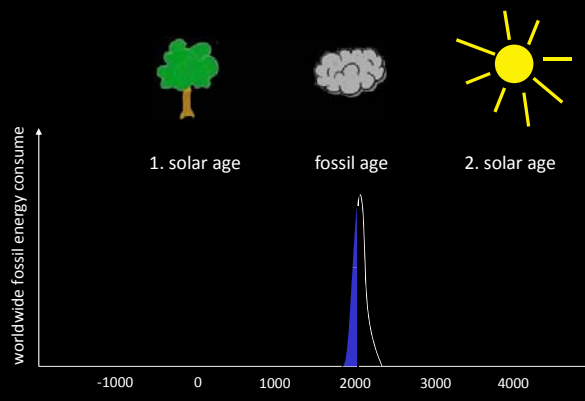
CanPHI Canadian Passive House Institute

Dr. Guido Wimmers

fossil energy

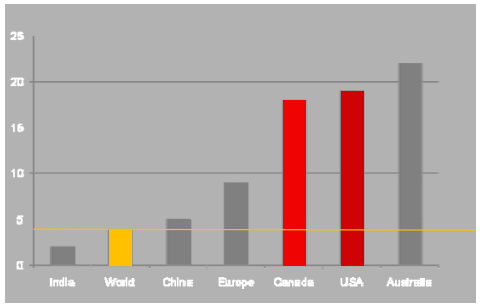


Graphic: Wim

Author: Wim

Emissions

- Kyoto protocol: target was to reduce emissions (based on 1990) by 2007 - **6%**
  In fact emissions increased by **+ 27%**



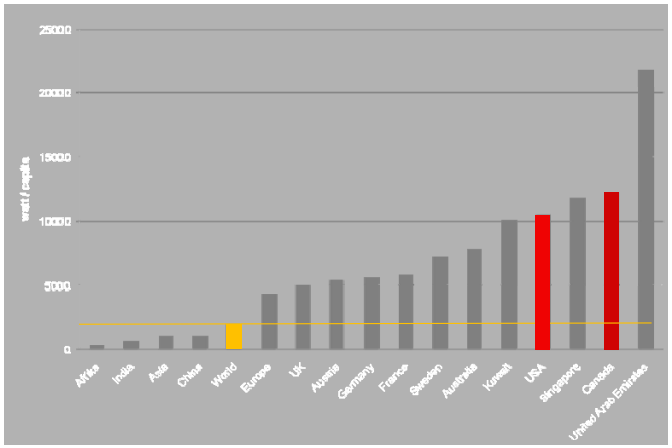
CO2 emissions per capita in tons per year

source: International Energy Agency

Graphic: Wim

Author: Wim

primary energy consumption per capita



source: International Energy Agency

Graphic: Wim

Author: Wim

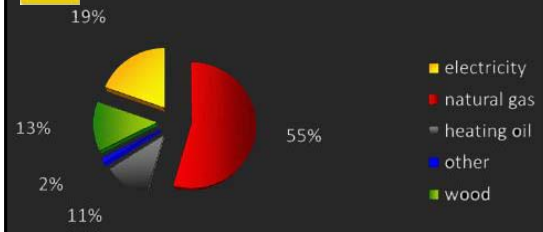
priorities

"The energy that office buildings use for heating, lighting and cooling is the major component of their environmental impact – approximately 85% of the total life cycle impact for typical office buildings."

[LEED; Cole & Kernan, 1996; Winistorfer and Chen, 2004; Trusty & Meil, 2000; CORRIM, 2004]

CanPHI _1.1.2

Canada´s total residential space heating energy use

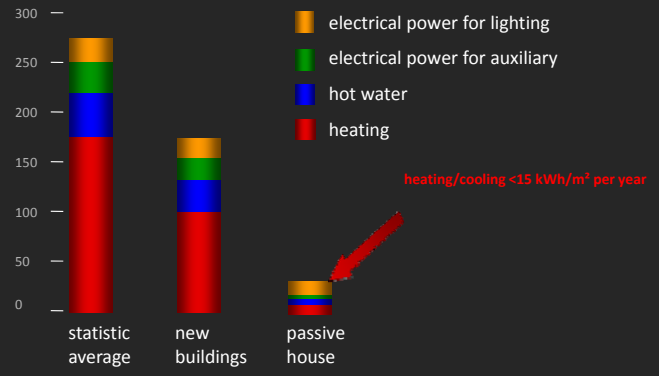


source: Energy Use Data Handbook 2006

- 2/3 provided by fossil energy
- energy use for residential space heating 800 PJ = 222000 million kWh
- total floor space 1500 million m²
- if really every m² is heated 150 kWh/m²

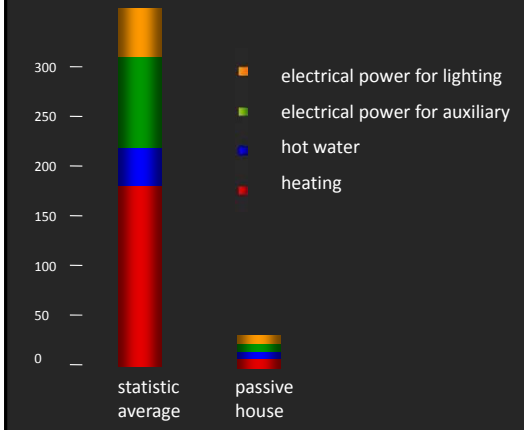
6

for residential buildings in kWh/m² per year



Source: NRCan Dec.2005

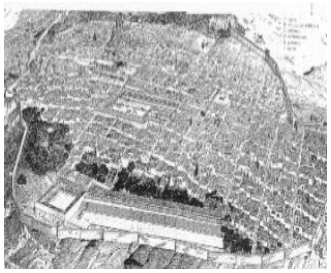
for commercial buildings in kWh/m² per year



source: Energy Use Data Handbook 2007

Passive House history

Early Passive Design



Priene, Asia Minor: city built 2500 years ago with local building code requiring orientation and design for solar gain in all buildings

In 400 BC the Greek philosopher Aeschylus wrote:

"only primitives & barbarians lack knowledge of houses turned to face the Winter sun."

…what does this say about current design practice?

Author: MI

forgotten pioneers of energy efficiency

Saskatchewan Conservation House, 1977

the "passive house" is borne in Canada!!!

forgotten pioneers of energy efficiency

Photo by M. Isaacs March 2010

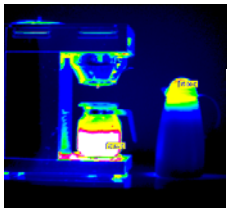
In 1977 a group of Canadian researchers built a demonstration house in Regina.
The Saskatchewan Conservation House, the nearly airtight building had 2x double glazed windows, R-40 wall insulation, R-60 roof insulation, and one of the world's first heat-recovery ventilators.

the first ‘Passivhaus’ in Darmstadt by Dr. Wolfgang Feist

11 years later, a German physicist, Dr. Wolfgang Feist, adopted this list, suggested a few further specifications, and coined a German word, Passivhaus, to describe the “modus operandi”.

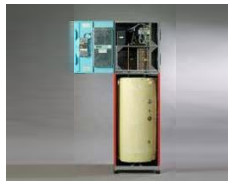
Basic principles of Passive House design

what is a Passive House?



- a Passive House is a **very** energy-efficient building which requires such a small amount of heat that it can be heated mainly by “passive” sources such as incoming sunlight and existing appliances
- heat recovery via a mechanical ventilation system is necessary

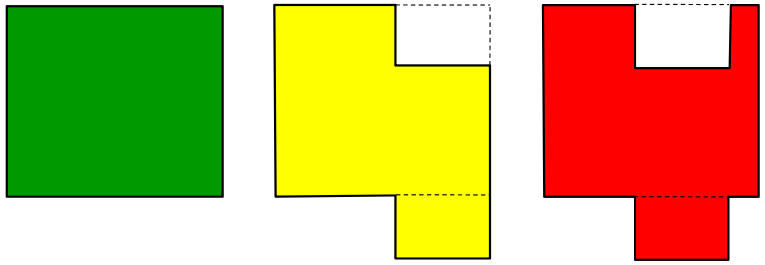
what is a Passive House?



- a Passive House still needs some energy, but the specific heat demand is minimal.
  15 kWh/m²year
- specific heat load shall not exceed 10 W/m²
- entire specific *primary* energy demand including domestic electricity must not exceed 120 KWh/m²year
- The PH Standard *should* become a precondition for the Living Building Challenge and for any Net Zero House initiative

Compactness

- Influence of an increased perimeter for the same floor area



Compact shape

Increase of wall area 10 %
Insulation ≥ 20mm

Increase of wall area 20 %
Insulation ≥ 40mm

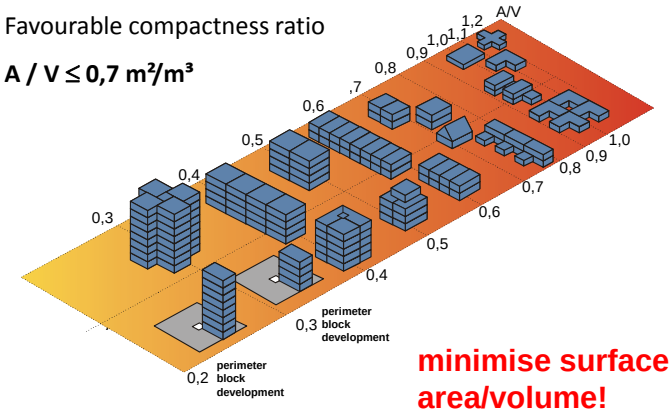
Source: [PHS 1.0]

Author: Wim

A/V-ratio (thermal envelope area/heated volume)

Favourable compactness ratio

A / V ≤ 0,7 m²/m³



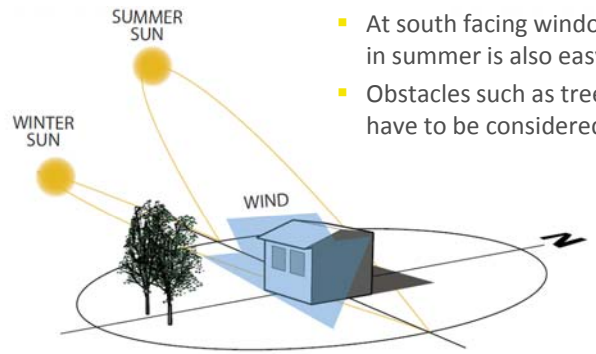
minimise surface area/volume!

Grafik: PHD

Author: AB

Orientation

- Orientation of the building to the south is crucial for solar heat gains.
- At south facing windows overheating in summer is also easy to prevent.
- Obstacles such as trees or buildings have to be considered.



Graphic: Lighthouse Sustainable Center

Source: Passive Design Tool Kit CoV

Author: Wim

Definitions and requirements of Passive House

Annual space heating/cooling demand

- **15 kWh/(m²a)**

4756 BTU/h/ft² or 1.394 kWh/(sqft a)

Heating/cooling load

- **10 W/m²**

Thermal performance

- **U ≤ 0.15 W/(m²K)**
- **thermal bridge free**
- **Psi ≤ 0.01**

Thermal bridges

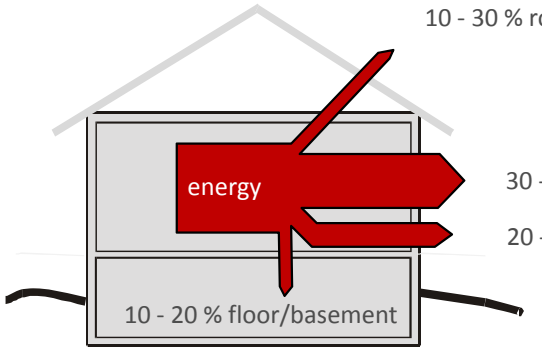



Graphic: Wim Author: Wim

Windows

- $U_w \leq 0.8\ W/(m^2K)$
- $SHGC \geq 50\%$

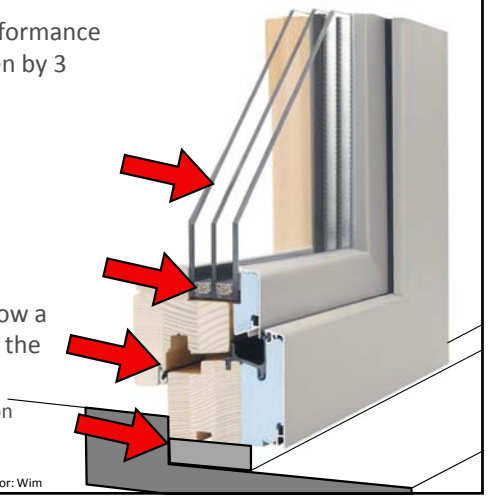
Ratio of heating energy losses for small buildings



Graphic: Wim Author: Wim

Thermal performance of windows

- The overall thermal performance of a window (U_W) is given by 3 different factors
  - Glass (U_g)
  - Frame (U_f)
  - Psi-value for the spacer
- To establish the actual performance of the window a 4th factor has to be put in the equation a well
  - Psi-value for the installation



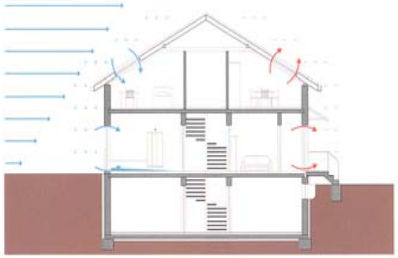
Graphic: Wim Author: Wim

Air tightness

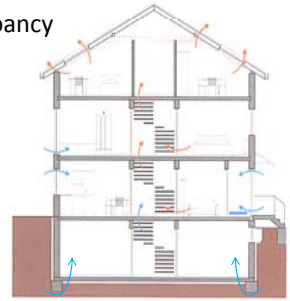
- $n_{50} \leq 0.6\ /h$

Infiltration and exfiltration

Wind



Buoancy



Grafik: ebök/Wim

Source: Zeller/Biasin

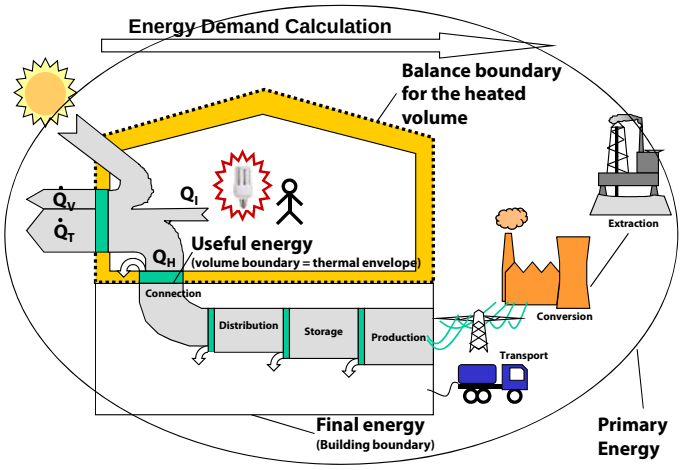
Author: JS

"Blower-Door-Test"

Annual primary energy demand

- **120 kWh/(m²a)**

What is primary energy ?



Graphic: PHD

Author: PHI / PHD

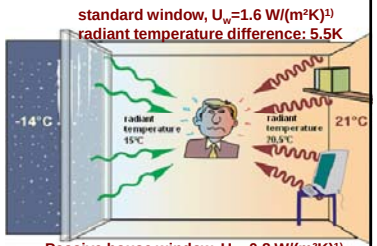
Winter comfort criteria

- $\Delta T_{horizontal} \leq 3K$
- $\Delta T_{vertical} \leq 2K$

Radiant temperature asymmetry

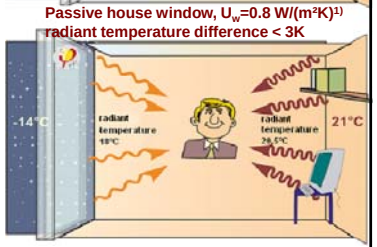
Room with standard window and double low-e glazing

- Low surface temperature of window
- Radiation temperature asymmetry too high
- Radiator below the window is necessary



Room with Passive House window and triple-glazing

- Surface temperature of window high
- Radiation temperature asymmetry small enough
- Radiator not necessary for comfort



Source: PHI /Sariri

Author: PHI / PHD

Passive House is applicable to:

residential

24 row houses in Lienz (altitude 700m)

- build 2004
- mixed construction with wood and concrete
- heat recovery ventilation
- small heat pump - air/water

Photo: Wim

Multi unit residential (350 units), Innsbruck

office building “chamber of commerce”, St.Pölten

office building, Innsbruck

- heating energy 8 kWh/m²
- blower – door test 0.23/@ 50Pa
- in slab radiant heating and cooling
- heat recovery ventilation
- heat pump

Photo: Wim

secondary school, Klaus



production facility renovation, wolfurt



residential renovation, linz

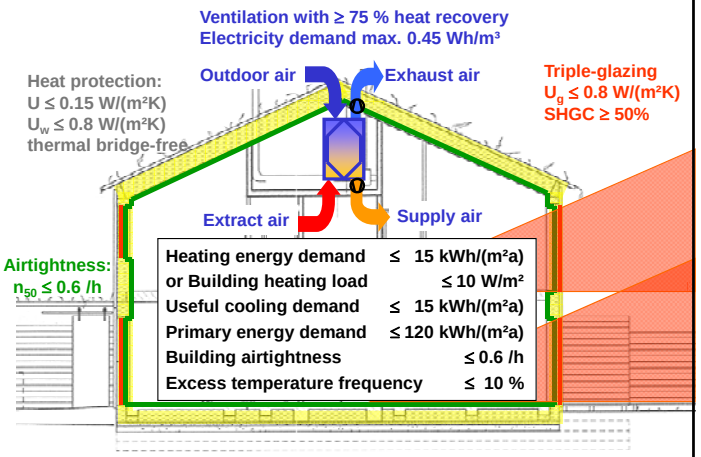

fire station

Super market

Photo: Rainer

Schiestlhaus, 2154m

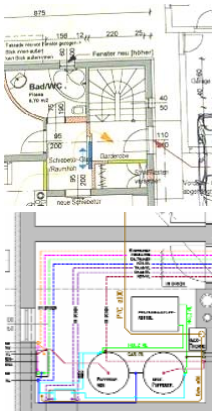
Passive House criteria (climate indipendent)



Source: PHI/ [Cepheus 18 und 22]

Author: PHD

Passive House - state of the art



- it is more than the addition of individual parts. It is a complex system which needs an integrated design for envelope, materials, heating and ventilation!
- But it is actually common sense and it's worth the trouble!

the result

- **energy efficient** (up to minus 90%)
- **comfortable** (all ASHRAE comfort criteria achieved)
- **economically** (reasonable additional cost, increased value, significantly lower operating costs)
- **environmentally friendly** (very low environmental longterm impact, energy plus easily possible)
- **healthy** (constant hygienic air quality)

Where are we going?

- Up to today over 25000 Passive Houses were build in almost every climate zone in over 20 countries around the world
- In 2009 the EU passed a directive asking that all states legislate Passive House construction by 2016 for new construction and renovation
- Energy efficiency/renewables are now bigger employers in Germany than the entire auto industry (Audi, BMW, Mercedes, Porsche, VW etc)

- CanPHI trained from October 2010 to today almost 200 highly motivated professionals in Passive House design
- There are currently more than 30 Passive House Projects in Canada in process

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www.passivehouse.ca