Criteria and Algorithms for Certified Passive House Components: Heat Pumps for Space heating, Cooling and DHW Production

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This document relates to different categories of heat pumps (HP).

If a combination of heat pumps with ventilation systems (MVHR) is regarded, see the reference to the criteria for "ventilation systems" respectively [PH ventilation 2025].

Several heat pump configurations are covered:

- Compact Heat Pump Systems, combining MVHR and HP for space heating, domestic hot water (DHW) preparation and possibly space cooling
- Single split HP units with recirculated air for heating and cooling
- Combined Ventilation and Split Units for heating and cooling, without DHW production
- Monobloc or split air-to-water HPs
- Packaged terminal air conditioners (PTAC/PTHP)
- Stand-alone dehumidifiers

Certificate: approved thermal quality

The market for highly energy-efficient buildings is expanding rapidly, and the demand for reliable high-performance components is growing. However, requirements and possibilities for achieving high efficiency are often unclear with some manufacturers specifying characteristic values which they cannot guarantee.

The Passive House Institute certifies highly energy-efficient components according to international criteria, in order to meet the requirements for comfort, hygiene and energy efficiency. In the context of the certification process, the Institute provides advice to manufacturers in relation to the optimisation of their products. This results in improved, future-proof products and reliable thermal characteristic values for input into energy balance software programmes.

Advantages of certification:

- Consultations relating to product development for highly efficient buildings
- Access to a growing market
- Increased market visibility and product recognition
- Independently tested & certified: use of the Passive House Component Seal
- Inclusion in the Component Database of the Passive House Institute
- Incorporation into the PHPP energy balance software programme for buildings

Passive House Institute

The **Passive House Institute** (PHI) is an independent research institute which has played a decisive role in the development of the Passive House concept. The Passive House Standard is the only globally recognised energy standard for buildings which stands for tangible and verifiable efficiency values.

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All products certified by the PHI are accordingly listed in the **Passive House Component Database** and made accessible to the international public. Integrated tools and information offer a high added value for building owners, designers and manufacturers.

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PHPP

The **Passive House Planning Package (PHPP)** is a cost-saving energy balance tool for highly energy efficient buildings. It has been validated on the basis of measured projects, provides precise results and can be used reliably by all.

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iPHA

iPHA, the International Passive House Association is the PHI's network of experts which is committed to the propagation of the Passive House concept and the dissemination of the relevant expertise and information. It brings together scientists and building owners as well as architects, designers and manufacturers.

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1 Preface

Passive House buildings allow to reach optimal thermal comfort with very low energy expenditure; they lie within the economically profitable range with reference to their life-cycle costs. To achieve this level of comfort and low life-cycle costs, the thermal quality of the components used in Passive Houses must meet stringent requirements. These requirements are directly derived from the Passive House criteria for hygiene, comfort and efficiency as well as from feasibility studies. The Passive House Institute has established component certification in order to define quality standards, facilitate the availability of highly efficient products and promote their expansion, and to provide planners and building owners with reliable characteristic values for input into energy balancing tools.

Passive House suitability with respect to building services components is mainly verified using the heat recovery of the air-to-air-heat exchanger (mechanical ventilation systems with heat recovery, MVHR) and the electric efficiency of heat pump systems that produce heating or cooling.

For the verification the electricity demand of a reference Passive House with different floor areas is calculated, and limiting values are given as criteria to be fulfilled. The performance of domestic hot water (DHW) production will be tested and evaluated where applicable.

2 Criteria and requirements for the ventilation

2.1 General information

The ventilation part of combined systems, such as Compact Heat Pump Systems or Combined Ventilation and Split Units for ventilation, heating and cooling must fulfill the certification criteria for ventilation systems suitable for Passive Houses, which are described in a separate document [PH ventilation 2025]. All the qualities described there, such as thermal efficiency of heat recovery and electrical efficiency of fans, airtightness of the system, air quality and respective filter quality, standby losses, sound level limitations, comfort requirements, and frost protection performance must be achieved. The definition of the operational range with respect to the airflows and the testing procedure for the ventilation part are described in this document as well.
If a heat pump is combined with a ventilation system, further requirements may apply. In general, it is important for every ventilation unit to make sure that outdoor (ODA) and exhaust (EHA) air mass flows are always balanced.

Combined systems may be equipped with recirculation airflow on the ODA/EHA and/or on the ETA/SUP side in order to increase their capacity or efficiency. In this case it must be verified that the tested unit is equipped with an appropriate balance control.

2.2 Test conditions and requirement

The measurements should be carried out with the external static pressure values as defined in [PH ventilation_2025]. These are to be adjusted for maximum recirculation airflow and the net ODA / EHA airflows as defined for simple ventilation units in [PH ventilation 2025], i.e. in the centre of the operational range. The settings of the orifices that adjust the external pressure stay the same for all measurements, regardless of any changes in the airflow rates.

If a manual re-adjustment of the balance is required for the tested unit, this should be done before starting the measurements. No further manual re-adjustment of the airflow balance is admissible after the beginning of the measurements. Any re-adjustment during the test has to be performed automatically by the tested unit itself, i.e. its control system ─ without influencing it by laboratory staff.

All airflow values have to be logged (10 sec intervals) throughout the tests, so that the behavior of the system can be tracked later. All results with all logged data and time steps must be provided to PHI.

The disbalance is defined as

$$\frac{|\dot{m}_{ODA} - \dot{m}_{EHA}|}{\dot{m}_{ODA,net}}$$

where $\dot{m}_{ODA,net}$ is the ODA mass flow rate without recirculation. The maximum disbalance allowed is 10%. Short periods of higher disbalance during stabilisation of the fans and the airflow control of the system are permissible.

The test report should include disbalance values for all typical recirculation airflow rates, including part-load operation of the heat pump.

3 Criteria and requirements

The following sections describe the testing procedure for energy efficiency, thermal comfort, and acoustic and hygienic assessment of **heat pump systems** using electric compressors (from now on referred to as “tested unit”).
For certification of heat pumps as “components suitable for Passive Houses”, the tests described below must be carried out by an independent inspecting authority (testing laboratory) approved by the Passive House Institute. All measured data and documentation for the tested unit must be made available to the Passive House Institute.

The manufacturer must provide a standard (off-the-shelf) unit for testing to the testing laboratory. Specially prepared devices will not be accepted for testing and must be taken back at the cost of the manufacturer. The inspecting authority must guarantee a testing procedure in accordance with these testing regulations.

3.1 Types of heat pump systems

Several setups of heat pumps and combinations of heat pumps with MVHR units are possible. Those which are most likely to be used in Passive House buildings and therefore can be submitted for testing and certification by PHI are listed here. Further different setups may be added later to this list.

3.1.1 Compact Heat Pump Systems: HP combined with MVHR

The ventilation system is combined with a heat pump for space heating, domestic hot water (DHW) preparation, and possibly space cooling. Heating and cooling is realized via the supply air. The exhaust air, possibly mixed with additional outdoor air, is used as a heat source. All components are integrated in one unit to form the 'classic' Compact Heat Pump System for Passive House buildings.

3.1.2 Combined Ventilation and Split Units

The ventilation system is combined with a heat pump that is typically used for space heating and cooling. The interior unit usually allows for a certain amount of recirculated air, thus increasing the heating and cooling capacity. A dedicated dehumidification function may be included. The systems are combined with an air source heat pump like in a mini-split that uses outdoor air as a heat source / sink.

3.1.3 Heat Pumps according to EN 14825

These standalone HP systems provide space heating and/or space cooling, but no MVHR. Typically, these are air-to-water or air-to-air systems. They are certified by evaluating a data set according to EN 14511 and EN 14825.

3.1.4 Single split heat pumps with recirculated air for heating & cooling

The testing procedure can be applied to single air-to-air split units.

3.1.5 External air-to-water heat pump combined with ventilation

Such systems may be regarded and tested as two separate units, but the interconnection and interaction has to be defied in some detail to get a sufficiently accurate modelling, see section 4.7

3.1.6 Packaged Terminal Heat Pumps (PTHP)

Packaged terminal heat pumps include a compressor and a fan coil in a single housing which is located in each living room next to the outside wall, often in a sleeve below the window. Through a (large) wall opening outside primary circulation airflow is collected to provide outdoor air (the source). The systems have to be airtight and thermally insulated to the outside as in off-mode outdoor temperature may affect the living space. Noise transfer from the outside and noise emissions from the compressor are other issues to be checked carefully.

3.1.7 Heat pump water heaters

DHW storage tanks can be combined with a small heat pump on top to produce heat for DHW in the tank. The heat pump can use different heat sources: outdoor air, exhaust air coming from a ventilation system, or indoor air.

For certification, only systems with outdoor air connection are considered, using the corresponding test points, see section 4.3.

3.1.8 Further combinations

As the variety of combinations is large new systems are welcome and will in the first place be regarded with respect to their parts ─ HP + ventilation. Please contact PHI.

3.2 Definition of limiting values

3.2.1 Efficiency Requirement for Heat Pump and combinations

The tested unit is assessed based on its final energy demand for a particular size of building. A matrix of different floor areas is calculated and the results are given as a table. The calculation is carried out for a typical Passive House and for up to 3 different climates:

- Hot, humid climate: Shanghai
- Hot, dry climate: Las Vegas
- Heating climate: Mannheim

The limiting values for the final energy demand are:

- 13 kWh/(m² year) for sensible/latent cooling in the hot and humid climate
- 11 kWh/(m² year) for sensible cooling in the hot and dry climate
- 9 kWh/(m² year) for space heating in a heating climate
- If a combined system can provide domestic hot water (DHW) with the heat pump an additional electricity demand of 11 kWh/(m² year) is allowed.

For units that provide ventilation (Compact Heat Pump Systems, Combined Ventilation and Split Units, etc.) the electricity for the ventilation system is not included in these limiting values.

3.2.2 Example: Efficiency Requirement for Compact HP Systems

For Compact Heat Pump Systems providing space heating, ventilation and domestic hot water (DHW) the limiting value for energy efficiency is a final energy (electricity) demand of 20 kWh/(m² year).

The demand is verified by calculating the energy balance for a Passive House reference building using the PHPP, with a standard climate data set typical for Mannheim. The Passive House reference building has a heating load of 12 W/m², a space heating demand of 15 kWh/(m²a) and a specific heat demand for DHW of 18 kWh/(m²a).

As for any mechanical system the size of the HP unit must match the required heating or cooling load, respectively, of the reference building. Thus the useful range of operation of a heat pump unit is calculated by varying the size (treated floor area, TFA) of the reference building to check if the power of the HP unit is matching the reference building. The limits of the useful range of the tested device are given by that size of the reference building for which the above-mentioned (section 3.2.1) limit values for the electricity demand are still fulfilled. Besides that, the useful range is restricted by the minimum and maximum air flow of the ventilation part as defined and tested according to [PH ventilation 2025]. This maximum useful range of the unit with respect to the building size is given in the certificate.

The final energy demand (electricity) and the corresponding SPF of the unit installed in the reference building are calculated as an average value over the useful range of the unit in m² (TFA) of the reference building. This average value is given in the certificate, too, but only as an additional information.

4 Test procedure for heating and cooling

4.1 Overall description of heat pump features to be tested

The evaluation of the operation of a heat pump should be carried out by separate measurements apart from those considering the ventilation part described in [PH ventilation 2025]. Depending on the system, the testing may include the following:

- Acoustical testing, may be done together with ventilation, but HP running
- Determination of the capacity and the COP of the heat pump for space heating and cooling
- Determination of the capacity and the COP of the heat pump for DHW production
- Testing of DHW storage losses
- Testing of standby losses
- Checking/evaluation of the frost protection strategy of ventilation heat recovery, e.g. hot gas defrosting

If heating is provided by a hydronic heating system, the test must be carried out at the flow temperatures for the type of heating system specified by the manufacturer, e.g. 35 °C for underfloor heating or 55 °C for radiators or for supply air heating. Preferably, both temperature levels should be tested.

For systems that allow for DHW production in a separate storage tank, e.g. typical air-to-water heat pumps, test points at a flow temperature of 55 °C must be provided. An additional test point at 20 °C ambient air temperature is required for these systems to determine the performance of the heat pump during DHW production in summer.

4.2 Test data collection and documentation

A time step of 10 sec. for logging of data should be chosen. All measurements must be continuous and documented graphically and by data files (e.g. .csv). All results must be provided (with all logged data for all time steps) as data files to PHI. The calculation formulas included in (Excel) data files must be included for any other than measured (logged) values. Calculated values for the heating or cooling capacity of the unit, the COP etc. have to be shown as such, so that the calculations can be tracked. Any odd behaviour of the unit must be documented.

4.3 Test points for heating

Certification is possible based on the test points given in the table in this section.

The humidity requirements for the indoor air are only relevant for systems where the exhaust air is part of the heat source, particularly Compact Heat Pump Units.

Table 1: Test points for heating

Outdoor air conditions									
dry-bulb temp.	ϑ	[°C]	-22(4)	-15(4)	-7	2	7	20	ϑ_{min}(5)
relative humidity	Φ		–	–	0.72	0.84	0.87	0.50	< 0.80
dew-point temperature	ϑ_d	[°C]	–	–	-10.7	-0.4	5	9.3	(5)
humidity ratio	W	[g_w/kg_{da}]	–	–	1.5	3.7	5.4	7.3	(5)
wet-bulb temp.	ϑ_{WB}	[°C]	–	–	-8	1	6	13.8	(5)
Indoor air conditions									
dry-bulb temp.	ϑ	[°C]	20	20	20	20	20	20	20
relative humidity	Φ		< 0.24	< 0.28	0.312	0.459	0.58	0.58	(5)
dew-point temperature	ϑ_d	[°C]	< -0.8	< 0.8	2.5	8.0	11.4	11.4	(5)
humidity ratio	W	[g_w/kg_{da}]	< 3.5	< 4	4.5	6.7	8.4	8.4	(5)
wet-bulb temp.	ϑ_{WB}	[°C]	< 10	< 10.5	11.0	13.2	14.9	14.9	(5)
Operation modes									
ON / OFF (1)			opt	opt(3)	opt	opt	req(3)		
ON / OFF Limit (2)			opt	opt	opt	opt	req		
Maximum			req	req	req	req	req		
(6) Required test points according to the climate zone for which the system is to be certified									
Outdoor air temperature	ϑ	[°C]	-22	-15	-7	2	7	20	ϑ_{min}(5)
arctic			req	req	req	req	req	Only for heat pump with DHW production	Only if not included in the other test points
cold			-	req	req	req	req		
cool, temperate			-	-	req	req	req		
warm, temperate			-	-	-	req	req		
warm			-	-	-	req	req		
hot			-	-	-	-	req		
very hot			-	-	-	-	req		

Explanations for Table 1

(1) approx. 20% of the capacity available at the test point ON/OFF Limit

(2) smallest capacity of the tested unit available at continuous operation (if the capacity were to be decreased further, the tested unit would start to switch on and off). This information must be supplied by the manufacturer or found by measurement. In case none of these are available/possible, please check with PHI how to proceed.

(3) For variable capacity units it is preferable to carry out the measurements using the unit's control system (same control settings as in a serial / off the shelf unit operating in a real building), including the ON/OFF operation. In that case, the test chamber may have a heat capacity of up to 5000 Wh/K per kW of maximum capacity at -7 °C outdoor temperature. Hardware-in-the-loop experiments are permissible.

Alternatively, the unit is cycled on for 6 min and then off for 24 min for an approximately 20 % part load by switching on and off the compressor only.

(4) As at these temperatures the humidity ratio is very low and has only a minor influence, there are no humidity requirements.

(5) ϑ_{min} is the lowest outside air temperature at which the heat pump is still operating. The value may be specified by the manufacturer and will be shown in the certificate. If ϑ_{min} is equal to the ambient temperature in one of the other measurements, no extra testing is necessary. The humidity ratio of the indoor air is 3 g/kg higher than the humidity ratio of the outdoor air.

(6) Depending on the climate zone for which the system is to be certified not all test points are required. E.g. for cool temperate climate only test points at -7 °C, 2 °C and 7°C are required.

The test points are similar to those of EN 14825.

The manufacturer may specify the climate zones (cf. Figure 5) for which the unit is to be certified. Table 1 shows which test points are required in each climate zone.

All measurements should start after reaching a (quasi-)steady state situation in the climate chamber.

Measurements at 2 °C and -7 °C must include at least one full defrost cycle, i.e. the time from e.g. the beginning of one defrost process to the beginning of the following defrost process must be evaluated.

Any direct electrical heater, which may be present in the unit, should be switched off during the heating measurements. If switching off is not possible this electric consumption has to be documented separately and will be subtracted during later evaluation.

4.4 Test points for cooling

Certification is possible based on the test points given in Table 2 in this section.

The humidity requirements for the outdoor air are only relevant for systems with ventilation function where the supply air passes over the cooling coil, particularly Combined Ventilation and Split Units.

Table 2: Test points for cooling.

Outdoor air conditions					
dry-bulb temp.	ϑ	[°C]	35	30	25
relative humidity	Φ		0.50	0.50	0.5
dew-point temperature	ϑ_d	[°C]	23.0	18.5	13.9
humidity ratio	W	[g_w/kg_{da}]	17.8	13.3	9.9
wet-bulb temp.	ϑ_{WB}	[°C]	26.2	22.1	17.9
Indoor air conditions					
dry-bulb temp.	ϑ	[°C]	27	27	27
relative humidity	Φ		47	47	47
dew-point temperature	ϑ_d	[°C]	14.7	14.7	14.7
humidity ratio	W	[g_w/kg_{da}]	10.5	10.5	10.5
wet-bulb temp.	ϑ_{WB}	[°C]	19	19	19
Operation modes					
ON / OFF (1)			optional	required(3)	optional
ON / OFF Limit (2)			optional	required	optional
Maximum			required	required	required

For annotations (1) to (3) see those annotations for Table 1 in section 4.3.

The test points are similar to those of EN 14825. For heat pumps with cooling function, all three test points given in Table 2 are to be measured, independently of the climate zone.

Any additional humidity-control functions (e.g. reheating) are deactivated during these measurements.

For units provided with an automatic humidity-control function, e.g. by an integrated reheating of the air leaving the coil, additional measurements have to be carried out for the test points “ON/OFF Limit” and “Maximum” at 30 °C ambient temperature as described in Table 2 above. For these measurements the humidity-control function must be activated, aiming to decrease the sensible heat ratio as far as possible, but not below zero (isothermal dehumidification). This is to be achieved by the standard control system settings as being used in real operation. No special adjustment of software for this particular investigation is allowed.
The dehumidification process, the hardware used and the applied software algorithms have to be described by the manufacturer and have to be confirmed by the testing laboratory.

4.5 Special aspects for certain heat pump systems

4.5.1 Testing air-to-water heat pumps ─ EN 14825 or EN 14511

If a full data set according to EN 14825 (average, warmer and colder climate, 35 °C and 55 °C flow temperature) is available for an air-to-water heat pump, it can be used for certification. No further measurements are necessary.
The same is valid for single speed compressors if data sets according to EN 14511 are available.

4.5.2 Silent mode testing for split units

For all systems that use recirculated indoor air, in particular split units, all measurements have to be carried out in silent mode. Indoor noise emissions in silent mode have to fulfill the requirements described for MVHR systems: To avoid user complaints about the ventilation system, the overall indoor noise emission of the system must be lower than 25 dB(A), see [PH_ventilation_2025].

The advantage of this procedure is that for certified products no general reduction of capacity and efficiency needs to be applied in the PHPP energy balance calculations.

4.5.3 Compact Heat Pump Systems

For Compact Heat Pump Systems with their combination of ventilation heat recovery, exhaust air heat pump, supply air heating and an integrated DHW tank, a specific test procedure has been defined. The heating and cooling related aspects are detailed in this section.

4.5.3.1 Additional ODA circulation airflow

If a tested unit uses additional (recirculation) outdoor air (ODA), this must be communicated with the Passive House Institute before measurements start. The amount of recirculated air and its control need to be specified in more detail and these should correspond to the values being used in real operation. Additional electricity consumed by the recirculation fan (if provided) is to be included in the COP/EER values.

4.5.3.2 Testing conditions during space heating operation mode

Depending on the functions provided by the tested unit, the following investigations are required. The measurement is done for the temperatures given in Table 1. The only exception for Compact Heat Pump units: instead of ϑ_{ODA} = 2°C from Table 1 use ϑ_{ODA} = 4°C with ϑ_{ETA} = 20°C and relative humidity (ETA) = 0.50 (humid test) to align for the testing procedure described in [PH ventilation 2025].
In addition the air flow rate for measurement is the nominal airflow rate as described in [PH ventilation 2025], which is within the useful range of the ventilation part of the unit. Please note: this nominal air flow rate is similar but not exactly the same as q_{vref} from [EN 13141-7]. If the difference is small, the measurement can be done with q_{vref}. Please check with PHI.
If those in Table 1 specified low ϑ_{ODA} temperatures cannot be tested with the unit's heat pump, the lowest possible temperature ϑ_{ODA} should be used and recorded in the documentation. The humidity of the extract air should be set 3 g/kg higher than that of the outdoor air, as specified in Table 1. This will prevent condensation in the heat exchanger.
All measurements should be carried out using the factory-set parameters. If possible, additional electrical heating should be turned off during the test procedure. If this is not possible, the power consumption for any electrical heating must be measured and then deducted. It must be ensured that the DHW in the tank is not heated during the test.

4.5.3.3 Evaluation of COP and capacity of Compact Heat Pump Systems

The COP of the heat pump in heating operation is calculated according to the following equation:

$$COP = \frac{Q_0 + P_{el}}{P_{el}}$$

where:

Q_0: enthalpy extracted from the exhaust air and *additional outdoor air* in the evaporator.

$$\mathbf{Q_0 = m_{exhaust} * (h'_{exhaust} - h''_{exhaust}) - m_{wp} * (h''_{exhaust} - h_{outdoor\ air})}$$

$m_{exhaust}$: air mass flow out of the passive heat recovery system (EHA) before it enters the evaporator of the heat pump

m_{WP}: additional outdoor air (ODA) mass flow drawn in to operate the heat pump.

$h'_{exhaust}$: specific enthalpy of the exhaust air before it enters the evaporator (after the heat recovery, matching temperature as defined in [PH ventilation 2025] (EHA)

$h''_{exhaust}$: specific enthalpy of the exhaust air behind the evaporator (EHA)

$h_{outdoor\ air}$: specific enthalpy of the outdoor air (ODA)

P_{el}: electricity consumption of the compressor, internal pumps and auxiliary fan for additional outdoor air, if applicable. This value can be determined from

$$\mathbf{P_{el} = P_{total} - P_{vent}}$$

where

P_{total}: total electricity consumption of the Compact Heat Pump System

P_{vent}: electricity consumption of the Compact Heat Pump System in ventilation mode at the same supply and extract airflow rates

Besides this, the thermal output of the heat pump at the ODA/SUP branch of the system must be recorded for the various test points.

For heat pumps combined with an MVHR, e.g. Compact Heat Pump Systems or Combined Ventilation and Split Units, the performance of the ventilation part of the system, especially the temperature ratio of the heat recovery, must be measured separately for all test points (compressor OFF mode). This is required to allow for a separate assessment of the effects of the ventilation heat recovery and the heat pump, see [PH ventilation 2025].

Important hint: To access the enthalpy of the exhaust air after the heat recovery the temperature and humidity measurements are to be carried out on all airflow streams and additionally (if the structure of the unit allows it, see below) in a position right after the heat recovery core before the fresh air stream and a possible recirculation air stream mix. This is especially important to provide the performance of the heat pump separately from the performance of the passive heat recovery of the MVHR part of the system.

If the tested unit does not allow for additional sensors installed right after the heat recovery, the tests have to be carried out once with HP OFF to get the data for sole HR operation and $h'_{exhaust}$ according to [PH ventilation 2025] and then once again with HP ON to get the data $h''_{exhaust}$ which gives the contribution of the HP. These two measurements have to be done carefully under the SAME conditions (airflow, humidity, etc.) as the evaluation depends sensitively on the difference of h' – h'' as described above.

It is crucial to measure the temperature and humidity at all 4 duct connections (EHA, EXT, SUP, ODA) at the time resolution specified in section 4.2. Although Q_0+P_{el}, a quantity based on the enthalpy extracted from the EHA or ODA, is the correct amount of heat delivered to the thermal envelope, it is often difficult to measure the humidity of the EHA accurately. During evaluation of the data by PHI possible inaccuracies can be detected and corrected, provided all 4 air conditions are known.

4.5.4 Space cooling by Compact Heat Pump Systems

Compact Heat Pump Systems which can provide cooling to the supply air are often not able to cover the full 12 W/m² cooling load of the reference building. Therefore, a detailed evaluation of the cooling efficiency is not possible. In that case the available cooling capacity and the corresponding COP at 35 °C / 27 °C from the laboratory test report are given as additional information in the certificate.

4.6 Frost protection for ventilation heat recovery by hot gas

For systems that provide a ventilation function with heat recovery, particularly Combined Ventilation and Split Units and Compact Heat Pump Units, the frost protection settings for the heat recovery core at low temperatures are evaluated based on the measurements taken in accordance with the descriptions in [PH_ventilation_2025].

Frost protection of the heat recovery is often realized by a direct electric pre-heater. A more efficient option is to use the hot gas of the heat pump instead of electric preheating. If the tested unit has this feature, the manufacturer has to describe the frost protection strategy of the system in detail, so that it can be clearly decided if direct electricity for frost protection is needed or not. This information has to be cross-checked and confirmed by the laboratory and has to be documented in the test report.

No additional measurements with / without hot-gas preheating are required in this case. The extra heat used for defrosting out of the hot gas is automatically included for each test point below -3 °C ODA temperature.

4.7 Stand-alone dehumidifiers

Dehumidifiers that are placed inside the building and directly act on the indoor air are tested at indoor conditions of 25 °C / 60% relative humidity.

The tested units have to achieve an efficiency of at least 1.8 l/kWh in continuous operation. This is equivalent to a COP of 1.25.

4.8 Packaged Terminal Heat Pumps (PTHP)

The following paragraphs describe the special testing procedure and performance requirements with respect to acoustics, airtightness and heat losses of wall type air-to-air heat pumps, also called “Packaged Terminal Air Conditioner” (PTAC), with integrated electric compressors, from now on referred to as PTHP.

If a sleeve (frame for installation in the wall), silencer or similar is part of delivery of the tested unit, this part must be included in all measurements. The installation in the test rig has to follow the manufacturer’s instructions. No additional measures such as air sealing should be allowed.

4.8.1 Acoustical testing

See section 4.10 for general acoustic testing requirements.

4.8.2 Airtightness

The external airtightness of the tested unit is to be investigated, i.e. the leakage between the interior and the exterior of the building that is caused by the tested unit. For the test, the PTHP is installed following the producer`s instructions, without additional air sealing.

The measurement is performed following the method described in EN 13141-8. The airtightness test is to be carried out for a negative and a positive pressure difference. The measurements are to be made at ± 50 Pa pressure difference. The airflow rate which is necessary to maintain the static pressure difference between the interior and the exterior is determined. The limit for airtightness is a leakage **airflow of 3 m³/h per tested PTHP**.

4.8.3 Heat losses through PTHP installed on façade

The transmission heat loss of the PTHP to the outside in stand-by mode is to be measured (compressor and fans are turned off during the measurement). The installation of the unit should follow the producer’s instructions and must correspond to the installation in real operation (building installation).

The limit value for **heat loss is 1 W/K per PTHP-unit.**

4.8.4 Energy efficiency of PTHP

The seasonal performance of the PTHP with respect to cooling and heating is evaluated according to the other heat pumps, see sections 4.1 to 4.4 above.

4.9 Hygienic requirements

Devices providing cooling below the dew point, like split units, PTHPs or Combined Ventilation and Split Units, have to provide hygienic drainage for the condensate and must provide adequate maintenance and cleaning options. Mould growth inside the cooling coil and drainage area must be avoided. Instructions for cleaning the unit must be provided by the manufacturer. Access to the filters and drainage system for the condensate is to be described. The user must be able to access the filters without the need for assistance from professionals. It must also be possible for the user to open the internal unit in order to carry out the basic maintenance (including cleaning of the heat exchanger). The drainage of the condensate from the internal unit is to be evaluated according to EN 14511-4. The construction of the drainage system must allow immediate draining of condensate from the unit in order to avoid mould growth.

4.10 Acoustics

As already mentioned in section 4.5.2 the noise emission for heat pump systems, which provide and use recirculated indoor air the have to be kept at a quite low level not to bother people in their living and sleeping rooms.

4.10.1 Split indoor units: similar requirements as for ventilation units

In particular for split units, all measurements have to be carried out in silent mode. Indoor noise emissions in silent mode have to fulfil the requirements described for MVHR systems: To avoid user complaints about the ventilation system, the overall indoor noise emission must be lower than 25 dB (A), see [PH_ventilation_2025].
The advantage of this procedure is that for certified products no general reduction of capacity and efficiency needs to be applied in the PHPP energy balance calculations.

4.10.2 Special requirements for PTHP – noise emission / transmission

The methods described in the standards EN 12102 [1] and ISO 3743-2 [2] are to be used to determine the sound power level of the PTHP unit. If the laboratory used is not equipped with a special reverberation test room, the ISO 3743-1 [3] standard can be followed instead.

4.10.2.1 Acoustics ─ inside unit audible indoor

The highest permissible value of the sound pressure level of the inside unit is **25 dB** (A) in order to consider room comfort (this value is assuming a room equipped with furniture). All subsequent measurements of the efficiency must therefore be carried out with a speed of the compressor and an airflow generating a maximal sound pressure level of 25 dB(A) indoors.

The tested unit must be positioned / fixed according to the manufacturer's instructions. The entire frequency spectrum (31.5 Hz – 8000 Hz) of the housing emission has to be recorded. Specification of the acoustic power in third-octave band steps as a table and as a diagram have to be delivered.

4.10.2.2 Acoustics ─ the unit audible to the outside

The measurement of the sound power level to the outside of a building (neighborhood) is mandatory as it could be a decisive factor for the selection of a unit in some projects. The result of the measurement is reported in the certificate, but there is no specific requirement because the accepted level of noise being generated by the unit depends on the local requirements.

4.10.2.3 Sound reduction index for outdoor noise coming to indoor rooms

A measurement of the sound reduction of the PTHP as installed in the façade is to be performed according to ISO 10140-2, which describes a measurement of outside airborne sound level reduction for ─ the audacity of outside noise in indoor rooms.

This measurement must be taken in order to provide adequate design values. The sound reduction index must be better than 35 dB. Reference is made to DIN 4109 for areas of category III (65 dB(A)).

5 DHW – storage losses, heating and reheating for heat pump systems with integrated DHW storage

Compact Heat Pump Systems, Heat Pump Water Heaters (HPWH), and similar systems include a DHW storage that is heated by a heat pump and, if required, an additional electric resistance heater. To calculate the energy required for DHW production and to determine the influence of the system on the energy balance of the whole building, the following data and parameters are required:

- the heat losses of the storage tank (U*A in [W/K]) and the corresponding DHW temperature ϑ_{tank}, both of which will mainly determine the standby losses U*A*(ϑ_{tank}-ϑ_{room}) of the DHW system. Note that for stratified storage tanks no single water temperature in the storage exists. Here, the combination of U*A and ϑ_{tank} is relevant.
- the capacity, delivered heat, used electricity and COP of the heat pump for heating up the storage
- the capacity, delivered heat, used electricity and COP of the heat pump for reheating the storage after tapping
- For compact heat pump units, the performance indicators for DHW production are determined at the nominal reference air flow rate as defined for the ventilation component in the context of determining the operational range; see section 4.5.3.2 above and [PH_ventilation_2025].

The European test standard for DHW heat pumps, EN 16147, determines overall efficiencies of DHW heat pumps for specific load profiles including storage losses. Its main purpose is to provide these data for the use on energy labels. The results from this test can also provide some of the above characteristics with sufficient accuracy, but additional measurements are required.

This section describes different possible test methods. The methodology described in section 5.1 is believed to provide the best accuracy at the lowest effort. Other options, some of them making use of test results from established standards, are described in the following sections.

For all tests a heat meter has to be installed at the storage tank measuring the tank entering and leaving water temperatures and the heat withdrawn from the tank during tapping. All temperatures and heat flows are to be recorded at least every 10 s. For systems where DHW production depends on the ventilation, the tests have to be done at an airflow rate within the useful range of the ventilation system, see [PH_ventilation_2025].

If the system needs additional recirculated outdoor air for the evaporator to provide enough power for DHW production, the extra electricity consumption of the fans has to be measured so that it can be included in the electricity consumption for DHW production. This extra outdoor air must be recirculated to the outside, not into the building. On the other hand for Compact Heat Pump Systems the electricity consumption assigned to the heat pump does not include the electricity needed to run the ventilation function (MVHR) to provide the basic / standard ODA/SUP and EHA/EXT airflows. The electricity needed for the MVHR operation has to be subtracted from the total electricity consumption of the unit when regarding the DHW production. For this purpose it needs to be identified, typically during the ventilation test or during the off cycle. Any additional electricity consumption that occurs due to heat pump operation, e.g. for additional ODA recirculation, has to be taken into account as part of the electricity required for DHW production.

The test conditions should be set as described in section 4.3 (see Table 1 for air conditions, use of electrical heater coils, etc.).

5.1 Specific test method for evaluation of a stratified DHW tank

The test described here includes some modifications compared to the test in EN 16147. For repetitions of the test at other ambient temperatures, the phases 1 to 4 may be omitted. If U*A is determined following the procedures described in sections 5.2.1 or 5.2.2 below, phase 1 to 6 may also be omitted. The DHW temperature set point is 50 °C or as close to this value as the tested unit permits.

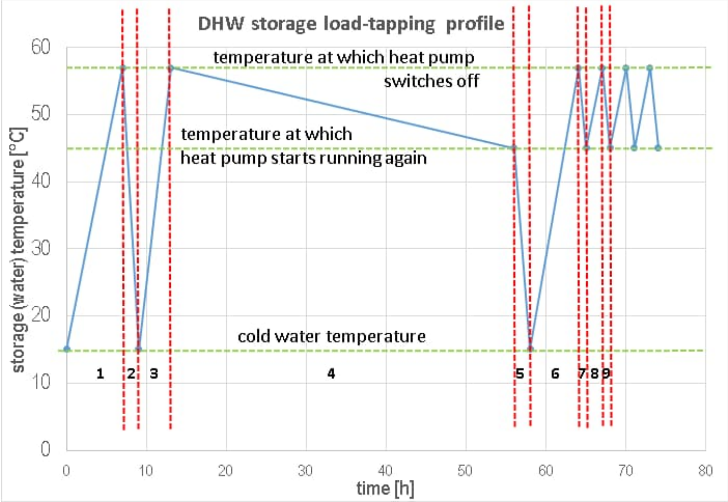


Figure 1: Load and tapping profile to evaluate a stratified water storage. For repetitions of the test at other ambient temperatures, the phases 1 to 4 may be omitted. If U*A is determined following the procedures described in sections 5.2.1 or 5.2.2 below, phase 1 to 4 may also be omitted, see text.

Explanations of the phases in storage load-tapping profile in Figure 1

Area 1: The cold water in the tank is heated by the heat pump until the heat pump stops.

Area 2: Water is drawn continuously via the heat meter until the water temperature has dropped to the cold water temperature (withdrawal of total heat content). The measurement may be stopped if the temperature difference of the leaving water and the cold water has dropped to less than 5% of its initial value. The remaining heat in the tank can be estimated by assuming a linear relationship.

Area 3: Heating as in area 1.

Area 4: Let the water in the tank cool down at room temperature (approx. 20 °C) until the temperature for restarting the heat pump is reached.

Area 5: Drain the entire heat quantity (continuous withdrawal of water as in area 2).

Area 6: Heating as in area 1.

Area 7: Withdrawal of water until the heat pump starts up again.

Area 8: Heating of the water in the tank by the heat pump as in area 1

Area 9: Withdrawal of water as in area 7

Procedure: repetition of steps 8 and 9 until the energy content of the drawn water differs by less than 10% from one step to the next.

Evaluation:

a) Determination of the storage losses and the tank temperature:

$$U * A = \frac{(Q_{tank,\,max} - Q_{tank,on})}{t_{cooling} * (\vartheta_{tank,4} - \vartheta_{room})}$$

where:

$Q_{tank,max}$: total heat quantity of the water tank from area 2

$Q_{tank,on}$: total heat quantity of the water tank from area 5

$t_{cooling}$: cooling time, duration of area 4

$\vartheta_{tank,4}$: average of the tank leaving water temperatures at the beginning and the end of area 4

ϑ_{room}: temperature of the room where the unit is located

b) Determination of the COP of the heat pump for heating up the hot water tank

$$COP_{heatup} = \frac{(Q_{tank,loss,6} + Q_{tank,max})}{W_{el,heatup}}$$

where:

$Q_{tank,loss,6}$: $U * A * (\vartheta_{tank,6} - \vartheta_{room}) * t_{heatup}$

$\vartheta_{tank,6}$: average of the tank leaving water temperatures at the end of area 5 and the beginning of area 7

t_{heatup}: heating time, duration of area 6

$W_{el,heatup}$: electricity consumption of the heat pump including the auxiliary pumps etc. whilst the hot water tank is being heated in area 6

c) Determination of the capacity of the heat pump for heating up the hot water tank

$$P_{heatup} = \frac{(Q_{tank,loss,6} + Q_{tank,max})}{t_{heatup}}$$

d) Determination of the COP of the heat pump for reheating the hot water tank

$$COP_{reheating} = \frac{(Q_{tank,loss,8} + Q_{drawn})}{W_{el,reheating}}$$

where:

$Q_{tank,loss,8}$: $U * A * (\vartheta_{tank,8} - \vartheta_{room}) * t_{reheating}$

$\vartheta_{tank,8}$: average of the tank leaving water temperatures at the beginning and the end of the last area 9

$t_{reheating}$: length of the last area 8

Q_{drawn}: total heat quantity of the water tank from the last area 9

$W_{el,reheating}$: electricity consumption of the heat pump including the auxiliary pumps during the re-heating process, i.e. the last area 8 and the last area 9

e) Determination of the capacity of the heat pump for heating up the hot water tank

$$P_{heatup} = \frac{(Q_{tank,loss,8} + Q_{drawn})}{t_{heatup}}$$

5.2 Storage heat losses U*A

This section describes alternative options to determine the specific losses U*A. These options may be simpler than the determination of U*A as described in section 5.1, but the heat losses of a stratified storage tank may be slightly overestimated.

5.2.1 Internal resistance heater

An electric resistance heater is installed at the bottom of the storage so that it heats up the whole volume of the storage.

The temperature of the storage tank is controlled to be at a setpoint between 45 and 60 °C by an on/off thermostat that operates the resistance heater. This procedure is run for several cycles until the difference in the electricity consumption of two consecutive cycles is less than 10%. The electricity that is required to keep the storage at the setpoint over the last full cycle of the heater equals the heat losses $Q_{tank,loss}$ of the storage during that cycle. From

$$Q_{tank,loss} = U{*}A * (\vartheta_{tank} – \vartheta_{room}) * t_{cycle}$$

the value of U*A is determined. ϑ_{tank} is the average temperature of the thermostat sensor.

The method of temperature measurement in the tank, the tank temperatures at the start and end of the cooldown period and the length of the whole cycle must be documented in the test report.

5.2.2 Exterior heater

This method does not require access to the interior of the storage. Instead, it keeps the storage warm by an external heater. The heat losses determined include losses from the integrated cold water pipes, including all valves and fittings. The result for U*A may be corrected by PHI by an estimate of these losses. For this purpose, the type, insulation, length, diameter and material of these pipes etc. must be communicated and verified.

Test procedure: The tank's U*A is determined by keeping a near constant temperature of the total hot water capacity with an external electrical heater. The hot and cold water connections of the tank are short-circuited. An external circulation pump installed in front of the electric heater ensures that the water is thoroughly mixed. Due to this, the DHW temperature in the tank is accurately known. It can be recorded using an external sensor, without any changes having to be made to the device itself. At this stage the internal temperature sensor of the tank can be calibrated by the external measurement. The hot water tank is then heated to a hot water temperature between 45 and 60 °C.

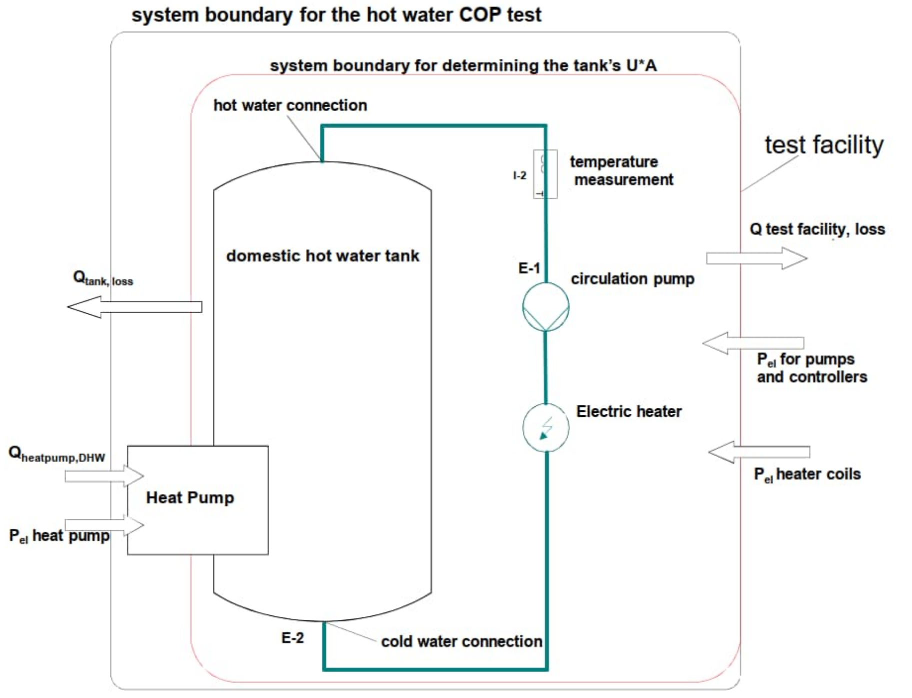


Figure 2: Test set-up for the simplified method to evaluate the storage tank. Other options are tests according to EN 12897 or EN 15332.

Evaluation and calculation of U*A: The following energy equation is applicable with sufficient accuracy:

$$W_{coil} + W_{pump} = (U{*}A\ (\vartheta_{tank} - \vartheta_{room}) + P_{test\text{-}facility,\ losses}) * t_{cycle}$$

where :

W_{coil}:	electricity consumption of the external heater coils
W_{pump}:	electricity consumption of the external circulation pump that contributes to heating the hot water. If this fraction is not known, the whole electricity consumption may be used.
$P_{test\text{-}facility,\ losses}$:	heat losses of the test facility (including a possible mathematical correction of the heat losses resulting from the built-in cold water pipes, valves and fittings within the unit)

5.3 Deriving DHW performance measurement according to EN16147

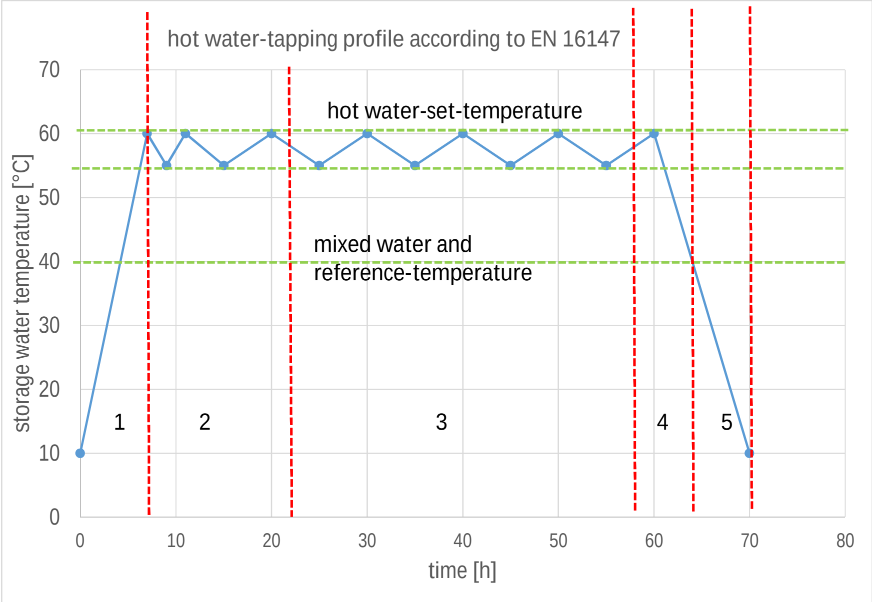


Figure 3: hot water tapping profile similar to that in EN 16147:2023-12
the several phases of consideration in and the sections in EN 16147 are as follows:
1 [Phase C] filling and heating-up (section 7.7)
2 [Phase D] Power-consumption during standby mode (7.8)
3 [Phase E] hot water tapping (7.9)
4 [Phase F] mixed water at 40°C and reference-water-temperature (7.10)
5 extending Phase F: extract all the heat Q_{tank} as described for area 2 or area 4 in Figure 1, see text

DIN EN 16147 describes a loading and tapping profile with several phases. In the norm, this is used to derive several overall integral performance parameters for energy labels and consumer information.

The detailed evaluation of measurement data which are collected during the test according to EN 16147 can, in principle, deliver the abovementioned key parameters which are necessary for the PHPP modelling of the DHW system. It is useful to determine the amount of heat Q_{tank} stored in the tank after heating up. This is readily done at the end of the test by extending phase F so as to extract all the heat as described for area 2 or area 4 in Figure 1.

To allow for a meaningful evaluation all data have to be gathered during the process and need to be provided to PHI. Furthermore, the specific heat losses of the storage (U*A) have to be determined separately following one of the procedures described in section 5.1.

The respective performance parameters can be calculated as follows:

In the standby cycle (phase D) P_{es} is determined, the average electricity consumption required to keep the storage warm.

In the tapping cycle (phase E) the full electricity consumption $W_{EL\text{-}M\text{-}LP}$ over the duration of phase E, t_{TTC}, is measured. The load profile selected for the measurement has the useful heat Q_{LP}. With the electricity consumption of the MVHR $W_{EL\text{-}Corr,MVHR}$ during the time t_{TTC}, the electricity consumption which has to be attributed to the DHW production is

$$W_{EL,reheating} = W_{EL\text{-}M\text{-}LP} - W_{EL\text{-}Corr,MVHR} - P_{es} * t_{TTC}$$

This allows for an estimate of the COP for reheating the hot water tank:

$$COP_{reheating} = Q_{LP} / W_{EL,reheating}$$

The corresponding capacity of the heat pump has to be determined from the time series of the measured data.

The COP for heating up the tank during the duration t_h of heating up the tank in phase C can be determined from

$$COP_{heatup} = (Q_{tank} + U{*}A * (\vartheta_{tank} - \vartheta_{room}) * t_h) / W_{eh\text{-}HP}$$

where:

ϑ_{tank}: average of the cold water temperature and the tank leaving water temperature at the beginning of phase E

$W_{eh\text{-}HP}$: electricity consumption during the heatup process, corrected by the electricity consumption of the MVHR

The capacity of the heat pump during heatup is easily calculated from

$$P_{heatup} = (Q_{tank} + U{*}A * (\vartheta_{tank} - \vartheta_{room}) * t_h) / t_h$$

6 Miscellaneous

All specified test procedures apply for typical cases. For unusual construction types alternative or additional testing may be necessary. It is recommended that this is agreed at an early stage with the Passive House Institute.

If, due to the available facilities in a certain laboratory, individual air conditions (temperature and humidity) cannot be achieved, after early agreement with the PHI an arrangement should be made which approximates the intentions of the requirements as much as possible

Data files (e.g. .csv) containing all raw measured data should be provided additionally to the report containing the results (usually in the form of a combination of text, tables and charts).

The information and description about used measurement technology must be given in any reporting, especially the precision of sensors etc.

It is recommended to agree upon the details of the testing procedure with the Passive House Institute prior to the measurements. Any possible deviations from the above described test methods should be consulted with the Passive House Institute.

7 Symbols and abbreviations

General symbols and abbreviations in addition to those given earlier

$\eta_{HR,t,\,eff}$	heat recovery rate of dry air	[%]
ϑ_{ETA}	Extract air temperature ETA	[°C]
ϑ_{EHA}	Exhaust air temperature EHA	[°C]
ϑ_{SUP}	Supply air temperature SUP	[°C]
ϑ_{ODA}	Outside air temperature ODA	[°C]
P_{el}	electric power	[W]
$\dot{m}$	Mass flow	[kg/h]
$\dot{m}_{Dis}$	Mass flow difference	[kg/h]
$\dot{m}_{PA}$	Mass flow of recirculated air	[kg/h]
c_p	specific heat capacity	[Wh/(kg.K)]
η_x	Humidity ratio	[%]
x_{ETA}	humidity ratio (absolute humidity) ETA	[g/kg]
x_{EHA}	humidity ratio (absolute humidity) EHA	[g/kg]
x_{SUP}	humidity ratio (absolute humidity) SUP	[g/kg]
x_{ODA}	humidity ratio (absolute humidity) ODA	[g/kg]

8 References

[DIN 4109-1]	DIN 4109-1: 2018-01 Sound insulation in buildings - Part 1: Minimum requirements, 2018
[DIN EN ISO 3743- 1]	DIN EN ISO 3743- 1: 2011, Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure measurements – Accuracy class 2 methods for small, movable sources in reverberant fields - Part 1: Comparison method in a test room with sound-reflective walls (ISO 3743-1:2010) (ISO 3743- 1: 2010); 2010
[DIN EN ISO 3743-2]	DIN EN ISO 3743- 2: 2018, Acoustics - Determination of sound power levels of noise sources from sound pressure measurements – Accuracy class 2 methods for small, movable sources in reverberant fields - Part 2: Method for special reverberation rooms (ISO 3743-2:2018); 2018
[DIN EN ISO 3744]	DIN EN ISO 3744: 2011, Acoustics - Determination of sound power levels of noise sources using sound pressure measurements - Methods for envelope areas with accuracy class 2 for an essentially free sound field over a reflecting plane (ISO 3744: 2010); 2010
[DIN EN ISO 9614-2]	DIN EN ISO 9614-2: 1996, Acoustics - Determination of sound power levels of noise sources using sound intensity - Part 2: Measurement with continuous scanning (ISO 9614-2:1996); 1996
[EN 12102:2013]	Air conditioners, liquid chilling packages, heat pumps and dehumidifiers with electrically driven compressors for space heating and cooling. Measurement of airborne noise. Determination of the sound power level
[EN 12897]	Wasserversorgung - Bestimmung für mittelbar beheizte, unbelüftete (geschlossene) Speicher-Wassererwärmer; Deutsche Fassung EN 12897:2016+A1:2020 Domestic Hot Water supply - Specification for indirectly heated, unventilated (closed) storage water heaters; German version
[EN 13141-7]	EN 13141-7:2021, Ventilation for buildings – Performance testing of components/products for residential ventilation- Part 7: Performance testing of a mechanical supply and exhaust ventilation units (including heat recovery), 2021
[EN 13141-8]	EN 13141-8: 2023-06; Ventilation for buildings- Performance testing of components/products for residential ventilation- Part 8: Performance testing of un-ducted mechanical supply and exhaust ventilation units (including heat recovery), 2023
[EN 14511]	EN 14511-4, Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling – Part 4: Operating requirements, marking and instructions
[EN 14825]	EN 14825:2023 Air conditioners, liquid chilling packages and heat pumps, with electric driven compressors, for space heating and cooling, commercial and process cooling ─ Testing and rating at part load conditions and calculation of seasonal performance. German version EN 14825:2022
[EN 15332]	Heizkessel - Energetische Bewertung von Warmwasserspeichern; Deutsche Fassung EN 15332:2019 Boilers - Energy rating of hot water storage tanks; German version
[EN 16147]	EN 16147-2023 Heat pumps with electrically driven compressors ─ testing, performance rating and requirements for marking of domestic hot water units (replaces EN 255-3)
[EN 16573]	EN 16 573:2017 Ventilation for Buildings ─ Performance testing of components for residential buildings ─ Multifunctional balanced ventilation units for single family dwellings, included heat pumps, February 2017
[EN 16798-1]	EN 16 798-1:2022 Energy performance of buildings – Ventilation for buildings Part 1 Indoor environmental input parameters
[EN 16798-3]	EN 16 798-3:2017 Energy performance of buildings – Ventilation for buildings Part 3: For non-residential buildings − Performance requirements for ventilation and room conditioning systems
[ISO 10140-2]	ISO 10140-2: 2021-04 Acoustic – Measurement of sound insulation of building components in test chambers – Part 2: Measurement of airborne sound insulation, 2021
[ISO 16890]	DIN EN ISO 16890- 1: 2017-08, Air filters for general ventilation - Part 1: Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM) (ISO 16890-1:2016) 2016
[PH_ventilation_2025]	Criteria and Algorithms for Verified Passive House Components: Ventilation systems with heat recovery ≤ 600 m³/h. Passive House Institute, Darmstadt, 2025.

9 Categories & climatic regions

9.1 Certification categories and scope of certification

Heat pump systems for space heating can be certified for different climate zones (cf. Figure 5). Depending on the climate zone for which the manufacturer decides to have a certification, different test points have to be measured (see section 4.3). The efficiency is evaluated for cool temperate climate, Mannheim, Germany, with respect to heating. With respect to cooling an appropriate climate data-set for hot & humid (Shanghai) or just hot & dry (Las Vegas) is chosen. The respective boundary conditions will be given in the special certificate. So far dedicated certificates for heating and/or cooling climates will be issued to make clearly visible for which climatic region the device is usable and certified. If a device is to be used and certified in both climatic regions, two certificates will be provided upon request.

Usage of data in PHPP: For internal algorithmic reasons each data-set in PHPP will contain both values (winter & summer) if applicable.

The table in Figure 4 shows how the data set of key-values for each device will be represented later in PHPP: all relevant data necessary for the energy balance calculation will be included so that these are available to any Passive House designer. Regular updates for PHPP users include information about the latest newly certified devices.

A constantly updated list of certified heat pump systems and combi-systems is available at https://database.passivehouse.com/en/components/list/heatpump.

Combined ventilation and split units (air source heat pump), PHI test method

with heating and/or cooling function

		Ventilation										
			Heating period		Cooling period							
ID	Description	Ventilation function	Heat recovery efficiency	Humidity recovery rate η_{ERV}	HR efficiency, cooling	Humidity recovery rate η_{ERV}	Specific electric efficiency	Range of use from to		Noise protection		
		Mark with an 'x'	%	%	%	%	Wh/m³	m³/h	m³/h	35 dB(A)	Supply air dB(A)	Extract air dB(A)
◄ Content												
	Certified Passive House components:											
	Combined ventilation units (ch: compact heat pump)											
1111ch0x	manufacturer N.N.	x	0.8	0.65	0.62	0.66	0.42	129	200		56.8	69.7

	Heating																				
		Heating test point 1										Heating test point 2									
		Temperature		Normal operation				Silent mode				Temperature		Normal operation				Silent mode			
ID	Heating function	Source	Sink	Heating capacity max / on-off limit		COP max / on-off limit		Heating capacity max / on-off limit		COP max / on-off limit		Source	Sink	Heating capacity max / on-off limit		COP max / on-off limit		Heating capacity max / on-off limit		COP max / on-off limit	
	Mark with an 'x'	°C	°C	kW	kW			kW	kW			°C	°C	kW	kW			kW	kW		
1111ch0x	x	-7	20	3.9	2.2	1.7	1.8	3.1	2	1.6	1.9	2	20	3.8	2.3	2	2.7	3.1	1.5	2	1.6

Figure 4: A typical representation of an evaluated data set in PHPP (example)

9.2 Assignment of the climate zones (regions with identical requirements)

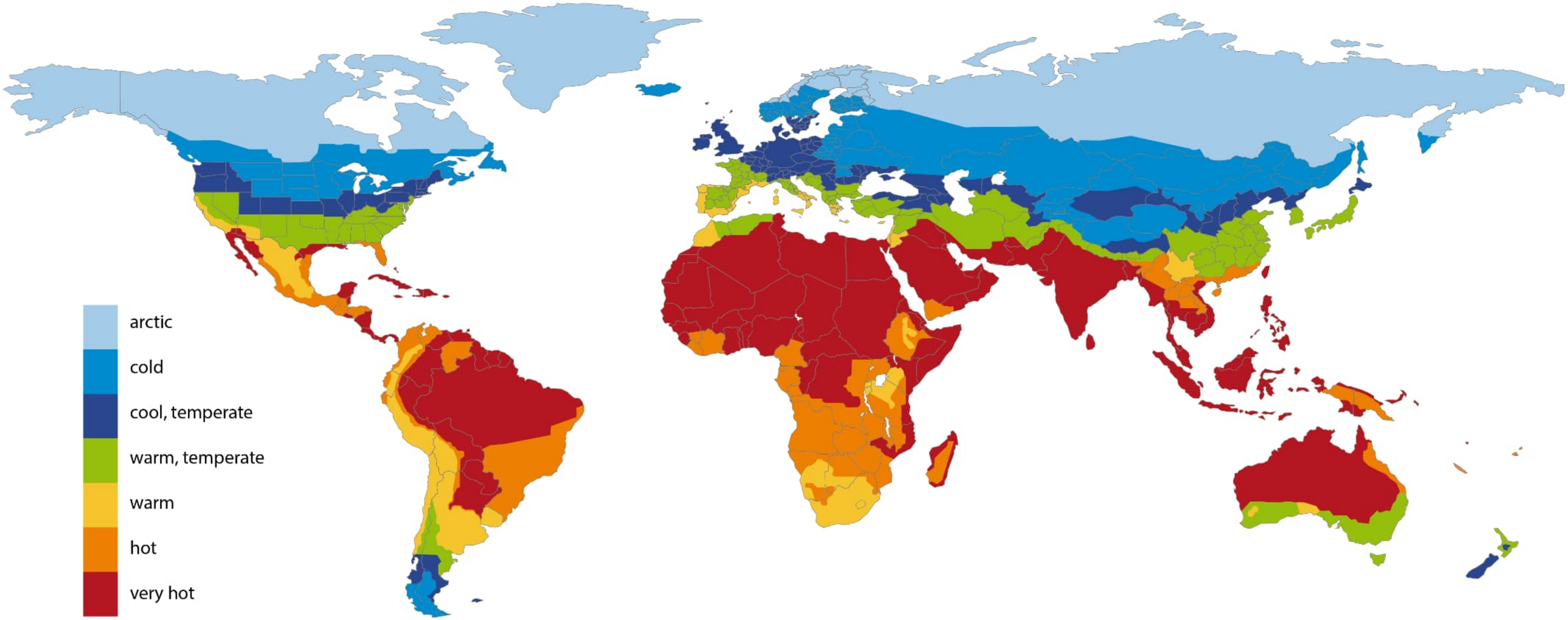
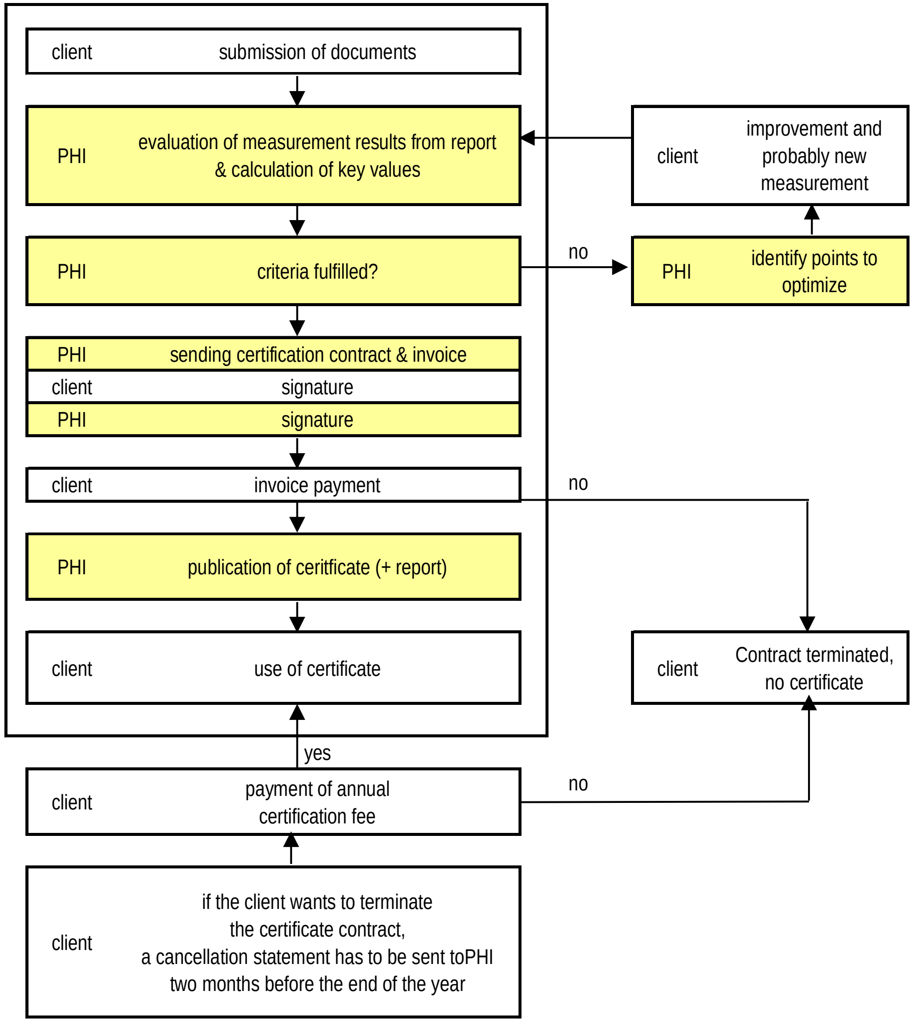


Figure 5: Assignment of regions with identical requirements

10 Formal aspects, services by the Passive House Institute

10.1 Certification procedure and contract procedure



10.2 Documents required for submission

The following documents have to be provided to PHI by the manufacturer so that the evaluation and the calculations can be done properly to provide the key values of the performance of the HP.

Please note: as there are many different configurations of HP and Combi-Systems possible any information will help to understand the product and to value the qualities of the component to be certified.

- The report from the testing laboratory with all results according to section 4.
- In addition to the reported results, a data collection of the relevant time-series of measurement must be provided to PHI in Excel or CSV format, see section 4.2. The data have to be described so that a unique relation to the final testing result is possible.
- A detailed manual and an installation description of the unit as is delivered to planers, installers and other technical staff.
- For heat pump systems especially a detailed description of the hydraulic configuration and additional drawings will be helpful.
- Description of filter quality for the MVHR and description of other service, repair and replacement parts, if this is not already included in the manual.
- The 'checklist component certification' including all the relevant information about the client's company and the component to be certified. A template will be provided by PHI.

10.3 Services provided by the Passive House Institute

Documentation with the certificate report including representation of the most important measurement results from the report.

Certification:

1. Use of the certificate by client
2. Implementation of the key performance values (HR efficiency, useful range, heating & cooling capacity and COP values, etc.) of the product into the Passive House Planning Package PHPP, so that it can be used for energy balance calculations.
3. Use of the seal "Certified Passive House component" by the client.

Presentation in the component database of the Passive House Institute

The component will be presented in the heat pumps category of the component database of the Passive House Institute together with the certificate.
https://database.passivehouse.com/en/components/list/heatpump

The component may be shown as an actual image or a rendering (to be provided by the client). In this category an option is available for showing further information about the certified product, such as photographs, illustrations and technical documents.

10.4 Coming into effect, temporary provisions, further development

The certification criteria and calculation regulations for Passive House suitable heat pumps shall become fully effective with the publication of this document. All previously published criteria shall then cease to apply with the coming into force of these provisions. Existing certificates will remain valid until further notice. The Passive House Institute retains the right to make future changes.

An up-to-date version of this text with the description of testing procedure and criteria is available from
https://database.passivehouse.com/en/components/#certification-methods-info