Norway

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:

Sintef Technology and Society
Architecture and building technology
N-7465 Trondheim
Tel: +47 40 00 67 23, Fax: +47 73 59 82 85
www.sintef.no, Inger.Andresen@sintef.no, Tor.H.Dokka@sintef.no

Passive House a definition

In Norway, we do not have any passive houses yet. However, there are several passive-house developments in the planning stage. The following definition is based on the definition used in Germany and Austria.

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 *Norwegian Standard NS 3940 defines the treated floor are (BRA – used area). All dimensions are measured from the interior surface of the exterior walls. Excluded are exterior walls, area with ceiling height lower than 1.2 m, un-heated external store-room. Included are floor surface ground and first floor incl. partitions and floor area under stairs.*

Passive House measures

Measure/ solution	*Passive House standard*
1. Super Insulation	
Insulation walls	U ≤ 0,15 W/(m^{2}K)
Insulation roof	U ≤ 0,15 W/(m^{2}K)
Insulation floor	U ≤ 0,15 W/(m^{2}K)
Window casing, doors	U ≤ 0,8 W/(m^{2}K)
Window glazing	U ≤ 0,8 W/(m^{2}K)
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

Lack of affordable heating technologies for low energy dwellings:

- small bio-burners
- low cost water based heating systems
- heat pumps for dhw
- only a few suppliers of solar collectors
- no passivehouse-windows (yet)

Other obstacles are:
- lack of knowledge among planners
- focus only on investment costs
- restrictive district heating legislation
- variable contractor skills

National publications

"Energieffektive løsninger i småhus. Redusert oppvarmingsbehov og bedret inneklima", Anvisning nr 40, Norges Byggforskningsinstitutt, Oslo 2005.

"Fremtidens energieffektive boliger. En veileder for planlegging av lavenergiboliger og passivhus", SINTEF Teknologi og samfunn, Arkitektur og byggteknikk, Trondheim 2005.

Pettersen TD, Myhre L, Wigenstad T, Dokka TH, *"Energimerking av boliger", Prosjektnr.* O 20461, Juni 2005. www.bygningsenergidirektivet.no

Overview building stock

The existing residential building stock in Norway is about 1.4 million units. The number of new buildings constructed in the residential sector amounts to slightly above 20-22 000, while the growth is around 12 000 per year (about 1%).

Typical Norwegian detached house.

Type of house	Existing building stock
Single family, row house	20%
Detached	50%
Apartment/flat	20%
Other	10%
# Passive Houses/ year	0

Norway climate

Norway's climate shows great variations. From its southernmost point, Lindesnes, to its northernmost, North Cape, there is a span of 13 degrees of latitude.

There are great variations in received solar energy during the year. The largest differences are found in Northern Norway, having midnight sun in the summer months and no sunshine at all during winter.

The highest annual temperatures can be found in the coastal areas of the southern and western part of Norway. In 1994 Lindesnes lighthouse (Vest-Agder) recorded the highest annual temperature ever, with 9,4 °C. The highest monthly mean temperature ever recorded is 22,7 °C for July 1901 in Oslo.

The mean temperature in the winter months are above freezing all along the coast from Lista (Vest-Agder) to the Lofoten area (Nordland).

The lower inland areas, both in the southern and northern parts of Norway, have very low mean temperatures in winter. The Finnmark Plateau is the coldest area with mean monthly temperatures around -15 °C.

For an average representation of the climate in Norway, the meteorological data of Oslo may be used. In Oslo, the minimum/maximum design temperature is –16°C for winter and 21°C for summer. The annual mean temperature is 5.7 °C and the annual mean wind speed is 2.2 m/s.

longitude	10.2
latitude	60.1
altitude	+94m

Norway best practice example

Thermal mass: There is no information available yet about the thermal mass of a Passive House equivalent in Norway.

Compared to typical construction:
The typical Norwegian house is designated "low" thermal mass.
Exterior walls: wood frame– low thermal mass
Interior (separation) walls: wood frame – low thermal mass
Floors: concrete slab – high thermal mass

Thermal insulation

	Passive House Equivalent example	*Typical House Norway*
Envelope component	**U-value [W/m²K]**	
Facade	0,16	*0,22*
Roof	0,11	*0,15*
Floor	PH std.: 0,15	*0,15*
Doors		*1,6*
Window frame	PH std.: 0,8	*1,6*
Windows	PH std.: 0,8	

Air tightness Passive House standard	$n_{50} \leq 0{,}6\ h^{-1}$
Air tightness typical Norway	$n_{50} \sim 2\ h^{-1}$

Norway best practice example

Envelope components, materials

Facade, exterior wall

Materials (out → in)	*Thickness [cm]*
Exterior cladding	2.2
Battening	1.3
Wind break (asphalt cardboard)	0.2
Mineral wool	5
Asphalt plate	1.2
Mineral wool	20
Plastic foil	0.2
Interior finishing	1.2-1.5

Floor

Thermal break 30 mm: y = 0,03 W/mK
Thermal break 50 mm: y = 0,02 W/mK
Thermal break 80 mm: y = 0,01 W/mK

Materials (out→ in)	*Thickness [cm]*
Rock filling	
Gravel	20-30
EPS	10
Plastic foil	0.2
EPS	15
Concrete plate	8
Finishing	

Norway best practice example

Envelope components, materials

Roof (external roof)

Materials (out → in)	*Thickness [cm]*
Roof tiles	
Furring	4,8
Battening	1,1
Bitumen felt	0.2
roof sheating	1.5
Furring	4.8
Wind break	0.2
Mineral wool	25
Plastic foil	0.2
Mineral wool	7
Interior finishing	1.2-1.5

Glazing, frames

Triple pane window	U_{window}= n.a.
Material	Wood
Glass pane	argon

Roof (tie-beam or cold attic roof)

Materials (out → in)	*Thickness [cm]*
Cold attic	
Mineral wool	20
Mineral wool	15
Plastic foil	0.2
Mineral wool	5
Interior finishing	1.2-1.5

Norway best practice example

Equipment/ installations

There is no information available regarding equipment in the passive house equivalent in Norway.

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	Yes, 90%

Compared to typical construction:
The most common heating system in Norwegian dwellings is electric heating with baseboard panels. The most common ventilation system is natural air supply with mechanical exhaust from baths and kitchen.

Heating	Heat generator Heating fluid Temp. control Heating system	Hydro electricity Thermostat Baseboad, elec.
Domestic hot water	Heating Energy source	storage electricity
Ventilation	System Heat recovery Ventilation Rate	Mechanical exhaust no 0.5 ACH

Norway best practice example

Energy Use

No information is available regarding energy use of Passive House equivalent houses in Norway. 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 50 kWh/m^{2}a treated floor area.

Compared to typical new build construction:
The energy use for heating is around 63 kWh/m^2 treated floor area, for domestic hot water 21 kWh/m^2, for lighting 17 kWh/m^2, for household appliances 25 kWh/m^2, and 1 kWh/m^2 for fans and pumps.

The sole responsibility for the content of this publication lies with the authors. It does not represent the opinion of the European Communities. The European Commission is not responsible for any use that may be made of the information contained therein.

This publication has been created by DHV www.dhv.com, as part of the European PEP project

Norway
The Passive House

Intelligent Energy Europe

The PEP-project is partially supported by the European Commission under the IEE Programme. EIE/04/030/S07.39990

SINTEF

For more information, please contact:

Sintef Technology and Society
Archtiecture and Building Technology
N-7465 Trondheim,
Tel: +47 40 00 67 23, Fax: +47 73 59 82 85
www.sintef.no,
Inger.Andressen@sintef.no
Tor.H.Dokka@sintef.no