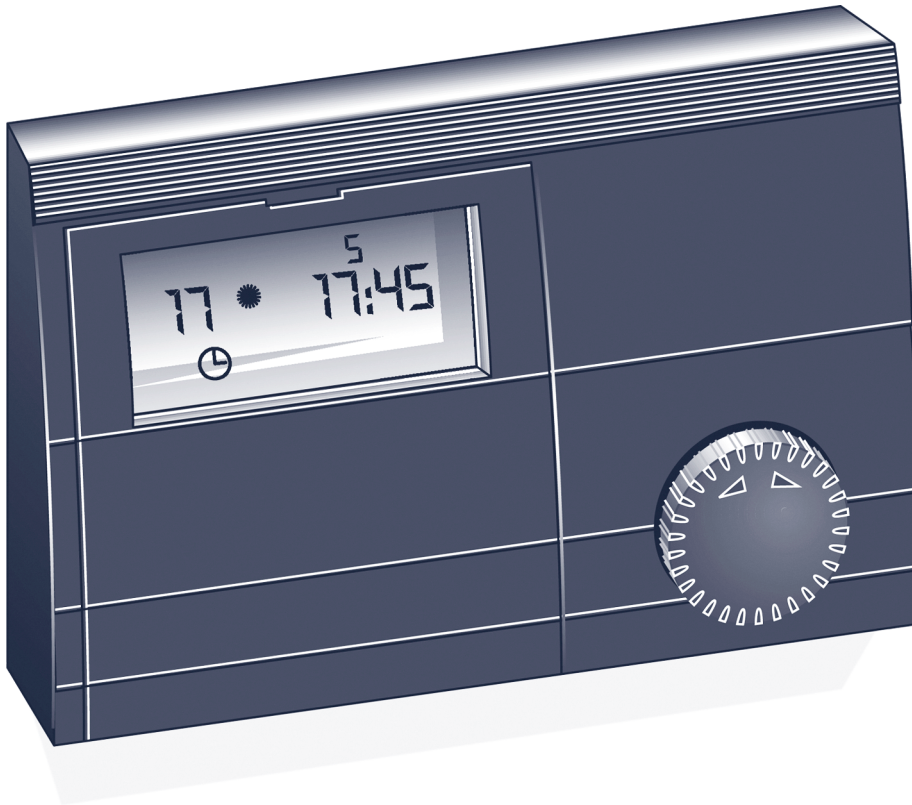
Optionally, a control element can be installed in the living spaces.

The control unit handles practically all the functions which are required for the problem-free operation of a building technology system, e.g.:

- Controlling the fan speed
  - Keeping the room temperature constant
  - Automatically switching on electrical re-heating
  - Internal system monitoring and control unit self-diagnostics
  - Displaying the system status and faults

In spite of the high degree of automation, the user can decide how and when the building technology system should operate:

### AWP 150



- Pre-setting room temperature parameters
  - Programming the nightly temperature and air quantity reductions
  - Manually switching the fan levels

#### **Outside temperature sensor**

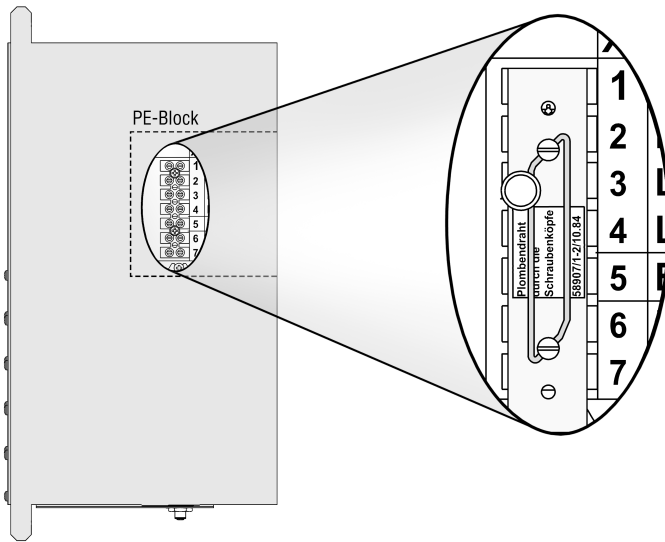
Attach the outside temperature sensor to a north- or northeast- facing wall behind a heated room, 2.5 m above the ground and 1 m to the side of doors or windows. The outside temperature sensor should be freely exposed to the environment.

#### **Electrical connection**

The AWP requires a separate, fixed electrical AC connection. The electrical connection must be registered at the responsible electrical supply company.

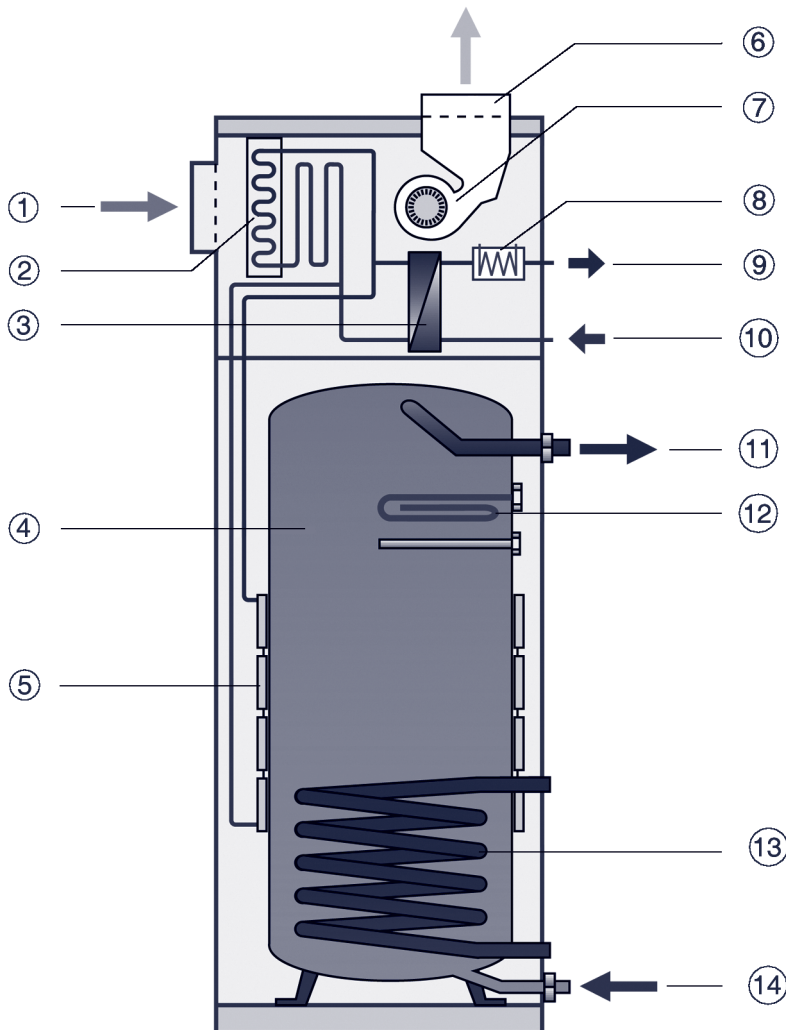
# PLANNING INSTRUCTIONS

## AWP 150



Ensure that the control cables are laid separately from the power supply cables.

### Special tariffs



## AWP 150

Several models of the AWP can be operated with special tariffs. Ask about the special tariffs at the responsible electrical supply company. The connection terminal for special tariffs can be sealed.

In order for special tariffs to be used, it must be ensured that there is always power on connection 1/N/PE 230 V (fan/control). During idle periods, it is recommended that only the auxiliary electrical heater be switched off and that the heat pump be allowed to continue to run.

### Hot water storage tanks

A specially enamelled hot water storage tank with a capacity of approx. 300 l is integrated into the AWP exhaust air heat pump.

The heat exchangers for the solar panel system and the air-water heat pump are fitted in the storage system. The relevant connections for the hot and cold drinking water as well as the feed to and return from the solar panels are fitted on the back.

- ① Exhaust connection
- ② Vaporiser
- ③ Capacitor (Heating)
- ④ Hot water storage tanks
- ⑤ Capacitor (Hot water)
- ⑥ Outgoing air connection
- ⑦ Exhaust fan
- ⑧ Electrical re-heating
- ⑨ Heater forward flow
- ⑩ Heater return flow
- ⑪ Hot water connection
- ⑫ Heating element
- ⑬ Solar heat exchanger
- ⑭ Cold water connection

### Planning process

1. Select the suitable exhaust air heat pump.
2. Define the exhaust air volumetric flow.
3. Define the volume of supply air
4. Specify the duct system:
5. Determine the installation location for the central unit.
6. Determine the layout of the outside air openings.
7. Determine the layout of the exhaust air valves.
8. Plan for a filter box in the exhaust air duct ahead of the device entry point.
9. Specify the duct layout.
10. Take special cases into consideration, e.g. fire places.

### Important planning details for exhaust air heat pumps

When planning a building technology system with an exhaust air heat pump, different points are important in respect of the central unit and the duct system. Important planning details for the central unit are explained in sections 1 to 4, followed by the duct system.

### Central unit installation location

Set up the central unit in such a manner that the duct system can be as short as possible.

The substrate on which the AWP is to be placed must be horizontal, stable (load-bearing capacity at least 500 kg) and durable. The unit should stand level; an uneven substrate can influence the noise characteristics of the AWP.

Do not set up the exhaust air heat pump directly under or near living rooms or bedrooms.

The exhaust air heat pump must not be operated in spaces that are at risk of explosion due to dust, gases or vapours.

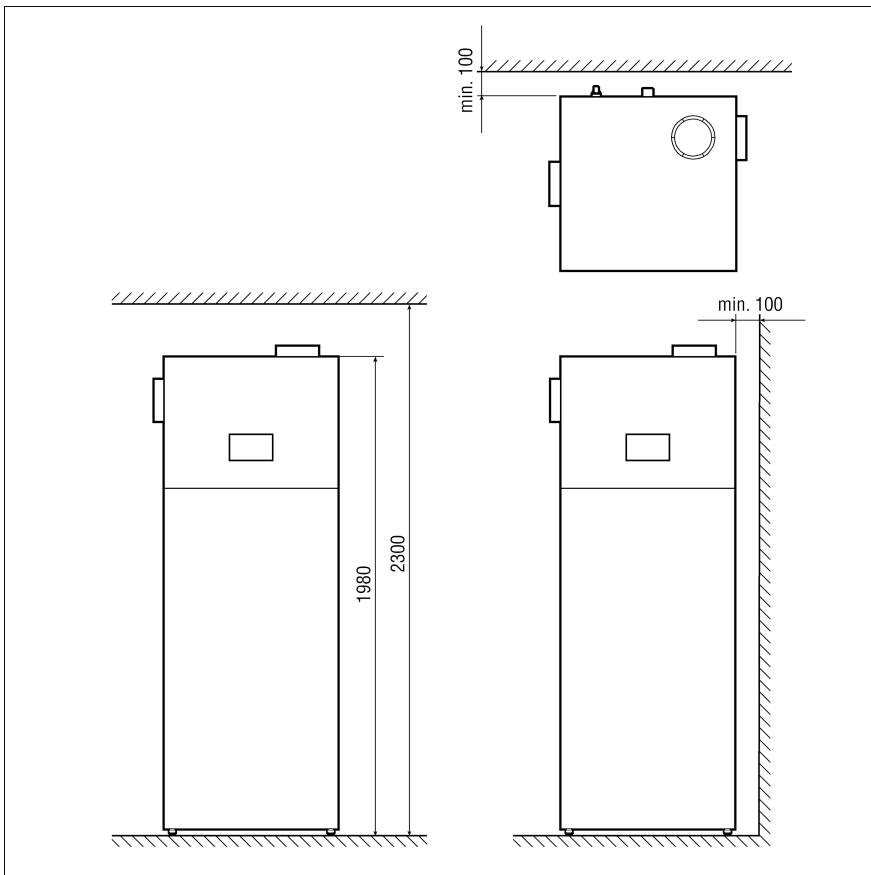
## AWP 150

The exhaust air heat pump must be set up in a frost-free environment. Furthermore, the temperature of the exhaust air that is fed to the unit must not drop below 15°C as otherwise, the vaporiser freezes. Furthermore, the efficiency of the heat pump operation drops with a decreasing exhaust air temperature.

The floor area of the set-up room must be at least 6 m<sup>2</sup> with a minimum volume of 13 m<sup>3</sup>.

If the exhaust air heat pump is set up in a boiler room, it must be ensured that the operation of the heating unit is not affected. Ensure that the central unit can be accessed for maintenance work and that there is a space of approx. 600 mm in front of the removable cover.

Do not constrict the exhaust air heat pump by walls and ceilings - maintain the minimum spacing according to the picture. To set up the unit without impedances, the room height must be at least 2300 mm.



Ensure that a 400 V three-phase AC electrical supply is available.

A siphon connection must be available for draining the condensation. If the siphon duct passes through an unheated area, it must be insulated, in order to prevent any icing and resulting breaks in the duct.

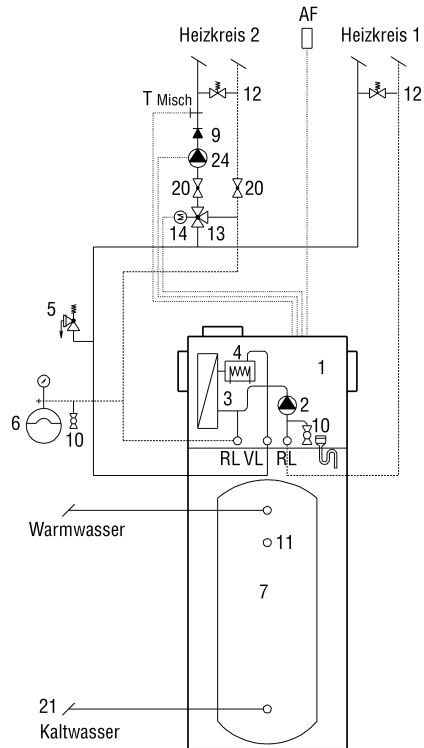
### Heating circuit

The conveyance of structure-borne sound is eliminated to a large degree by the low-vibration construction of the heat pump. The forward and return flows are on the angular connectors provided. The AWP is equipped with a circulation pump as standard. This can be connected directly to the heating system. It must be ensured that the minimum volume flow is maintained under all operating conditions by using, for example, an appropriately regulated overflow valve. The minimum volume flow is 400 l/h. Please take note of DIN 4751 and TRD 721 in regard to safety-related equipment.



## AWP 150

### Second heating circuit

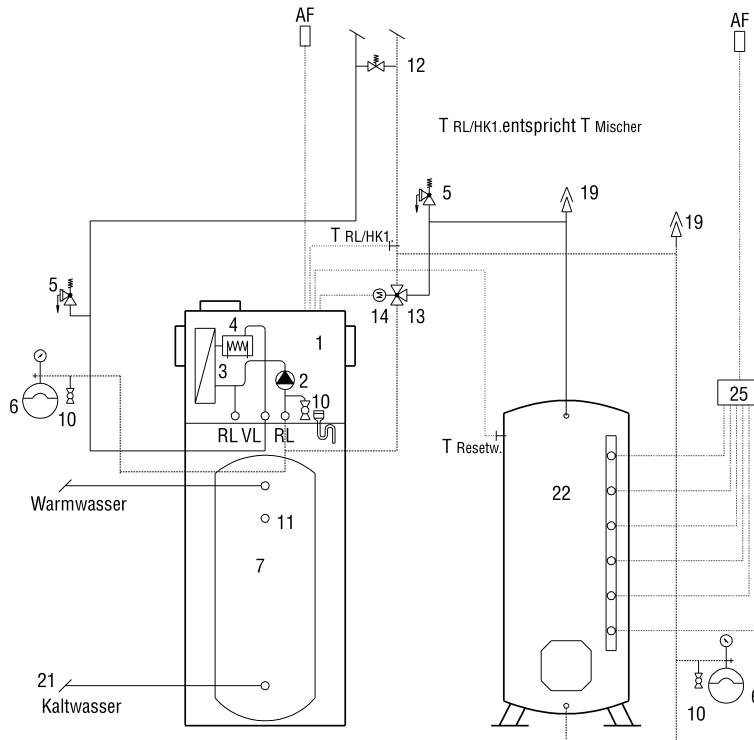


As standard, the AWP is equipped to control a second heating circuit with another forward flow temperature. The second heating circuit must be equipped by the customer with a mixer servomotor and a circulation pump.

- 1 - ventilation unit with heat pump
- 2 - circulation pump, heater
- 3 - condensor of the heat pump
- 4 - electrical re-heating
- 5 - safety valve
- 6 - expansion tank
- 7 - service water reservoir
- 9 - non-return valve
- 10 - filling and drainage cock
- 11 - circulation connection
- 12 - overflow valve
- 13 - mixer
- 14 - servomotor for mixer
- 20 - stop valve
- 21 - safety group acc. to DIN 1988
- AF - external sensor
- VL - forward flow
- RL - return flow

## AWP 150

### Buffer battery



The AWP can be combined with a buffer battery. This permits the use of both inexpensive nighttime power and other sources of power. The discharge control is integrated in the AWP.

Please be aware that the solution shown can only be achieved with the AWP 150 and 200 versions, not with the AWP...S versions.

- 1 - ventilation unit with heat pump
- 2 - circulation pump, heater
- 3 - condensor of the heat pump
- 4 - electrical re-heating
- 5 - safety valve
- 6 - expansion tank
- 7 - service water reservoir
- 10 - filling and drainage cock
- 11 - circulation connection
- 12 - overflow valve
- 13 - mixer
- 14 - servomotor for mixer
- 19 - ventilation
- 21 - safety group acc. to DIN 1988
- 22 - buffer battery
- 25 - charge control
- AF - external sensor

## AWP 150

VL - forward flow

	Volumetric flow [m³/h]
Kitchen	40
Bathroom	40
WC	20
2. Bathroom	40
2. WC	20

	Volumetric flow [m³/h]
Living room	50
Office	30
Parents' bedroom	40
Children's room	30

RL - return flow

### Volumetric flow regulations - layout of the duct system

	Volumetric flow [m³/h]
Kitchen	40
Bathroom	40
WC	20
Total exhaust air volumetric flow	100

	Volumetric flow [m³/h]
Living room 24 m²	$24 \times 2.40 \times 0.4 = 23$
Bedroom 15 m²	$15 \times 2.40 \times 0.4 = 14.4$
Children's room 13 m²	$13 \times 2.40 \times 0.4 = 12.5$
Total supply air volumetric flow	49,9

## AWP 150

The German Ordinance on energy saving in buildings (EnEV) stipulates an air exchange rate of at least 0.4 for living units. The following guide values for the exhaust and supply air volumetric flows are valid here. This means that the air in odorous and humid areas such as kitchens, bathrooms and WCs must be extracted and the fresh air must be supplied to living-rooms and bedrooms.

The exact values depend on the quantity of air being supplied by the fans in use and the size of the rooms.

### Layout example:

Duct diameter [mm]	Maximum volumetric flow [m <sup>3</sup> /h]	Maximum flow velocity [m/s]
100	80	2,9
125	125	2,9
160	200	2,8

Design the layout of fans and the duct system, based on these specific supply and exhaust air volumetric flows.

### Duct dimensioning

The duct diameter to be installed, depends on the calculated volumetric flow:

Use smooth-walled folded spiral seams ducts for the duct system.

Ducts with rough inner surfaces should not be used for reasons of hygiene and flow.

### Opening for outgoing air

The outgoing air opening can be made in the roof as well as the walls.

Ensure that the cross section is sufficient for the corresponding planned volumetric flow.

Do not make openings on the prevailing wind side, in order to prevent problems caused by wind pressure.

Do not fit opposite windows of neighbouring houses.

### Exhaust and supply air openings

The supply air is supplied decentrally. Filtered fresh outside air flows into the supply air spaces via suitable supply air elements. The system must be laid out in such a manner that the supply air volume flow in the living area has a pressure that is no more than 8 Pa below that of the outside air. For instance, there are supply air elements that record the outside temperature using an integrated thermostat and control the opening of the valve.

In general, one opening per room is sufficient. In the case of rooms with more than 25 m<sup>2</sup> 2 openings should be used, in order to better ventilate the room.

Exhaust air openings:

- As close to the ceiling as possible.
- Close to sources of humidity and odours.
- As far away as possible from the door.

Supply air openings:

- In the upper area (2 m to 2.20 meters), left and right next to the window,
- Alternatively, window fans in the upper window frame.
- Not near seating areas.
- Close to radiators.
- As far away as possible from the door.

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### Duct layout

Pay attention to safety regulations when fitting the duct system:

- Observe the fire lobbies.
- Ensure that fire places can function.

The duct system must be fitted so that it is as short as possible, in order to guarantee better thermal insulation.

In addition to this, you must always ensure that the air flow generated is not noticeable and could not be considered to be intrusive.

If the controlled domestic ventilation system is installed as a retrofit, experience has shown that it is better to put the duct system in corridor areas. Suspended ceilings are also a good location for installing duct systems.

Other possible installation sites:

- On walls or sunk into the plastering.
- Floors.
- Floor paving.
- Jamb wall
- Cladded pitched roofs.

### Cooker extraction hood

It is forbidden to connect the domestic ventilation control system to a cooker extraction hood.

Extracted kitchen air is usually very greasy. This would contaminate the exhaust air ducts and the heat pump, which in turn will severely reduce the lifetime of these components.

### Sound insulation - duct system

There are 2 classes of sound disturbances, which can be emitted by controlled domestic ventilation systems:

- Sound transfers within the duct system, e.g. from fans in the central unit, telephonic sound.
- Flow sounds coming from the exhaust air openings.

Both classes of sounds can be prevented by taking different measures:

Disk valve - nominal size	Maximum volumetric flow [m <sup>3</sup> /h]
100	40
125	80

Sound absorbers in the exhaust air duct to the central unit absorb the sound of the fans.

Sound absorbers in each of the interconnected exhaust air duct branches prevent telephony effects.

Flow sounds first occur at specific volumetric flows, depending on the diameter of the openings. Therefore, the openings must be made large enough for the exhaust air flows, or else more openings must be provided. Alternatively, the supply air elements can naturally also be used in the sound insulated model.

### Thermal insulation - duct system

Temperature losses along the duct system reduce the degree of heat recovery.

Therefore the exhaust air ducts must be laid within the thermally insulated building envelope. In areas where this is not possible, e.g. in uninsulated attics, the exhaust air ducts must be insulated with approx. 50 mm thick insulating material.

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In principle, outgoing air ducts must be insulated with approx. 100 mm thick insulating material. An additional insulating steam-tight padding should be fitted, in order to prevent the insulation material from becoming soaked through. Damp insulation no longer provides the required insulation.

Here, you could use a padding of 30 mm Armaflex and additionally 50 mm of aluminium-foiled rock wool.

### Solar panels

Solar variant AWP...S must be used in conjunction with a solar panel system. By utilizing energy radiated by the sun, up to 60 % of the necessary energy for the hot water heating can be saved in an average year. The solar collectors required for this must be provided by the customer.

All solar panels have a coating made of highly transparent solar safety glass, that absorbs 91% of the sun's radiation. The selective absorber collects the short-wave light (absorption rate of 95%) and stores this as energy, whilst the selective coating blocks long-wave thermal reflection (maximum emission of 12%). Altogether the thermal insulation fitted on all sides of the solar panel housing reduces thermal losses to a minimum.

With optimum weather conditions, hot with full sun, the solar panels will heat up to 190°C. Even on a cloudy but bright day or in clear winter weather, the water temperature in the tank will still be between 40°C and 50°C.

The maximum water temperature in the tank is 65°C.

If special panels are installed, it may be necessary to install a solar control unit and to limit the maximum water temperature to 65°C.

### Regulations and conditions

The following regulations and conditions for mounting and operating exhaust air heat pumps must be taken into account:

#### Water installation

- DIN 475, sheets 1 and 2: Safety-related equipment of hot water heaters.
- DIN 1988: Technical regulations for drinking water installations.
- TRDS 721: Safety equipment protecting against excess pressure - safety valves.

#### Electrical installation

- DIN VDE 0100: Conditions for setting up high-voltage systems with a nominal voltage up to 1000 V.
- VDE 0701: Conditions for commissioning, modifying and inspecting used electrical devices.
- TAB: Technical requirements for connections to the low-voltage mains.

#### Coolant

- EN 378: Safety- and environment-relevant conditions.

#### Ventilation ducts

- DIN 1946 Pt. 1, Pt. 2, Pt. 6, Pt. 10: Room air technology.
- DIN 2088: Ventilation systems for domestic areas.
- VDI 2087: Air channels.

#### General conditions

- Summary of technical requirements for heated spaces, e.g. heated space guidelines/state building regulations, local building regulations, and commercial, fire brigade and legal anti-pollution conditions and regulations.
- TA-Lärm: Technical instructions for protection against noise.

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### Definitions

#### 3-liter house

A low-energy house in which the thermal insulation has been improved even more is called a 3-liter house. It has an annual heating requirement of less than 30 kWh/m<sup>2</sup>. In addition, a central heating system (with conventional burner technology or with a heat pump) is still required in Germany. Some sources also call 3-liter houses "ultra houses" or "ultra-low-energy houses"

#### Exhaust air

Air that is extracted from the living area.

#### Outside air

Air that is drawn in from the outside.

#### System energy performance index $e$

In DIN V 4701, Part 10: Energetic evaluation of system technologies, the system energy performance index is used to compare different system technologies used for heating, for heating drinking water and for ventilation. It describes the relationship between the primary energy absorbed by the system technology and the heat energy that it releases. The smaller the system energy performance index, the more economic the system technology in energy terms.

#### Blower-door test

See Air sealing of buildings.

#### Coverage

Non-dimensional degree of performance (0-1) that a system provides to cover the annual heating requirement or the drinking water heating requirement of a building or area.

#### Electrical effect ratio

This index compares the energy in the supply air flow that is provided by the ventilation unit to the consumed electrical output of all electrical consumers that are installed in the unit.

#### German Ordinance on energy saving in buildings (EnEV)

This gathers together the previous requirements of the Thermal Insulation Directive and of the Heating System Directive. It sets new standards for energy savings in new buildings. In addition, with existing buildings, the thermal insulation must be improved in certain cases and old, inefficient heat generators must be replaced.

#### End energy P

This is made up of the primary energy plus the secondary energy and the effort involved in transporting these to the limits of the building. This is then converted into power output - heating energy, light and mechanical (services) energy.

#### End energy requirement Q

The amount of energy that is required to cover annual heating energy requirements  $Q_H$  and drinking water heating requirements  $Q_W$  calculated at the system limits of the building in question, based on requirements placed on and effort required by the system technology. The additional amount of energy that occurs due to upstream process chains during the generation of the corresponding fuel used, are not taken into account.

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### Outgoing air

Air that is returned to the atmosphere.

### Heating limit temperature

This is the outside temperature, based on which, if it rises further, it can be assumed that heating of the building is no longer required due to solar and internal heating sources.

### Heating requirement, annual heating requirements (Q)

Heat that must be supplied to the heated rooms in order to maintain the internal target temperature. This corresponds to the "heat requirement" according to 3.1.14 of DIN EN 832 or DIN V 4108-6, if this is not determined using a ventilation heat requirement that is reduced due to heat recovery. If heat recovery is taken into account in calculations according to DIN EN 832 or DIN V 4108-6, the heating requirement according to the present provisional norm corresponds to the total of the annual heating requirement according to DIN V 4108-6 and QWR according to DIN V 4108-6, equation 50.

### Heating energy requirements Q

The energy that must be supplied to the heating system in order to cover the heating requirement (see 3.1.15 of DIN EN 832).

### Auxiliary energy H

The energy (power) that is not used directly to cover the heating requirement or the drinking water heat requirement (e.g. energy to drive system components - circulation pumps, controllers, etc., as well as energy for the pipeline heating in the case of drinking water heating).

### Yearly working index

Average annual value of the performance rate. It is the ratio of the annual available heat to the annual energy consumption. Among other things, it depends on the evaporation temperature of the coolant in the heat pump.

### Air sealing of buildings n50

The EnEV (German Ordinance on energy saving in buildings) requires an air-tight external envelope for buildings. This is a significant pre-requirement for the annual heating requirement that is already required for low-energy houses. The pressure difference between the inside and the outside of a building is measured with a pressure of 50 Pa. The air exchange that is then attained is a measure for the air-tightness of the building, in various regulations. This is measured using a blower-door test. This is always recommended. The air-tightness of the building is tested, possible leaks are detected and can be specifically eliminated.

### Humidity, relative

This describes the ratio between the actual water vapour content of the air to the maximum water vapour capacity at the corresponding temperature. The range in which people are comfortable is between approximately 40% (moving towards dry air) and 55% (moving towards humid air).

### Air quality

Air in buildings should be fresh and should contain as few pollutants or vapours as possible. It should not smell stale or stuffy. People have very different expectations of the air that they inhale. They react individually to increased carbon dioxide concentrations, the perspiration of other people or to furniture or office equipment. Due to the many components of air, there is no reliable or objective measuring procedure to evaluate the air quality of a room. The perceived air quality does not depend



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solely on the air-stress situation in the room. With the help of ventilation, the room air is continuously diluted with fresh air. The higher the rate of air exchange, the more positive the assessment of the room air quality by the people who are present.

### Hourly air exchange

The air exchange indicates how often per hour the room volume is replaced by the outside air current. It consists of the air exchange of the infiltration from leaks in the building and the current wind condition, the free air exchange through open windows and doors and the mechanical air exchange due to the ventilation unit. The overall air exchange for the building is in a range of 0.6 to 1.3 per hour. DIN 4701, Part 10, Energetic evaluation of heating and room air-related systems, specifies a mechanical air exchange of 0.4 per hour for the system comparison. This means that at the given operating level, the room volume is completely exchanged within 150 minutes.

### Natural ventilation

Natural ventilation means that the building itself is the ventilation system. It must then take on all the duties of a ventilation system on its own. In the case of large buildings, the consensus of opinion is that it is easier to install a mechanical ventilation system in the building than a natural one. Whenever there is a draught somewhere, if the paper blows off the table when the door is opened, if the flat smells of fish that is being prepared in another flat - this is natural ventilation, which has never really been got under control.

### Low energy house

A low energy house has an annual heating requirement of less than 70 kWh/m<sup>2</sup>a. In addition, a central heating system (with conventional burner technology or with a heat pump) is still required in Germany. New buildings must be constructed as low-energy houses, in accordance with the German Ordinance on energy saving in buildings 2002.

### Standard outside temperature

The lowest temperature value, averaged over two days, that was not exceeded 10 times in the period between 1951 and 1970. The values depend on location and therefore differ from city to city. In Germany, the standard outside temperature is generally in the range from -10°C to -16°C.

### Power output requirement

The energy that must be output by the heating system under standard conditions in order to cover the heating requirement and the drinking water heating requirement.

### Usable area A

According to the Energy Savings Directive, defined as  $A_N = 0.32 \text{ l/m} \times V_e$

### Passive energy house

A passive house is a building in which the heating requirement is so low, that you can dispense with a conventional heating system, without any loss of comfort levels. In Germany, this is the case if the heating requirement is less than 15 kWh/m<sup>2</sup>a based on the living area. This corresponds to a maximum heating load of 10 W/m. Taking into account all the house systems that require energy (heating, hot water, electrical equipment, etc), an overall amount of 120 kWh/m should not be exceeded.

### Primary energy Q

Primary energy is the term for the energy content of natural fossil and renewable energy sources. This includes, on the one hand, energy raw materials such as coal, oil, gas, etc. and, on the other hand, renewables sources of energy such as hydro-electric, biomass and solar energy. On the other hand, secondary energy is the term for the amount of energy in energy car-

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riers that can be obtained only after further processing primary energy carriers, such as electrical power, district heating or heating oil.

### Primary energy requirement Q

The amount of energy that is required to cover annual heating energy requirement QH and drinking water heating requirement QW (based on requirements placed on and effort required by the system technology), taking into account the amount of energy that is generated by the upstream process chains outside of the "building" system boundary during the production, conversion and distribution of the corresponding fuels used.

### Primary energy savings

The energy savings due to a ventilation unit depends on the degree of heat provision and on the electrical effect ratio. Balancing the recovered and the applied energy, results in potential savings based on the heating period and the ventilation heat requirement. The primary energy savings are then calculated from the energy savings and a correction factor on the applied primary energy.

### Heat recovery index

This is an index for calculating heat exchangers as the ratio of the temperature differences between supply air and exhaust air and between exhaust air and outside air. The loss and conversion heat flows of the fans and other installed equipment are not taken into account. The energy content of moist air, the latent heat, is also not taken into account.

### Secondary energy

See Primary energy

### Telephony

Sound transfer from one room to another through the duct system.

### Thermal heat recovery rate

Heat recovery parameters (exhaust heat source) from dry air, i.e. without taking any possible condensation into account. Does not contain heat from other sources, e.g. waste heat from a motor in the supply air flow. Only heat exchanger parameters, without taking into account other system components.

### Drinking water heating requirement Q

The heat energy that must be added to heat the desired amount of drinking water.

### Drinking water heating energy requirement Q

The energy that must be supplied to the drinking water system in order to cover the drinking water heat requirement.

### Overflow opening

An opening, through which the air will flow from one room to another, depending on the flow direction.

### Degree of heat provision

Heat recovery parameters (exhaust heating source) including the energy recovered due to any possible condensation. In addition to this, the heat from other sources that end up in the supply air flow, e.g. waste heat from a motor in the supply air flow, is included in the calculation. Therefore, these are parameters for the entire system, made up of heat exchanger, fans, etc.

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### Heat transmission coefficient (k value or u value)

The u value describes the quality of the thermal insulation. It is a measure of the heat loss in components. The lower the value, the better the thermal insulation and therefore the energy savings.

### Heat energy W

The energy that is used directly to cover the heating requirement or the drinking water heating. This type of energy can be, for example, oil, gas, wood or power.

### Heat recovery

This generally describes a purely temperature-related efficiency. It predicts to what degree the outside air will be pre-heated to the supply air temperature by the air-air heat exchanger. In this case, the exhaust air is cooled down to the outgoing air temperature.

### Heat recovery rate

This is defined in VDI standard 2071 as the ratio of the entering and exiting enthalpy currents and changes in temperature, humidity and density. In this manner, not only detectable, but also latent heat is taken into account. This index is used to balance the energy that is actually removed from the exhaust air current.

### Efficiency

The ratio of the targeted utilisable energy to the energy used in a conversion process is termed the efficiency of the conversion process, e.g. in power plants or heating systems.

### Central domestic drinking water heating system

A drinking water heating system in which the heat for the hot drinking water is generated in a unit within the living area and is transported via distribution ducts to several rooms within the living area. Water serves as the heat carrying medium. The distribution ducts are generally shorter than is the case for central systems to heat drinking water and do not have a circulation pump.

### Supply air

Air that flows into the living area.

### Supply air element

Defined opening of the external wall of a building to let outside air flow into the interior.