

Very Low-Energy House Concepts in North European Countries

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NorthPass

What is a Very Low-Energy House?

Different cross-border and national definitions and concepts

- «Low energy house»

  Buildings with significantly lower energy demand than buildings just meeting the mandatory building regulations. Typical criteria are 25-50 % below minimum requirements

- «Passive house»

  As defined by Passivhaus Institut the heat demand is lower than 15 kWh/m²/a or heating load below 10 W/m², total primary energy demand is below 120 kWh/m²/a, n_{50} below 0,6, and temperature above 25 ºC less than 10% of the hours of use

In Sweden, Norway and Finland the term is used for other, national values, too

What is a Very Low-Energy House?

Different cross-border and national definitions and concepts

- «Active house»

  is a term used for low energy houses with focus on daylight utilization, natural ventilation strategies and renewable energy supply on the building

- «Zero energy building»

  is a term used for low energy houses with renewable energy supply on the building, which equals the energy demand in annual balance

What is a Very Low-Energy House?

Different cross-border and national definitions and concepts

- «Zero emission building»

  is a term used for buildings with renewable energy supply on the building, which offsets emissions caused by the production of the conventionally produced energy consumed by the building

- «Plus-energy-building»

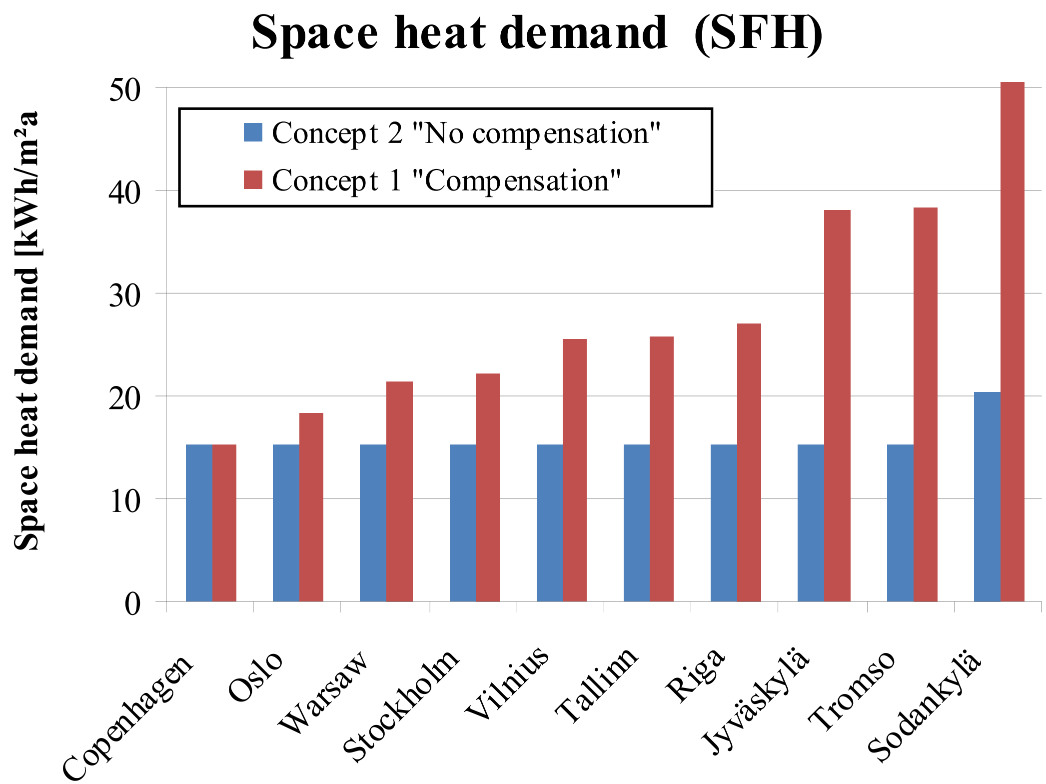
  is a term used for low energy houses with renewable energy supply on the building, which more than equals the energy demand in annual balance

What is a Very Low-Energy House?

Space heat demand around Northern Europe

- **Concept 1**
  A building meeting the passive house criteria in Copenhagen is moved around North European climate zones

- **Concept 2**
  U-values of a building are modified to meet the passive house criteria in each climate zone



What is a Very Low-Energy House?

Labeling and certifying

Several schemes for labelling and certification of energy efficient and sustainable buildings

Why build Very Low-Energy Houses instead of Conventional Houses?

- Very Low-Energy Houses have lower environmental impact
- Very Low-Energy Houses have lower Life Cycle Costs if energy prices are high
- To take action against climate change and reduce energy consumption
- To fulfil political agreements

Source: commons.wikimedia.org

Reference: IVL (2011) *Economic and environmental impact assessment of very low-energy house concepts in the North European countries*

Why build Very Low-Energy Houses?

To reduce environmental impact

- Life Cycle Assessments demonstrate that Very Low-Energy Houses have lower environmental impact than Conventional Houses – they use less primary energy and cause less greenhouse gas emissions
- Greenhouse gas emissions from energy consumption are more important than greenhouse gas emissions from building material production
- It is important not only to reduce energy consumption but to use renewable energy whenever possible

Portvakten, a Swedish Very Low-Energy House. Source: IVL Swedish Research Institute

Reference: IVL (2011) *Economic and environmental impact assessment of very low-energy house concepts in the North European countries*

Why build Very Low-Energy Houses?

Lower Life Cycle Costs with higher energy prices

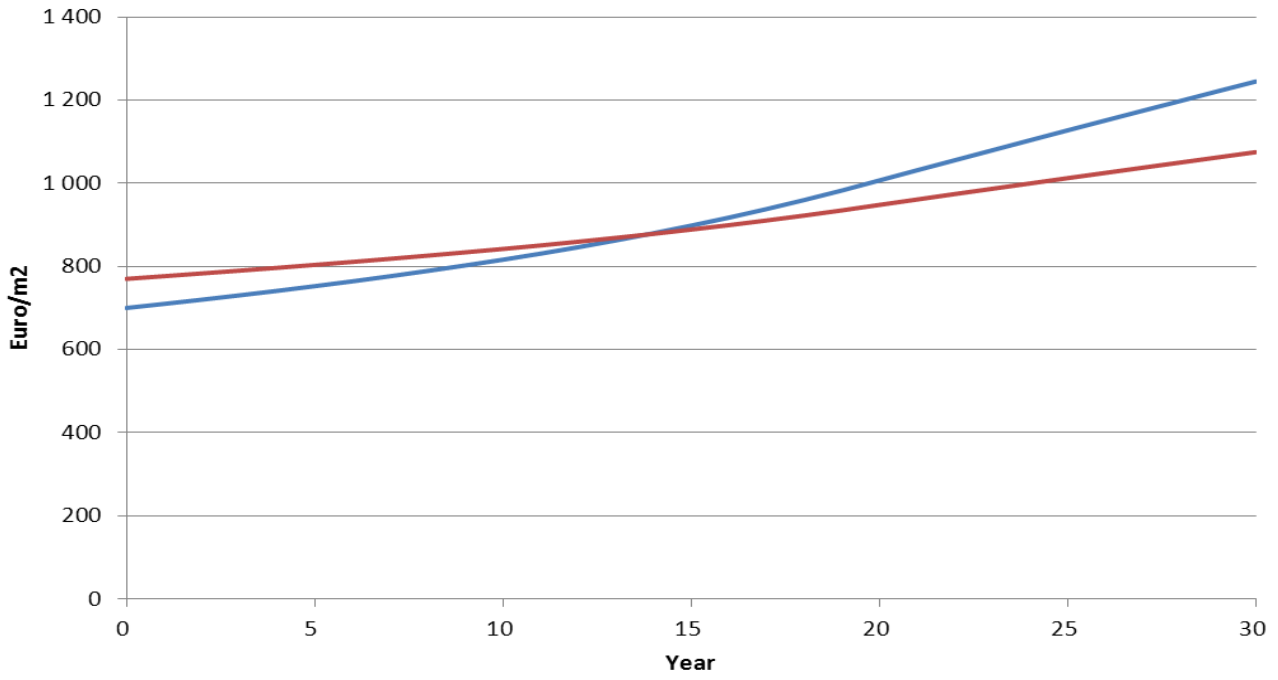
- Lower energy costs with a lower energy consumption
- The energy price is important for economical comparisons between Very Low-Energy Houses and Conventional Houses
- Life Cycle Costs assessments, for different energy price trend scenarios, show that Very Low- Energy Houses have lower Life Cycle Costs than Conventional Houses for a high energy price trend

Source: commons.wikimedia.org

Reference: IVL (2011) *Economic and environmental impact assessment of very low-energy house concepts in the North European countries*

Why build Very Low-Energy Houses?

Life Cycle Costs for a Very Low Energy House



Reference: IVL (2011) *Economic and environmental impact assessment of very low-energy house concepts in the North European countries*

Life Cycle Cost for two Lithuanian multi-family buildings for a scenario with high energy price development and a time span of 30 years

Why build Very Low-Energy Houses?

To take action against climate change and reduce energy consumption

- Increased awareness that the climate change is caused by human activities, e.g. energy production from fossil fuels
- It is important that we reduce greenhouse gas emissions to avoid further global warming. Less fossil energy consumed results in lower greenhouse gas emissions
- Rescource constraints for oil and gas production, the resources are not as easily accessible anymore

Source: commons.wikimedia.org

Reference: Intergovernmental Panel on Climate Change, (2007), *Fourth assessment report Climate change 2007*

Why build Very Low-Energy Houses?

To fulfill political agreements

- The building sector accounts for 40 % of the energy use within EU. There is a great potential of reducing energy use and thereby greenhouse gas emissions
- With a more energy efficient building sector a country becomes less dependent on imported energy
- There are many political agreements to improve energy efficiency and to reduce greenhouse gas emissions, e.g. EU's Energy Performance of Buildings Directive

Source: commons.wikimedia.org

Comfort and indoor climate

Benefits in a very low energy house: Thermal comfort

- Homogeneous warm walls, floor and window surfaces because the construction is well insulated and airtight and low u-value windows are used
- No draft along the floor or downdraft from window since the construction is well insulated and airtight, thermal bridges are minimized and low u-value windows are used
- The temperature variation during the day and year is low compared to traditional buildings because of the high level of insulation, the effective solar shading and air tightness

Isover.dk

Comfort and indoor climate

Myths and facts

Myth: *Very low energy houses are too hot in the summer.*

To avoid risk of overheating in the summer:

- It is important to design the house optimally and to install external solar shading on windows facing east, west and south
- Thermal mass can even out temperature peaks
- Guide the occupants to control the heating and ventilation system and possible adjustments
- Without the use of external shading on warm and sunny days, the very low energy house can have the same problems as conventional houses keeping the temperature within the comfort zone

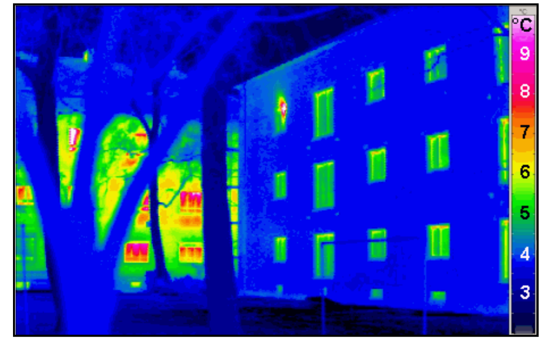
Comfort and indoor climate

Benefits in a very low energy house: Indoor air quality

An effective mechanical ventilation system will:

- Ensure clean and plentiful fresh air
- Remove dust and odour with the exhaust air. Reduce risk of allergies
- Control the air humidity and reduce the mould risks
- Give possibility to adjust ventilation rates according to the needs

Comfort and indoor climate



Myths and facts

Myths: *Very low energy houses cannot breathe through the building envelope because it is too airtight and consequently the indoor environment is bad. / Very low energy houses have risks of having moisture problems*

- A good air change is important to ensure optimal indoor air quality, but it must be done through mechanical demand controlled ventilation or by opening the windows - not uncontrolled air leakage through the building envelope

- A leaky building envelope can result in moisture and mould in the construction (and thereby a poor indoor environment) because warm moist air passing through the leaks into the construction will condensate when it cools. The moist can furthermore destroy the constructions and thereby reduce the lifespan of the building. An airtight building will not experience this risk

Comfort and indoor climate

Benefits in a very low energy house: Acoustic comfort

- Reduction of external noise from neighbours, traffic and other outdoor activity because of well insulated and airtight constructions as well as good windows

- The ventilation system must be designed correctly to separate indoor and outdoor sounds. The system may cause noise due to fans and airborne sound from distribution channels and nozzles. If not done properly, the system will generate extra unnecessary noise, which is also the case in conventional houses

Comfort and indoor climate

Myths and facts

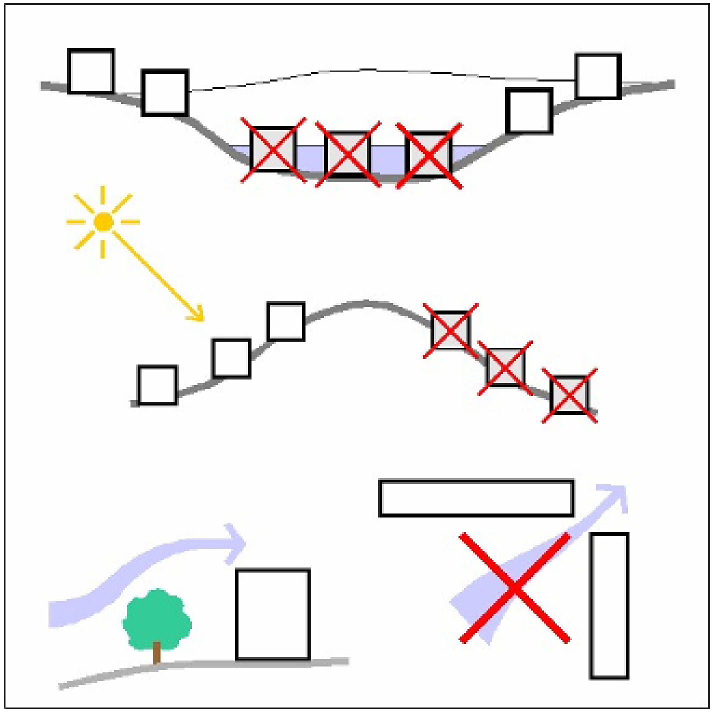
Myths: *Very low energy houses have technology that is too complicated for the occupants*

- It is not more complicated to live in a very low energy house than living in a conventional house. It may even be easier
- With the right guidance it is easy to live in a very low energy house
- Education and information about the house is crucial and will teach the occupants how their behaviour affects the energy consumption.
- Most of the system is automatically controlled, so the occupant do not need much involvement

How to build a Very Low-Energy House

Choosing the right building site

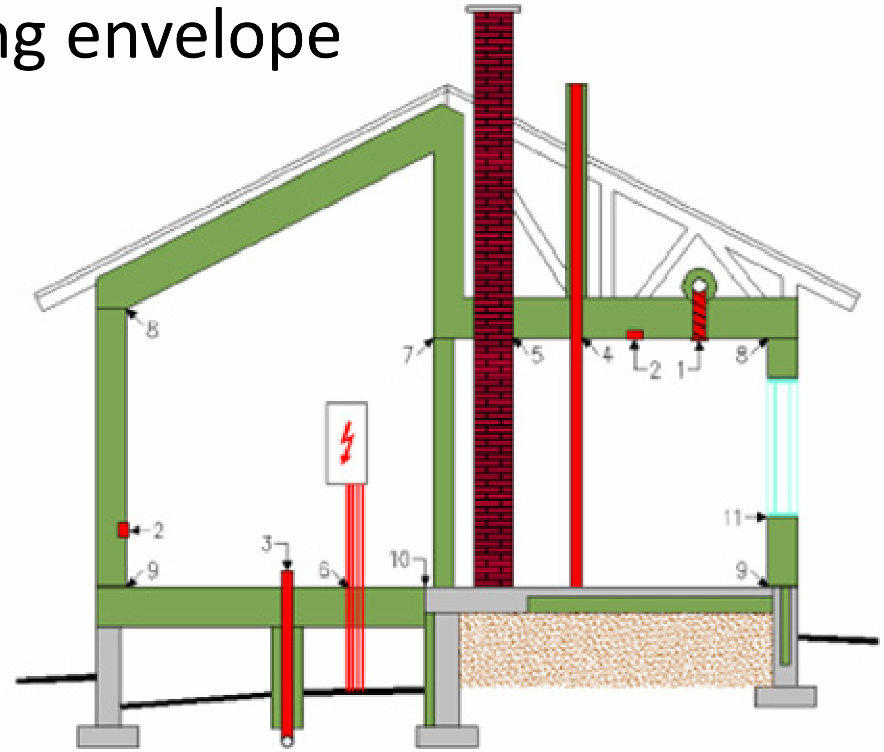
- Low and sunny southern slope enables integration of solar energy systems
- Broad-leaved trees and planting reduce over-heating in summer
- Optimised distances between buildings



How to build a Very Low-Energy House

Well-insulated and air-tight building envelope

- Low U-values of structures:
  - Walls, floor, roof < 0.12 W/m²K
  - windows < 0.8 W/m²K
  - doors < 1.0 W/m²K
- Minimal thermal bridges
- Good air tightness of the envelope
  - n50 < 0,6 1/h
- Low ratio of thermal envelope to building volume (A/V)



Places, where problems with air tightness typically exist in an open wooden building system. www.puuinfo.fi

How to build a Very Low-Energy House

Utilization of the solar gains

- Main window orientation from South-East to South-West enables winter time solar gains
- Important with external adjustable shading to decrease risk of overheating. Also optimized balconies and overhangs of roof structures
- Glass size and type according to the climate, place and orientation

Row-House in Batschuns, Austria
Architect: Walter Unterreiner
Photo: Passivhus.dk

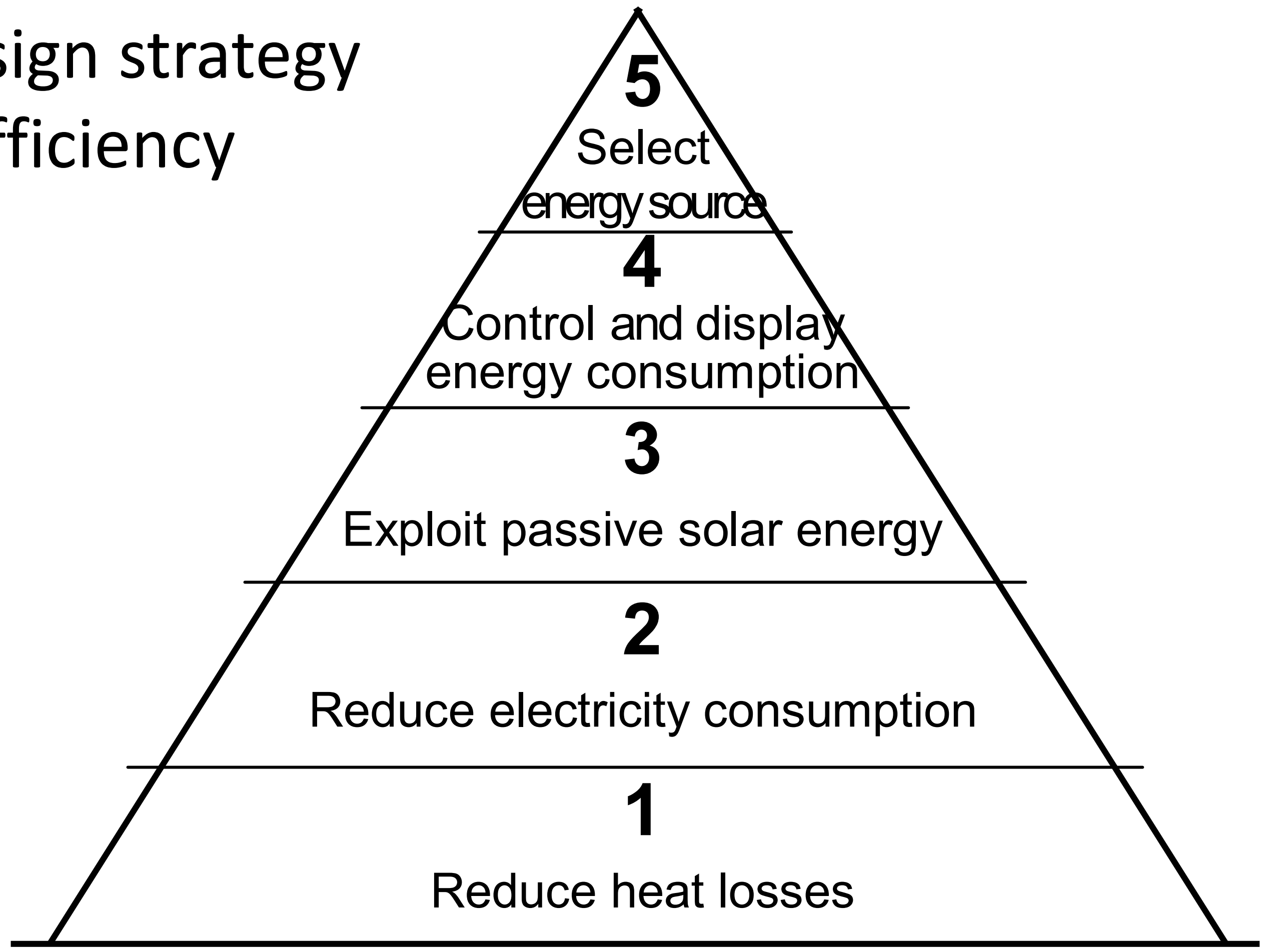
How to build a Very Low-Energy House

Temperature zones

- Thermal mass combined with sliding set points for heating system help to utilize passive free energies. Indoor temperature can vary freely inside the sliding scale, and structures can store or supply heat according to the indoor temperature
- Required amount of thermal mass is not very high: a massive floor in a lightweight building is sufficient
- Preferable placing warmer areas to the inner circle of the building and cooler areas to the outer circle of the building

How to build a Very Low-Energy House

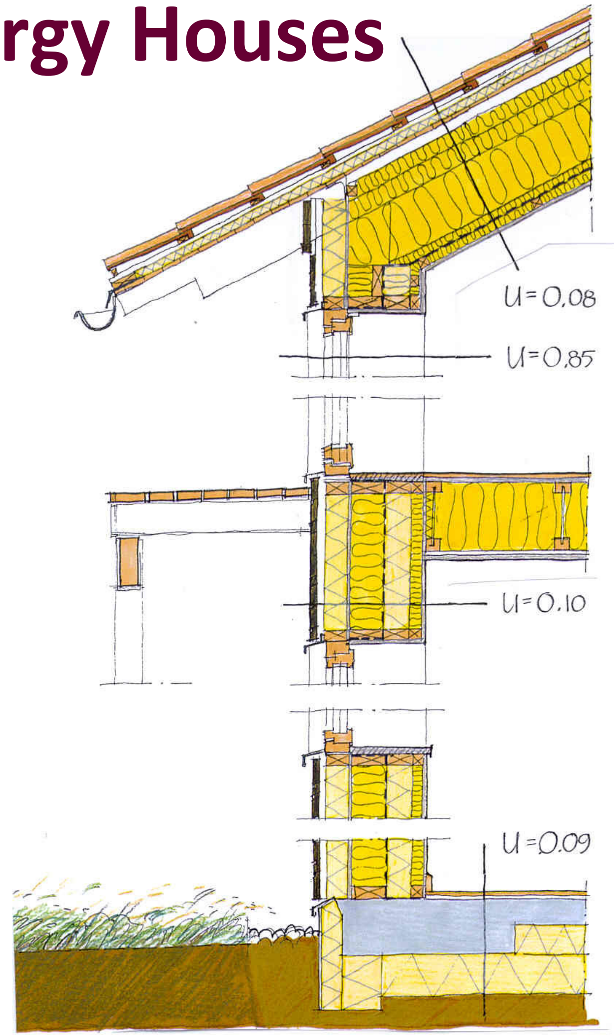
Five step design strategy
for energy efficiency



Components for Very Low Energy Houses

Components to reduce heat losses

- Thermal insulation with a low thermal conductivity < 0.05 W/m K

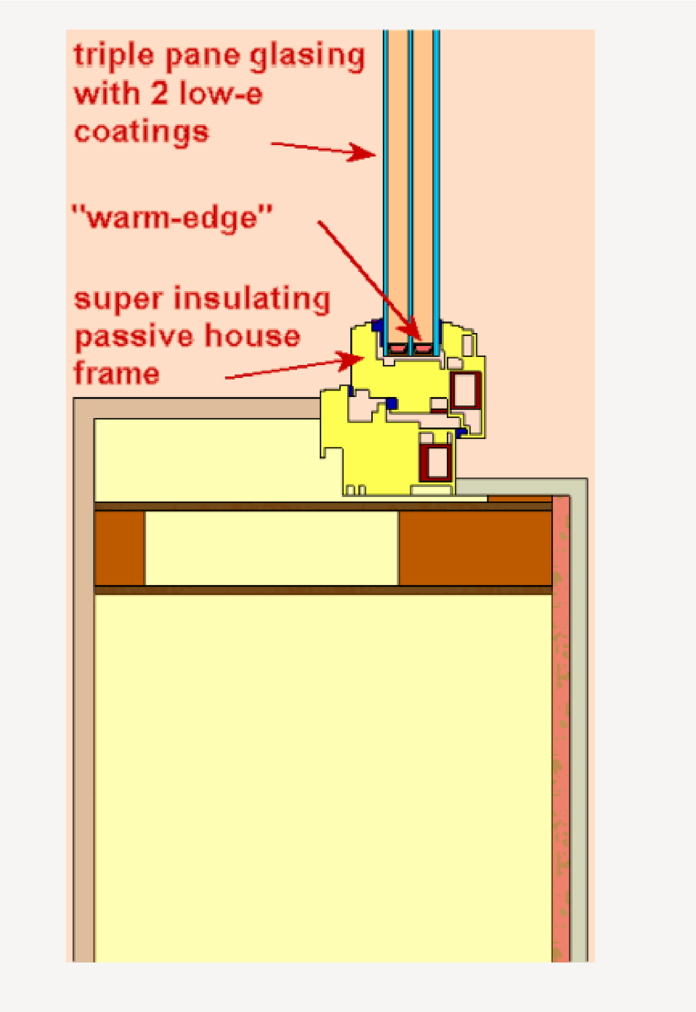


Source: efem arkitekter

Components for Very Low Energy Houses

Window components to reduce heat losses and utilise solar energy

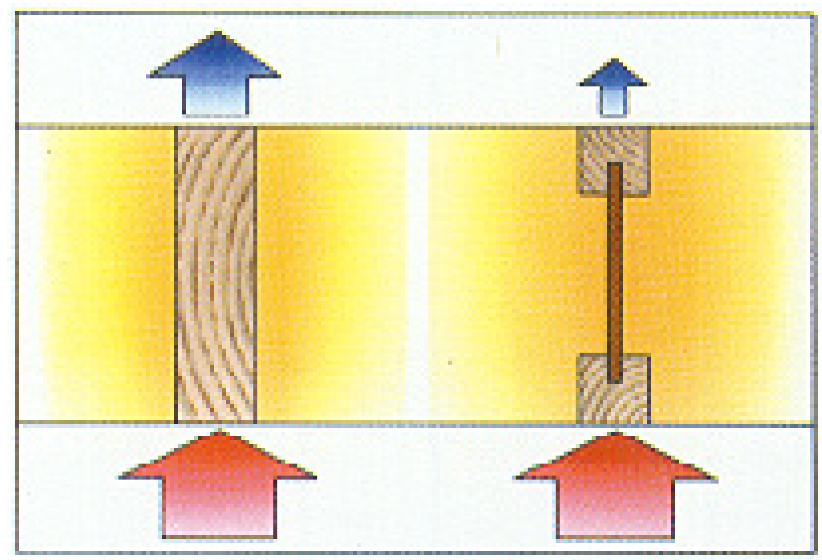
- Windows with
  low U-value < 0.8 W/m²K,
  solar transmittance > 0.4 (to allow solar gains),
  light transmittance > 0.5 (to reduce consumption of electricity for lighting)



Components for Very Low Energy Houses

Envelope components to reduce heat losses

- Entrance doors with U-value < 1.0 W/m²K
- Structural frame components minimizing thermal bridges



Source: Masonite Beams AB

I-beam

Components for Very Low Energy Houses

Airtightness components

- Airtightness products of high quality, to fulfil stringent requirements on airtightness

Photo: Jan Trygg

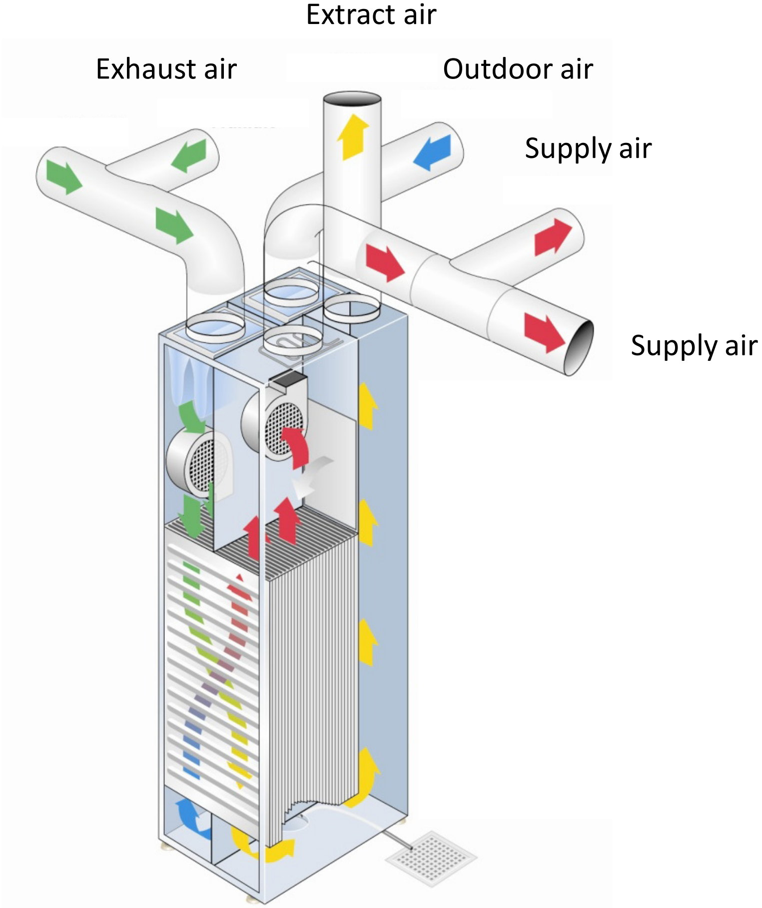
Airtightness and air leakage testing

Photo: Jan Trygg

Components for Very Low Energy Houses

Ventilation components to reduce heat losses and electricity consumption

- Air-to-air heat recovery with heat recovery efficiency > 80 %
- Ventilation systems with specific fan power < 1.0 kW/(m³/s)



Air-to-air heat recovery unit
Source: REC Indovent AB

Components for Very Low Energy Houses

Energy efficient electrical components

- Heat pumps with seasonal coefficient of performance > 3
- Efficient circulating pumps with an efficiency > 40 %
- Domestic hot water heaters (low standby losses)
- Energy efficient tap hot water fittings
- Household appliances with a low use of electricity (Class A and better)

Components for Very Low Energy Houses

Components to control and display energy consumption

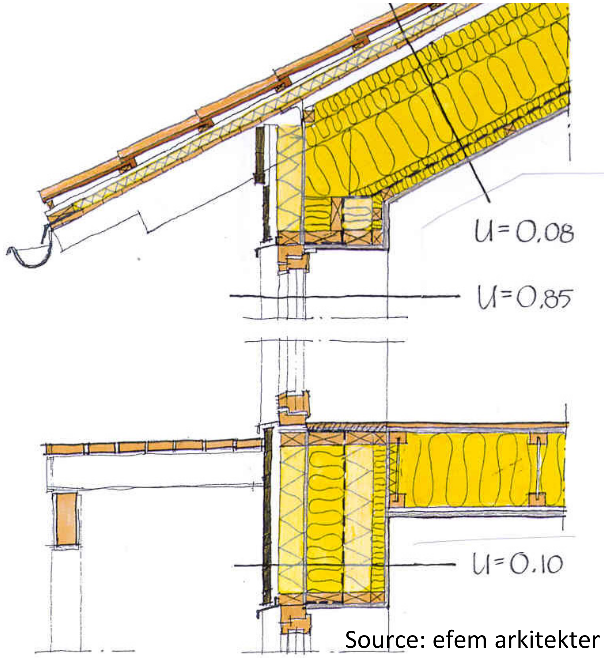
- User friendly control systems for efficient control of heating and ventilation

Photo: Kaisa Svennberg

Components for Very Low Energy Houses

Components to avoid high indoor temperatures and cooling demand

- Solar shading + overhangs, awnings, Venetian blinds

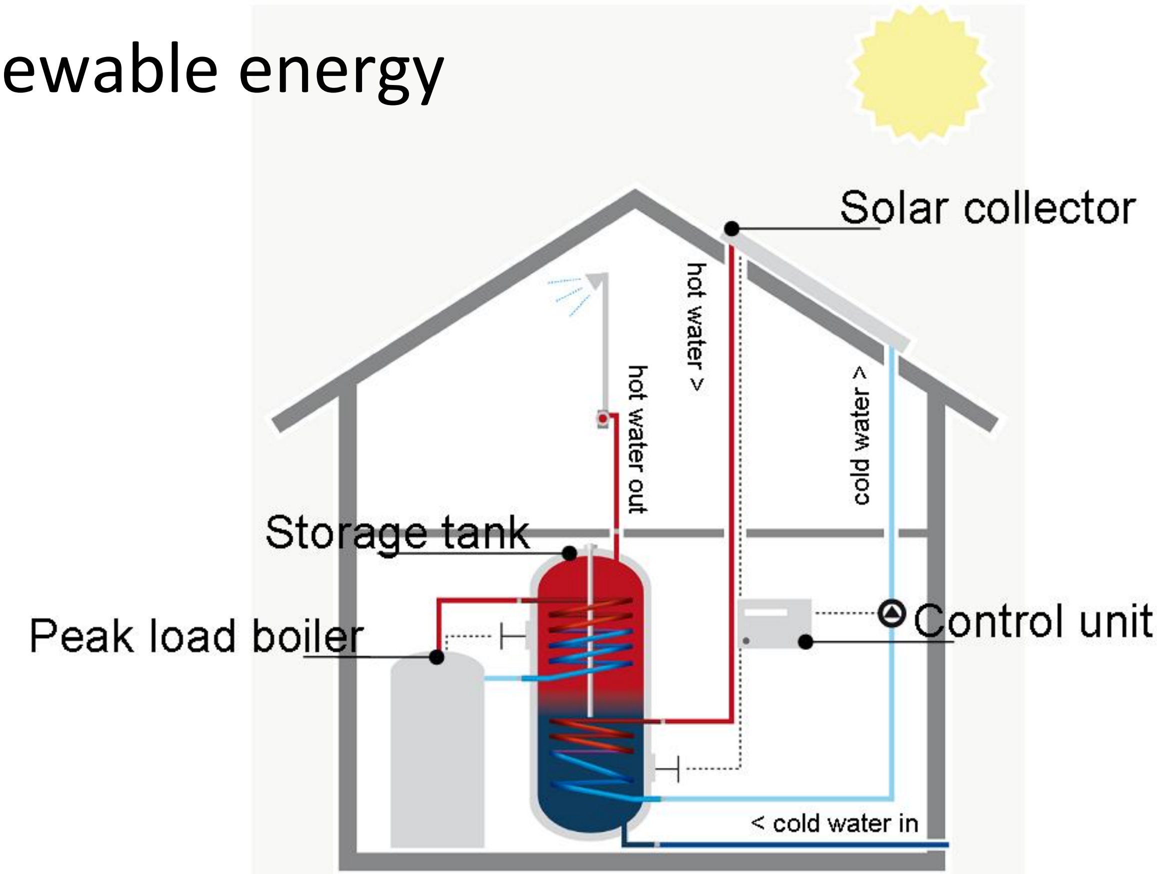


Source: efem arkitekter

Components for Very Low Energy Houses

Components for renewable energy

- Solar collectors, photovoltaic, biomass boilers



Source: Andresen, I. (2008). Planlegging av solvarmeanlegg for lavenergiboliger og passivhus, SINTEF Byggforsk

Components for Very Low Energy Houses

Conclusions regarding components

- Most of the mentioned components are available in the countries participating in the NorthPass project
- For more information: see the NorthPass database on components

Examples from Finland

Helsinki: Several sustainable houses in a suburban area

- Some of the buildings were constructed by large developers, some by the residents or groups of the residents
- The largest solar heating capacity in Finland
- Subsidies from the Ministry of Environment and the Finnish Funding Agency for Technology and Innovation (TEKES)

More information:
http://www.hel.fi/static/ksv/julkaisut/eco-viikki_en.pdf

Example from Norway

Bergen: Løvåshagen cooperative housing is the first Norwegian dwelling block with passive house standard. Architects: ABO Plan og Arkitektur

More information: http://lovashagen.rediger.no/

Example from Sweden

Lindås: The first Swedish dwelling block with passive house standard built in 2001 and still performing very well according to a recent study.
Architects: efem arkitekter

Passivehouse Lindåsen. Photo Maria Wall

More information:
http://www.egnahemsbolaget.se
http://www.efemarkitektkontor.se/sid3_2_Lindas.html

Examples from Denmark

Vejle: 10 low-energy houses in collaboration with Isover and other actors in the building sector

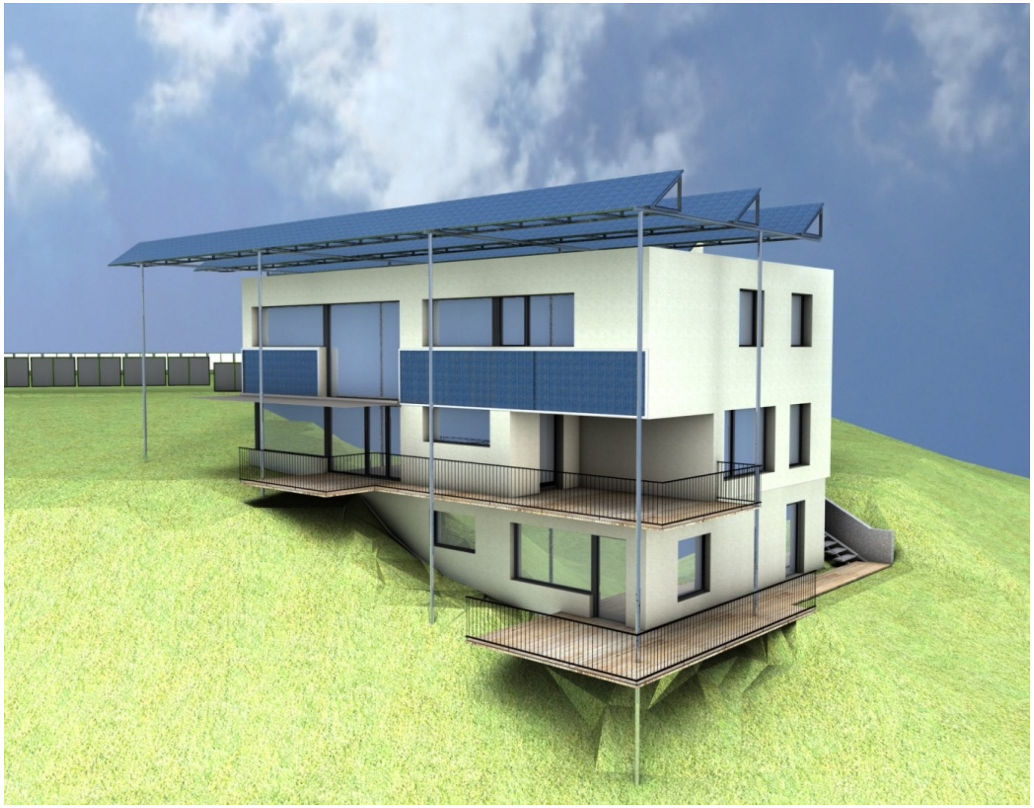
- The target: houses certified according to the international passive house standard, focus on indoor comfort

More information:
http://www.isover.com/exportPdf/export/node_id/885/language/eng-GB

Example from Estonia

Põlva: Single-family house. Construction started in autumn 2011. Architects: Architekturbüro Reinberg ZT GmbH, Austria and Sense OÜ, Estonia

- Target: first international passive house standard certification in Estonia



More information (in Estonian): http://www.sense.ee/#projektid

Example from Latvia

Valmiera: Renovation of a 9-storey apartment building by ESCO

- The Energy consumption has decreased by 50%. Indoor air temperature has increased by 1 to 2 ^{o}C

More information:
http://www.sunenergy.lv/index.php?option=com_content&view=article&id=12&Itemid=31&lang=en

Example from Lithuania

Vilna: Comprehensive renovation of an apartment building from 1965, prepared by Vilnius municipality

- The renovation concerned the external walls, windows, stairs, outer doors, roof, balconies. Inner and outer engineering networks were modernised, and outdoor area were upgraded

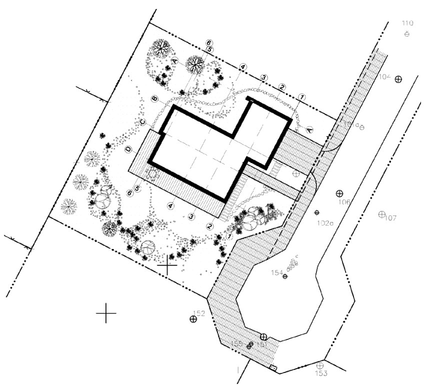
More information:
http://www.renovacija.lt/index.php/stories_of_success/list_of_projects/51

Example from Lithuania

Vilnius: The first Lithuanian detached house with passive house standard. 2009.

Architect: Rytis Kripas,

UAB «Veikmės projektai»



More information:

http://www.veikme.lt/objektu_meniu/namai/pirmas_veikmes_pasyvus_namas/apie_projekta/1119

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Example from Poland

Wrocław: Single family house. Cooperation between architectural design studio Lipińscy Domy, Institute of Heating and Ventilation and NAPE

Lipińscy Dom Pasywny 1

- Yearly space heating demand is 15 kWh/m^{2}a. A standard house uses eight times more energy
- The demand for heating of domestic hot water is 14 kWh/m^{2}a and is two times lower than in standard house
- Half of the energy is supplied by solar collectors