

# What is a passive house?

Explanation by "Passivhaus Institut Dr. Feist, Darmstadt"

A passive house is a building in which a comfortable interior climate can be maintained without active heating and cooling systems (Adamson 1987 and Feist 1988).

The house heats and cools itself, hence "passive".

For European passive construction, prerequisite to this capability is an annual heating requirement that is less than 15 kWh/(m<sup>2</sup>a), not to be attained at the cost of an increase in use of energy for other purposes (e.g., electricity). Furthermore, the combined primary energy consumption of living area of a European passive house may not exceed 120 kWh/(m<sup>2</sup>a) for heat, hot water and household electricity.

With this as a starting point, additional energy requirements may be completely covered using renewable energy sources.

The term "Passive House" refers to a construction standard. The standard can be met using a variety of technologies, designs and materials. It is a refinement of the low-energy house (LEH) standard. "Passive Houses" are buildings which assure a comfortable indoor climate in summer and in winter without needing a conventional heating system.

To permit this, it is essential that the building's annual demand for space heating does not exceed 15 kWh/ (m<sup>2</sup>a). The minimal heat requirement can be supplied by heating the supply air in the ventilation system - a system which is necessary in any case.

Passive Houses need about 80% less heating energy than new buildings designed to the standards of the 1995 German Thermal Insulation Ordinance (Wärmeschutzverordnung).

The standard has been named "Passive House" because the passive heat inputs - delivered externally by solar irradiation through the windows and provided internally by the heat emissions of appliances and occupants

- Essentially suffice to keep the building at comfortable indoor temperatures throughout the heating period.

It is a part of the Passive House philosophy that efficient technologies are also used to minimize the other sources of energy consumption in the building, notably electricity for household appliances.

The target of the CEPHEUS project is to keep the total final energy demand for space heating, domestic hot water and household appliances below 42 kWh/(m<sup>2</sup>a). This is lower by at least a factor of 4 than the specific consumption levels of new buildings designed to the standards presently applicable across Europe

The Passive House standard offers a cost-efficient way of minimizing the energy demand of new buildings in accordance with the global principle of sustainability, while at the same time improving the comfort experienced by building occupants.

It thus creates the basis on which it is possible to meet the remaining energy demand of new buildings completely from renewable sources - while keeping within the bounds set by the limited availability of renewables and the affordability of extra costs.

The passive house philosophy builds upon two basic principles

Principle 1:

Optimize what is essential anyway

What makes the approach so cost-efficient is that, following the principle of simplicity, it relies on optimizing those components of a building which are necessary in any case: The building envelope, the windows and the automatic ventilation system expedient anyway for hygienic reasons.

Improving the efficiency of these components to the point at which a separate heat delivery system can be dispensed with yields the savings which largely finance the extra costs of improvement.

Principle 2:

Minimize losses before maximizing gains Passive Houses prevent available heat from escaping as rigorously as possible (i.e. give precedence to loss minimization). Both the computations carried out with theoretical models and the practical experience gathered with numerous projects show that, under Central European and comparable climatic conditions, such a strategy is fundamentally more efficient than strategies relying primarily upon passive or active solar energy use.

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### **Passive solar gain**

Optimized south-facing glazing (Specification: Close to 40% contribution to space heating demand)  
Super glazing Measure Low emissivity triple glazing (Specification: U-value = 0.75 W / (m<sup>2</sup>K), solar transmission factor g = 50%)  
Super frames Measure Super insulated window frames (Specification: U-value = 0.8 W/ (m<sup>2</sup>K))

### **Super insulation**

Passive houses have an exceptionally good thermal envelope, preventing thermal bridging and air leakage. To be able to dispense with an active heating system while maintaining high levels of occupant comfort, it is essential to observe certain minimum requirements upon insulation quality.  
Building shell: Super insulation (dependent on the climatic situation of the country)

### **Thermal-bridge-free construction**

Building element junctions (Specification: (linear thermal transmittance, exterior dimensions) below 0.01 W/ (mK))

### **Air tightness**

Airtight building envelope (Specification: less than 0.6 air changes per hour at n50)

### **Electric efficiency**

Means efficient appliances. Through fitting the Passive Houses with efficient household appliances, hot water connections for washing machines and dishwashers, airing cabinets and compact fluorescent lamps, electricity consumption is also slashed - by 50% compared to the average housing stock, without any loss of comfort or convenience. All building services are designed to operate with maximum efficiency. High-efficiency appliances are often no more expensive than average ones. As a rule, they pay themselves back through electricity savings. Meeting the remaining energy demand with renewables.

### **Hygienic ventilation**

Combining efficient heat recovery with supplementary supply air heating. Passive houses have a continuous supply of fresh air, optimized to ensure occupant comfort. The flow is regulated to deliver precisely the quantity required for excellent indoor air quality. A high performance heat exchanger is used to transfer the heat contained in the vented indoor air to the incoming fresh air. The two air flows are not mixed. On particularly cold days, the supply air can receive supplementary heating when required. Additional fresh air preheating in a subsoil heat exchanger is possible, which further reduces the need for supplementary air heating. Directed air flow through whole building; exhaust air extracted from damp rooms.

### **Heat recovery**

Counterflow air-to-air heat exchanger (Specification: Heat transfer efficiency  $h > 80\%$ )  
Latent heat recovery from exhaust air compact heat pump unit (Specification: Max. heat load 10W /m<sup>2</sup>)

## FAQs

What is it like living in a passive house?

Answers to frequently asked questions about the construction standard of the future

1) Can a house really stay warm without a heating system?

*Passive houses that have been tested and are already occupied have conclusively proven: Even in our middle European climate, houses can be built with such low heating energy requirements that minimal additional heat added to incoming fresh air, is sufficient to keep the house warm and comfortable in winter. Measurements in passive home subdivisions have proven that energy requirements for heating can be accurately predicted, and that even with a great variety of occupants, calculated consumption agrees with average actual consumption.*

2) Aren't passive houses too expensive?

*There are already companies that offer passive homes at prices comparable to standard construction.*

*However, in general, the high quality of passive construction components tends to be reflected in 8-10% higher costs than an average building.*

3) Can you open windows in a passive house?

*Of course, occupants may open windows whenever they want; however, they won't have to. A passive house is continuously supplied with fresh air via the ventilating system. This has advantages: Unlike window ventilation, fine filters in the ventilating system keep out dirt and pollen. Air quality within the house is always excellent, even when occupants are away and/or windows are never opened. Of course, as with all houses, if windows are left open in winter for longer periods, the inside air temperature will decrease noticeably, and energy consumption for heating will increase.*

4) People often express reservations about the need for a ventilation system: Are there problems with bacteria, noise and drafts?

*The ventilation system in a passive house is a fresh air supply system, not an air conditioning system that recirculates inside air. Bacteria growth is only a problem in recirculating air systems (and then, only if poorly maintained). Fan and valve noises are almost completely eliminated by sound control measures (e.g., vibration isolation mounts, low air speed, acoustic lining in ducts). Jet nozzles guide incoming air along the ceiling from where it uniformly diffuses throughout the room at velocities that are barely perceptible.*

5) Isn't a passive house a complicated, high-tech house?

*No, a passive house is very user-friendly and the equipment is easy to operate. The ventilation system has fewer controls than a normal television. Passive house technology is so simple, there's no need to hire someone to perform annual air filter changes; you can do it yourself.*