Smith House, 2003, Urbana, IL

PHIUS

Passive House Institute US

Waldsee BioHaus, 2006, Bemidji, MN

What is a Passive House?

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 4.75 KBtu/sf/yr (15 KWh/(m^2a). 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 (Warmeschutzverordnung).

The standard has been named Passive House because the passive heat inputs - delivered externally by solar radiation through the windows and provided internally by the heat emissions of appliances and occupants - essentially suffice to keep the buildng 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 consumpiton in the building, notably electricity for household appliances.

Stanton House, 2009, Urbana, IL

Passive Solar Gain

When efficiency potentials have been maximized, the passive gain of incoming solar energy through glazing dimensioned to provide sufficient daylight covers about 40% of the minimzed heat losses of the house. To achieve this, the windows have low-emissivity triple glazing and superinsulated frames. These let in more solar heat than they lose. The benefit is enhanced if the main glazing areas are oriented to the south and are not shaded.

Solar Gains

Measure	Optimized south-facing glazing
Specification	Close to 40% contribution to space heating demand

Superglazing/Superframes

Measure	Low-emissivity triple glazing Super insultated frames
Specification	U value ≤ 0.14 Btu/hr-ft2-°F Solar Heat Gain Coefficient >50%

Superinsulation

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. (see guidelines on back)

Building Shell

Using an energy modeling program called the Passive House Planning Package (PHPP), wall systems can be designed directly working with regional climate data. This ensures appropriate insulation levels that match the climate zone.

Thermal-Bridge-Free Construction

It is important to minimize energy losses. Thermal bridging can greatly reduce energy performance if they are not properly detailed and avoided.

Airtightness

By preventing air "leaks" in and out of the house, drafts are eliminated, temperature is carefully regulated and moisture is kept out of the wall assembly.

Specification *Blower door test ≤ 0.6 ACH 50*

The Cleveland Farm, 2007, West Tisbury,

Guidelines for single family envelopes

Envelope Insulation:	W/m^2K	$hr\text{-}ft^2\text{-}°F/Btu$
Minneapolis, MN	U=0.08	R=71
Chicago, IL	U=0.094	R=60
Ashville, NC	U=0.22	R=26
Seattle, WA	U=0.13	R=44
Houston, TX	U=0.19	R=30
Phoenix, AZ	U=0.14	R=40
Las Vegas, NV	U=0.14	R=40

Thermal Bridge Free Construction

Linear Thermal Transmittance	0.01 W/mK	0.006 Btu/hr-

Heat Recovery Ventilation

Net Efficiency	h=75%	75%
Electric Consumption of motor	$0.45\ Wh/m^3$	$0.68\ W/cfm/ft^3$

Comparisons between Single and Multi Family (guideline R val

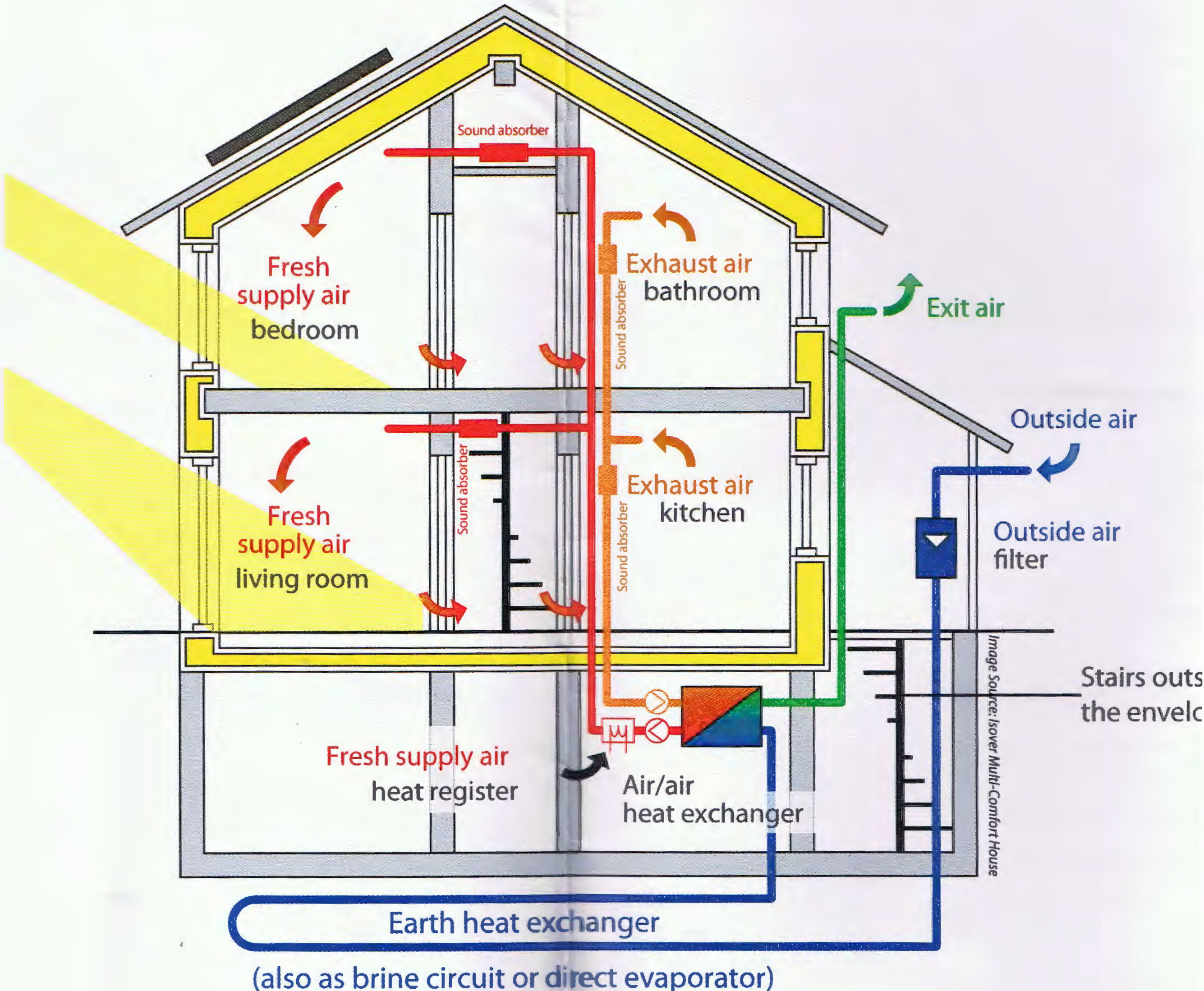
Envelope Insulation:	W/m^2K	$hr\text{-}ft^2\text{-}°F/Btu$
Single Family 3000 HDD	U=0.15	R=38
Single Family 5500 HDD	U=0.09	R=56
Multifamily 3000 HDD	U=0.19	R=32
Multifamily 5500 HDD	U=0.14	R=40

High Performance Windows (recommended guidelines)

	W/m^2K	$Btu/hr\text{-}ft^2\text{-}°$
Overall Thermal Transmittance	U≤0.8	U≤0.14
Solar Heat Gain Coefficient	g-value ≥50%	SHGC ≥50

Smith House, 2003, Urbana, IL

What makes a building a Passive House?



Efficient Appliances

Through fitting the Passive houses with efficient household appliances, hot water connections for washing machines and dishwashers, and compact fluorescent lamps, electricity consumption is also slashed by 50% compared to the average housing stock, without any loss of convenience. The ventilation system, for instance, is driven by highly efficient DC motors. High-efficiency appliances are often no more expensive then average ones because of short payback periods due to energy savings.

Cost

To achieve Passive House standard requires an additional upfront investment of approximately 15% of the construction budget, as compared to regular energy code compliant 2x4 construction. This number varies by region and building.

Why build Passive Houses?

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.

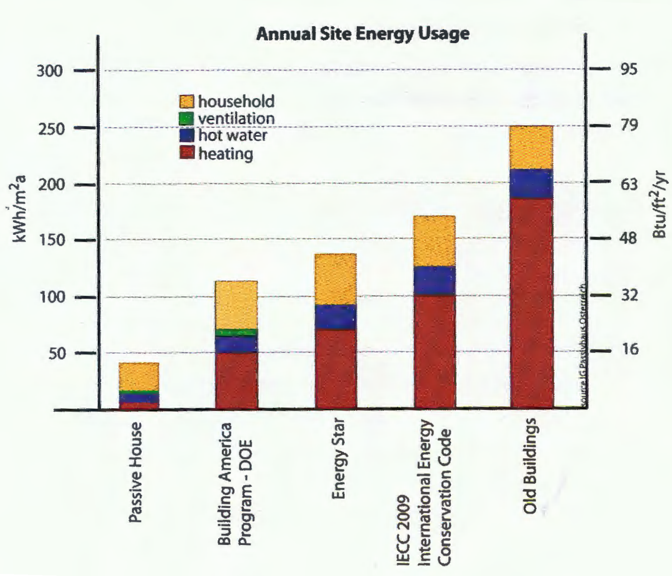
Passive House makes it possible to meet the remaining energy demand of new buildings completely from renewable sources - while keeping within the bounds set by the limited availability of renewables and the affordability of extra costs. The Passive House philosophy builds upon two basic principles:

Principle 1: *Optimize what is already essential*

What makes the approach so cost-efficient is that, following the principle of simplicity, it relies on optimizing these components of a building which are necessary in any case: the building envelope, the windows, and the mechanical ventilation system normally required for hygenic reasons. The goal is to improve the efficiency of these components to the point in which no conventional heating system is needed. The savings from eliminating the furnace largely pay for the envelope upgrades.

Principle 2 : *Minimize losses before maximizing gains*

Passive Houses prevent available heat from escaping as rigorously as possible (i.e. emphasizing 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.



Ventilation System

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.

Heat recovery

Measure	Counterflow air-to-air heat exchanger
Specification	Heat transfer >80%

Latent heat recovery from exhaust air

Measure	Compact heat pump unit
Specification	Max heat load 3.2 BTU/hr/ft^2 (10 W/m^2K)

Hygenic ventilation

Measure	Directed air flow through whole building; exhaust air extracted from damp rooms
Specification	0.3 air changes per hour

Renewable Energy

Cost-optimized solar thermal systems can meet about 40-60% of the domestic hot water demand of a Passive House. Small affordable photovolatic/wind or hybrid systems can meet the low energy demand in a Passive House to become net zero.

A slight larger renewable system will off set source related carbon emissions, resulting in a carbon neutral building.