Denmark

The Passive House

National Publication

What is a Passive House?

*In this age of **increased energy prices** and **emission excesses**, efficient energy use is becoming more and more important. This is no longer solely an environmental consideration, but increasingly also a financial one. Some **40% of our annual energy consumption** is used in buildings. The Passive House concept primarily focuses on residential buildings, though these principles are applicable in other building types as well. As the numbers show, **energy-wise**, there is **much to be gained in buildings**. For this reason, more and more building professionals have recognized the Passive House approach as the sensible way forward.*

The Passive House is a residence that has been optimally designed to retain energy. Much attention is paid to performance of the materials and components with respect to **indoor climate**. The advantage being that temperatures inside the residence have very few fluctuations, resulting in **notably higher indoor comfort.**

The **Passive House concept** applies **established techniques** and **solid design principles** to realize a residence that utilizes it's energy optimally.
By **reducing heat losses** to a minimum through optimal insulation and heat recovery techniques and **maximizing passive heat gains**, the Passive House is so efficient that it no longer requires a conventional heating system.
This means that the **cost savings** for the heating system can, in part, compensate for the higher cost of high performance building components.
Moreover, by using less energy over its lifetime, a Passive House not only generates a **smaller environmental impact**, it also incurs **lower energy costs** during use. In addition, a Passive House decreases the financial impact on occupants that rising energy prises may bring.

Introduction

What is PEP?

PEP, which stands for **'Promotion of European Passive Houses'** is a consortium of European partners, supported by the **European Commission**, Dictorate General for Energy and Transport.

Why Promotion of European Passive Houses?

It is generally recognized that, within the housing sector in Europe, **many building activities** can be expected over the coming decades. The old building stock will need to be refurbished or, in many cases, even demolished and new buildings erected. The existing housing stock is responsible for a **large share of our total energy consumption**, and therefore many **energy savings** can be accomplished in these upcoming reconstruction activities. As previous demonstration projects (such as CEPHEUS) have demonstrated, the **reduction of non-renewable energy demand** by a **factor 4** (compared to contemporary national standards) is not only **possible** but also **realistic**. The Passive House concept is a **sound** and relatively **low-cost method** to achieve these energy savings. To spread this knowledge throughout the professional building community, beyond the select group of specialists, PEP has set out to spread the experience gained throughout Europe on the Passive House concept.

What does PEP do?

Goal of P.E.P. is to promote regional economic activities, especially for SMEs (which perform a significant part of the work in the housing industry) in order to induce a substitution of expenses for energy use during the lifetime of houses with investment in the building envelope.

To achieve this goal, the consortium intends to:

- communicate the passive house concept and specific solutions in different European regions and climates

Introduction

- adapt the existing Passive House design tool (PHPP, Passive House Planning Package) to meet the demand of architects and planners in different countries
- develop practical information packages, such as building product documentation, design guides, research results, calculation methods and quality assurance activities to assist building professionals throughout Europe in the development of Passive Houses
- set up a certification program for Passive House buildings and technologies and a link to the national Energy Performance Certification system according to the EU building directive
- organize national workshops and the annual international Passive House Conference
- Create national Passive House websites for continuous up-to-date information provision

How can I find out more?

For more information, please contact:

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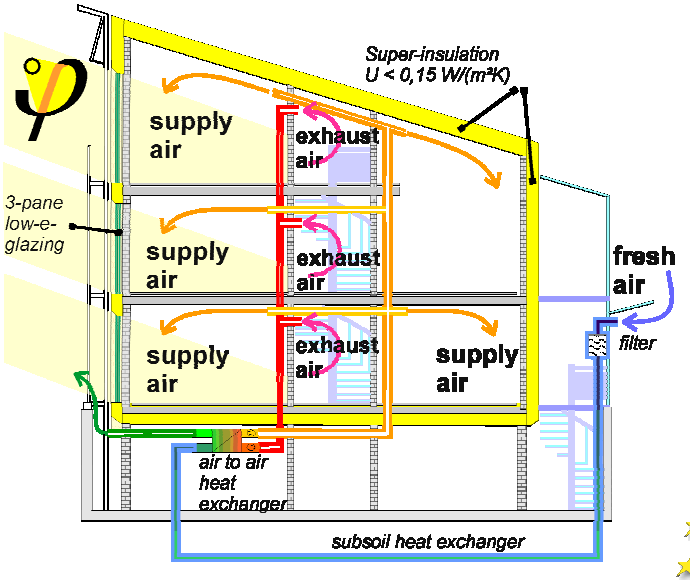


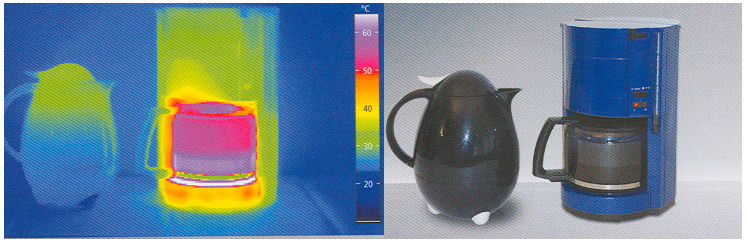
Passive House a definition

The term **Passive House** refers to a specific construction standard for residential buildings with good interior comfort conditions during winter and summer, without traditional heating systems and without active cooling. Typically this includes very good insulation levels, very good air- tightness of the building, whilst a good indoor air quality is guaranteed by a mechanical ventilation system with highly efficient heat recovery.

Thereby the design heat load is limited to the load that can be transported by the minimum required ventilation air. However space heating does not have to be carried through the ventilation system. For 40° - 60° Northern latitudes, under conditions specified in the PHPP calculation model[1]:

- the total energy demand for **space heating and cooling** is limited to **15 kWh/m² treated floor area**[2];
- the total **primary energy use** for all appliances, domestic hot water and space heating and cooling is limited to **120 kWh/m² treated floor area**[2]

A passive house has a **high level of insulation** with **minimal thermal bridges**, **low infiltration**, and utilizes **passive solar gains** and **heat recovery** to accomplish these characteristics. Consequently **renewable energy** sources can be used to meet the resulting energy demand.



The Passive House Concept illustrated: Passive (thermos) versus Active (stove)
Source:Informations-Gemeinschaft Passivhaus Deutschland

1 *Passive House Planning Package, Passiv Haus Institut*
2 *Treated floor area is equal to the internal floor area based on internal wall dimensions. Internal walls are excluded from the area.*

Passive House measures

Measure/ solution	*Passive House standard*
1. Super Insulation	
Insulation walls	U ≤ 0,15 W/(m²K)
Insulation roof	U ≤ 0,15 W/(m²K)
Insulation floor	U ≤ 0,15 W/(m²K)
Window casing, doors	U ≤ 0,8 W/(m²K)
Window glazing	U ≤ 0,8 W/(m²K)
Thermal bridges	linear heat coeff ψ ≤ 0,01W/(mK)
Air tightness	n50 ≤ 0,6 h-1
Minimal Shape Factor (Area TFA/ Volume TV)	
2. Heat Recovery/ IAQ	
Ventilation counter flow air to air heat exchanger	heat recovery ηHR ≥ 75 %
Ventilation air sub-soil heat exchanger	air outlet after sub-soil heat exchanger above frost temperature
Ventilation ducts insulated	
Other heat recovery (e.g. ventilation & DHW return pipes)	
DHW heat recovery	
DHW pipes insulated	
Minimal space heating	postheater ventilation air/ low temperature heating
Efficient small capacity heating syst.	biomass, heat pump, gas, co-generation (e.g. district heating), etc.
Air Quality through ventilation rate	min. 0,4 ach^{-1} or 30 m^3/pers/h or national regulation if higher
3. Passive (Solar) Gain	
Window glazing	solar energy transmittance g ≥ 50 %
DHW (solar) heater	
Thermal mass within envelope	
Solar orientation	
Night-time shutters	
Shading factor [%] (East & West)	

Measure/ solution	*Passive House standard*
4. Electric Efficiency	
Energy labeled household appliances [Labeling A - G]	Energy reduction 50% of common practice
Hot water connections washing machines/ dishwashers	
Compact Fluorescent lighting	
Regular maintenance ventilation filters	
Direct Current motor ventilation	
Efficient fans: SFP (Specific Fan Power)	≤ 0,45 W/(m3/h) (transported air)
5. On-site Renewables	
Wind turbine	
Photo Voltaics	
Solar thermal energy	
Biomass system	
Other	
	=basic measure/ solution
	=often applied optional measure/solution
	=other optional measure/ solution

Passive House barriers/publications

Barriers to build passive houses:

Building know-how
- Very limited know-how in general among architects, costumers etc
- Best building practice not existing - no guidelines, no help etc.
- House companies - should we make an ”emergency” heating system ?

Lack of good Danish component
- Windows !

Officially related barriers
- District heating/natural gas requirements problematic
- Politicians are still ignorant about passive houses
- New directive does not include passive houses
- No official passive house program with economical support

National publications

No publications are available yet.

Overview building stock

The existing building stock used for living is around 1.6 million houses in general of good quality.

New building was in 2004:
Apartments: 9064
One family houses
(row and separate houses)):14673

Wood houses are not common but are getting more popular. (New building: Wood houses: 15-20 % Brick houses: 75-80 %)

Type of house	Existing building stock
Semi-detached, row houses	13%
Detached	72%
Apartment/flat	5 %
Other	9 %
# Passive houses/ year	None

Standard wood house

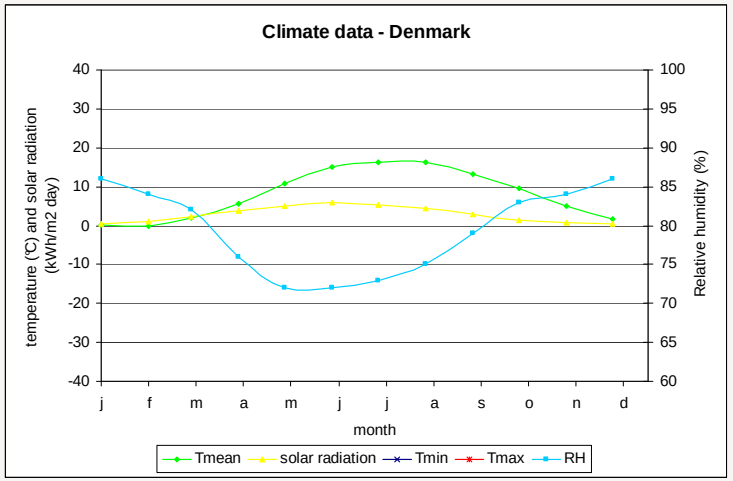
Standard brick house

Denmark climate

Danish climate is temperate; humid and overcast; mild, with windy winters and cool summers.

The minimum/maximum design temperature is –12°C for winter (no design temperature for summer).

longitude	9° 35′E – 15° 5′E
latitude	54° 20′ N – 57° 27′ N
altitude	< 173 m



Denmark best practice example

In Denmark there are no examples of certified passive houses. The examples given are examples of low energy houses.

Company: Rockwool
Goal: 15 kWh/m2 per year
Measurements: 51 kWh/m2 per year
Calculated with Danish methods the energy consumption is 10 kWh/m² pr year while a calculation with the PHP gives an annual consumption of 24 kWh/m² pr. year.

Problem:
- heavy cold bridges at foundation etc.
- lower internal heat generation
- solar energy less useful than expected

Company: Harmony
Goal: 15 kwh/m2 per year (calculated according to Danish standard

Passive House characteristics

Thermal mass: No information is available regarding thermal mass of the Passive House equivalent in Denmark.

Compared to typical construction:
15-20% of new to build houses are wood, 75-80% of new to build houses are of bricks.
The typical Danish house brick house is designated "high" thermal mass.
Exterior walls: bricks– high thermal mass.
Interior (separation) walls: bricks –high thermal mass. Floors: concrete – high thermal mass.

Air tightness Passive House standard	$n_{50} \leq 0,6$ h-1
Air tightness typical Denmark	$n_{50} \leq 2.3$ h-1

Thermal insulation

	Passive House standard	*Typical House Denmark*
Envelope component	**U-value [W/m²K]**	
Facade	0,15	0.20
Roof	0,15	0.15
Floor	0,15	0.15
Doors		1.5
Window frame	0,8	2.0
Windows	0,8	1.5

Passive House characteristics

Equipment/ installations:

No information is available regarding equipment and installations of the Passive House equivalent in Denmark.

Heating	Heat generator Heating fluid Temp Control Heating system	N/A
Domestic hot water	Heating Energy source	N/A
Ventilation	System Heat recovery Ventilation rate	N/A

Compared to typical construction:
The typical Danish house is heated by floor heating/district heating.

Heating	Heat generator Heating fluid Temp. control Heating system	District heating water thermostats floor heating
Domestic hot water	Heating Energy source	Spiral in hot water tank District heating
Ventilation	System Heat recovery Ventilation Rate	 yes 0.5 h^{-1}

Passive House characteristics

Energy Use:

No information is available regarding energy use of Passive House equivalent houses in Denmark. However, according to the Passive House standard the space heating energy demand of a passive house is limited to a maximum of 15 kWh/m^2 treated floor area (excluding interior walls). And the total energy demand for heating, ventilation, electricity for fans and pumps and household electricity is limited to around 42 kWh/m^2a or 120 $kWh_{primary}$/m^2a treated floor area.

Compared to typical construction:

The new Danish building directive starting 2006 requires a yearly heating demand for single houses less than approximately 60 kWh/m^2 (exterior dimensions)

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Intelligent Energy Europe

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