



## Passive houses

### Key point

- *A passive house saves significant amount of energy, improve interior comfort and bolsters greater resilience towards oil price rises.*

### Passive house explained

The passive house is more than just a low-energy building, which does not require mechanical heating or cooling. Passive design is a bundle of design principles aiming to reduce the heating, cooling and dehumidification load via the building envelope such as roofs, walls, windows and floors. The concept can be applied for both new and retrofitted construction projects in residential, public and commercial buildings.

According to the Passive House Institute, such a design provides the following distinctive performance:

- A passive house requires less than 15 kWh per (square metre per year) for heating or cooling (living spaces).
- The heating and cooling load is limited to a maximum of 10 W per square metre and primary energy use may not exceed 120 kWh per (m<sup>2</sup>a).
- A passive house must be airtight, with air change rates limited to n50 = 0.6 per hour.
- In warmer climates and/or during summer months, excessive temperatures may not occur more than 10 per cent of the time.

### How it works

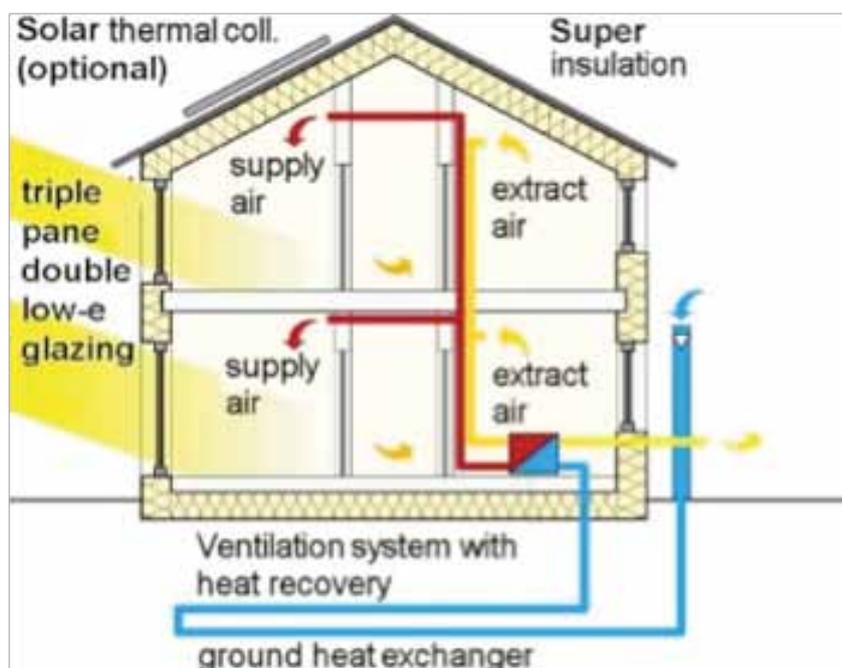
Vast energy savings in passive houses can be achieved via building orientation and energy-efficient building envelopes, such as insulation, glazing and a quality ventilation system. The style of buildings, material to be used and specific technologies vary according to the climate zone, level of market development and design and construction culture and practices.

In cold climates, for example, passive houses use solar passive designs, insulation, heat recovery and highly insulated windows. In hot climates, solar protection is emphasized, such as shading devices, proper size and quality of windows and a building's thermal mass (to avoid the penetration of heat into the building during the daytime when the ambient temperature rises).

The following are regarded as essential for all climates (figure 1):

- **Insulation:** Strengthening the insulation of the building envelope is critical in controlling heat gains and losses, such as with thermal bridge-free design, airtight construction and highly insulated windows. The level of insulation and types of insulation measures will differ from region to region.
- **Thermal bridge-free design:** The heat loss at thermal bridges, such as edges, corners, connections and penetrations, is generally high. The passive house is designed to avoid thermal bridges. Better insulation can make up for thermal bridges and allow for a good energy balance.
- **Good-quality ventilation:** Fresh air is not merely a matter of comfort but a necessity for healthy living. To ensure that closed doors do not hinder the flow of air, appropriate air transfer openings are installed above door frames. A heat recovery-ventilation system may be used to transport heat during the cold season, cool air during the hot periods and dry air to dehumidify, if necessary.

**Figure 1: How a passive house works**



Source: Wolfgang Feist, *What is a Passive House?* (Darmstadt, Germany, 2010). Available from [www.passiv.de/07\\_eng/PHI/Flyer\\_quality\\_assurance.pdf](http://www.passiv.de/07_eng/PHI/Flyer_quality_assurance.pdf) (accessed 24 February 2008).

## Trends in development

Passive solar houses are found mostly in Europe. There have been initiatives to establish standards and certifications, such as the Passive House Standard by the International Passive House Association and the Passive House Certificate for Old Buildings by the Passive House Institute. The European Parliament proposed that all buildings meet passive house standards of airtightness and energy efficiency by 2011. The passive house concept is gaining popularity in the Canada, the United States and some Asian countries as a result of the growing demand for greenhouse gas emissions reduction, long-term energy savings and good indoor air quality.

Conferences of interest on passive house design:

- Sixteenth annual International Passive House Conference, organized by the Passive House Institute, in Hanover, Germany in March 2012. ([www.passivhaustagung.de/sechzehnte/Englisch/index\\_eng.php](http://www.passivhaustagung.de/sechzehnte/Englisch/index_eng.php)).
- Sixth annual North American Passive House Conference, organized by the Passive House Institute in October 2011 ([www.passivehouse.us/phc2011](http://www.passivehouse.us/phc2011)).
- Fourth Nordic Passive House Conference, organized by the VTT Technical Research Centre of Finland in October 2011 in Helsinki ([www.phn11.fi/phn11-home/phn11.html](http://www.phn11.fi/phn11-home/phn11.html)).

## Strengths of a passive house

- **Saves energy and bolsters greater resilience towards oil price rises:** On average, passive house dwellings, which are built with airtight insulation that maximizes the use of natural heating systems such as the sun, achieve an energy savings of 90 per cent when compared with existing houses and more than 75 per cent when compared with average new construction.<sup>1</sup> In terms of heating oil, passive houses use far less than typical low-energy buildings.
- **Improves comfort:** Passive buildings provide a higher degree of comfort during both hot and cold months by controlling heat gains and losses as well as the humidity. Such buildings also enable air to flow constantly throughout the house and to stay fresh.

<sup>1</sup> International Passive House Association, *Active for More Comfort: The Passive House* (Darmstadt, Germany, 2010). Available from [www.passivhaustagung.de/Passive\\_House\\_E/passivehouse.html](http://www.passivhaustagung.de/Passive_House_E/passivehouse.html) (accessed 12 December 2011).

## Challenges with a passive house

- **Upfront additional investment costs compared with standard houses:** In Germany where passive house design is popular, the additional expense derived from such a concept is 3–8 per cent higher than standard houses. Investments made in the designing and the higher-quality building components are largely offset by avoiding the need for investment in expensive heating, cooling and lighting systems. The upfront investment, however, is likely to be higher in developing countries where the concept and thus manufacturers of necessary components remain undeveloped.<sup>2</sup>
- **Lack of awareness of the concept and benefits:** The passive house is quite unknown to the public in general and to policymakers in particular. Thus accurate information on the actual costs and benefits are often lacking, which is prerequisite for considering and promoting the concept.
- **Immature market:** The construction or building industry in the region is not evolving or developing fast enough to accommodate many new technologies. The components or materials required for the passive house are not readily available or are expensive.

## Considerations for replicating

**Take an incremental approach:** Increasing the minimum energy performance of buildings via building codes could be a useful priority during the market transformation, especially in least developed countries in the region.

**Invests in research and development:** Because the passive house is not a specific design technique but a design principle, constructing passive houses does not necessarily have to rely on modern technologies developed in European countries. Countries in the region can revisit their traditional and vernacular designs, such as design principles applied for tropical architecture that inspire lower resource consumption of buildings.

**Institutionalize standards or certificates:** Similar to the initiative in Europe, there is a need to introduce passive house standards in line with the climatic zone and to conduct sensitizing campaigns and capacity-building programmes for all parties associated with the building sector.

## Further reading

*Passive Houses Solutions*, Working Paper for the Promotion of European Passive Houses Project, by the European Commission under the Intelligent Energy Europe Programme (Brussels, 2006).

Passive House Institute website: [www.passiv.de](http://www.passiv.de).

International Passive House Association website: [www.passivehouse-international.org](http://www.passivehouse-international.org).

<sup>2</sup> Passipedia website "Affordability". Available from [http://passipedia.passiv.de/passipedia\\_en/basics/affordability](http://passipedia.passiv.de/passipedia_en/basics/affordability) (accessed 30 January 2011).