PASSIV HAUS INSTITUT *Dr. Wolfgang Feist*
For more information see: www.passiv.de

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 higher costs. These costs have been computed for passive homes that have already been built: For an interior unit of a row house in Hannover-Kronsberg, having a living area of 100 m_ (1076 ft_), around DM 15000 (€ 7669); for one unit of a double-house in Nürnberg, with a living area of 130 m_ (1399 ft_), around DM 25700 (€ 13140). In the long run, annual energy savings between DM 1000 and DM 2000 (€ 511 and € 1023), coupled with tax advantages (German Eco-Supplement) and special interest rates offered under the passive house promotion program of the "Kreditanstalt für Wiederaufbau" (German Credit Institution for Reconstruction), make passive houses (in Germany) more economical than conventional construction.

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.

Recommendation for Inside Air Humidity in Winter, in Homes with Ventilation Systems, Particularly Passive Homes

Dr. Wolfgang Feist, Passivhaus Institut - December 2000

The relative humidity of indoor air is particularly dependent on: Quantity of humidity from indoor sources (e.g. plants, cooking, clothes dryers, etc.). Quantity of fresh air supplied from outside.

Water vapor from indoor sources of humidity is diluted by the incoming fresh air. The greater the volume of incoming fresh air, the lower the indoor relative humidity.

This dilution effect is particularly pronounced in winter, because cold outdoor air contains very little humidity (e.g., there are only 3 g of water per m_ air at -5°C(23°F)/90% relative humidity). When this air is brought inside and warmed to 20°C (68°F), it's relative humidity is only 17.6%, before additional moisture is added by indoor sources. With "normal" household sources (330 g/h - varies) and "normal" ventilation (e.g., 120 m_/h (4238 ft_/h), from German Industry Standard "DIN 1946") this example would result in a

relative humidity of 33.5%. In general, this value will be comfortable as long as the air is reasonably clean (free of dust).

In cases where ventilation is within standards, but occupants still perceive the air as too dry, decreasing the fresh air supply volume is an easy fix. The decrease in volume of fresh air causes the humidity to increase, because moisture from interior sources is diluted less. If the fresh air supply in the above example is decreased to 75 m_/h (2649 ft_/h), which is well within acceptable limits for acceptable air quality, the indoor humidity will increase to 44%. In the interest of maximum energy savings, the rate of ventilation with fresh air should not be higher than needed to achieve a comfortable indoor humidity.

Conventional design tends toward higher rates of ventilation. In the past, air change rates as high as 0.5 or even 0.8 were considered necessary to keep interior humidity in winter low enough to discourage the development of condensation, which can cause mildew and damage to building components. But this risk does not exist in a passive house. Outside building elements are so well insulated that interior surfaces are too warm for condensation to occur even at 60% relative humidity; and moisture barriers and air seals prevent moist inside air from reaching building elements that could cool it to below the dew point. Therefore, fresh air volume can be lower, particularly when occupants perceive the humidity as being too low. "Appropriate" air change rates for residences are between 0.3 and 0.4. For passive houses, we generally recommend leaning toward the lower rate. This keeps the indoor air quality good, while maintaining a comfortable humidity and maximizing energy savings.

Summarizing solutions to too low indoor air humidity:

1. Decrease the air change rate.
2. Consider adding sources of moisture (e.g., more plants).
3. Keep the home as free of dust as possible: clean often with a **good vacuum cleaner** having a fine dust filter and make sure the ventilation air filtration (if any) is working properly.

Incidentally, air that is practically dust-free does not feel "too dry" even if it contains very little moisture; people feel very comfortable in cold air at high elevations (where there is very little dust). Since the air in a residence cannot be kept free of dust with reasonable effort, there is a practical lower limit to relative humidity (about 30%) below which most occupants consider air too dry. When that point is reached, solutions 1. and/or 2. above should be used.

Translation and shortening of original German text produced by Energieinstitut Vorarlberg, Austria.
For more information see: www.energieinstitut.at

The concept of the Passive House developed by Dr. Wolfgang Feist of Passivhaus Institute, Darmstadt, Germany is usually considered the norm. The regular (German) house requires 150 – 250 kWh/m_ and year for the space heating alone. A passive house will have a yearly usage of 10–15 kWh/m_. For a home with a living area of 100m_ this means 100m_ x 15kWh = 1500 kWh per year. (This equals 150 liter heating oil per year.)

How does it work?
It is basically an improvement of the "Low-energy-house" concept so far as no active space-heating is required. The energy that is never lost does not have to be replaced. The overall heat losses must be so small they can be counteracted by passive solar heat in the windows, heat generated by people and appliances and very small additional heat.

The thee most important factors:
- Maximal heat retention
- Energy efficient heatrecovery
- Passive solarheating through windows on south side.

The criteria for a Passive House per m_ living area:
- Max. 10 W/m_ constant heating-load
- Max. 15 kWh/(m_a) annual space-heat requirement
- Max. 42 kWh/(m_a) annual total amount of active energy input
- Max. 120 kWh/(m_a) total energy requirement for space-heating, domestic hot water and household appliances

Original German text:
Energieinstitut Vorarlberg, Austria
Einige Energieexperten auf den letzten Umwelttagungen forderten, daß vor allem die Industrieländer ihren Ressourcen- und Energieverbrauch nicht nur merkbar, sondern radikal senken müssen. Der Bauphysiker Prof. Panzhauser hat schon vor vielen Jahren den Begriff "Entschwenden statt Verschwenden" geprägt. Amory Lovins, Ernst Ullrich von Weizäcker und Friedrich Schmidt-Bleek fordern in ihren Büchern (siehe Punkt Literatur) eine Senkung des Energie- und Ressourcenverbrauches um den Faktor 4 bis 10.

Das bedeutet z.B. daß ein Auto statt wie derzeit üblich 8 Liter pro 100 km nur 1/4 bis 1/10 also 2 Liter bis 0,8 Liter pro 100 km verbraucht.

Das Energiekonzept für die sogenannten "Passivhäuser" von Dr. Wolfgang Feist erreicht für den Neubau den Faktor 8 bis 10. Während der Gebäudebestand üblicherweise einen Heizwärmebedarf von 150 kWh/(m_a) bis 250 kWh/(m_a) hat, kommen diese Passivhäuser pro Jahr mit nur 10 kWh bis 15 kWh pro m_ aus. 10 kWh = 1 Liter Heizöl.
100m_ Wohnnutzfläche x 15kWh/m_ = 1.500kWh = 150 Liter Heizöl pro Jahr.

Wie funktioniert ein derartiges "Passivhaus"?
Der Grundgedanke dazu ist so einfach wie plausibel: Was nicht verloren geht, muß auch nicht ersetzt werden. Ein Haus kühlt nur insoweit aus, als es Wärme nach außen verliert. Dieser Wärmeverlust wird im Passivhaus so weit verringert, daß allein die Sonnenwärme und die im Haus freigesetzte Wärme zusammen mit extrem wenig Heizenergie ausreicht, den Wärmeabfluß auszugleichen.

Die wichtigsten drei Elemente

- Maximale Wärmebewahrung

- Energieeffiziente Wärmerückgewinnung
- Passive Sonnenenergienutzung durch Südorientierung

Die Kriterien für ein Passivhaus

- Max. 10 W/m_ Heizlast
- Max. 15 kWh/(m_a) spez. Heizwärmebedarf
- Max. 42 kWh/(m_a) spez. Gesamt -Endenergiekennwert
- Max. 120 kWh/(m_a) spez. Gesamt-Primärenergiekennwert

Alle Angaben beziehen sich auf m_ Wohnfläche!