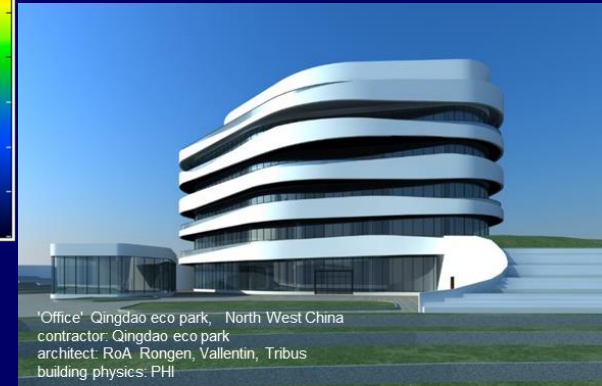
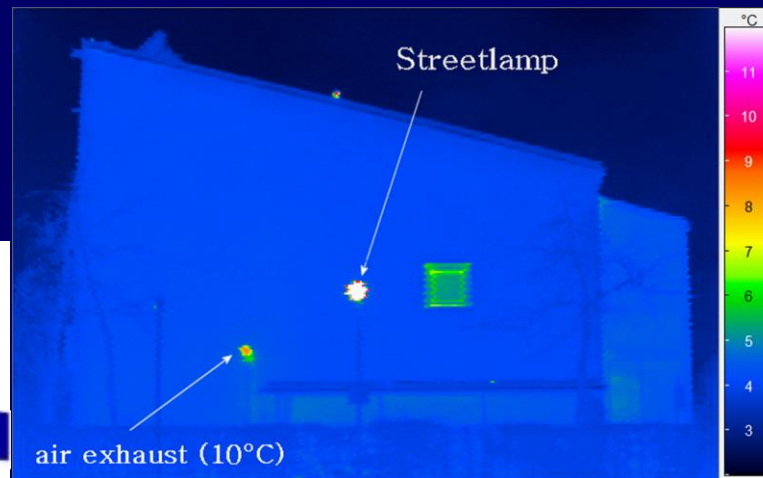
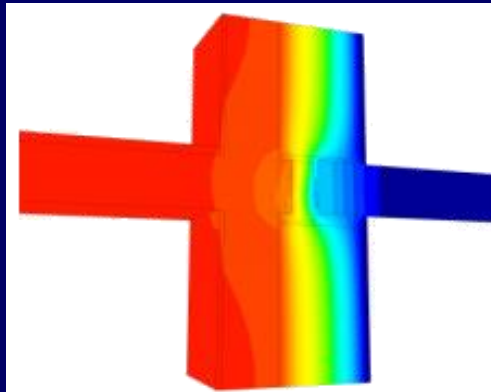


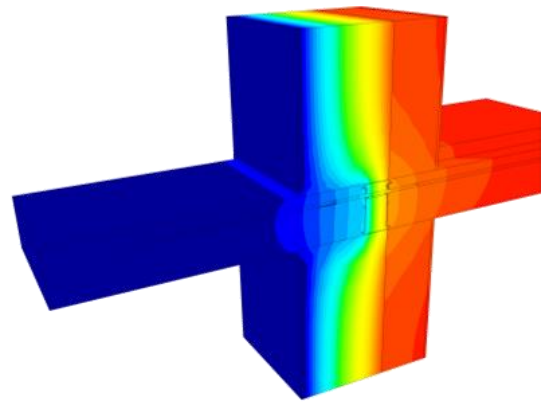
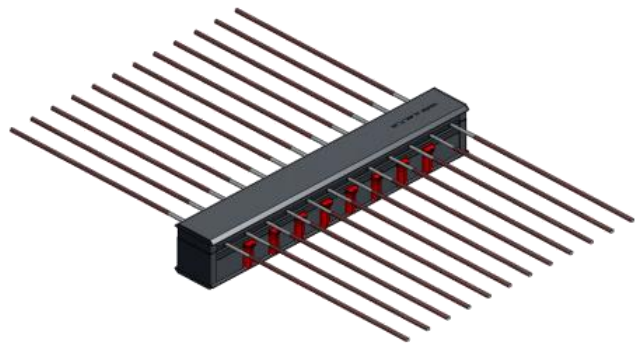
Global Energy Transition: successful by using solid physics



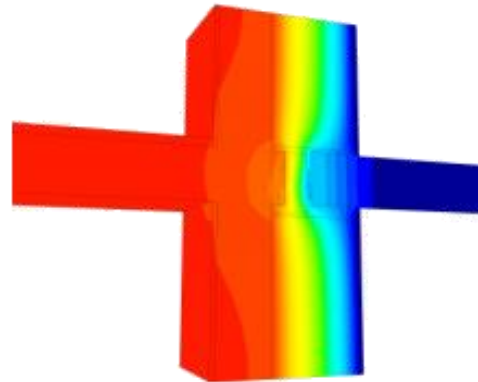
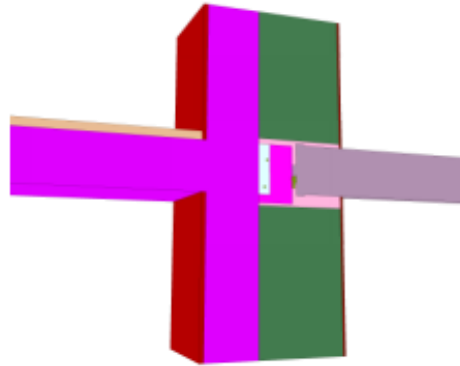
$$-c_p \rho \frac{\partial T(t, \vec{r})}{\partial t} + q_Q(t, \vec{r}) = -\nabla(\lambda(\vec{r}) \nabla T(t, \vec{r}))$$

3D-heat conductive transfer

Numerical solutions easily available; don't just calculate - but
→ systematically improve the solutions

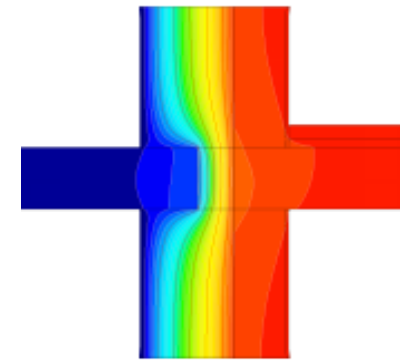
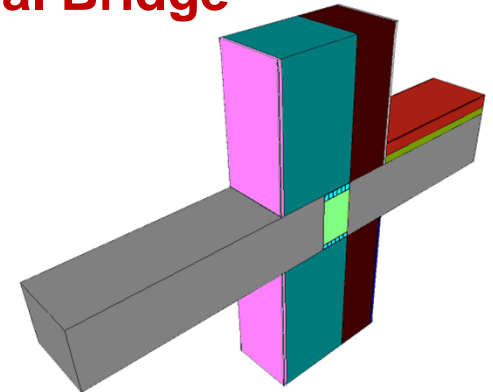


Halfen, GERMANY
HIT SP & HIT HP



Schöck, GERMANY
Isokorb R
for refurbishment

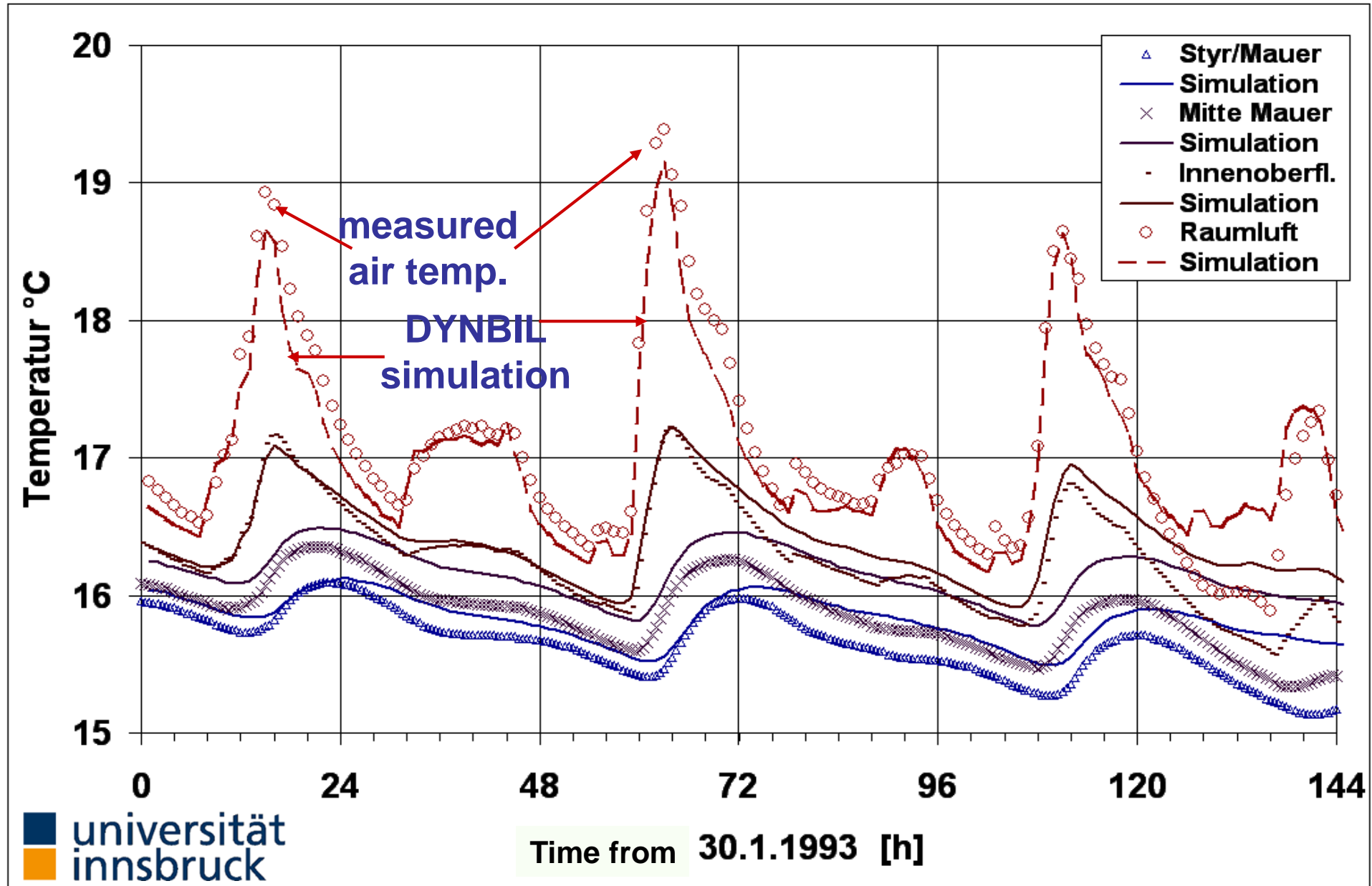
Thermal Bridge
Free



Schöck, GERMANY
Isokorb QXT

Time Dependent Simulation & Measurement

Full thermal network; IR radiation; solar radiation; windows; ventilation; IHGains





**Factor
5**



Before

After



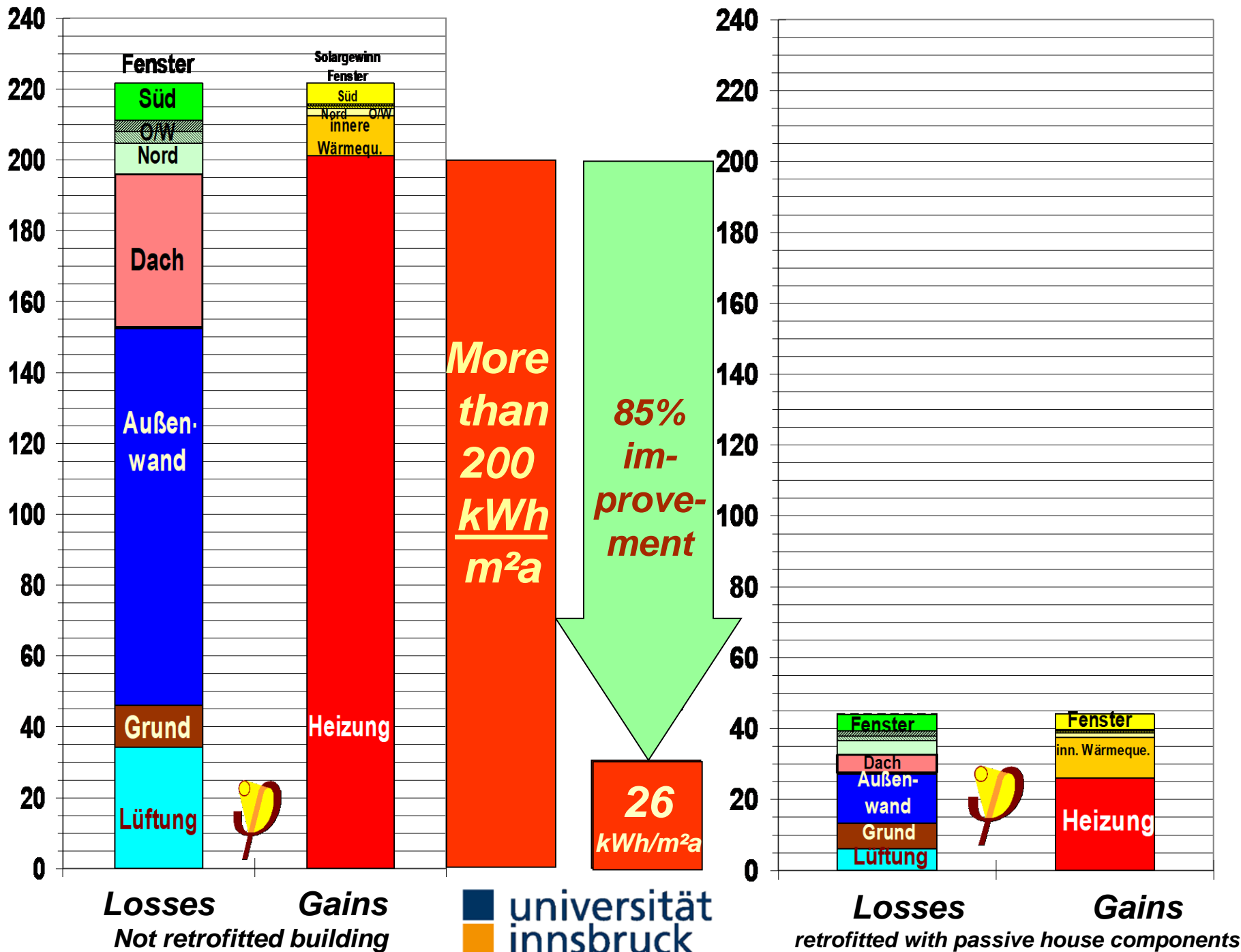
**More
than
200
kWh
m²a**

**85%
im-
prove-
ment**

**26
kWh/m²a**



Energy flow by area and year kWh/(m²a)



Essentials for Passive Buildings

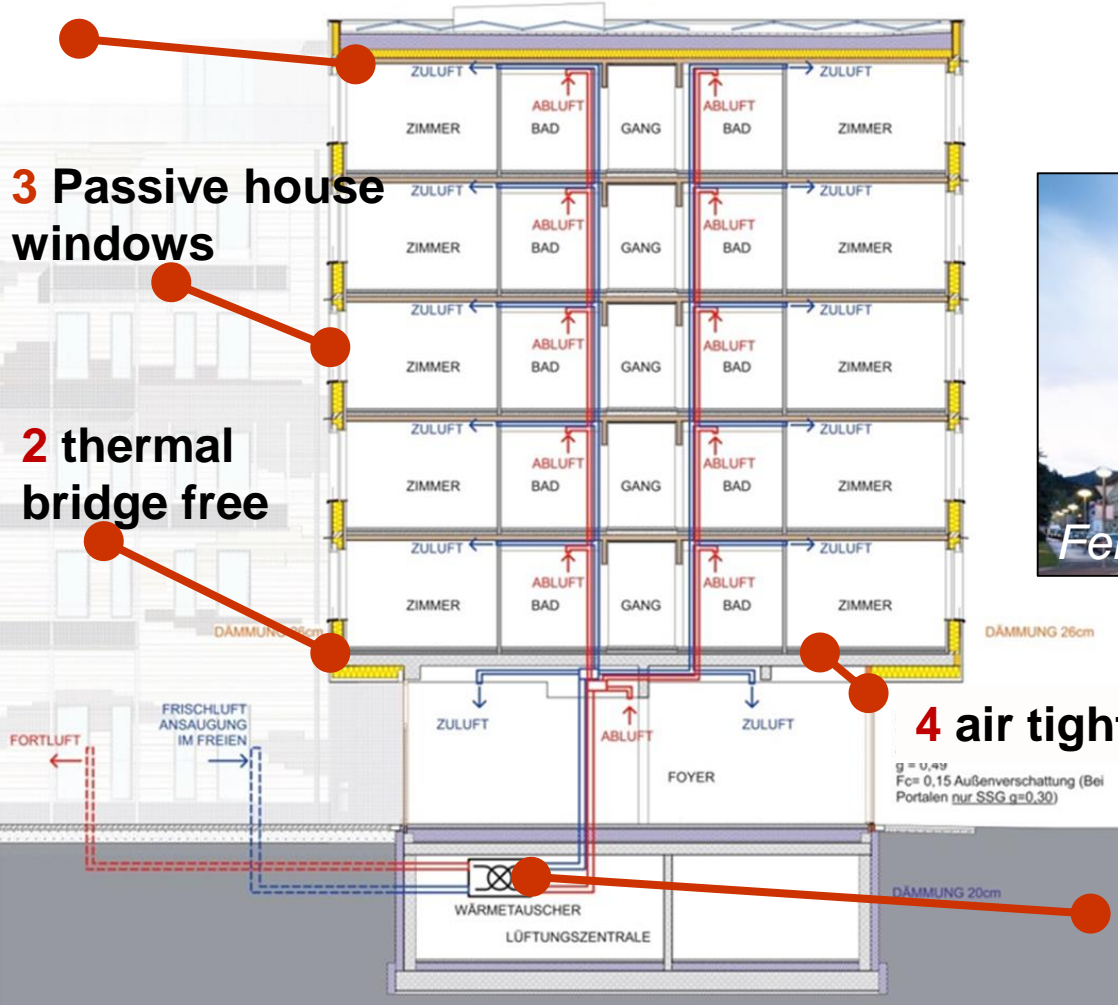
1 insulation

3 Passive house windows

2 thermal bridge free

4 air tight

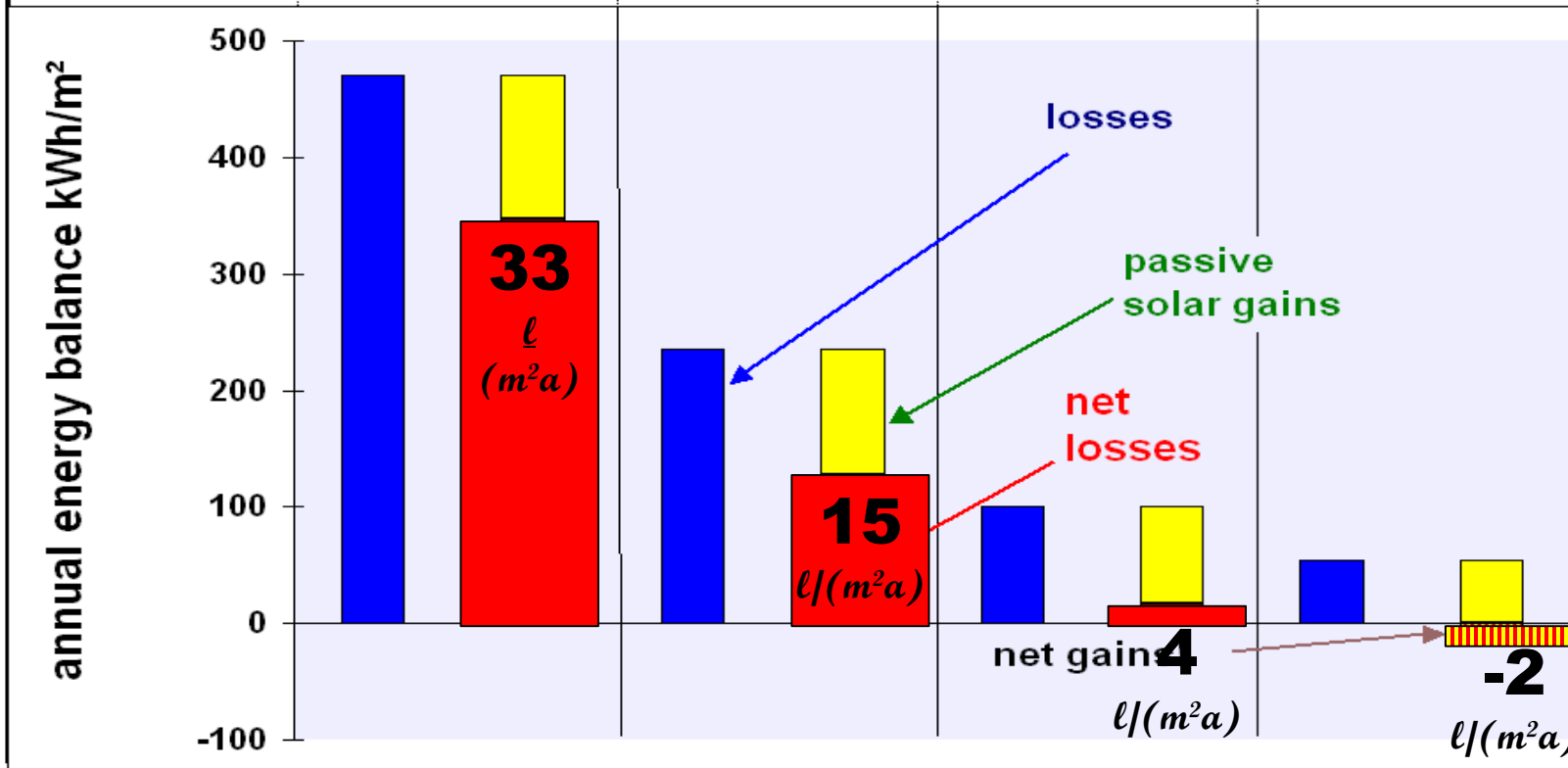
5 heat recovery



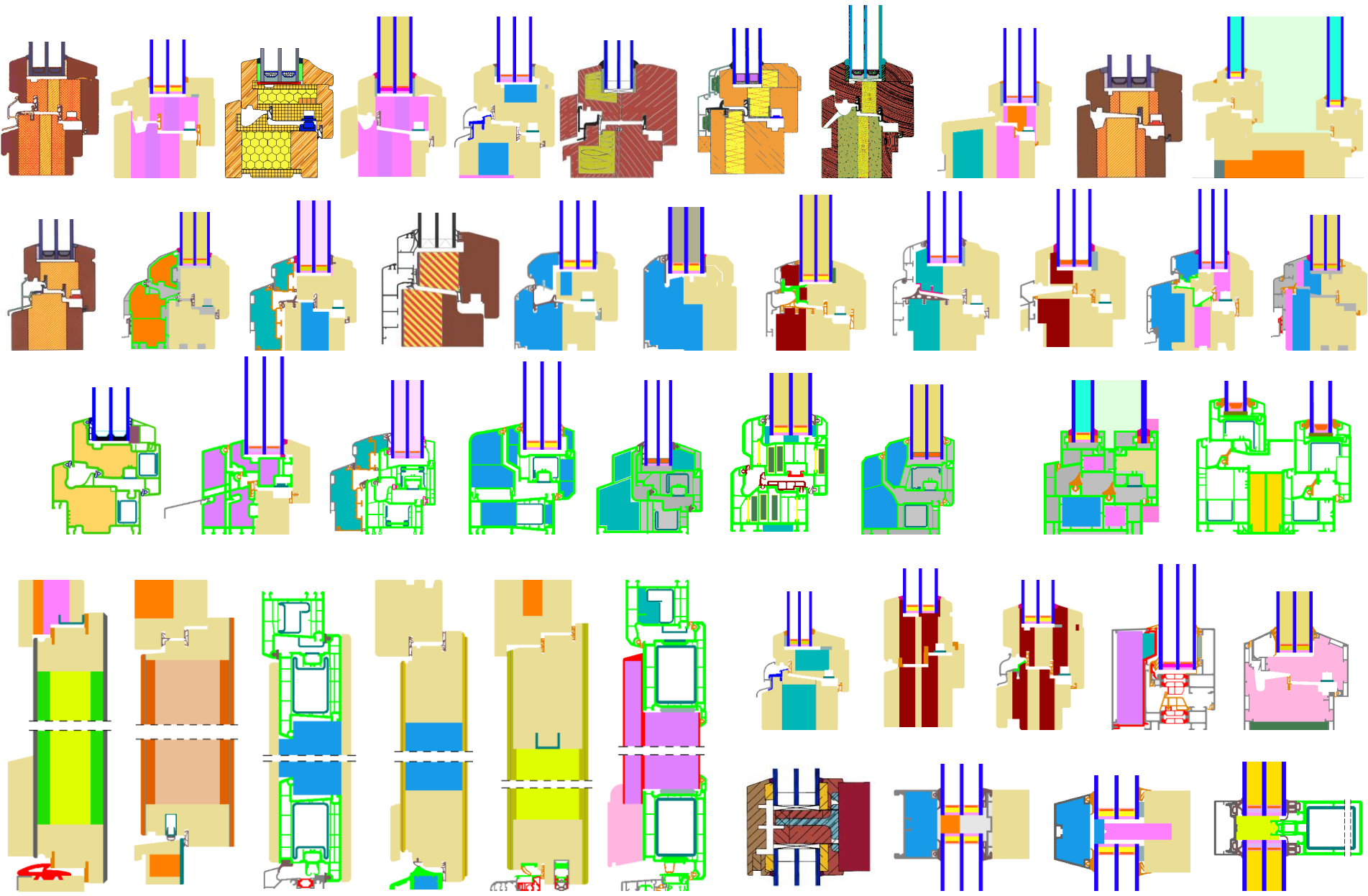
performance based!
15 kWh/(m²a)



Type	single	double	double low-e, Ar	triple low-e, Ar
U_g - value (W/(m ² K))	5.60	2.80	1.20	0.65
Surface temperature	-1.8 °C	9.1 °C	15.3 °C	17.5 °C
solar transmittance	0.92	0.80	0.62	0.48



Window frames: Factor 5 using applied physics



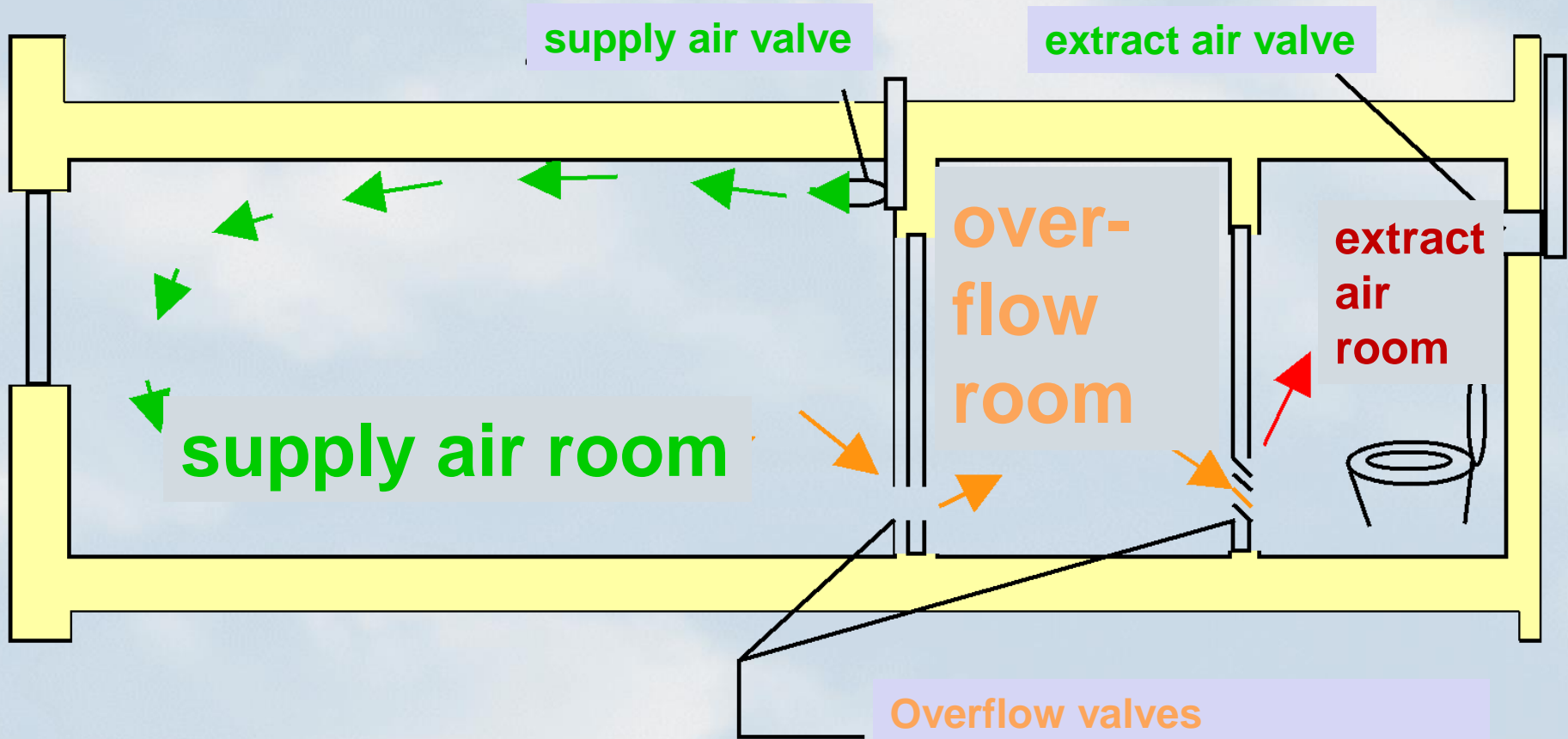
Ventilation: Indoor Air Quality using applied physics

Piston flow ventilation

→ supply air

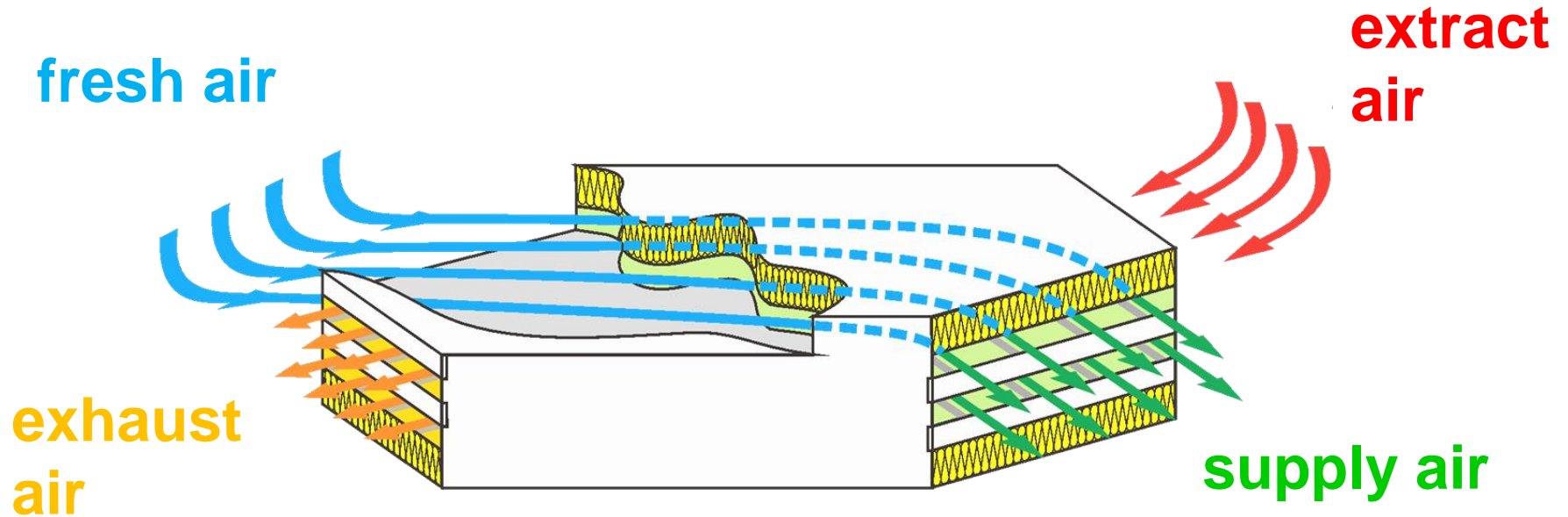
→ overflow

→ extract air



Air to Air Heat Recovery

Factor 5 using applied physics: counter flow heat exchanger



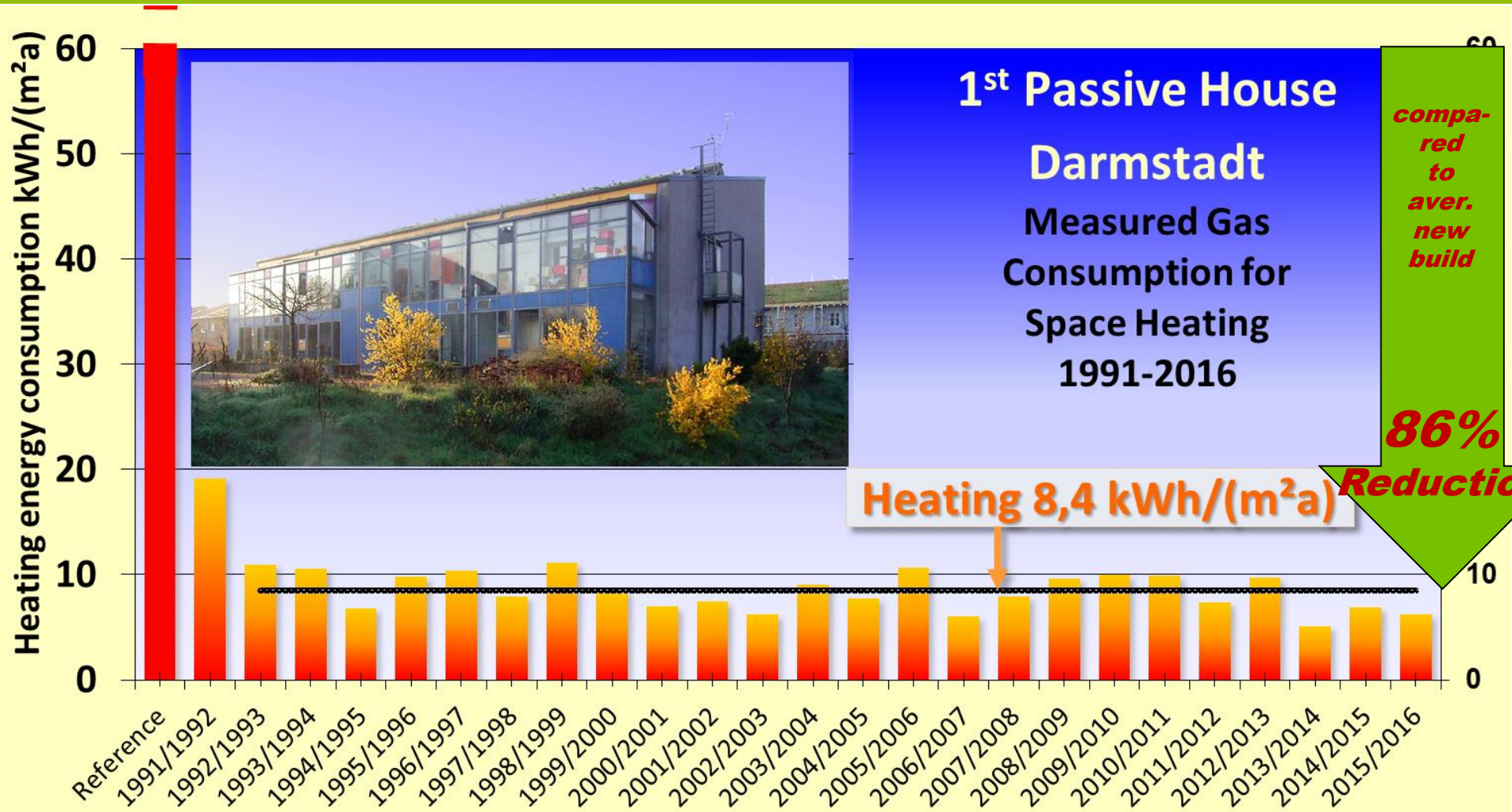
Modern heat exchangers:

- more than 80% and up to 98% heat recovery
- electricity for fans: some $2 \cdot 20 \text{ W}$

Primary energy savings by a factor 4 to 6.

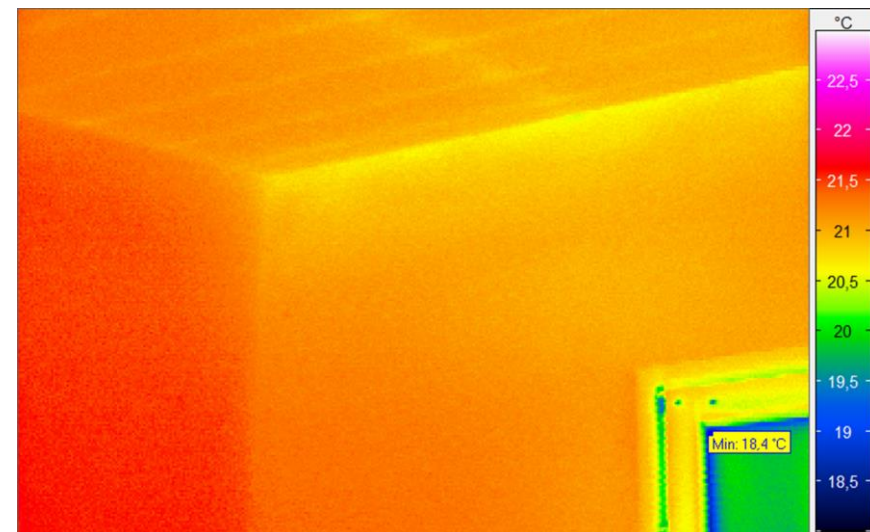
(compare: state of the art heat pumps primary energy by factor 2)

Heating a quarter century of monitoring

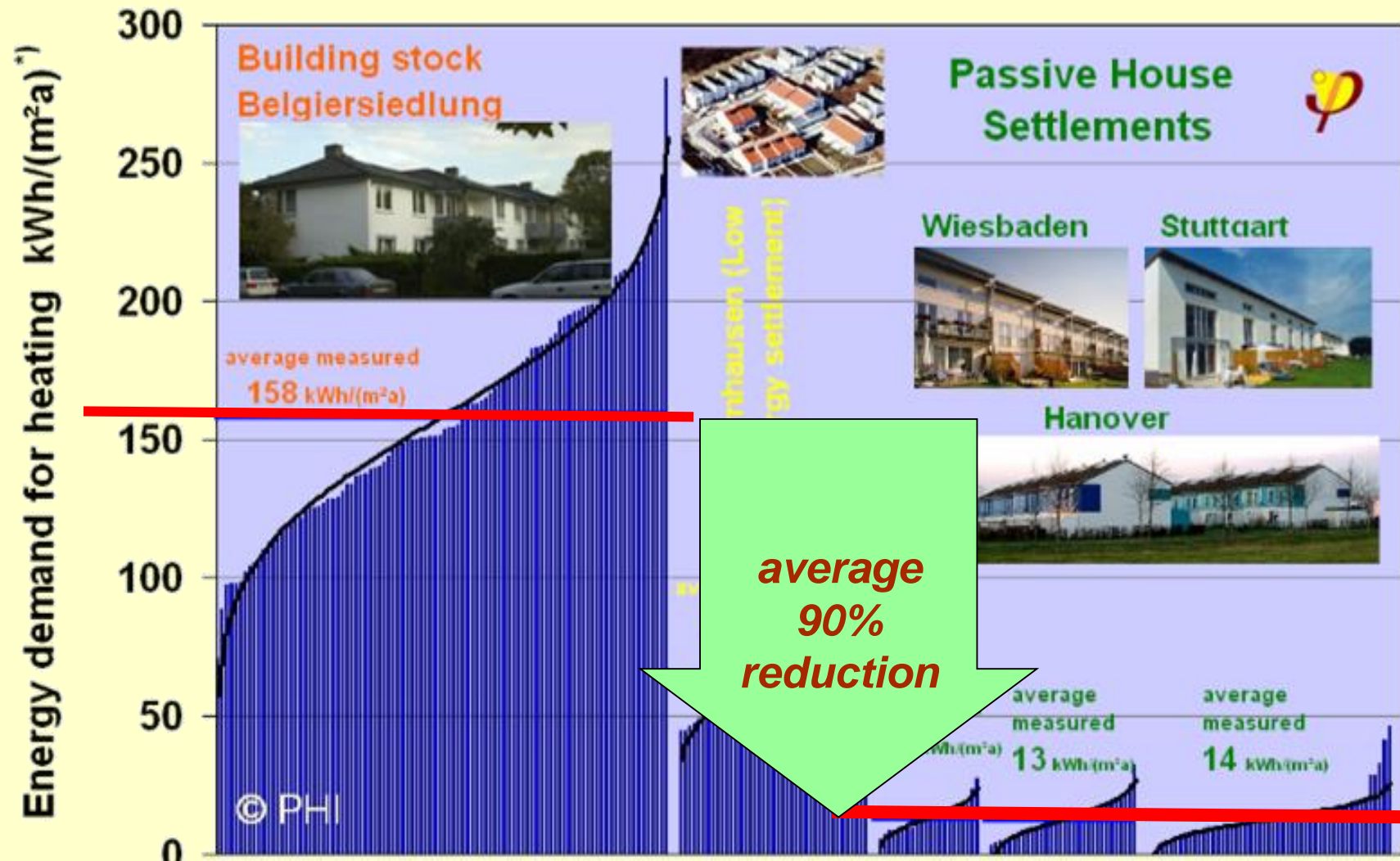


After 25 years...

- structural load capacity (σ_{10} 59 kPa) ✓
- thermal conductivity 0,0412(12) W/(mK) ✓
- windows-heat-transfer 0,78(5) W/(m²K) ✓
- still thermal bridge free ✓
- air tightness unchanged (0,21(4) h⁻¹) ✓
- 80% heat recovery ✓
- indoor air quality: IDA 2 ✓
- LCE: at least 50 yrs life expectation
ALL components ✓



Passive house – quality confirmed, monitoring results



When to exchange a window?

... If the old is damaged!

... Or: if a retrofit done anyhow,

... Or: if the new one is a gift.

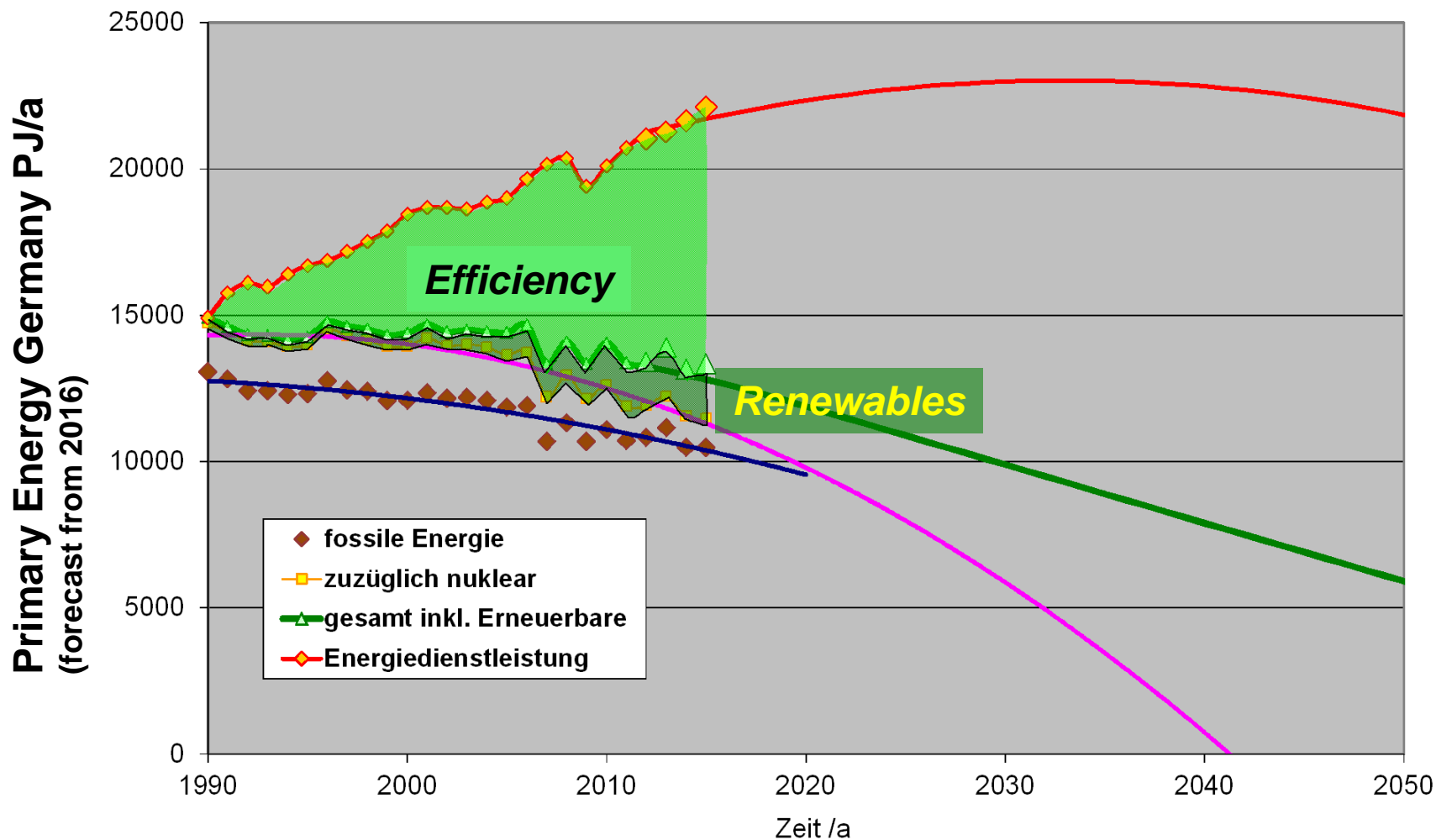
consequence:

Windows retrofitted ~ 40 years.

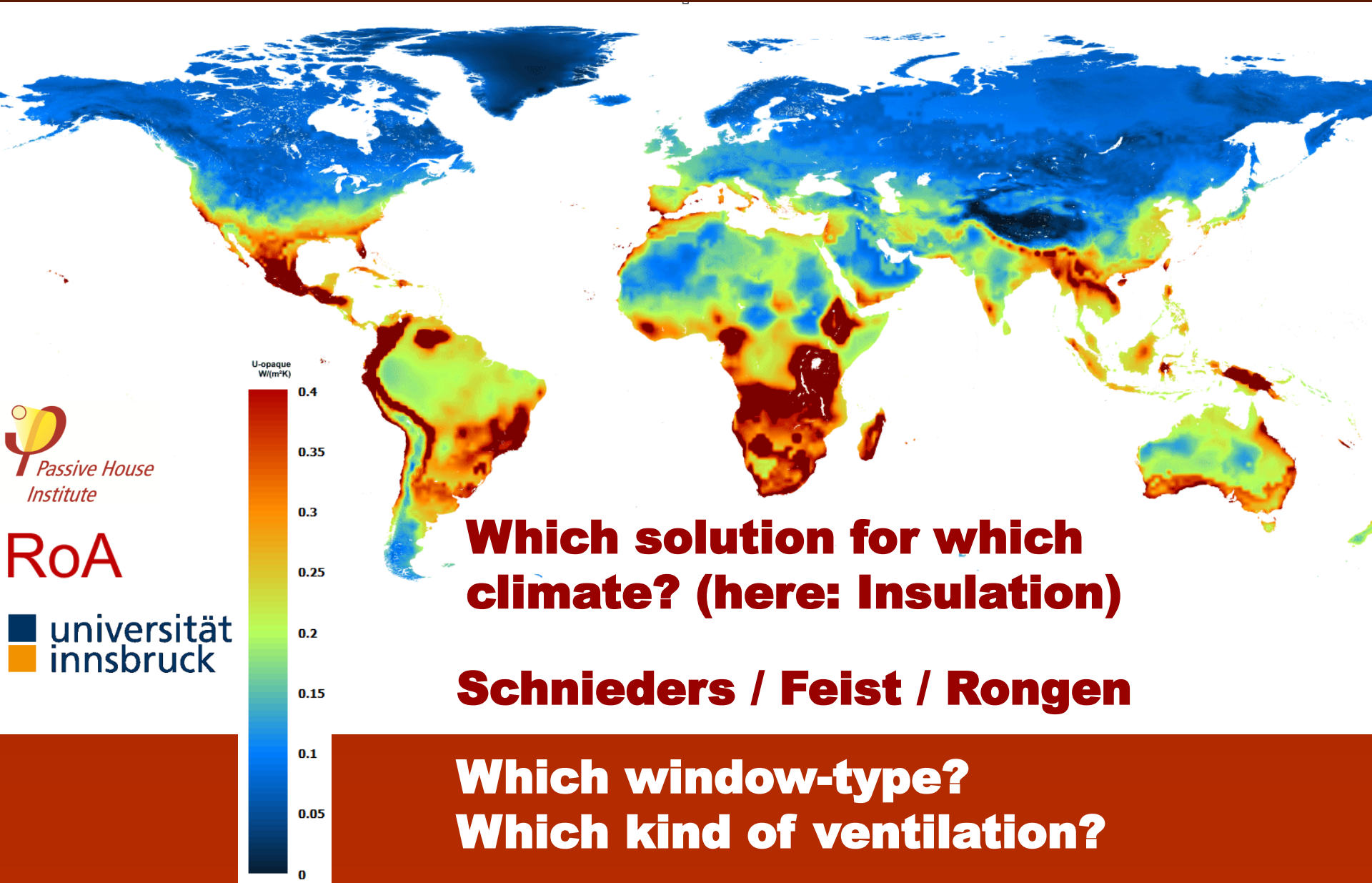
Do not loose the opportunity!



Success of the energy transformation: improved energy-efficiency in Germany



Passive House in all Climates



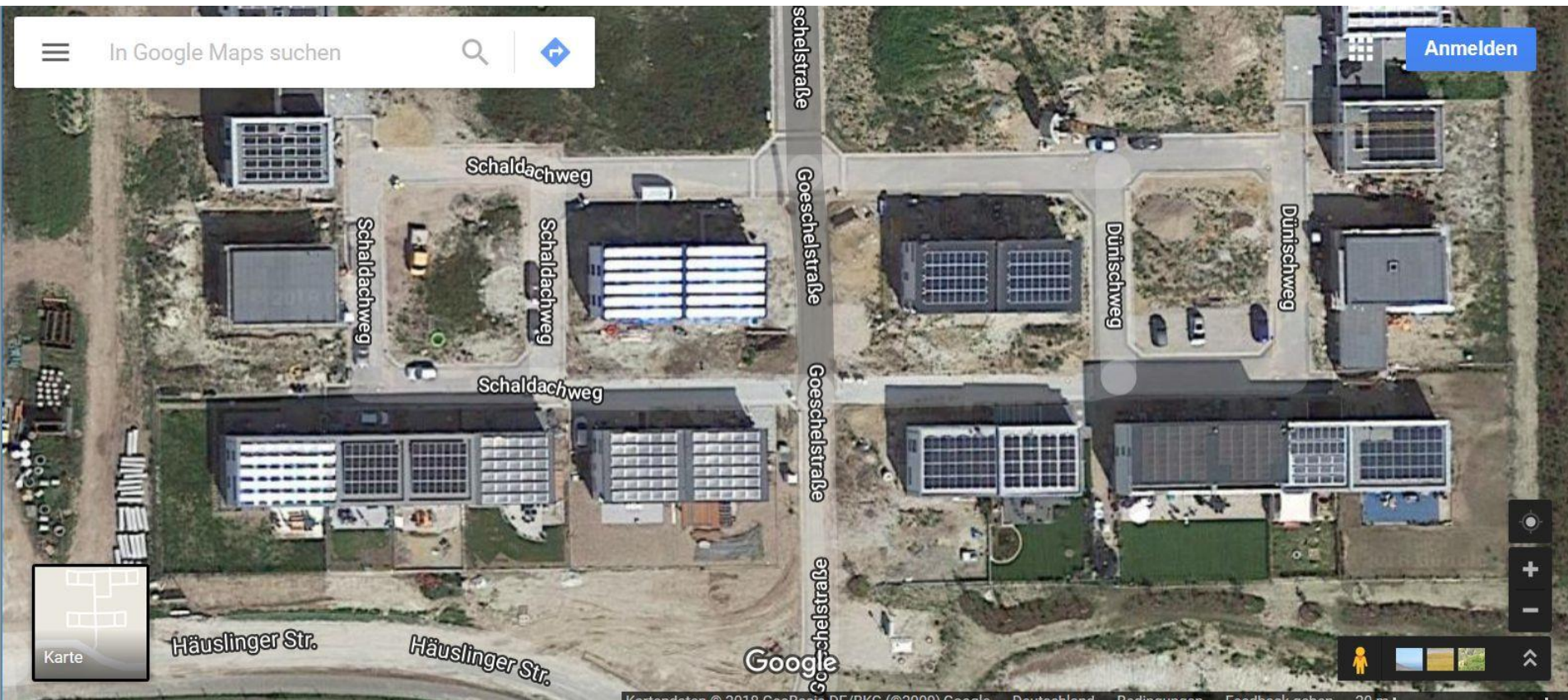
**Which solution for which
climate? (here: Insulation)**

Schnieders / Feist / Rongen

Which window-type?

Which kind of ventilation?

PH regional: Positive Energy Development/Erlangen



Passive House + Photo Voltaics → completely sustainable energy concept with balanced PER

PH around the globe: examples from China



Picture: Frauenkirche und Theatinerkirche, B. Roemmelt

22ND INTERNATIONAL PASSIVE HOUSE CONFERENCE 2018

Munich | Germany

9 | 10 March 2018

with exhibition,
workshops,
excursions



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und Technologie

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