PASSIPEDIA
The Passive House Resource

The Passive House - definition

The Passive House is not an energy standard but an integrated concept assuring the highest level of comfort. The exact definition is as follows:

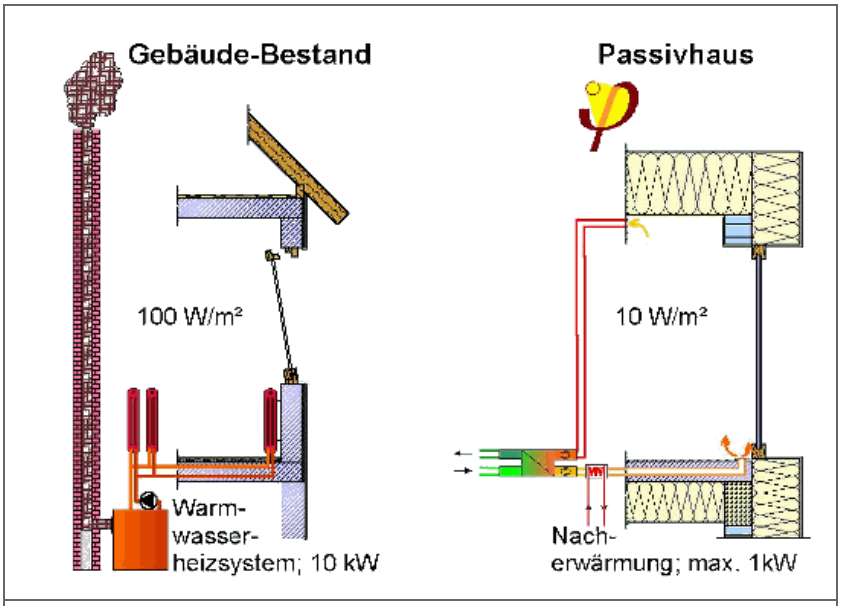
> *"A Passive House is a building, for which thermal comfort (ISO 7730) can be achieved solely by post-heating or post-cooling of the fresh air mass, which is required to achieve sufficient indoor air quality conditions – without the need for additional recirculation of air."*

This is a purely functional definition which doesn't contain any numerical values and is valid for all climates. This definition shows that the Passive House is a fundamental concept and not a random standard. Passive Houses have not been "invented" by anyone – in fact, the Passive House principle was discovered. It may be debatable whether the term "Passive House" accurately describes this concept – well, there is no other term better suited for it. Thermal comfort is achieved to a maximum extent through passive measures (insulation, heat recovery, passive use of solar energy and internal heat sources).

The following considerations help to shed light on this concept:

- All airtight buildings (any low-energy building needs to be airtight), except those in so called "lucky climates", require the use of an efficient ventilation system. In Passive Houses this system can also be used for heating purposes, without the need for additional ducts, major technical interfaces, auxiliary fans etc.
- This concept allows for the construction of houses equipped with a highly efficient heat recovery system at a very affordable price. This is usually rather difficult to do since the ventilation system costs just as much as a heating system – a double investment which hardly pays off. The way to go therefore involves cutting back on one of the two systems: either on the ventilation system, e.g. by installing an exhaust system only; in this case the building will become a low-energy house with conventional heating; or on the heating system by using the ventilation system for heating as well – in this case the building will become a Passive House.

This heating concept automatically implies extremely low energy consumption. After all, **using the fresh ventilation air for heating without an additional heating system can only work in buildings with very low net heat losses**. This requires an excellent insulation of the building envelope – especially in cold climates to keep the desired warmth inside the building, but also in hot climates to keep undesirable heat out. The calculation of the energy balance will help determine the level of insulation that will be required in a given building and climate.



Basic principle of a Passive House: The ventilation system supplies at least the amount of fresh air required for good indoor air quality.

Can't this air be used for heating as well? – Yes it can – provided that the building requires very little heat to begin with.

Heating load - the Passive House requirement

The following calculation illustrates the **heating load** Passive House requirement:

To ensure good indoor air quality, one person needs about 30 m³ of fresh air per hour. This supply air can only be heated up to 50°C to avoid the scorching of dust. The specific heat capacity of air is 0.33 Wh/(m³K) at normal pressure and a temperature of approx. 21°C (comfort, see ISO 7730). From this the heat flow can be calculated:

30 m^3/hr/pers * 0.33 Wh/(m^3K) * (50 - 20) K = 300 W/pers

Hence: Fresh air heating can supply 300 Watt per person. Assuming 30 m² of living space per person the maximum heating load at a given point of time may not exceed **10 Watt per square metre of living space – independent of the climate**: As these figures refer to that day of the year where the maximum amount of heat needs to be supplied to the building (**heating load**), Passive Houses require different levels of insulation depending on the individual climate: more insulation in extreme climates, less insulation in milder ones.

The specific values for heating loads (measured in W (Watt))are not identical to the ones for energy (measured in kilowatt hours (kWh)), the numbers for which are often easier to come by. The Passive House heating demand criterion of 15 kWh/(m²yr) typically relates to a heating load of 10W/m² in Central European climates, however, it is only supposed to serve as a rough benchmark which may vary with different climatic conditions: in Stockholm a house with a heating load of 10W/m² may use more like 20kWh/(m²yr); in Rome it might be as low as 10kWh/(m²yr).The Passive House criteria allow buildings to go by either criterion - the 15 kWh/(m²yr) heat demand OR the 10W/m² heating load.

The physics behind the passive house, shown here, is the exact same in all climates - and the energy services (comfort criteria according to ISO 7730) are the same for human beings. Everything relevant for the criterea is taking place within the thermal envelope, i.e. within the comfort zone. Therefore: Yes, this is independent of climate, building style, construction method, … In some climates, the so called lucky climates, the 10 W/m² criterion might not be relevant - because where is no need for heating or cooling, anyhow (like in Bogota). Reasonably built Houses in these climates are always passive houses, anyhow. So, the criterion is irrelevant there - it's fullfilled, anyhow.

Some critics came up stating “there can't be one size for every site”. This statement is correct, it is already anticipated in the criteria: That is, why passive house is a functional standard rather than a descriptive one. Of course the criteria lead to different solutions in different climates: You will need more insulation in Stockholm than in Palermo and more shading the other way arround. But designers are absolutely free how to choose their solution meeting the PHPP-energy-balance. So, there will be many different solutions in each climate; that is, why a functional standard has much more flexibility than a descriptive one.

To complicated for some building designers? OK, one can also go with some exemplary solutions nearby ore realized in comparable climates. You will find lots of examples in the Passive House database [http://www.passivhausprojekte.de/index.php?lang=en] [http://www.passivhausprojekte.de/index.php?lang=en]].

See also

What is a Passive House?

Building physics - basics
