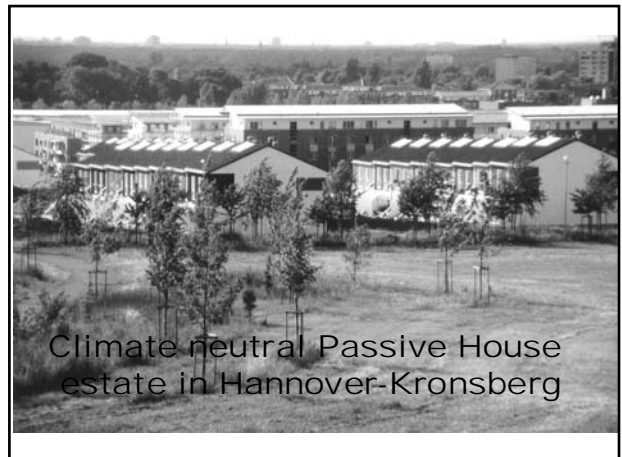
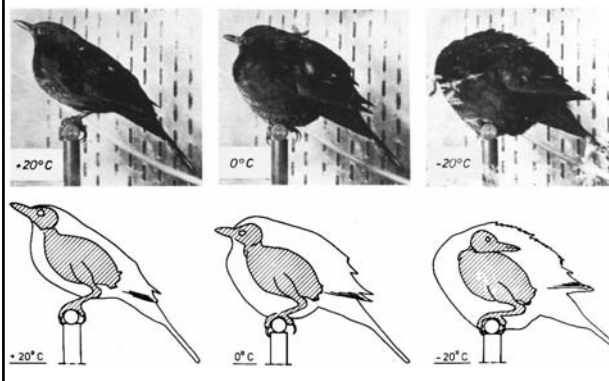
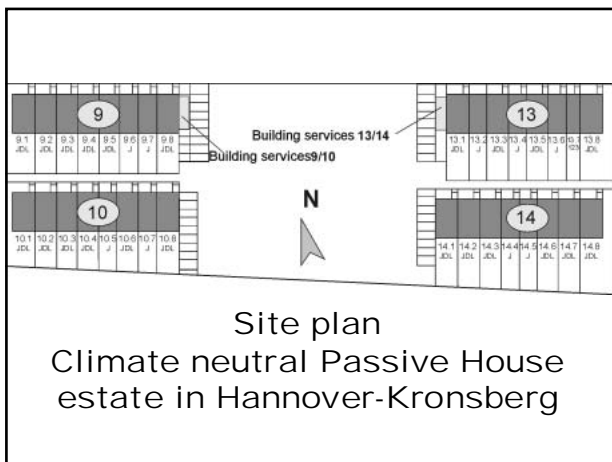


Design principles for Passive Houses



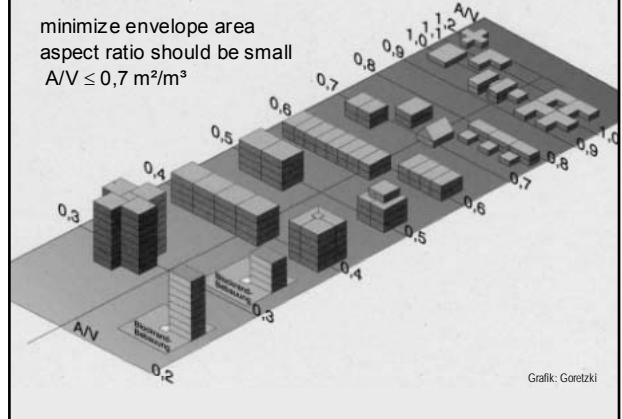
Climate neutral Passive House estate in Hannover-Kronsberg



Site plan
Climate neutral Passive House estate in Hannover-Kronsberg

compact building design makes life easier

minimize envelope area
aspect ratio should be small
 $A/V \leq 0,7 \text{ m}^2/\text{m}^3$



Grafik: Goretzki

compact building design

compact building...
... yet without neighbour



Haus Mainz, Solarsiedlung Aachen
Architekt: G. Weiss, Aachen

take any form of roof ...



Haus Meyer, Gehlen, Worchengladbach
Architekt: M. Brausem, Köln

Standard Elements: Passive House

Outer wall (south and north facade)	Outer wall (gable side)	floor slab	roof
Prefabricated lightweight wood element	Concrete with EIFS	Concrete with insulation	Lightweight with I studs
R-45	R-58	R_m 45 R_0 63	R-60

Insulated Wall Constructions; about R-40 ... R-60

EIFS: external thermal insulation

timber frame construction

Insulating lost form filled with concrete

timber frame using special studs

in future vacuum insulation

type I during construction at the passive house in Wolfurt

type II stainless steel. Door of a factory

prefabricated wall I

prefabricated wall II

take care about good quality on building site!

avoid gaps in thermal insulation layer

$\Psi = 0,32 \text{ W/(mK)}$

$\Psi = 0,017 \text{ W/(mK)}$

take care about good quality on building site!

gaps in insulation layer ...

...have to be filled

avoid thermal bridge effects $\psi_s \leq 0.01 \text{ W/(mK)}$

corner above cellar (NOT a Passive House)

lime brick wall

concrete

minimum temperature with furniture: 9,4 °C
damage (mold) follows the temperature profile
[Geyer 2003]

What is a thermal bridge?

Outside: -10 °C

Insulation

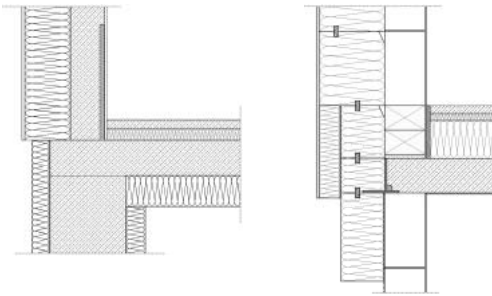
Inside: 20 °C

0.2 W/m between two heat flow lines

$d_1 = 400 \text{ mm}$ $d_2 = 200 \text{ mm}$ $Q_1 + Q_2 = 8,381 \text{ W/m}$
 $U_1 = 0,096 \text{ W/m}^2\text{K}$ $U_2 = 0,184 \text{ W/m}^2\text{K}$
 $Q_1 = 2,872 \text{ W/m}^2$ $Q_2 = 5,509 \text{ W/m}^2$ **real heat flow = 8,646 W/m**

the difference: with simple calculation $\sum U_i \cdot A \cdot \Delta\vartheta$
 the two-dimensional thermal flow effects are neglected:
 $\Psi = 0,0088 \text{ W/mK}$

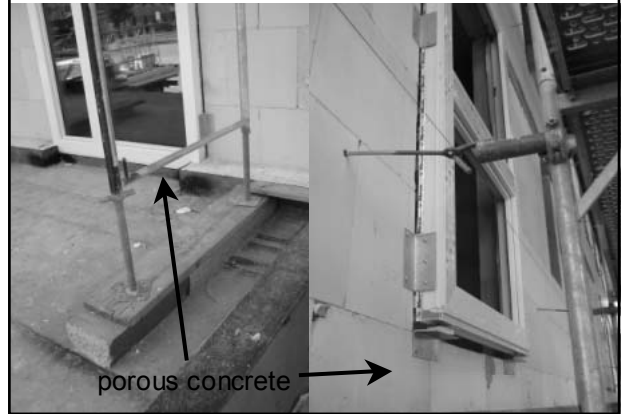
constructive thermal bridges



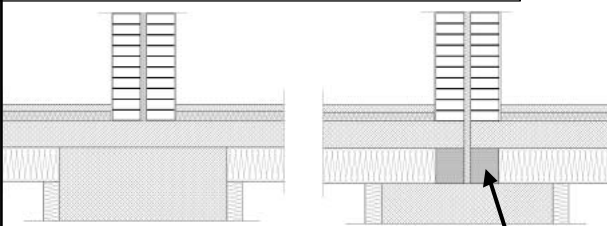
don't do that!
 $\Psi_e > 0,1 \text{ W/(mK)}$
 severe thermal bridge

solution: thermal separation
 $\Psi_e < 0,01 \text{ W/(mK)}$

without thermal bridge ...

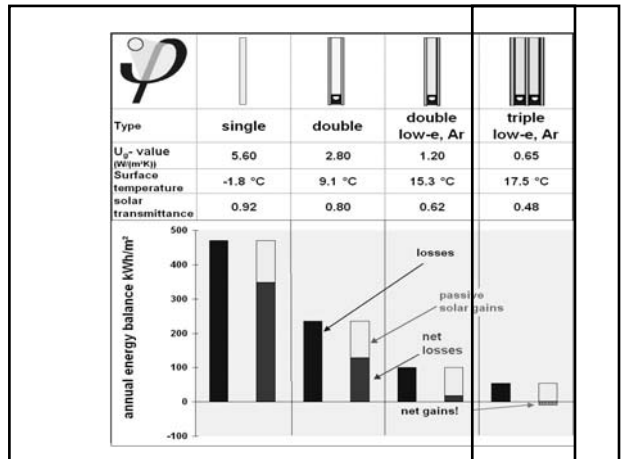


constructive thermal bridges

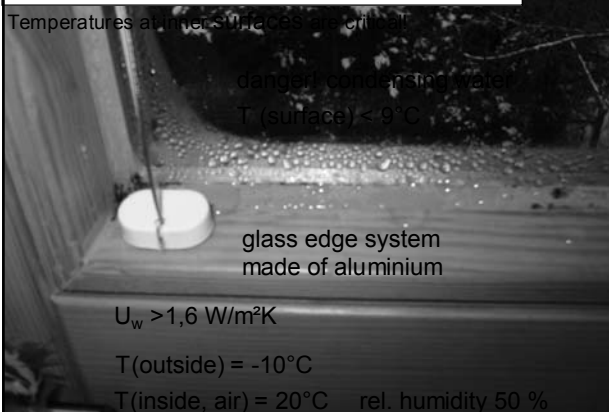


don't do that!
 conventional
 foundation with
 concrete
 $\Psi_e > 0,63 \text{ W/(mK)}$
 severe thermal bridge

**solution: foundation out of
 porous concrete**
 $\Psi_e < 0,11 \text{ W/(mK)}$
 acceptable thermal bridge

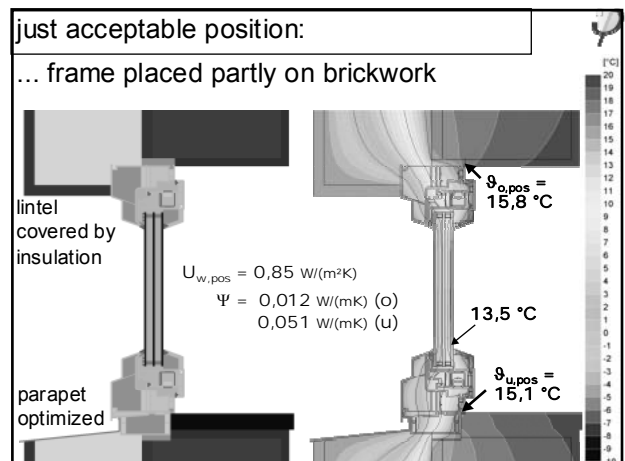
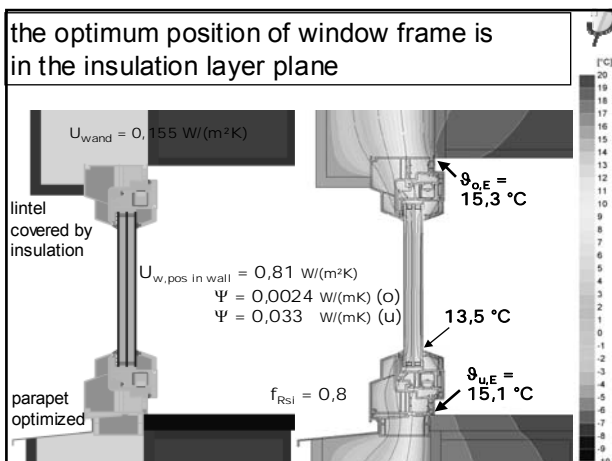
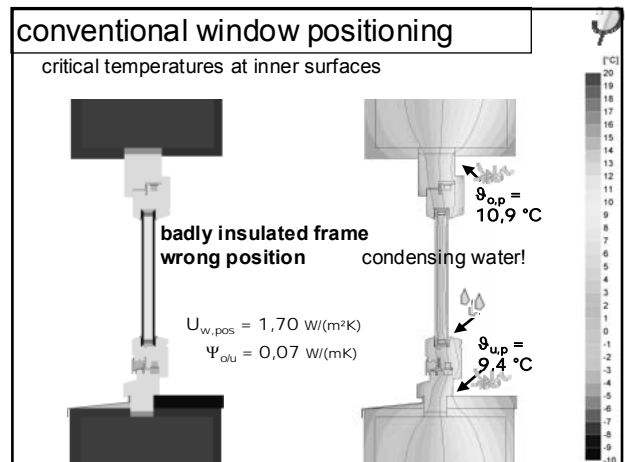
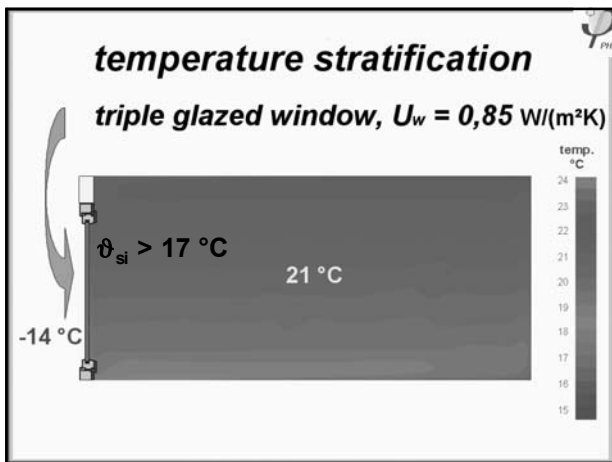
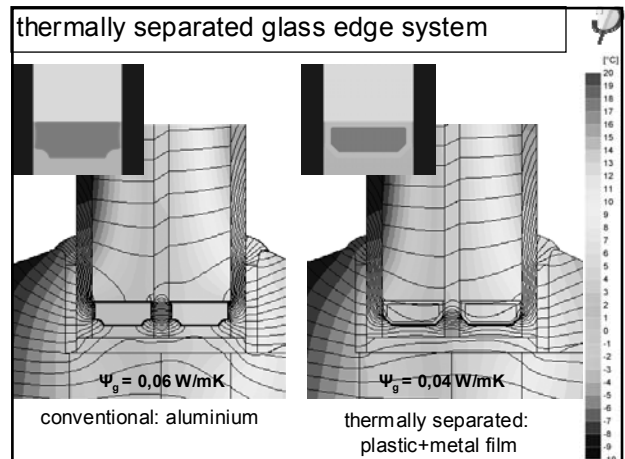
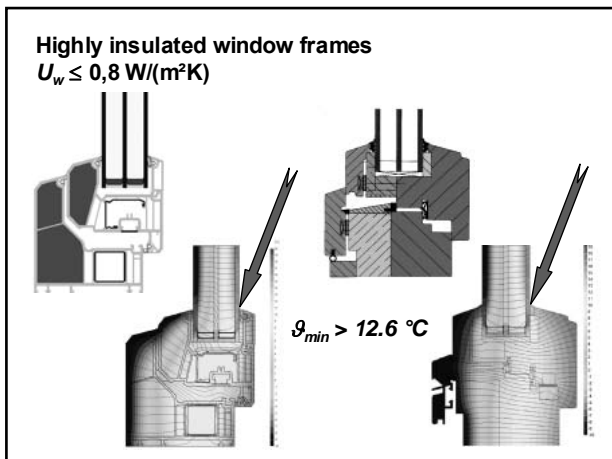


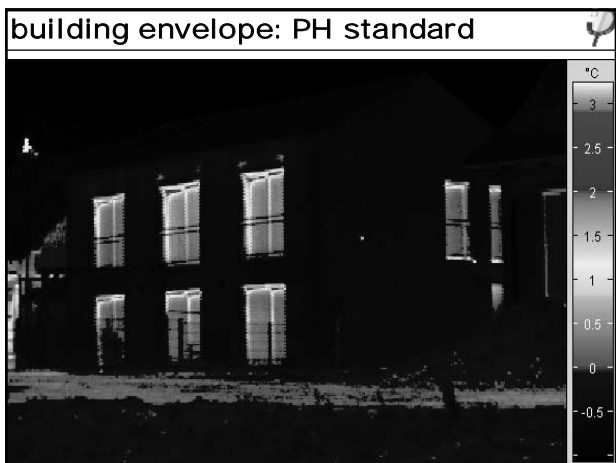
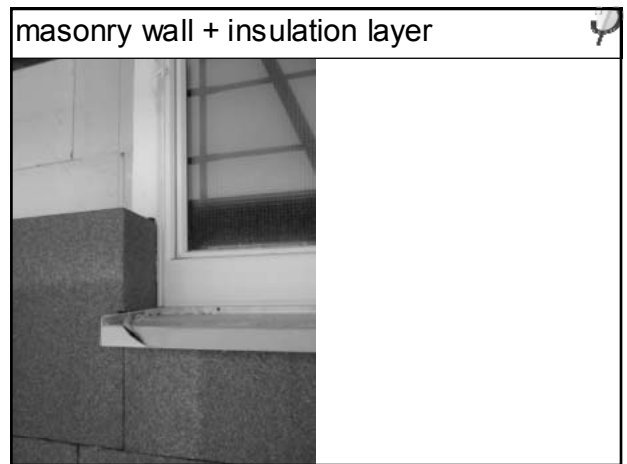
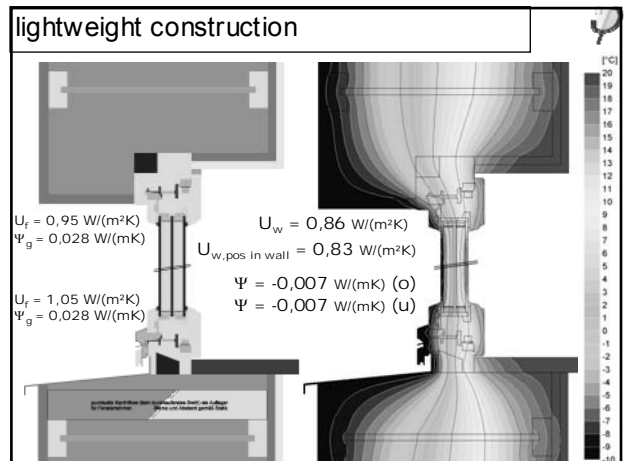
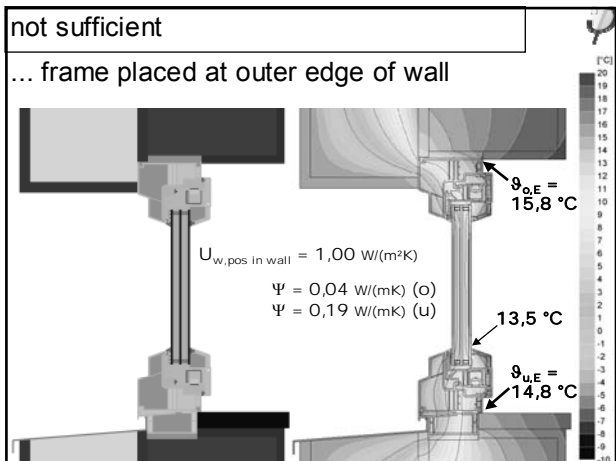
conventional window frame



Superinsulated windows:
 U_w not higher than
0.8 W/(m²K)

innovative products:
 - improved c comfort
 - added value
 - energy conservation
 - CO₂ mitigation
 - job creation by small and medium enterprises



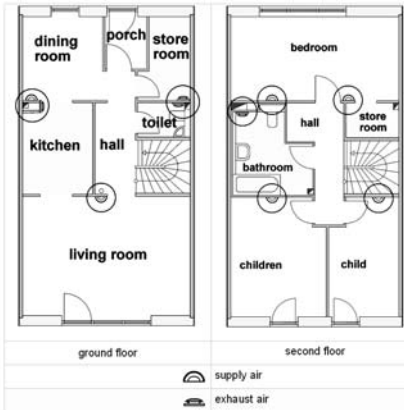


Ventilation: Supply, Transfer, Exhaust

design of ground plans

short supply lines

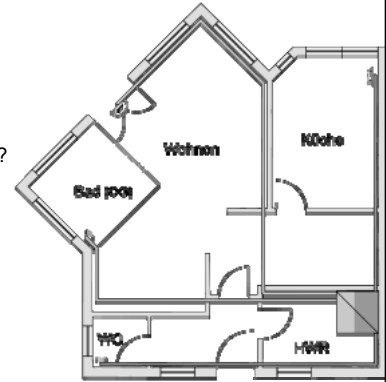
clear functional zone separation



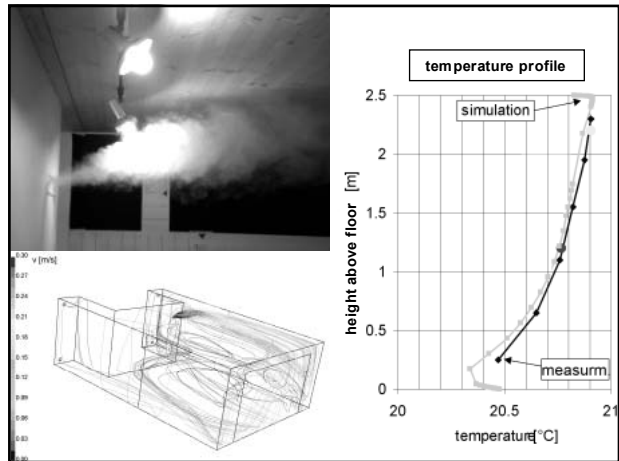
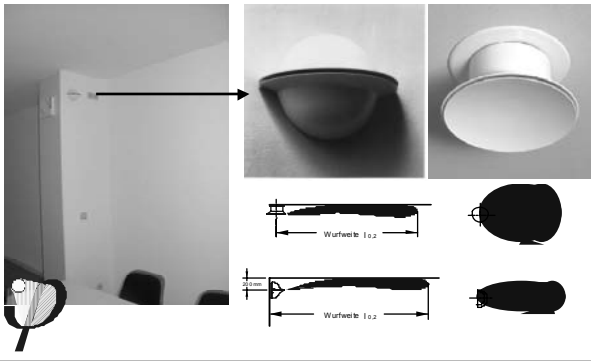
design of ground plans

...short supply lines?

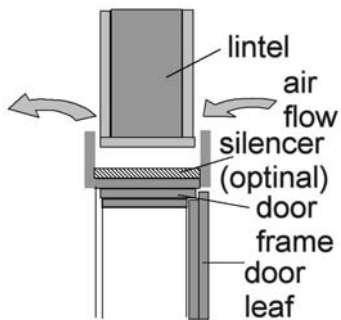
...clear functional zone separation?



Wide casting nozzles using the ceiling as a „duct“



Airflow between rooms

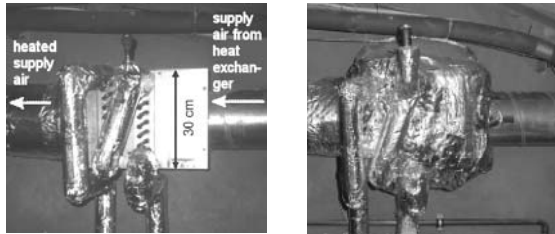


Central Ventilation Unit



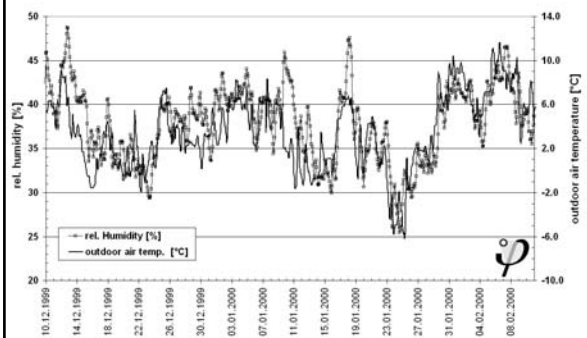
Heating with the Ventilation System

Air/Water Postheater:



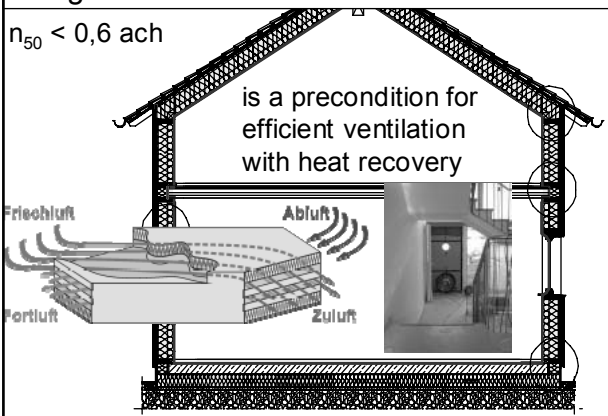
... after insulation

Maximum ventilation rates

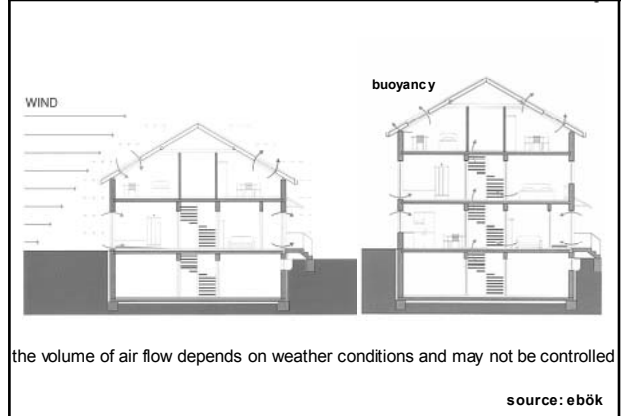


air-tightness

$n_{50} < 0,6 \text{ ach}$



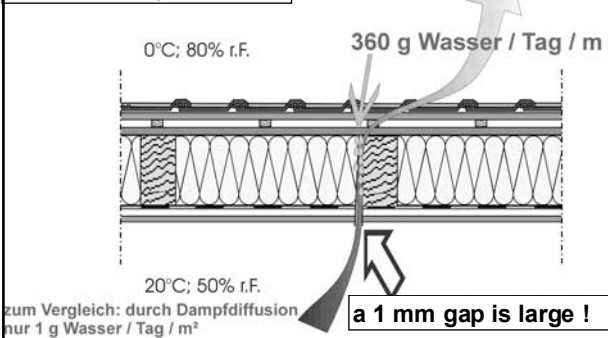
air-flow through leakages of a building



air-tightness is essential !

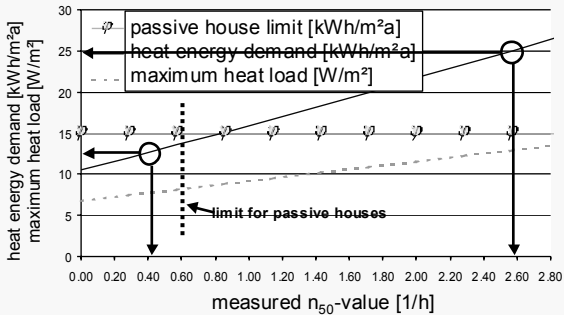
avoid gaps where humid air may flow out

goal: $n_{50} < 0,6 \text{ ach}$

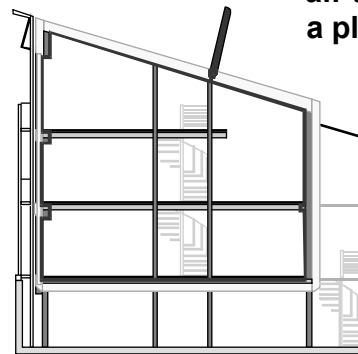


air-tightness is essential!

influence of air tightness on heating energy demand and maximum heat load



air tightness is a planning task



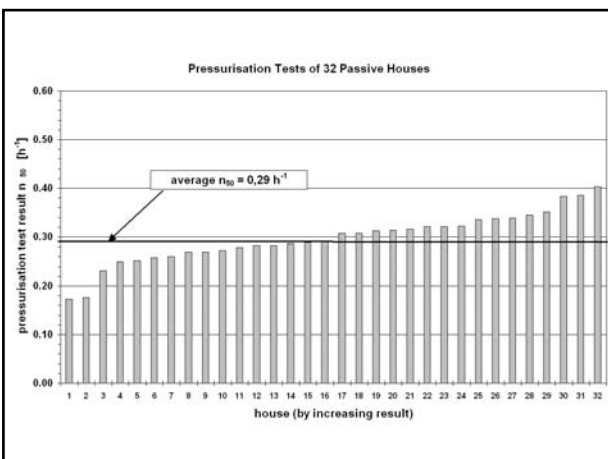
use the 'rule of drawing pencil' to imagine the airtight plane
one airtight envelope must cover the whole heated building volume.

3 principles for the airtight envelope

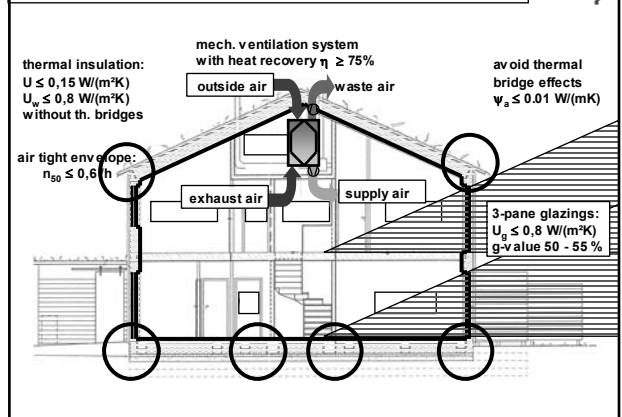
- (1): **rule of drawing pencil**
- (2): design only ONE airtight layer.
Combining two leaky layers will *not* do!
- (3): airtight layer should be placed inside the wall; airtight materials are usually vapour retarders as well

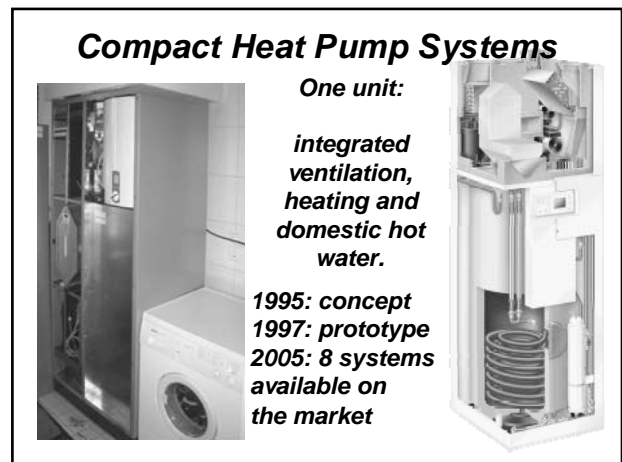
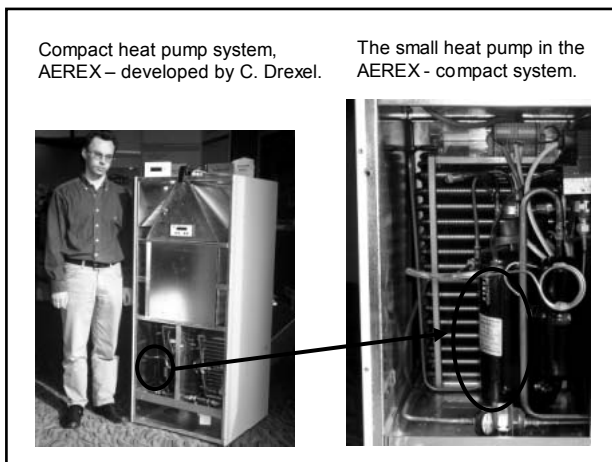
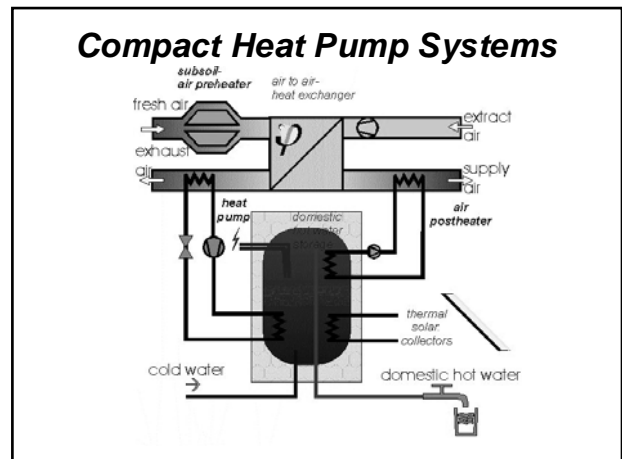
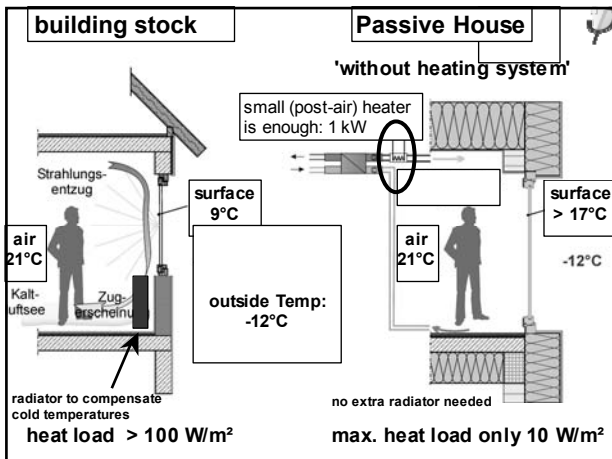


bad planning = bad quality



Passive House Qualities – five basics





Other possible heat generators

- wood pellet stoves
- condensing gas boiler
- oil boiler
- district heat with CHP (large buildings only?)
- gas / wood / oil fired compact units

