A Collection of Primary Tools

Green Buildings

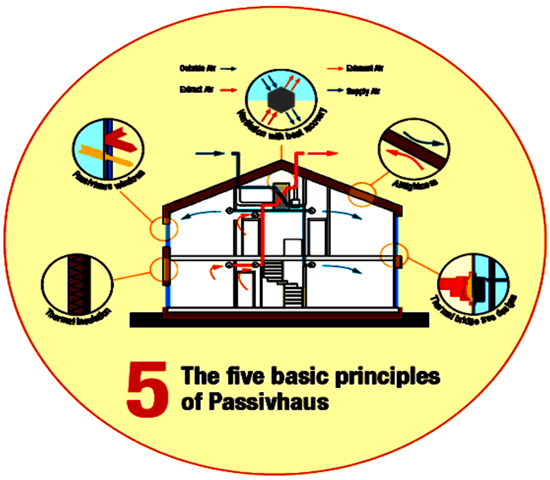
Tool GB 1: Passive Building Design.

<u>What this tool does:</u>

The German term ¨Passivhaus¨(= Passive House) stands for a rigorous energy-efficiency standard for buildings, covering residences, offices, commercial buildings, hotels, schools and any other public facilities. The Passive House concept entails that it reduced energy requirements, mostly heating for buildings through a design that ensures minimisation of energy losses through good insulation or even air tightness. Passive housing has been used for new buildings, but increasingly it is also used for used for building retrofits in urban renewal.

The concept passive house design is mostly applied for cold climate zones, but it can also be modified for use in moderate subtropical or tropical climates. In such climates, instead of good insulation and air tightness, it is rather the design features of shading and ventilation which are important.

The vast majority of passive houses have been built in Germany and Scandinavian countries, but it is also picking up in other European countries, like Austria, Spain, Switzerland, and the United Kingdom.



http://www.ordingbo.it/2017/11/07/5-conferenza-nazionale-passivhaus/five-steps/

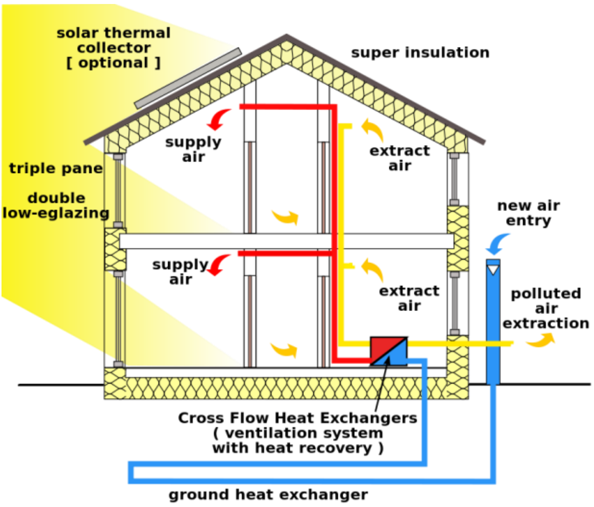
<u>How does the tool work?</u>

¨The Passivhaus standard requires that the building fulfills the following requirements:

- The building must be designed to have an annual heating and cooling demand as calculated with the Passivhaus Planning Package of not more than 15 kWh/m^2 per year in heating or cooling energy OR be designed with a peak heat load of 10 W/m^2 .
- Total primary energy (source energy for electricity, etc.) consumption (primary energy for heasting, hot water and electricity) must not be more than 120 kWh/m^2 per year.
- The building must not leak more air than 0.6 times the house volume per hour ($n_{50} \leq 0.6$ / hour) at 50 Pa (0.0073 psi) as tested by a blower door, or alternatively when looked at the surface area of the enclosure, the leakage rate must be less than 0.05 cubic feet per minute

By achieving the Passivhaus standards, qualified buildings are able to dispense with conventional heating systems. While this is an underlying objective of the Passivhaus standard, some type of heating will still be required and most Passivhaus buildings do include a system to provide supplemental space heating. This is normally distributed through the low-volume heat recovery ventilation system that is required to maintain air quality, rather than by a conventional hydronic or high-volume forced heating system.

Standard ¨Passivhaus¨



Source: www.passiv.de/en/01_passivehouseinstitute/01_passivehouseinstitute.htm

In Passivhaus buildings, the cost savings from dispensing with the conventional heating system can be used to fund the upgrade of the building envelope and the heat recovery ventilation system. With careful design and increasing competition in the supply of the specifically designed Passivhaus building products, in Germany it is now possible to construct buildings for the same cost as those built to normal German building standards.

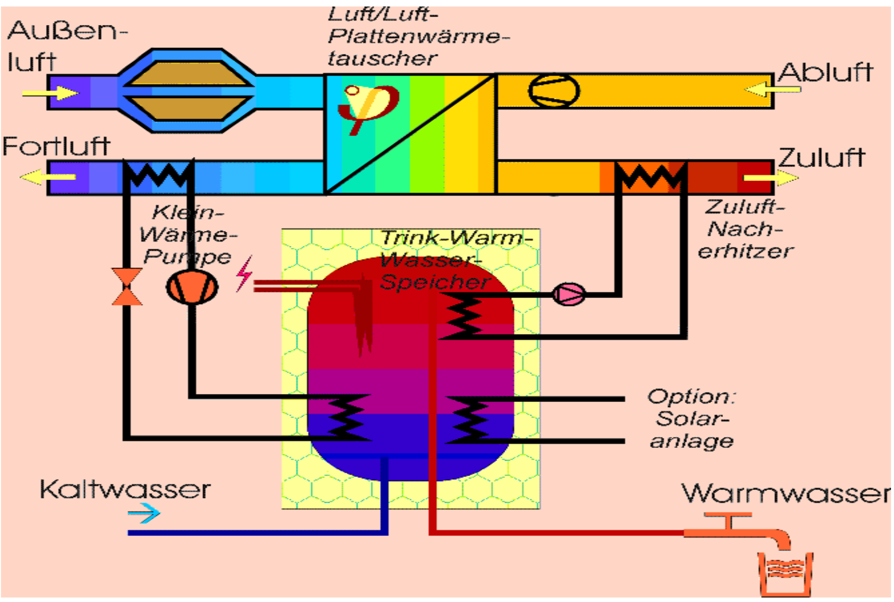
On average passive houses are reported to be more expensive upfront than conventional buildings - 5% to 8% in Germany, 8% to 10% in UK, and 5% to 10% in USA.

Evaluations have indicated that while it is technically possible, the costs of meeting the Passivhaus standard increase significantly when building in Northern Europe above 60° latitude. European cities at approximately 60° include Helsinki in Finland and Bergen in Norway; Moscow is at 55°.

These facts have led a number of architects to construct buildings that use the ground under the building for massive heat storage to shift heat production from the winter to the summer. Some buildings can also shift cooling from the summer to the winter. At least one designer uses a passive thermosiphon carrying only air, so the process can be accomplished without expensive, unreliable machinery.¨ (Source: https://en.wikipedia.org/wiki/Passive_house)

Example:

Heat Exchanger



How the Heat Exchanger works:

In addition to the heat exchanger (centre), a micro-heat pump extracts heat from the exhaust air (left) and hot water heats the ventilation air (right). The ability to control building temperature using only the normal volume of ventilation air is fundamental

Source: https://en.wikipedia.org/wiki/Passive_house

Features:

Passive solar design and landscape.

Passive solar building design and energy-efficient landscaping support the Passive house energy conservation and can integrate them into a neighbourhood and environment. Following passive solar building techniques, where buildings are compact in shape to reduce their surface area, with principal windows oriented towards the equator - south in the northern hemisphere and north in the southern hemisphere - to maximize passive solar gains. However, the use of solar gain is secondary to minimizing the overall house energy requirements.

Passive houses can be constructed from dense or lightweight materials, but some internal thermal mass is normally incorporated to reduce summer peak temperatures, maintain stable winter temperatures, and prevent possible overheating in spring or autumn before the higher sun angle "shades" mid-day wall exposure and window penetration. Exterior wall color, when the surface allows choice, for reflection or absorption (Insulation) qualities depends on the predominant year-round ambient outdoor temperature. The use of deciduous trees and wall trellised or self-attaching vines can assist in climates not at the temperature extremes.

Superinsulation.

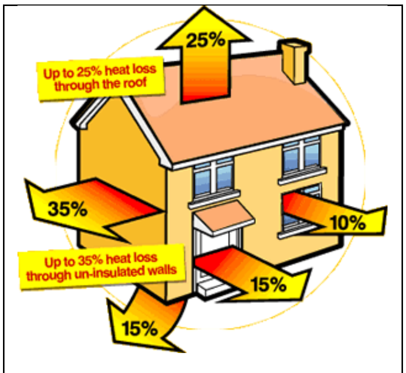
Passivhaus buildings employ superinsulation to significantly reduce the heat transfer through the walls, roof and floor compared to conventional buildings. A wide range of thermal insulation materials can be used to provide the required high R-values. Special attention is given to eliminating thermal bridges. A disadvantage resulting from the thickness of wall insulation required is that, unless the external dimensions of the building can be enlarged to compensate, the internal floor area of the building may be less compared to traditional construction. In Sweden, to achieve passive house standards, the insulation thickness would be 335 mm (about 13 in) (0.10 W/(m^2.K)) and the roof 500 mm (about 20 in) (U-value 0.066 W/(m^2.K)).

Advanced window technology.

To meet the requirements of the Passivhaus standard, windows are manufactured with exceptionally high R-values (low U-values, typically 0.85 to 0.70 W/(m^2.K) for the entire window including the frame). These normally combine triple-pane insulated glazing (with a good solar heat-gain coefficient, low-emissivity coatings, sealed argon or krypton gas filled inter-pane voids, and 'warm edge' insulating glass spacers) with air-seals and specially developed thermally broken window frames.

Airtightness.

Building envelopes under the Passivhaus standard are required to be extremely airtight compared to conventional construction. In order to achieve these metrics, recommended best practice is to test the building air barrier enclosure with a blower door at mid-construction if possible.



http://www.corbwell.ie/res/heatloss.gif

Passive house is designed so that most of the air exchange with exterior is done by controlled ventilation through a heat-exchanger in order to minimize heat loss (or gain, depending on climate), so uncontrolled air leaks are best avoided. Another reason is the passive house standard makes extensive use of insulation which usually requires a careful management of moisture and dew points. This is achieved through air barriers, careful sealing of every construction joint in the building envelope, and sealing of all service penetrations.

Ventilation.

Use of passive natural ventilation is an integral component of passive house design where ambient temperature is conducive — either by singular or cross ventilation, by a simple opening or enhanced by the stack effect from smaller ingress with larger egress windows and/or clerestory-operable sky-light.

Some Passivhaus builders promote the use of earth warming tubes. These are buried in the soil to act as earth-to-air heat exchangers and pre-heat (or pre-cool) the intake air for the ventilation system. In cold weather the warmed air also prevents ice formation in the heat recovery system's heat exchanger. Concerns about this technique have arisen in some climates due to problems with condensation and mold. Alternatively, an earth to air heat exchanger can use a liquid circuit instead of an air circuit, with a heat exchanger (battery) on the supply air.

Space heating.

In addition to using passive solar gain, Passivhaus buildings make extensive use of their intrinsic heat from internal sources—such as waste heat from lighting, white goods (major appliances) and other electrical devices (but not dedicated heaters)—as well as body heat from the people (Every person, on average, emits heat equivalent to 100 watts. Thus, a conventional central heating system is not necessary.

Instead, Passive houses sometimes have a dual purpose 800 to 1,500 watt heating and/or cooling element integrated with the supply air duct of the ventilation system, for use during the coldest days. It is fundamental to the design that all the heat required can be transported by the normal low air volume required for ventilation. The air-heating element can be heated by a small heat pump, by direct solar thermal energy, annualized geothermal solar, or simply by a natural gas or oil burner. A well-designed Passive house in the European climate should not need any supplemental heat source if the heating load is kept under 10W/m².

Because the heating capacity and the heating energy required by a passive house both are very low, the particular energy source selected has fewer financial implications than in a traditional building, although renewable energy sources are well suited to such low loads.

The Passive House Standards in Europe determine a Space Heating and cooling Energy Demand of 15 kilowatt hours per square meter of Treated Floor Area per year or 10 Watts per square meter peak demand. In addition, the total energy to be used in the building operations including heating, cooling, lighting, equipment, hot water, plug loads, etc. is limited to 120 kilowatt hours per square meter of Treated Floor Area per year (or in Imperial units 38.0 BTU/sf*yr.).

https://en.wikipedia.org/wiki/Passive_house

Literature / further information:

- http://www.passivehouse-international.org/index.php?page_id=79
- http://en.wikipedia.org/wiki/Passive_house
- GIZ 2015: Training textbook. Comparison of Energy Efficiency in Chinese and German Cities in the Context of the Global Situation. Beijing (in English & Chinese).
- GIZ 2015: Training textbook. Comparison of Modern Low Carbon Urban Development Concepts between China and Germany. Beijing (only in Chinese).
- GIZ 2015: Training textbook. German Experiences to obtain Energy Efficiency Gains in Cities through Green Buildings. Beijing (in English & Chinese).
- GIZ 2015: Training textbook. German Experiences to obtain Energy Efficiency Gains in Cities through Integrated Planning Approaches. Beijing (in English & Chinese).
- GIZ 2015: Training textbook. German Experiences to obtain Energy Efficiency Gains in Cities through Application of Renewable Energies in Urban Areas. Beijing (in English & Chinese).
- GIZ 2015: Training textbook. German Experiences to obtain Energy Efficiency Gains in Cities through Eco-Industrial Park (EIP) Development. Beijing (in English & Chinese). http://low-carbon-urban-development-germany-china.org/current-projects/qualification-of-key-actors-on-energy-efficiency-in-the-building-sector/downloads-of-qualification-of-key-actors-on-energy-efficiency-in-the-building-sector/
- ICLEI. 2016. *Solutions Gateway Sourcebook. Easy-to-use guidance for local governments. Low Carbon Solutions for Urban Development Challenges.* http://e-lib.iclei.org/wp-content/uploads/2016/05/ICLEI_Solutions-Gateway-Sourcebook_final-web1.pdf see also: www.solutions-gateway.org
- Snodgrass, E.C. and McIntyre, L. 2010. *The Green Roof Manual. A professional Guide to Design, Installation, and Maintenance*. Timberpress. Portland.

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