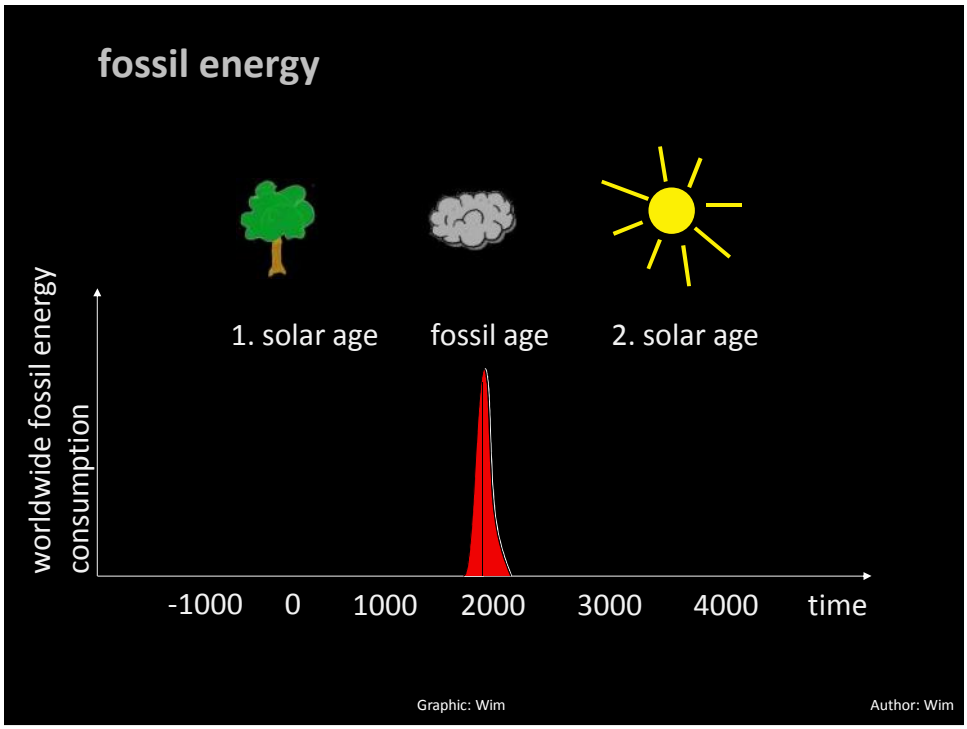
CanPHI Canadian Passive House Institute

BCBEC and CanPHI presents:

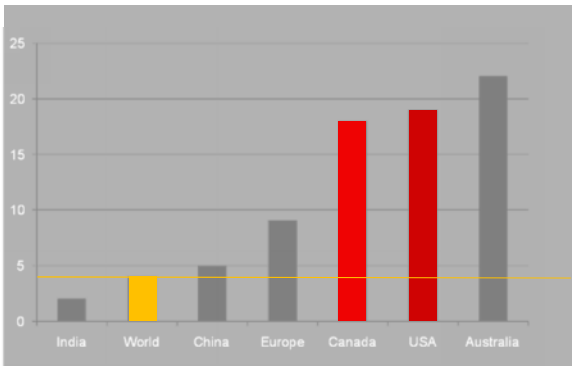
Passive House in BC, principles and applications

Part 1: Dr. Guido Wimmers



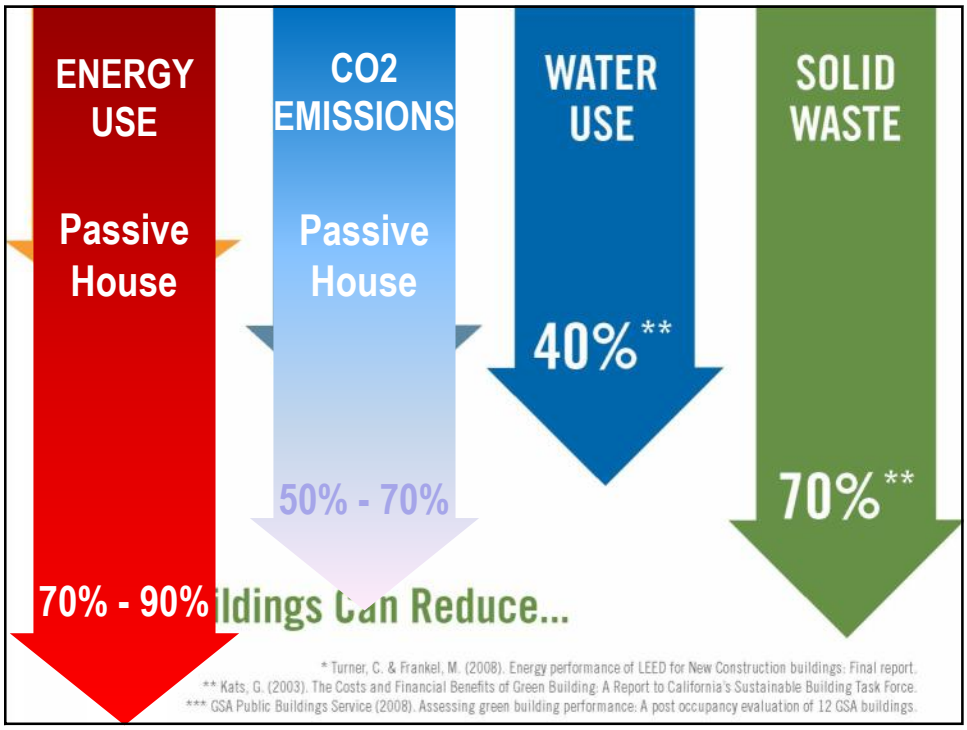
Emissions

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

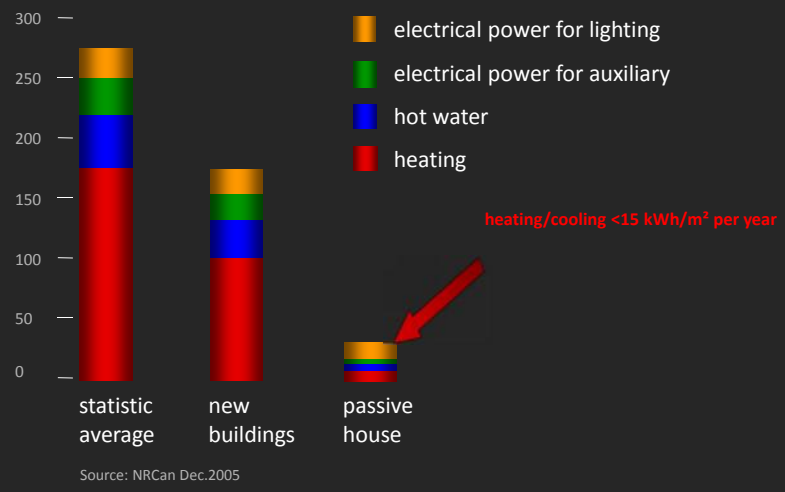


CO2 emissions per capita in tons per year

source: International Energy Agency Graphic: Wim Author: Wim



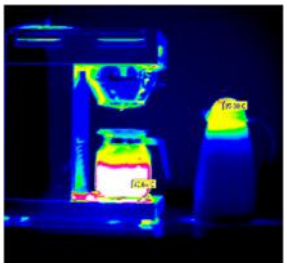
for residential buildings in kWh/m² per year



Source: NRCan Dec.2005

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, lights & appliances
- heat recovery via a whole-house **mechanical ventilation** system is necessary
- The concept works well in **any climate**, from cold/dry to hot/humid: physics is the same everywhere!

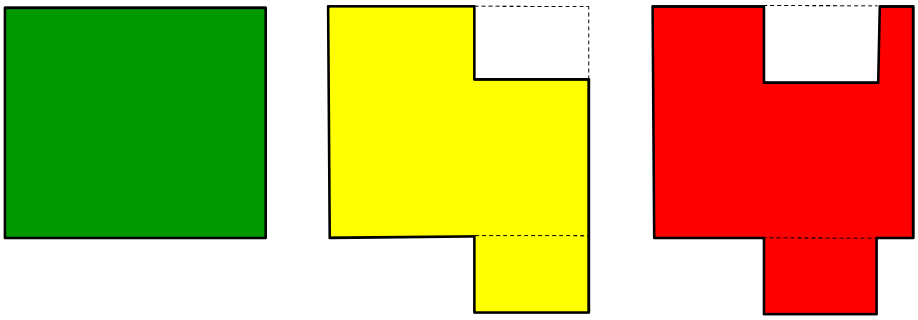
Author: GW

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

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

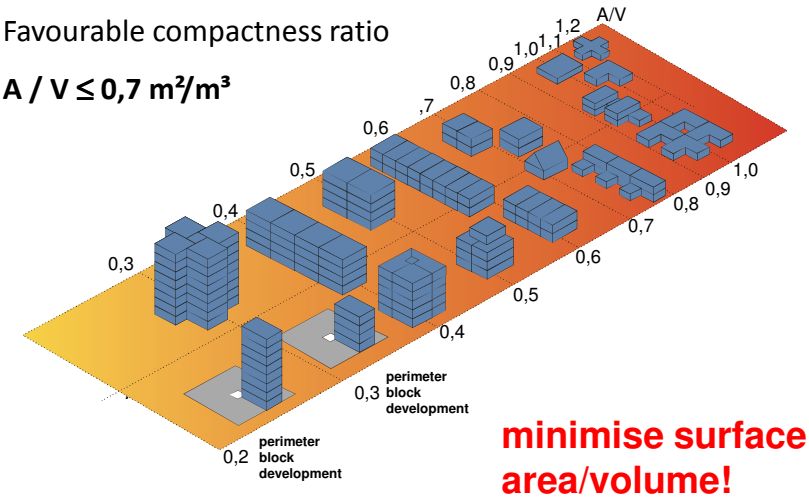
Source: [PHS 1.0]

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

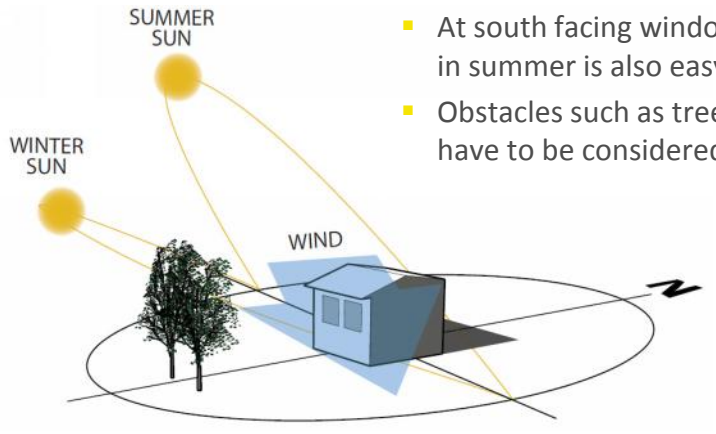
Author: AB

Non-optimal shape factors…

Habitat 67, Montreal

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

affordability

- Passive House is aiming at a reduction of energy consumption of 70-90%.
- Some incremental cost for the advanced envelope, but it is also saving cost for mechanical system and energy cost in future
- Aiming at 100% or adding renewable energy systems instead would be unfortunately today far more expensive!

Requirements and Criteria of Passive House

Annual space heating /cooling demand

- **15 kWh/(m²a)**

4756 BTU/h/ft² or 1.394 kWh/(sqft a)

Annual space heating demand

- The annual space heating demand is the "fuel consumption"

Author: Wim

Heating/cooling load

- 10 W/m²

Heating load

- The heating load is the “power”

Author: Wim

Thermal performance

- $U \leq 0.15$ W/(m²K)

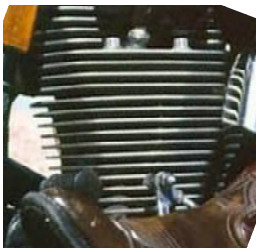
  R ≥ 38

- thermal bridge free

  Psi ≤ 0.01

Thermal bridges

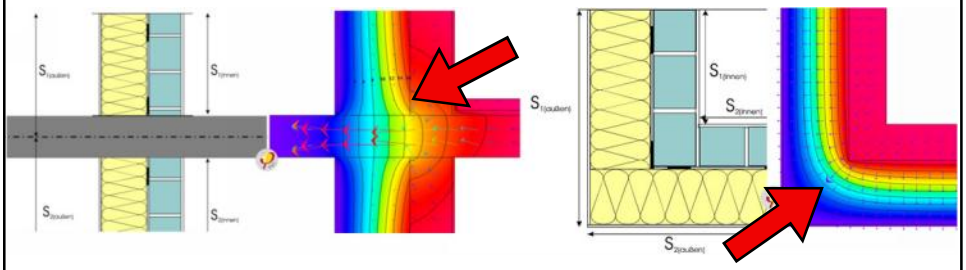





Graphic: Wim Author: Wim

What is a thermal bridge?

- We talk about thermal bridges if the isotherms (lines of equal temperature) of a given detail are curved or bend.



Author: Wim

Calculation of thermal bridges (as per DIN EN ISO 10211)

$$Q_{1D} = A_1 * U_1 * DT_1 + A_2 * U_2 * DT_2$$

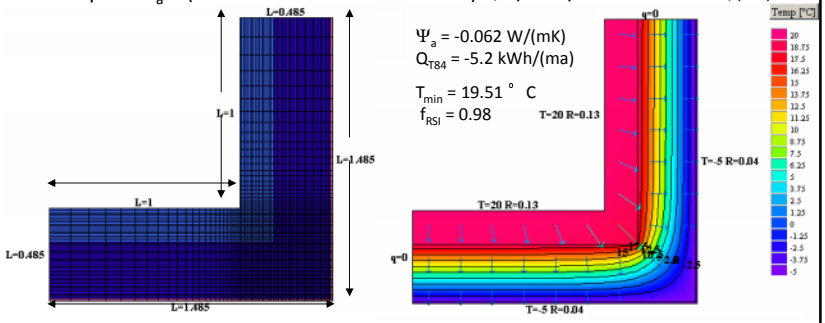
Example: $U_1=U_2$ = 1/(0.13+0.175/2.3+0.3/0.04+0.01/1+0.04)=0.129 W/(m²K)

$$Q_{2D} = A_1 * U_1 * DT_1 + A_2 * U_2 * DT_2 + \Psi * l * DT_{max(1.2)}$$

Example : Q_{2D} = 8.0275 W/m as per HEAT2-6.0

$$\Psi = (Q_{2D} - A_1 * U_1 * DT - A_2 * U_2 * DT) / l / DT_{max(1.2)}$$

Example : Ψ_a = (8.0275 – 0.129*1.485*2*25)W/K / 1 m / 25 K = -0.062 W/(mK)

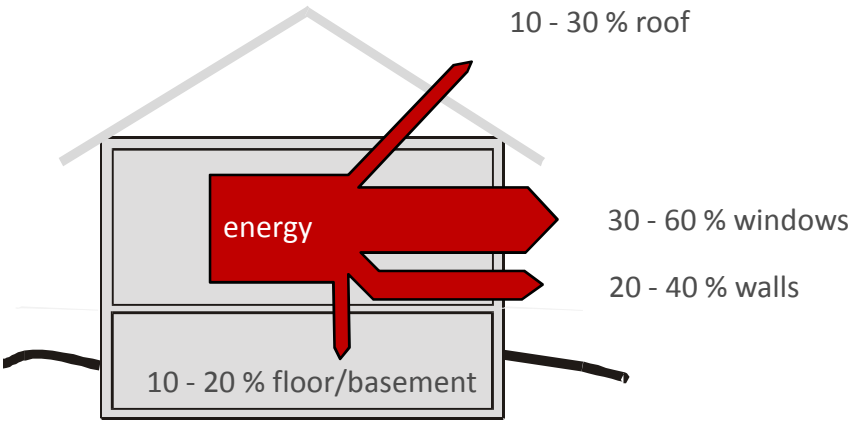


E-B.4 14 10/09 Source: PHD Author: JS

Windows

- $U_w \leq 0.8$ W/(m²K)
- SHGC ≥ 50%
- Comfort criterion

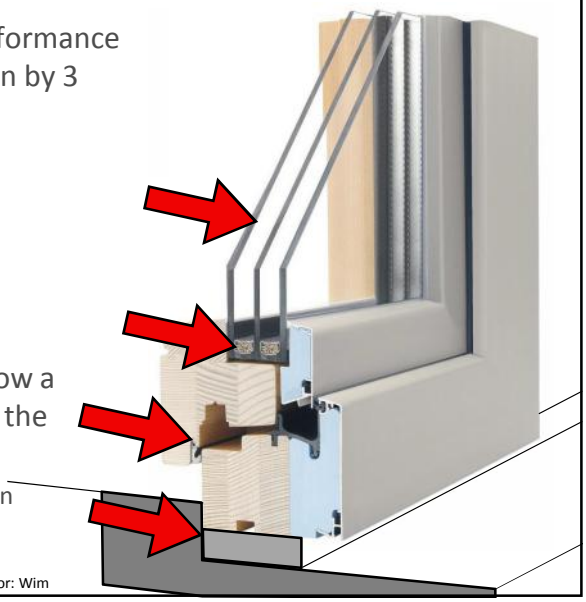
Ratio of heating energy losses for small buildings



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

Windows

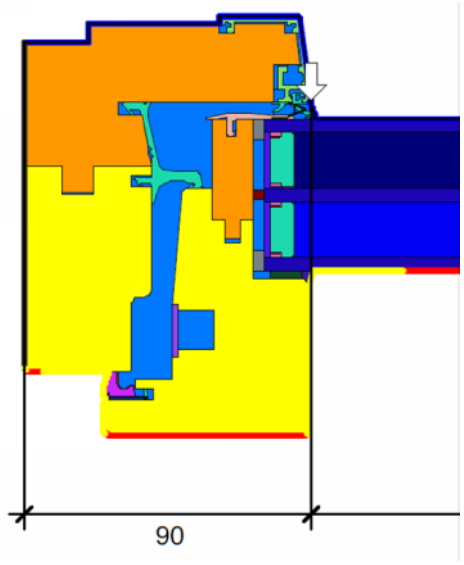
Conclusion:

- You need a glazing U-value of ≤ 0.8 W/(m²K)
  - To achieve comfort criteria
  - To minimize your heat losses
  - To achieve the overall U_w requirement
- You need an overall U-value for the window of $U_w \leq 0.8$ W/(m²K)
  - To achieve comfort criteria
  - To minimize your heat losses
- You need SHGC of over 50% (south facing, applicable for most building types)
  - To maximize your solar gains in winter
  - After balancing losses and gains to achieve a surplus in heating energy throughout all your window (passive thermal collector)

  Note: prevent overheating in summer (excess temperature)

Author: Wim

Tomorrow's window will look different



- Deep, narrow frames
- Sash entirely covered with insulation
- Glass-only characteristic with no visible frame

$\Psi_{installation}$ = 0.00 W/(mK) possible

CanPHI _2.3 Source:Wim Author:Wim

Winter comfort criteria

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

Thermal Comfort : the Passive House essential!

Essential factors which influence thermal comfort

- Air temperature
- Surface temperatures
- Local temperature differences (vertical and horizontal)
- Drafts
- Relative air humidity

Passive House design takes all these into account to provide unprecedented levels of indoor thermal comfort year-round

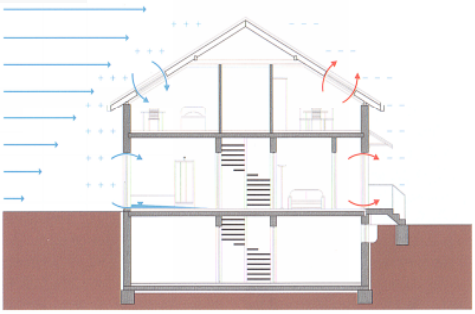
Source: [EN ISO 7730], IG Passivhaus Deutschland Author: PHD

Air tightness

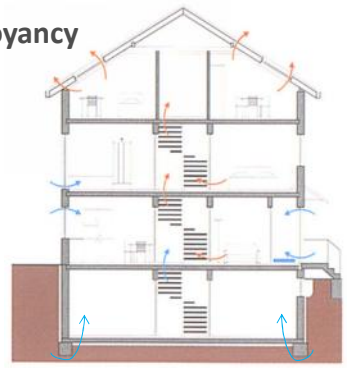
- $n_{50} \leq 0.6$ /h

Infiltration and exfiltration

Wind



Buoyancy



Grafik: ebök/Wim

Source: Zeller/Biasin

Author: JS

Why is air tightness important?

Air tightness is necessary to:

- Avoid damages through condensation inside the envelope components because of warm humid air infiltrating, cooling down and condensation
- Minimize heat losses due to warm air losses
- Minimize overheating due to warm air infiltration from outside (wind tightness) in summer

The “air tight” layer has to be on the inside

The “wind tight” layer has to be on the outside

Author: Wim

insulated panels for Langley PH

taping

installing

Pre-drywall airtightness test

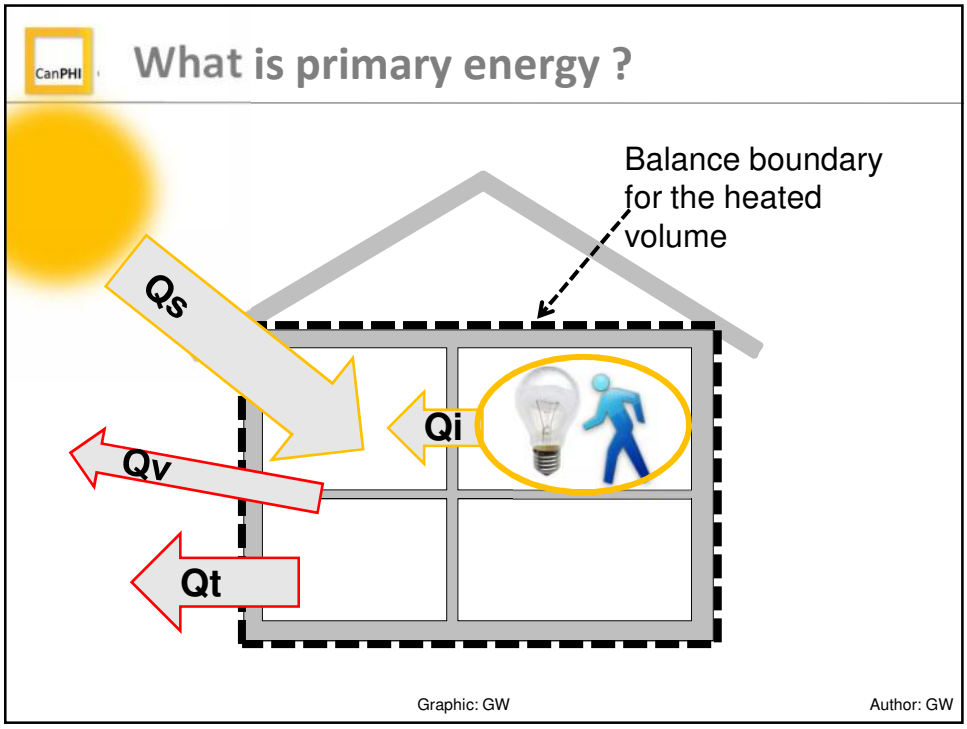
Search for leakage

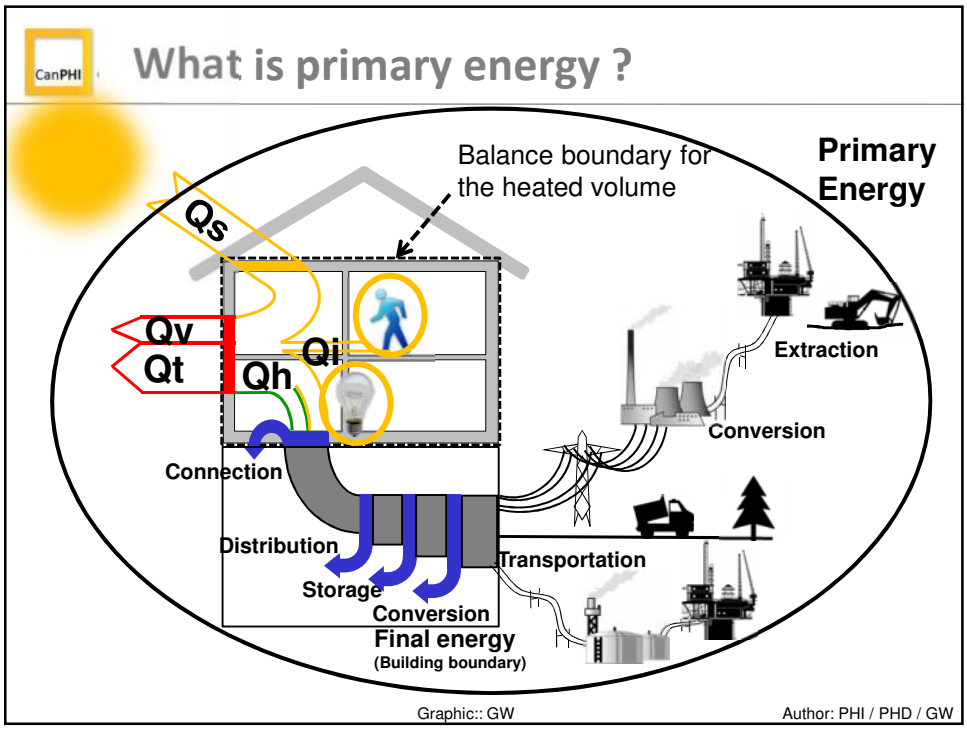
plywood

Air tightness result Langley PH

Annual primary energy demand

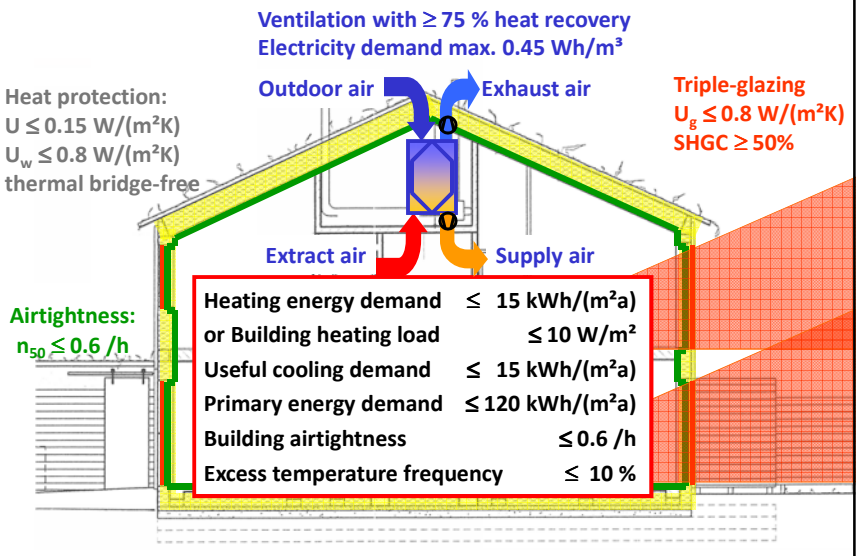
- 120 kWh/(m²a)


What is primary energy ?
Balance boundary for the heated volume
Qs
Qi
Qv
Qt
Graphic: GW
Author: GW


What is primary energy ?
Balance boundary for the heated volume
Primary Energy
Qs
Qv
Qt
Qi
Qh
Extraction
Conversion
Connection
Distribution
Transportation
Storage
Conversion
Final energy
(Building boundary)
Graphic:: GW
Author: PHI / PHD / GW

Summary

Passive House criteria (climate independent!)



Source: PHI/ [Cepheus 18 und 22]

Author: PHD

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?

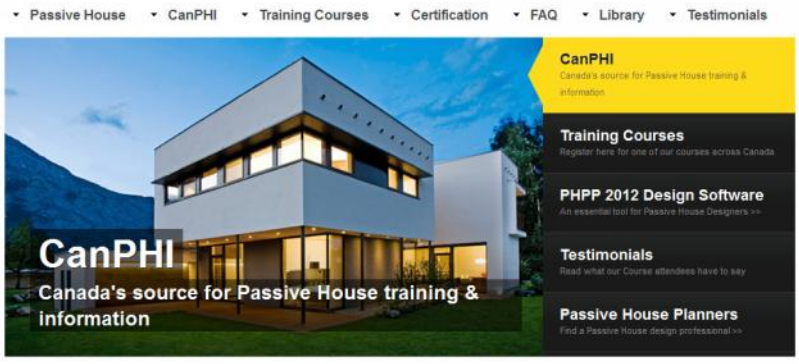
- Today about 40000 Passive Houses are build in almost every climate zone in over 30 countries around the world
- In 2009 the EU passed a directive asking that all states legislate “Passive House equivalent” construction by 2016 for new construction and renovation
- CanPHI trained over the last 2 years almost 250 highly motivated professionals in Passive House design
- There are currently more than 40 Passive House Projects in Canada in process (**including large residential and commercial**)

CanPHI So…where in Canada are Passive House projects now built or planned?

Surrey BC
Chelsea QC
Whitehorse YK
Edson AB
Fredericton NB
Saanich BC
Kingston ON
Edmonton AB
Gabriola Island BC
Halifax NS
Whistler BC
La Salle ON
Montebello QC
Mont Tremblant QC
Vancouver BC
Port Coquitlam BC
Calgary AB
Summerland BC
Uclulet BC
Medicine Hat AB
Ottawa ON
Quebec QC
Toronto ON
Langley BC
Collingwood ON
Penticton BC
Oakville ON
Nelson BC
Cannington ON
Wakefield QC

CanPHI Canadian Passive House Institute

www.passivehouse.ca



CanPHI Canadian Passive House Institute

- Non profit, education of construction industry
- Only licensed partner of IPHA for Passive House courses in Canada
- Upcoming Passive House Courses:
  - Vancouver October 22 - 26
  - Edmonton November 05 – 09
  - Cranbrook Feb 4 – 8, 2013

Passive House in BC, principles and applications

Part 2: Lydia Dürfeld

The Vancouver 2010 Olympic Austria Passivhaus

- **Annual heating bill for the Austria Haus (now the Lost Lake Passivhaus) from February 2011 to February 2012:**

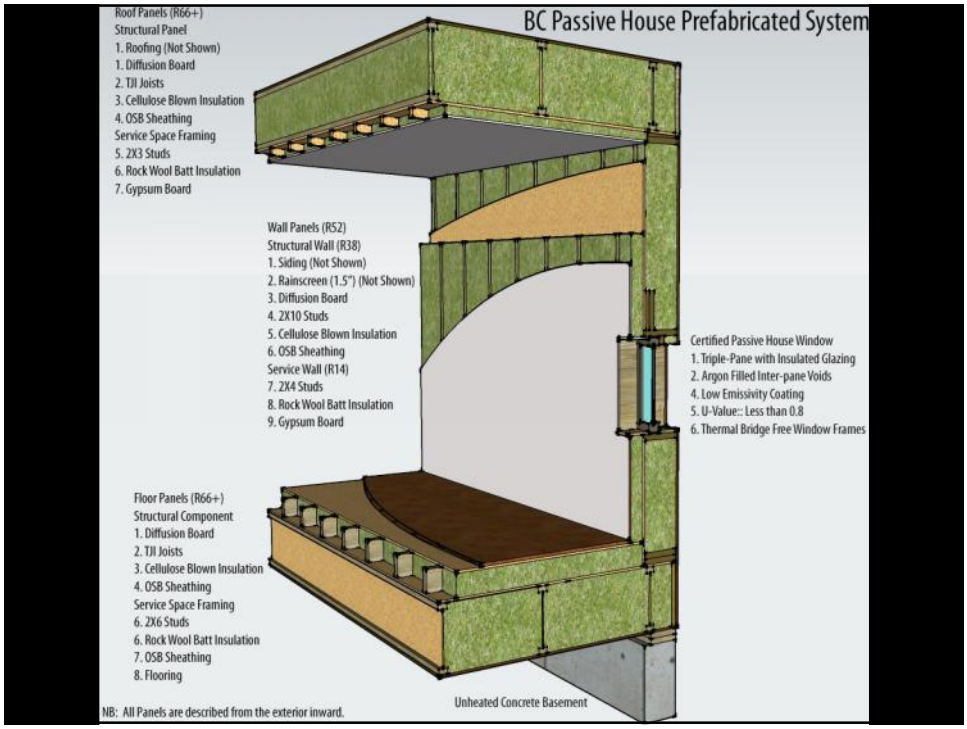
$ 233.75

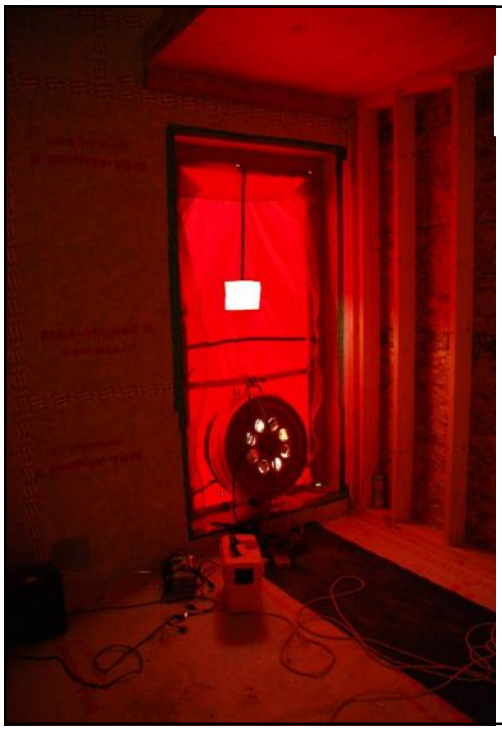
Rainbow Passive House

PASSIVEHOUSE

Demonstrate that:

- We can achieve the Passive House Standard;
- We can meet the Standard at Affordable construction costs;
- We can meet the Standard using sustainable building materials with low embodied energy;
- We can meet the Standard using locally based, when available, and;
- Design a panelized system that works well with prefabrication and transportation .


BC Passive House Prefabricated System
Roof Panels (R66+)
Structural Panel
1. Roofing (Not Shown)
1. Diffusion Board
2. TJI Joists
3. Cellulose Blown Insulation
4. OSB Sheathing
Service Space Framing
5. 2X3 Studs
6. Rock Wool Batt Insulation
7. Gypsum Board
Wall Panels (R52)
Structural Wall (R38)
1. Siding (Not Shown)
2. Rainscreen (1.5") (Not Shown)
3. Diffusion Board
4. 2X10 Studs
5. Cellulose Blown Insulation
6. OSB Sheathing
Service Wall (R14)
7. 2X4 Studs
8. Rock Wool Batt Insulation
9. Gypsum Board
Certified Passive House Window
1. Triple-Pane with Insulated Glazing
2. Argon Filled Inter-pane Voids
4. Low Emissivity Coating
5. U-Value:: Less than 0.8
6. Thermal Bridge Free Window Frames
Floor Panels (R66+)
Structural Component
1. Diffusion Board
2. TJI Joists
3. Cellulose Blown Insulation
4. OSB Sheathing
Service Space Framing
6. 2X6 Studs
6. Rock Wool Batt Insulation
7. OSB Sheathing
8. Flooring
Unheated Concrete Basement
NB: All Panels are described from the exterior inward.



0.25 ACH and
0.3 ACH at 50 PA

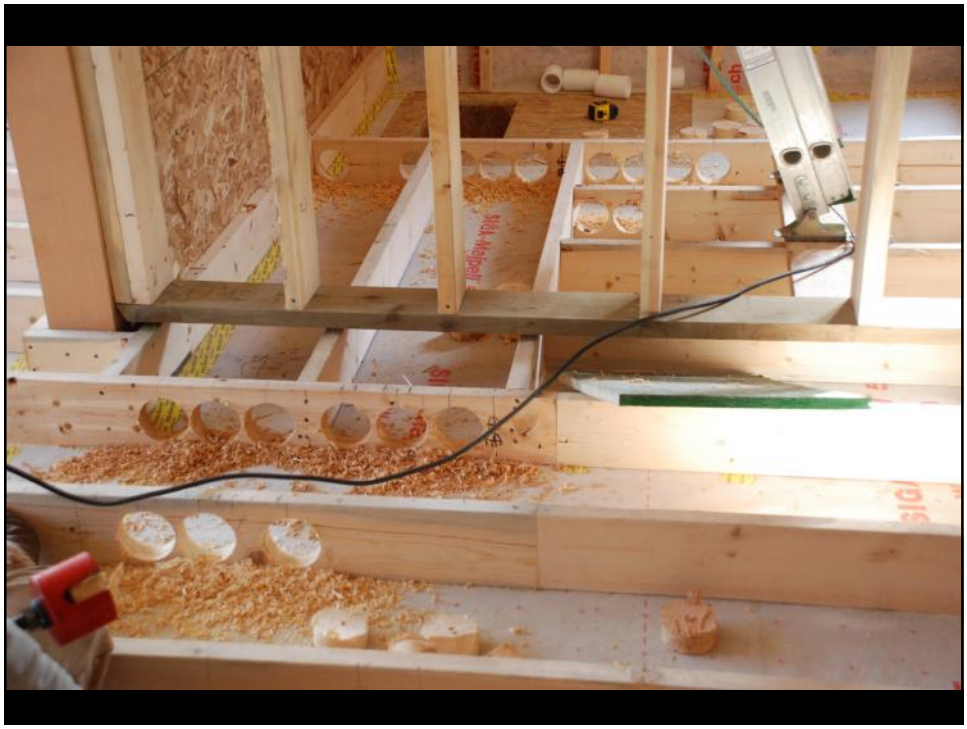
Airtightness Comparison

	ACH
Rainbow Passive House	0.25 & 0.3
Passive House Standard	0.6
R2000	1.5
Average Canadian Home	5-7

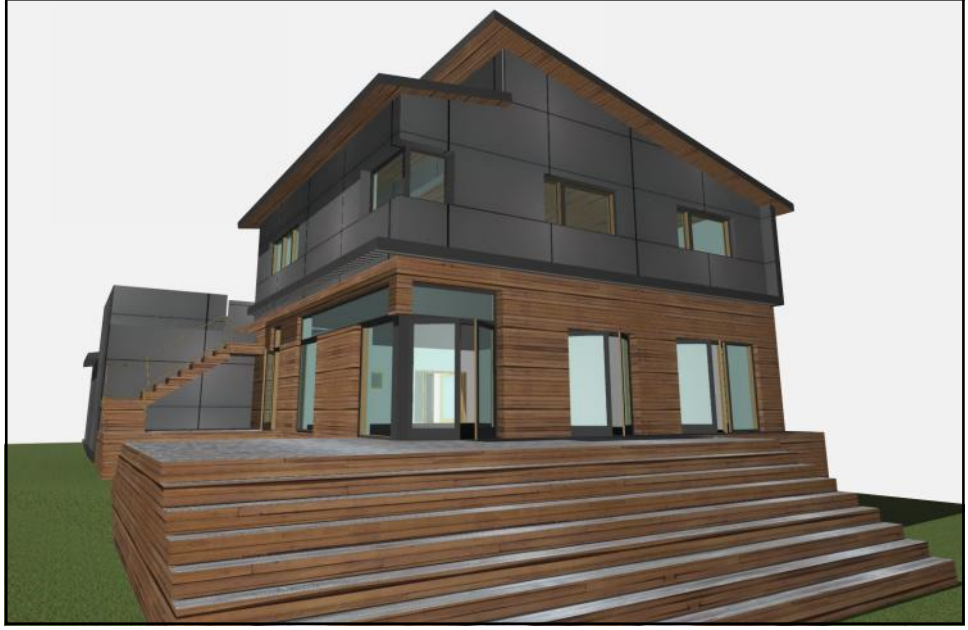
Reduce Thermal Bridging

Reduce Thermal Bridging

Prefabrication



Moving Forward…



To avoid this... work with the municipality up front to determine an approval process that will work for all parties.

If you want to go fast... Go alone, if you want to go far, go together!

Thank you