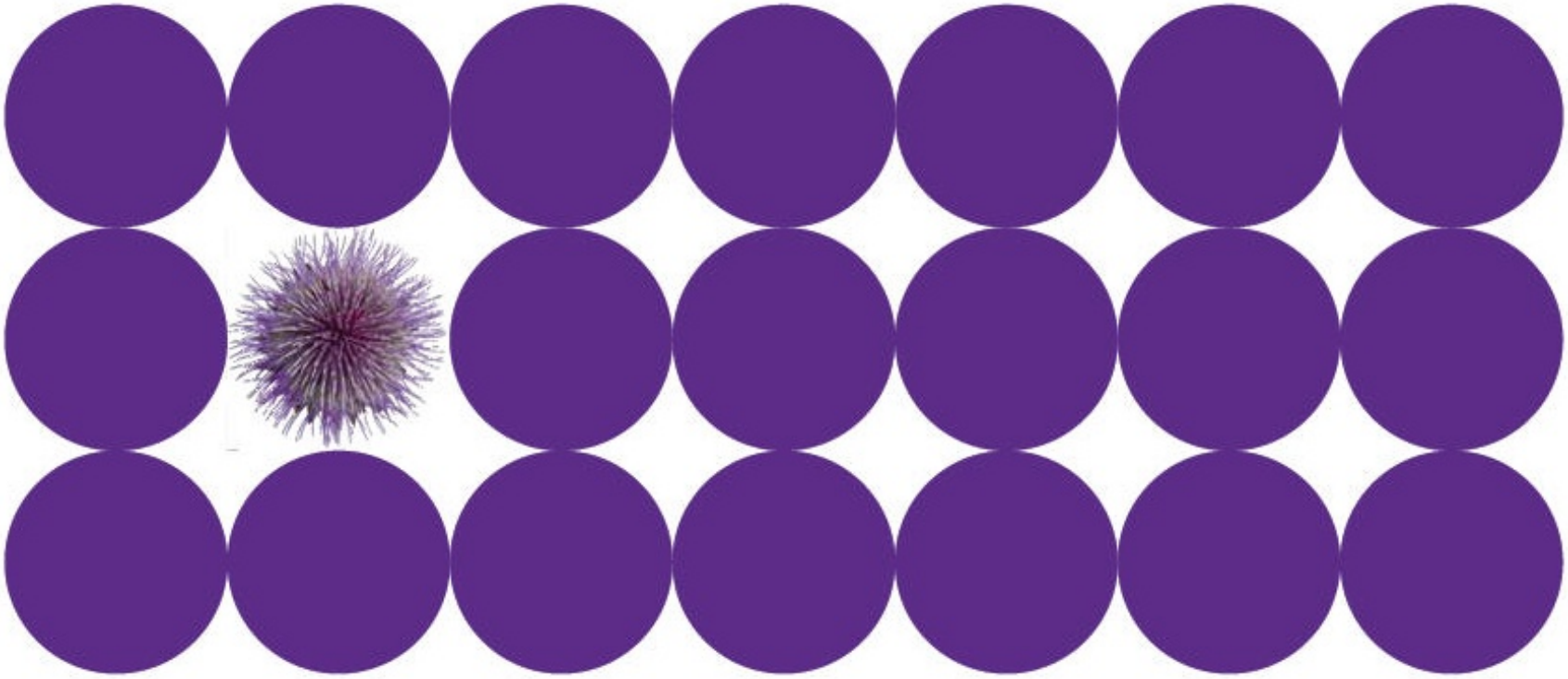
Climate Envelopes for contemporary Architecture –
Developing Zero Emission Buildings



Dr.-Ing. Werner Jager

September 5th, 2012

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EU Road Map to ZEB

- EU Target: nZEB near Zero Energy Building
- definition: *very high energy efficient building near zero, the energy consumed to be covered to a significant extent by renewables including on-site/nearby production*
- methodology: holistic building approach, up to Member States to define levels and details

- New criteria: "cost-optimal solution"
- definition: *lowest cost over entire life time (energy investment, gains, earnings etc.)*
- methodology: EU frame under work till mid-2011, details left to Member States

- Forecast
  - **Countries to develop national nZEB road maps and action plans during 2011 + 2012**
  - **Taking off of nZEB requirements before 2015 and gradually increase towards the 2020 targets**

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Energy Consumption to operate

Actions needed:

a. Highly insulated building envelope (Passivehouse Standard)

b. Effective sun protection system – exterior, adjustable

c. Heat reflection/ heat capture/ heat storage – passive

d. Natural ventilation whenever possible – night cooling

e. Double skin – Breating Facade solutions

f. Integrate solar gaining systems - active.

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The Building Envelope

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Impact of the Building Envelope

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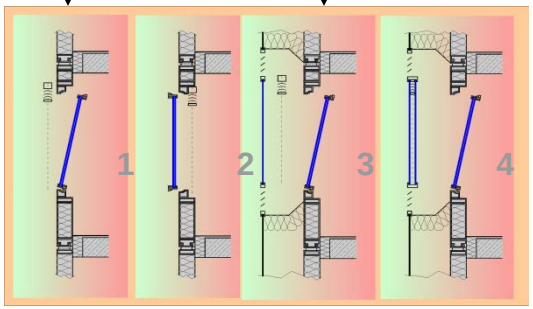
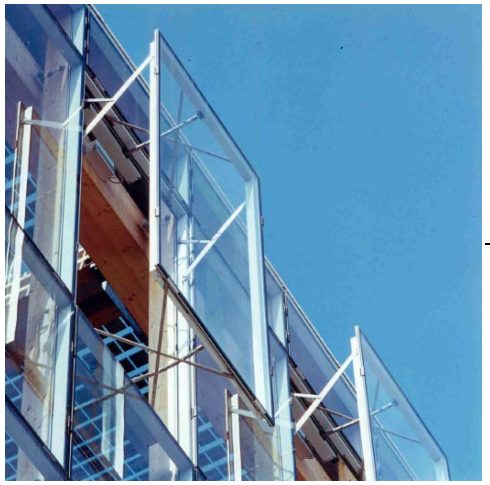
Building Envelopes in Comparison





HYDRO

Outdoor Test Facilities – e.g. Toulouse

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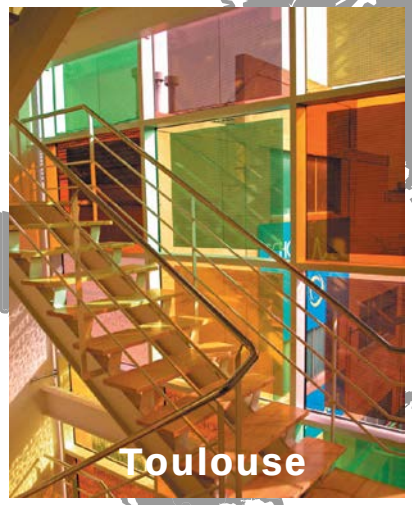
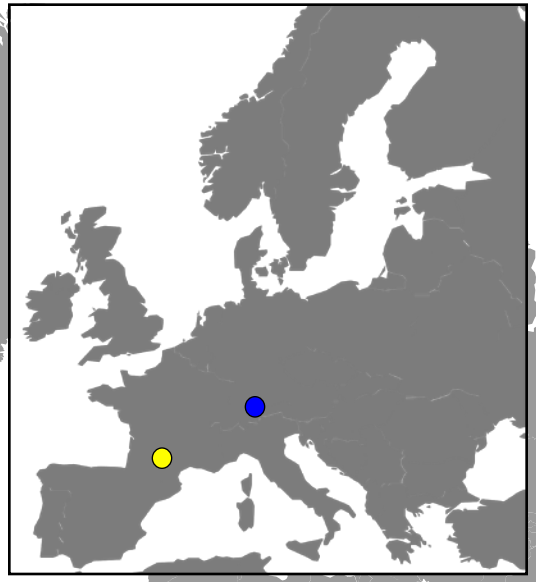
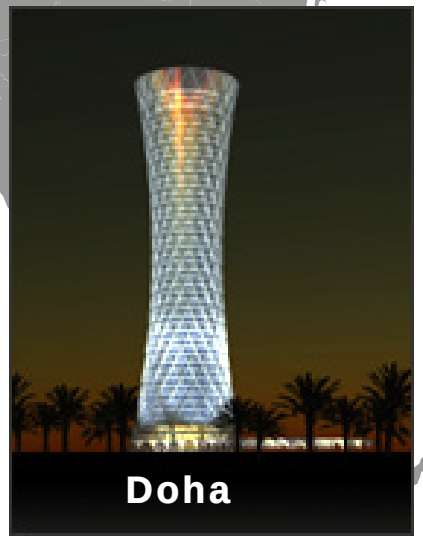
Green Labs Test Centre Network







Lab SOLAR

Lab ENVELOPE

Lab GREEN

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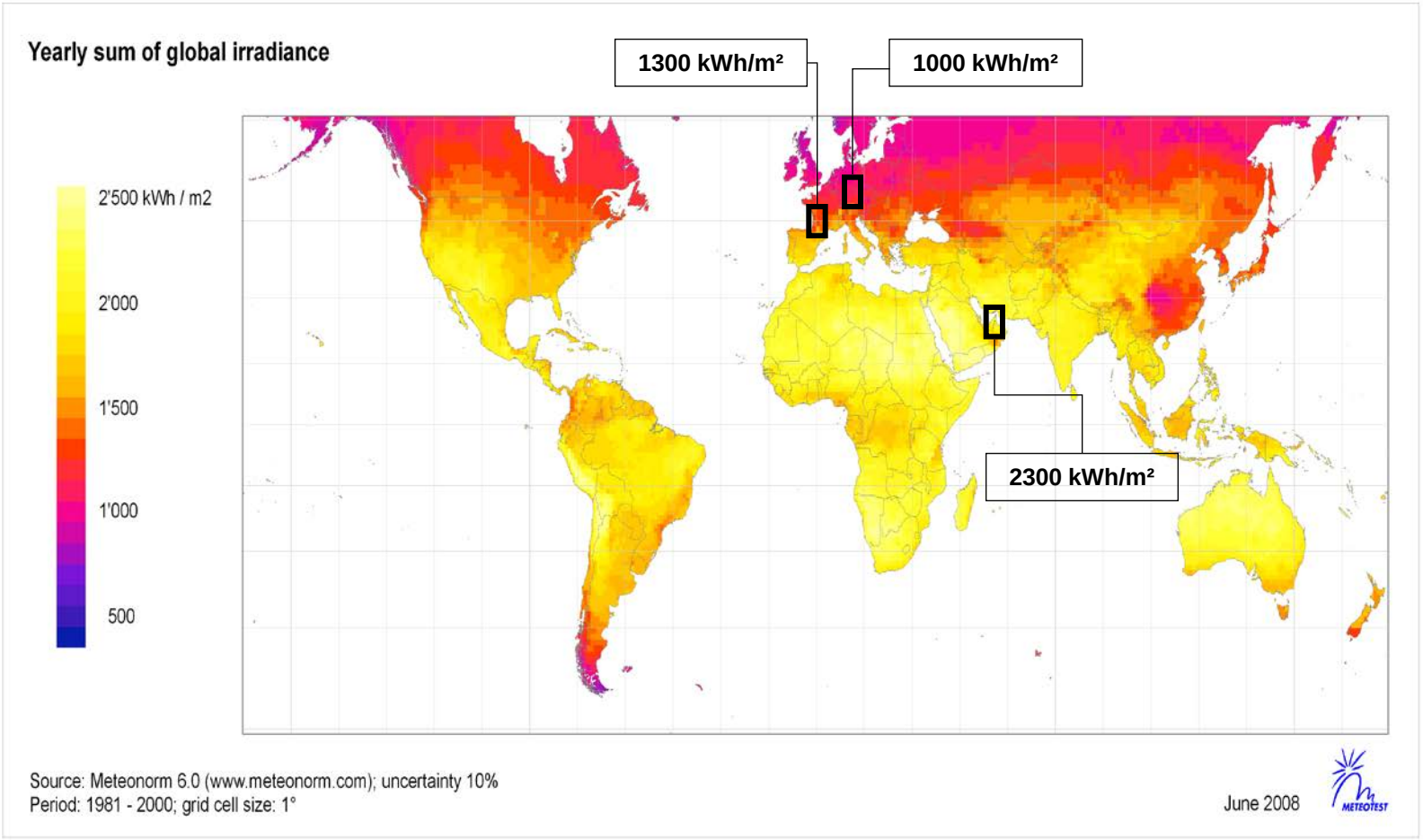
HBS Research Centres – Cross check the numerical Simulations



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Outdoor Test Facilities – e.g. Bellenberg

Comparison measurements between Reference (1) and Variations (2,3,4)

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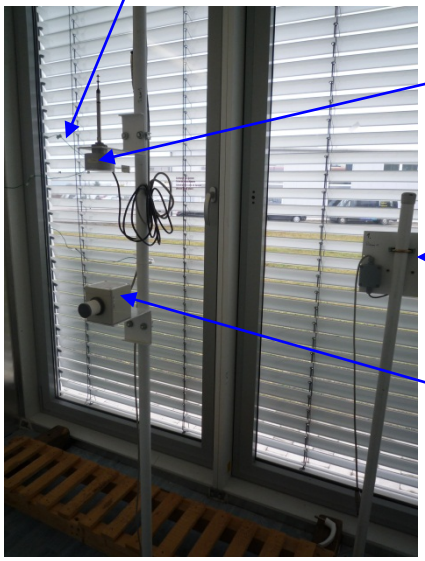
Sensor equipment



CO_2 - Injection

Room Temperatures

Surface Temperatures

Air Velocity

Solar Radiation

Gas Chromatograph

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InventSkin

ZEB Technology

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Overheating – challenging opportunities

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How to deal with overheating?

Endessa HQ, E-Madrid

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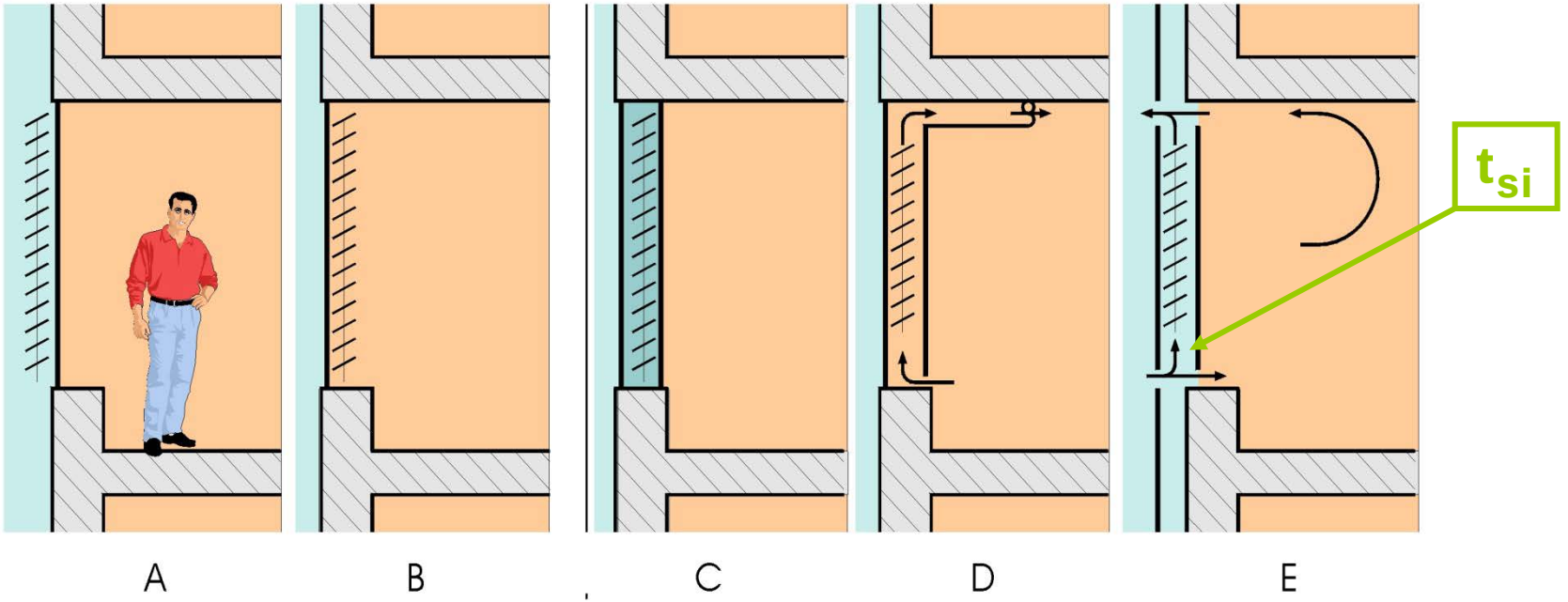
Sun Protection



A/B. Single Skin window and facades

C. Box and Coupled Windows

D. Exhaust air Window

E. Double Skin Facade

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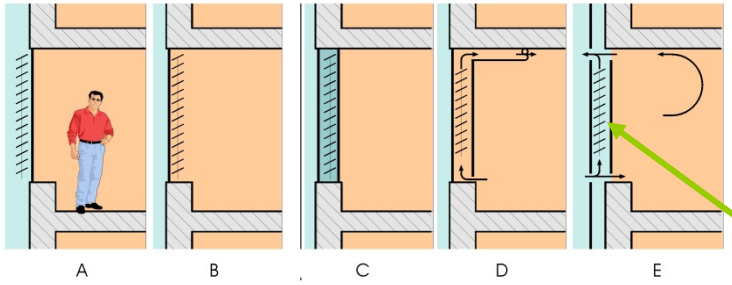
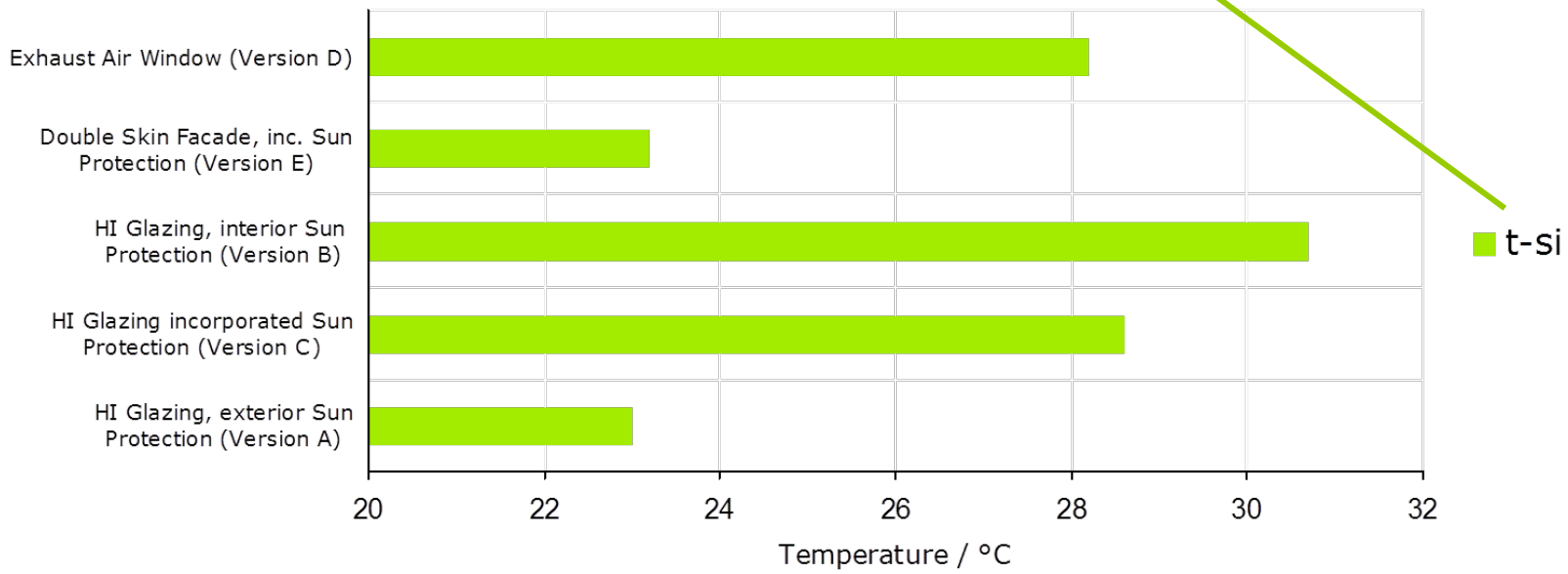
Sun protection

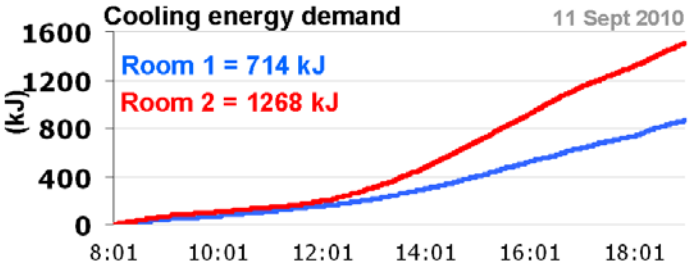
Results

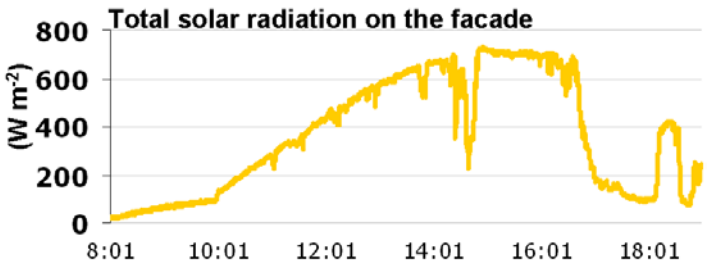




Sun protection

Up to 43 % cooling energy savings with Brise Soleil





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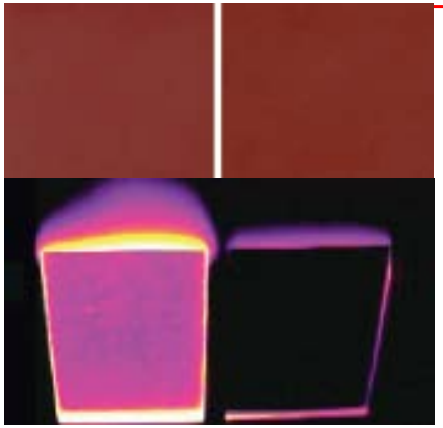
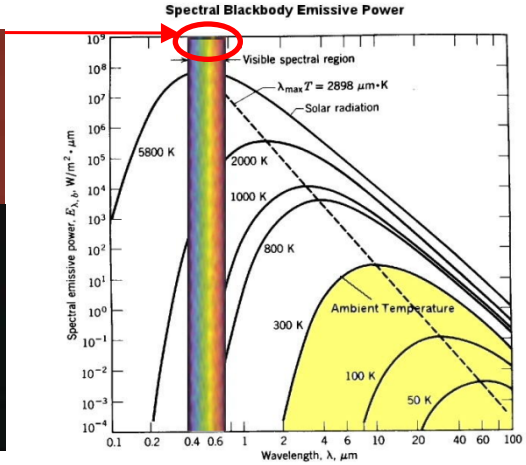
*Invent*Skin® – Hydro´s Powder Coatings

Hydro´s Low Absorption Coatings

- Reflect sunlight
- Reduce cooling energy demand by up to 30%





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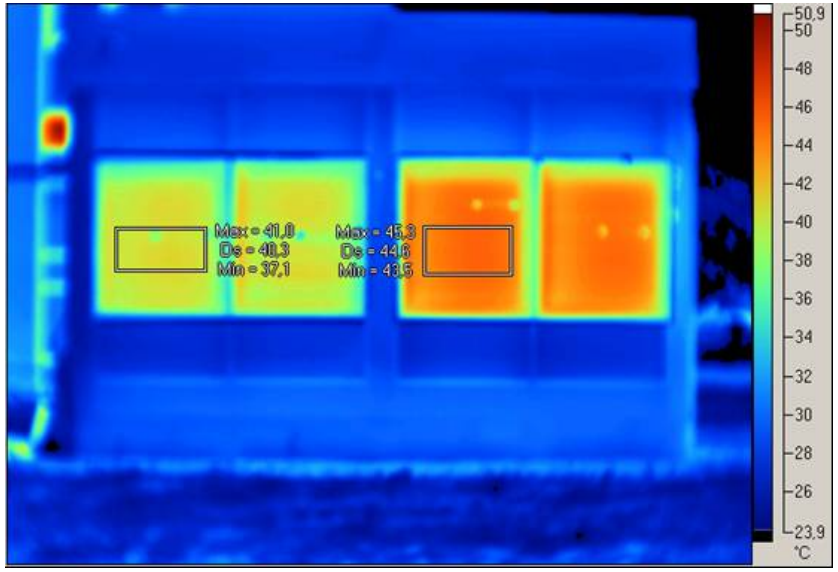
Sun protection

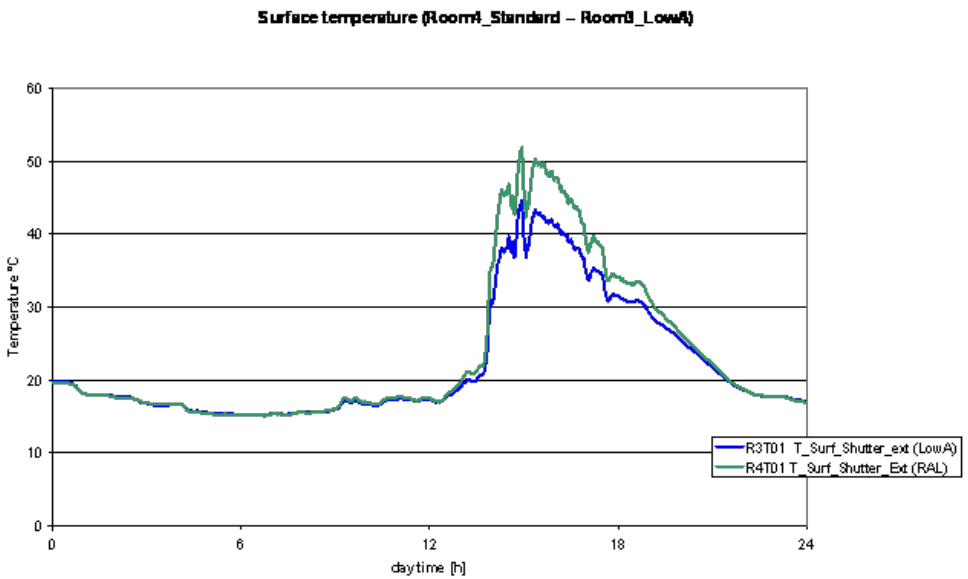
Measurement of HBS Low A Powder coatings



HYDRO

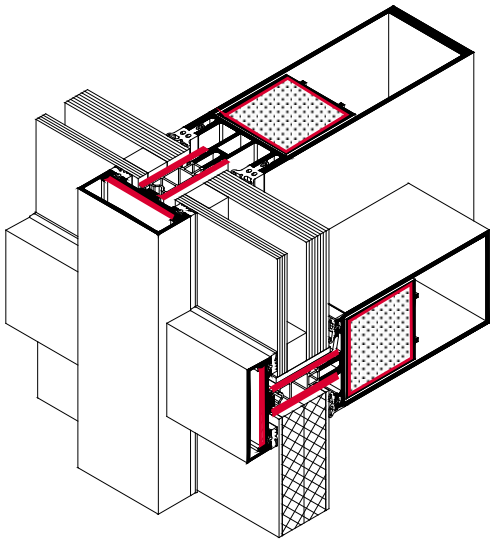
Sun protection

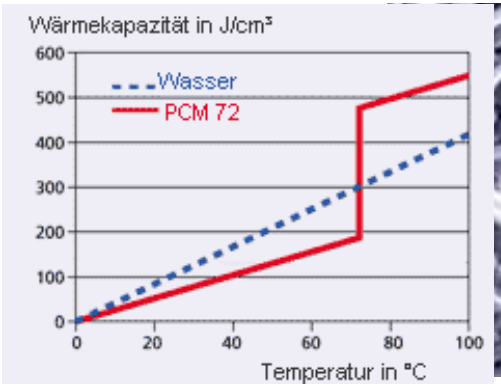
Measurement of HBS Low A Powder coatings

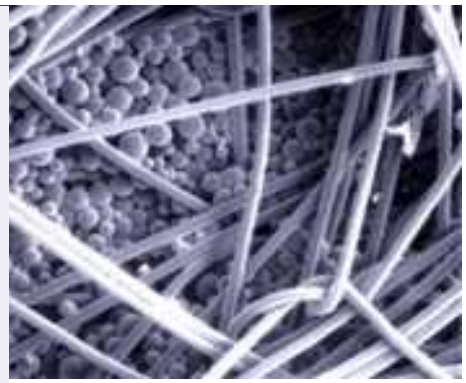


Energy Storage

Phase Change Material (PCM) in Curtain Wall







Application:

PCM in aluminium construction stores 3000 Wh thermal Energy or 300 W per 100 kg PCM.

A 3 m tall aluminium profile can host ~ 30 kg PCM.

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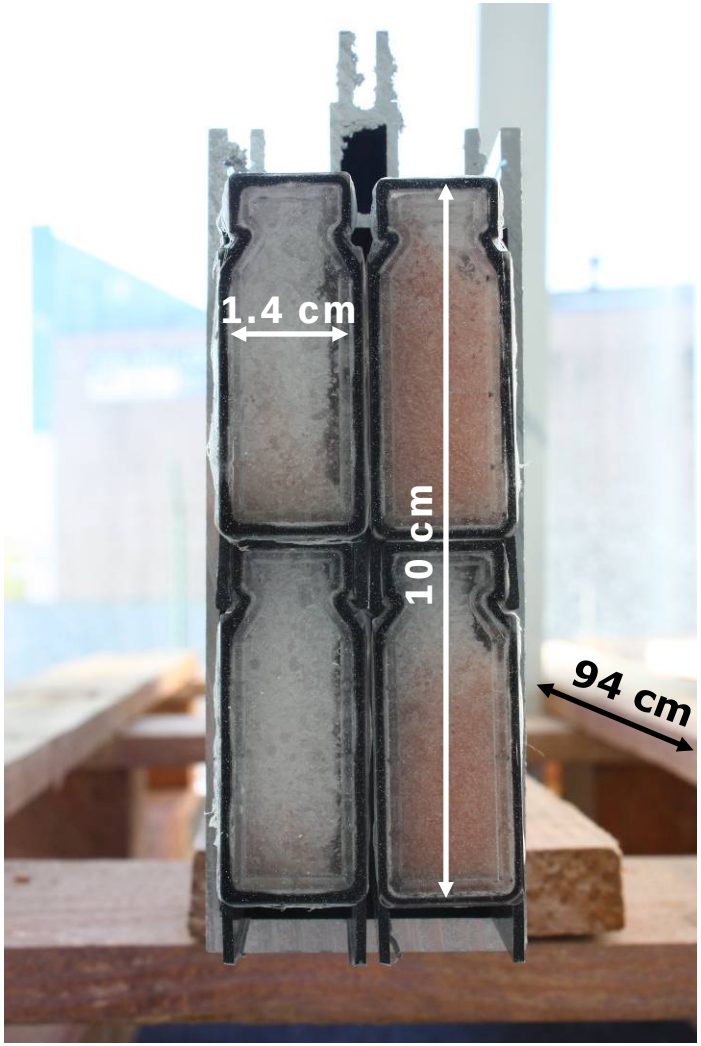
Energy Storage - Measurement



Theoretical (approximated)

Volume=1.4x2x10x94x8=21056 cm^3

Mass=21.056x**1.5**=31.58 kg

Latent heat of fusion=31.58x**158**=4990 kJ

Heat due to temperature increase=31.58x6.2x**2.7**=528 kJ

Total heating energy=5518 kJ

Measured

Total heating energy=**5718 kJ**

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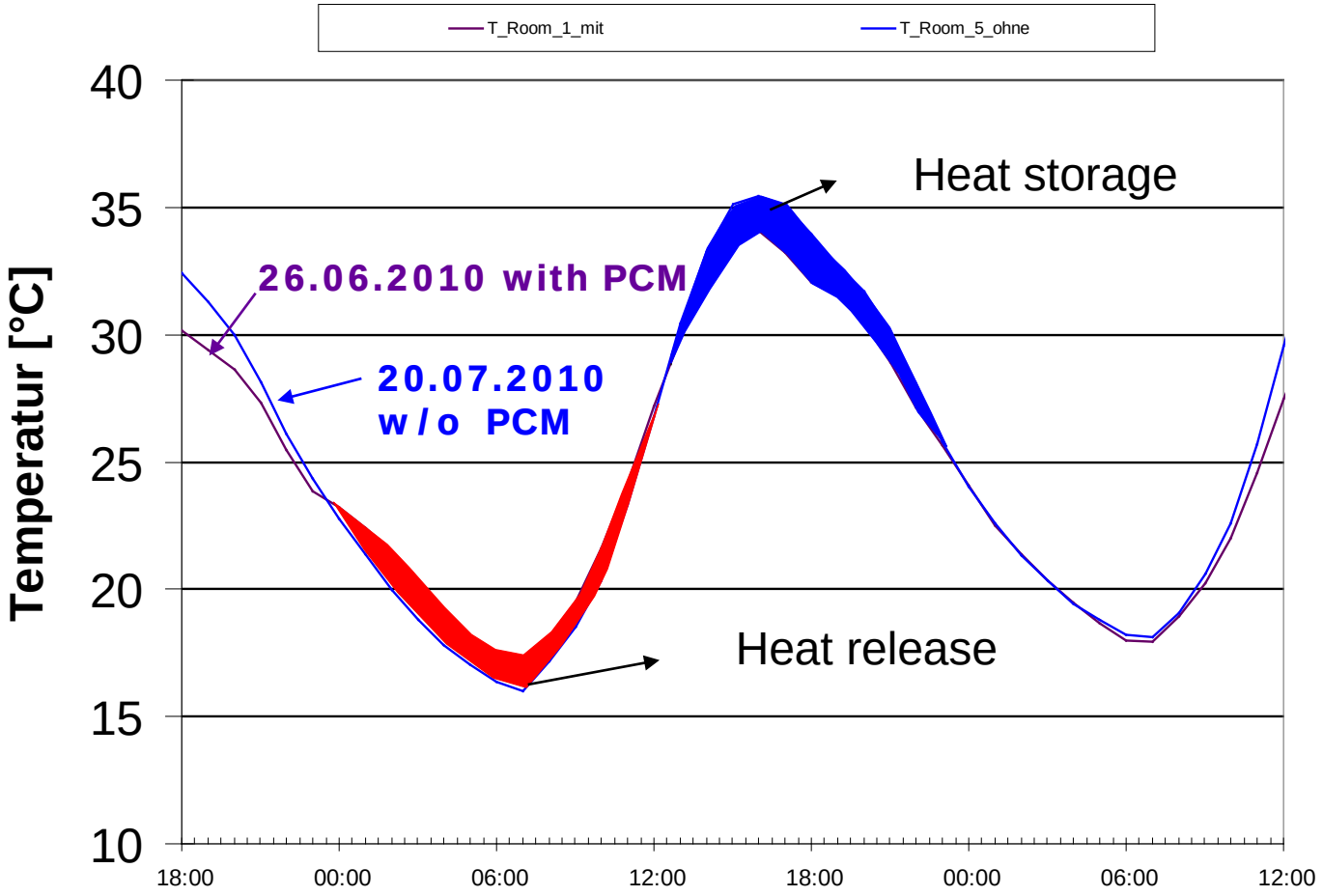
Energy Storage



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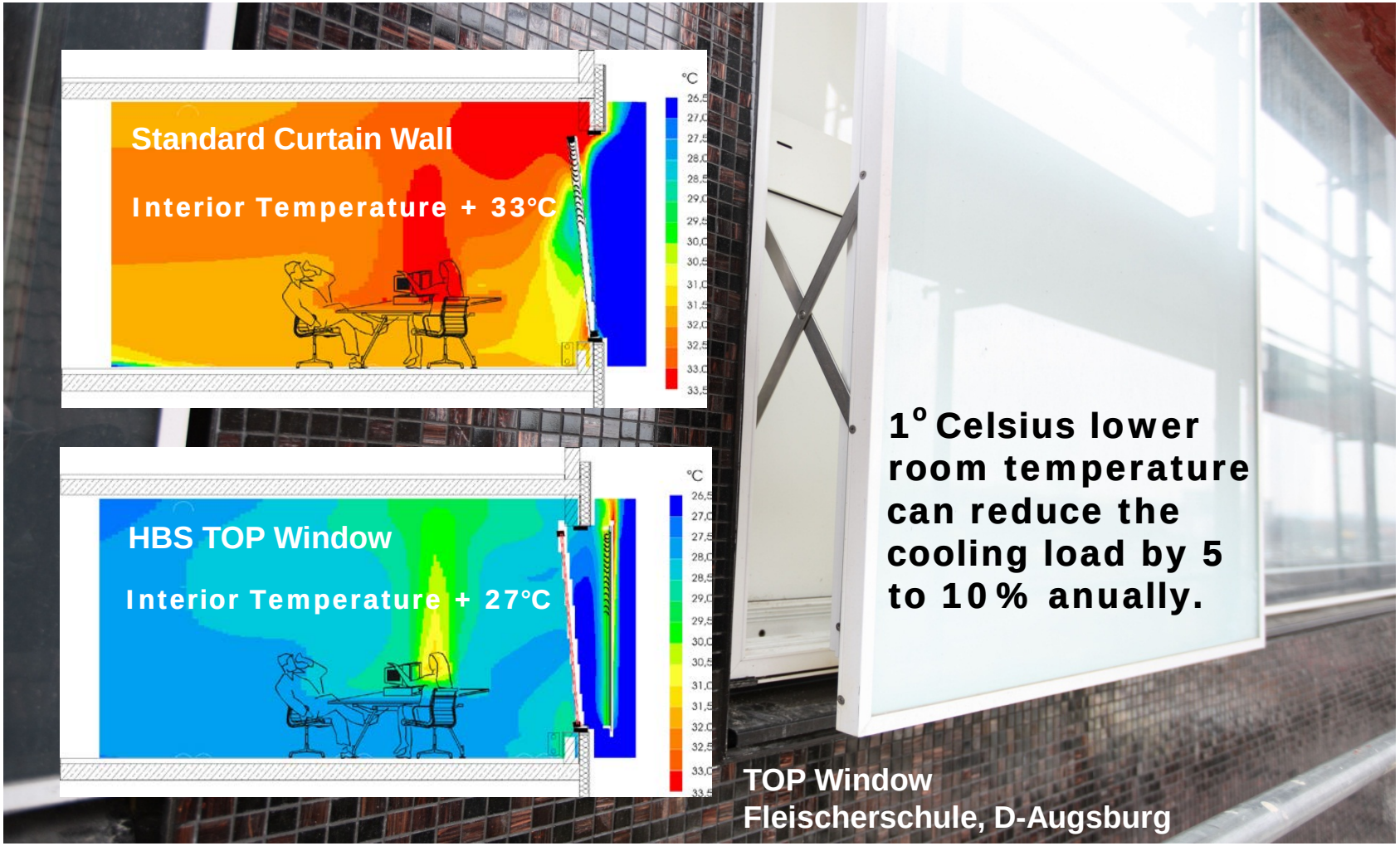
Breating Facade

Double Skin Solutions

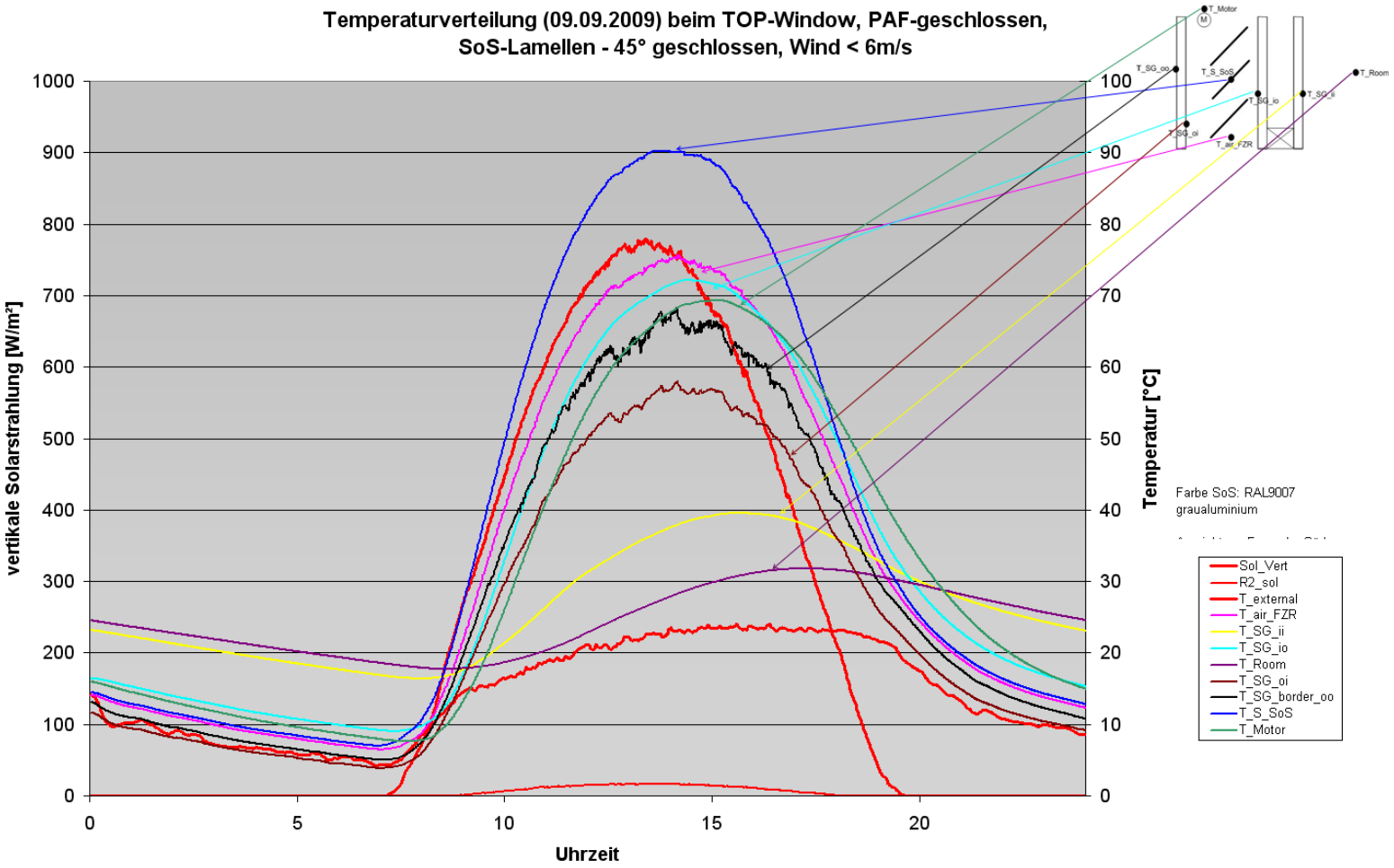
HYDRO

Impact of the Building Envelope – An Example



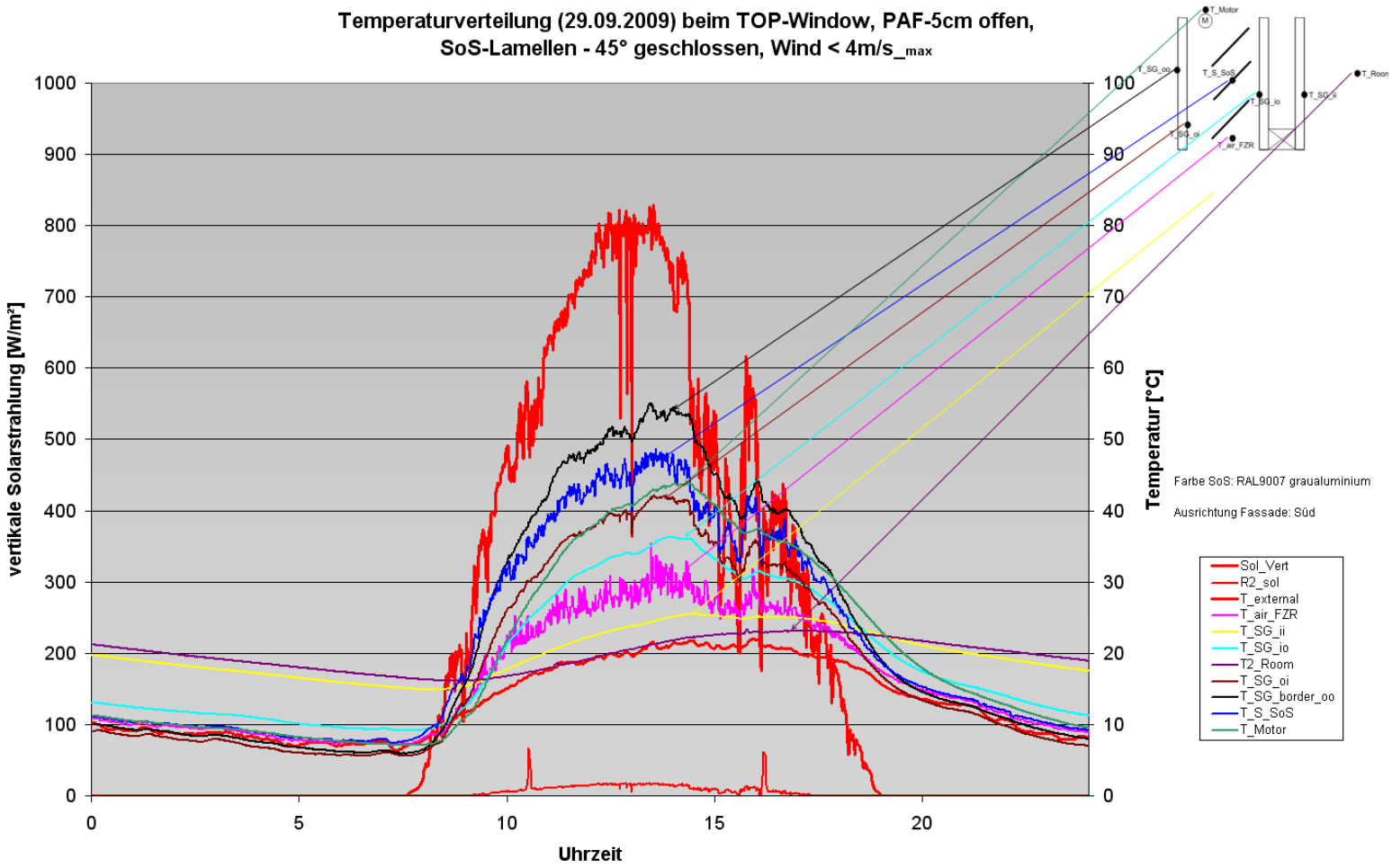
HYDRO

WICLINE 215



HYDRO

WICLINE 215


Temperaturverteilung (29.09.2009) beim TOP-Window, PAF-5cm offen,
SoS-Lamellen - 45° geschlossen, Wind < 4m/s_max
vertikale Solarstrahlung [W/m²]
Temperatur [°C]
Uhrzeit
Farbe SoS: RAL9007 graualuminium
Ausrichtung Fassade: Süd
Sol_Vert
R2_sol
T_external
T_air_FZR
T_SG_ii
T_SG_io
T2_Room
T_SG_oi
T_SG_border_oo
T_S_SoS
T_Motor

Impact of the Building Envelope – WICLINE 215

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Solar

Building Integration

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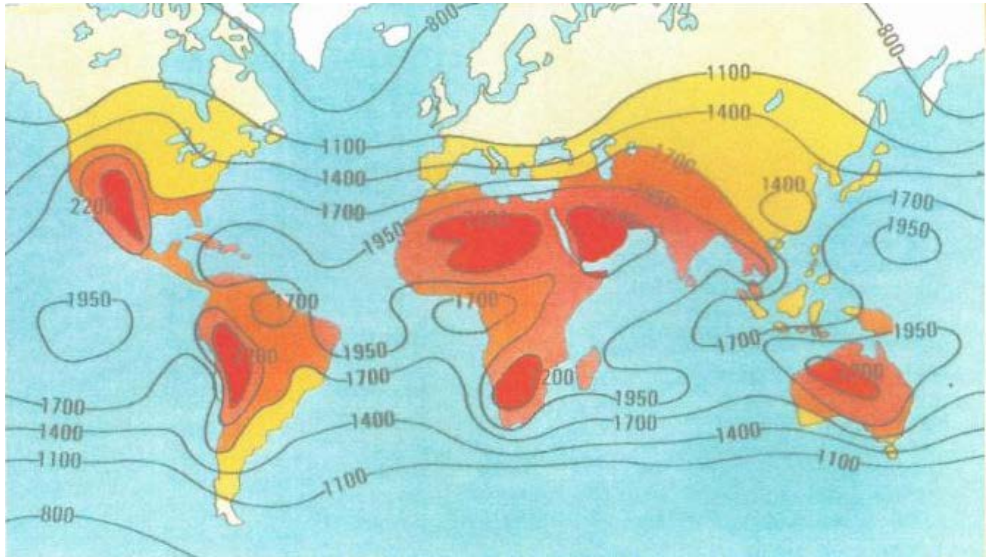
Possibilities for Solar Application

Solar Systems:

Annual Solar Energy
In kWh per year



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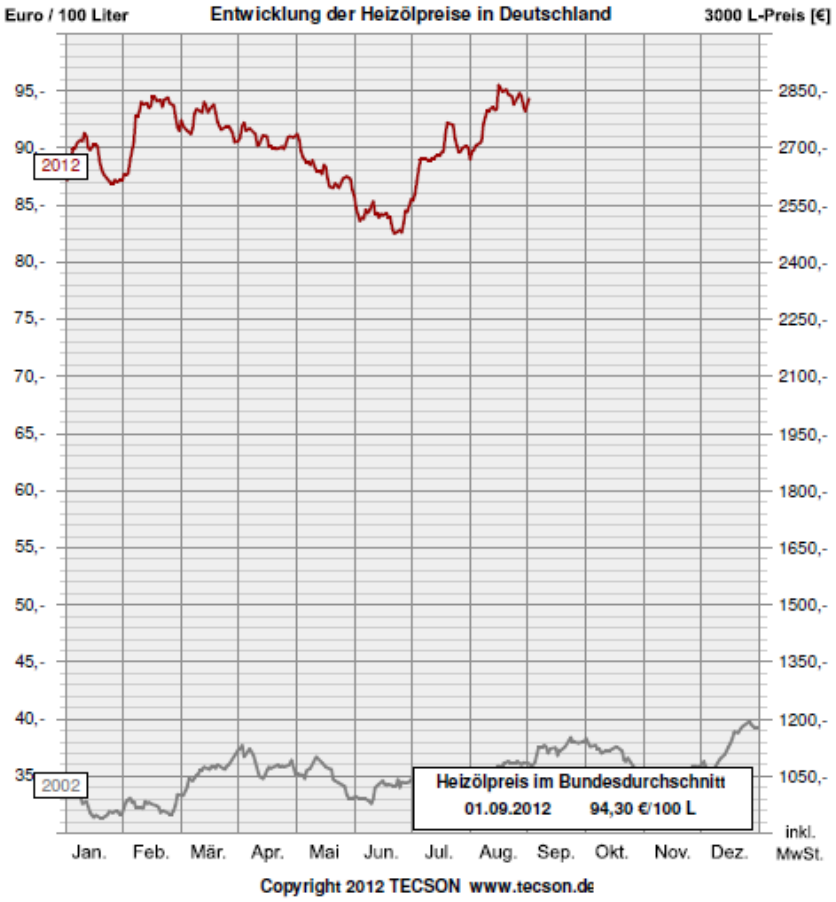
Heating Oil Price Development 2002/2012

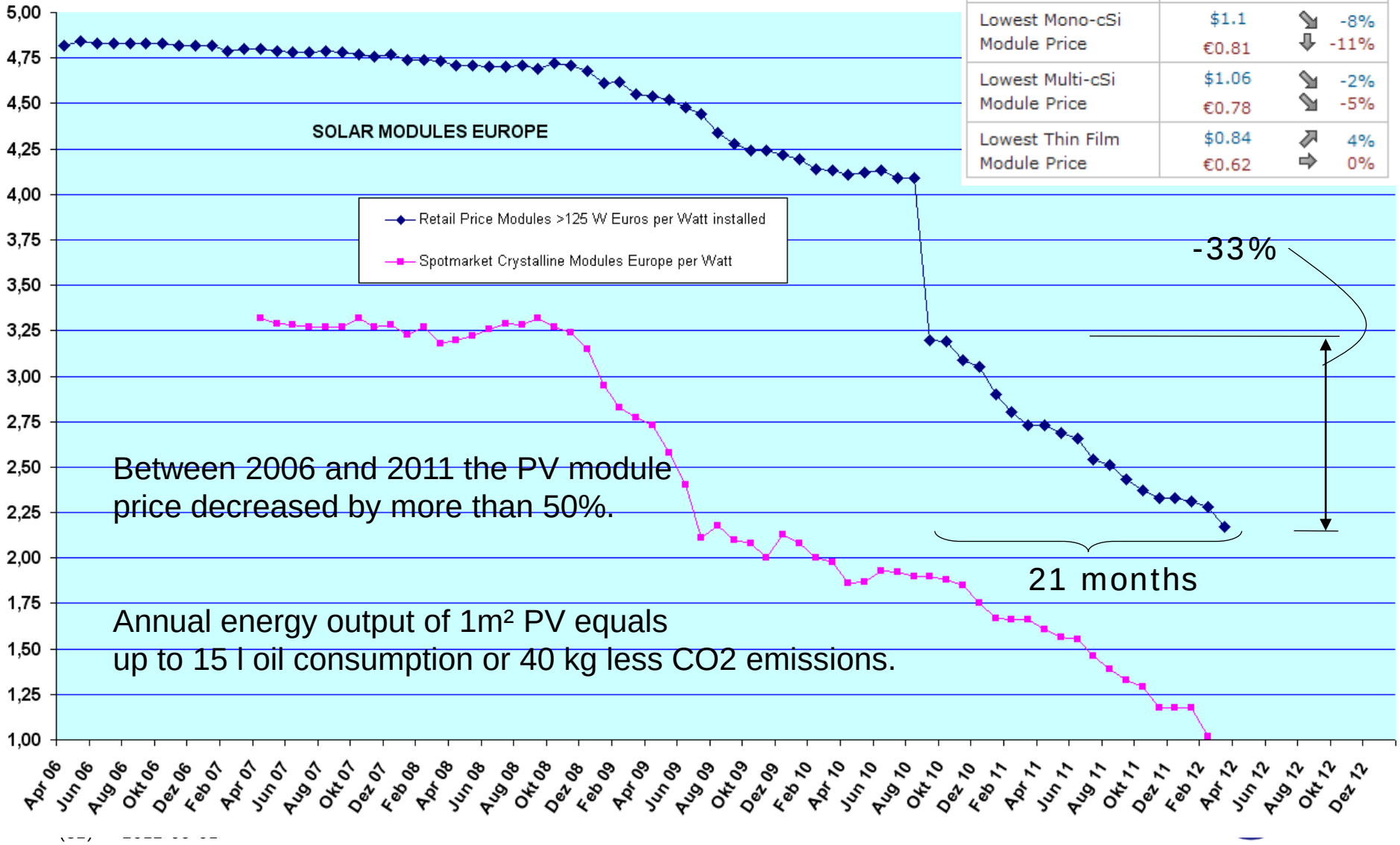
Between 2002 and 2012 the heating oil price increased by more than 200%.

1 Liter oil equals
~10 kWh energy
~ 2.64 kg CO_2 emissions



PV Module Price Development 2006-2012 YTD

Module Pricing Trends per Watt peak			
United States	$2.29	↘	0%
Europe	€2.17	↘	-5%
Number of Prices <$2.00 or €1.54/Wp	329 (34% of survey)	↗	9%
Lowest Mono-cSi Module Price	$1.1 €0.81	↘ ↓	-8% -11%
Lowest Multi-cSi Module Price	$1.06 €0.78	↘ ↘	-2% -5%
Lowest Thin Film Module Price	$0.84 €0.62	↗ →	4% 0%



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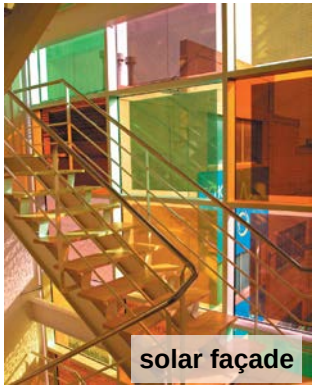
Photovoltaic Building Integration


solar façade


gard-corps


sun screen


skylight

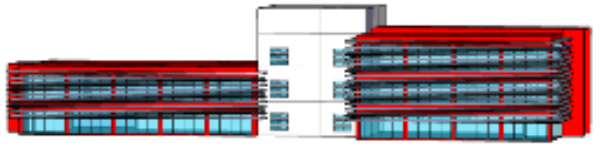

test field Barcelona

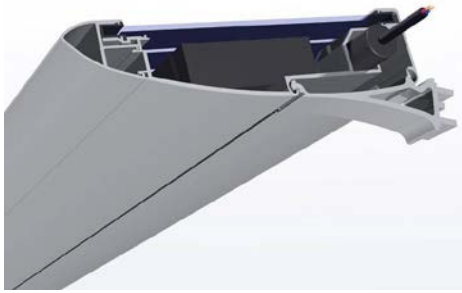

sun shadding

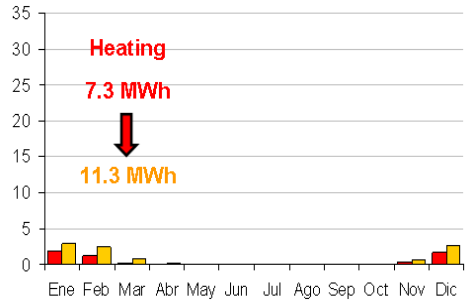

roof integration

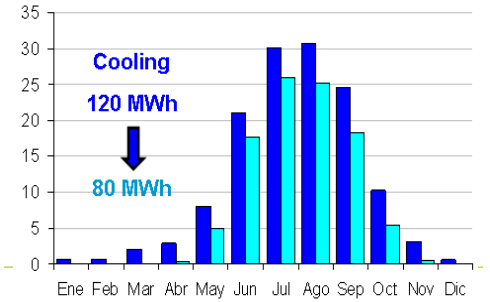
HYDRO

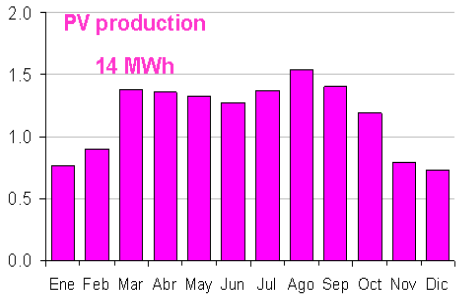
Photovoltaic Building Integration











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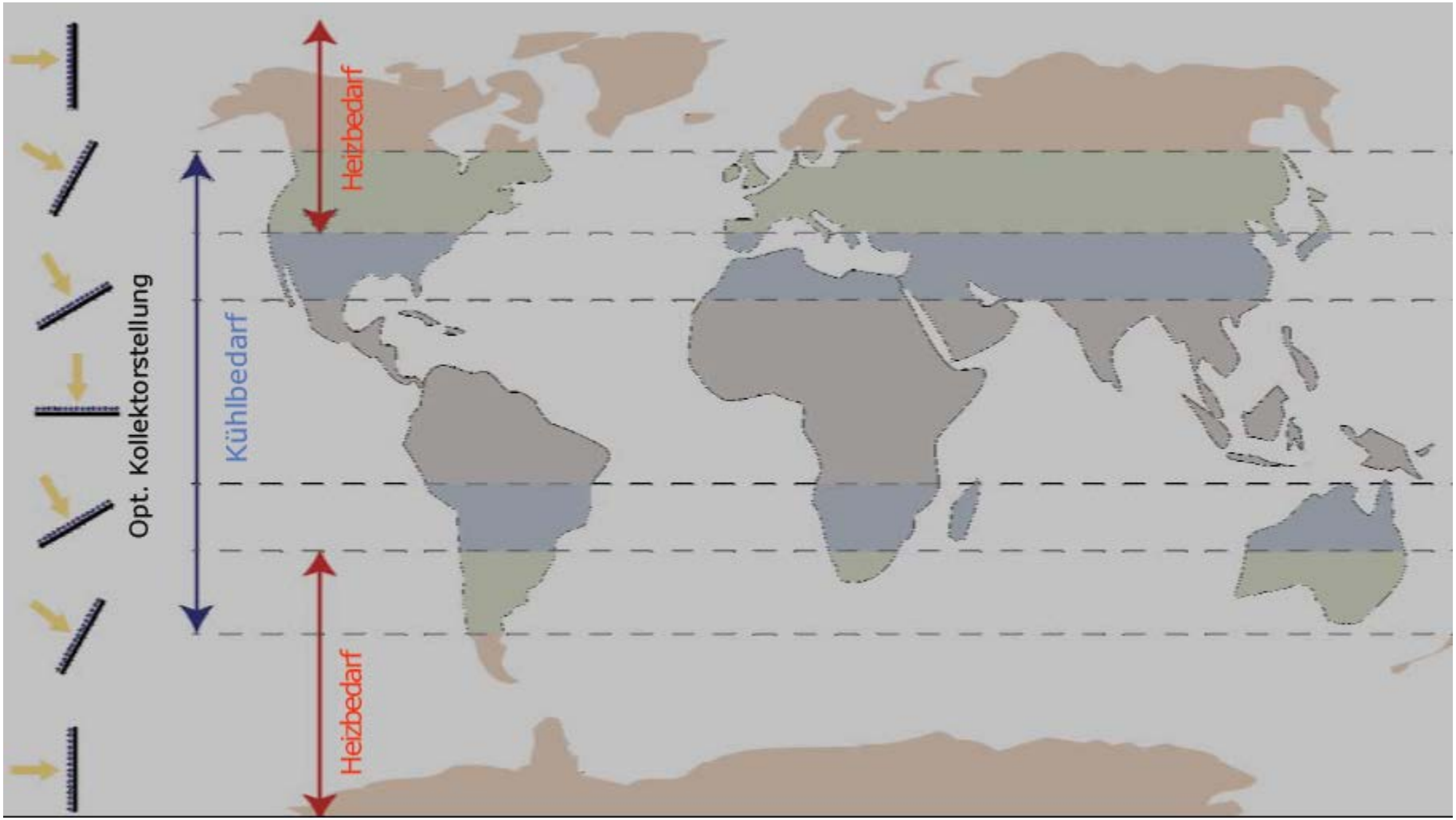
Solar Thermal Collector – Optimal Orientation



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Solar Thermal

WICTEC CPC

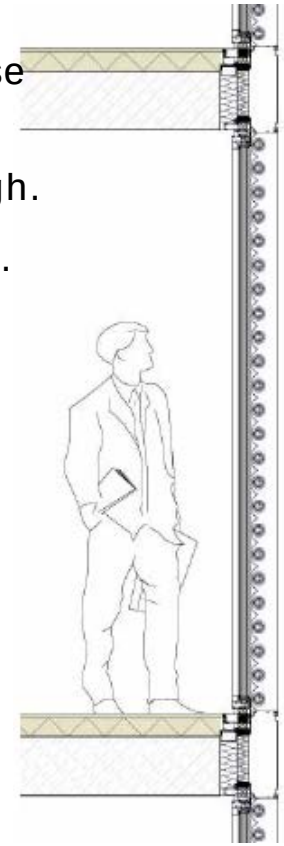
Design Principle:

Curtain wall collector integrated into a double skin solution

Combination with a back packed reflector to increase efficiency

Reflector is semit perfomated to enable view through.

Collector liquid of above +90°C enable solar cooling.



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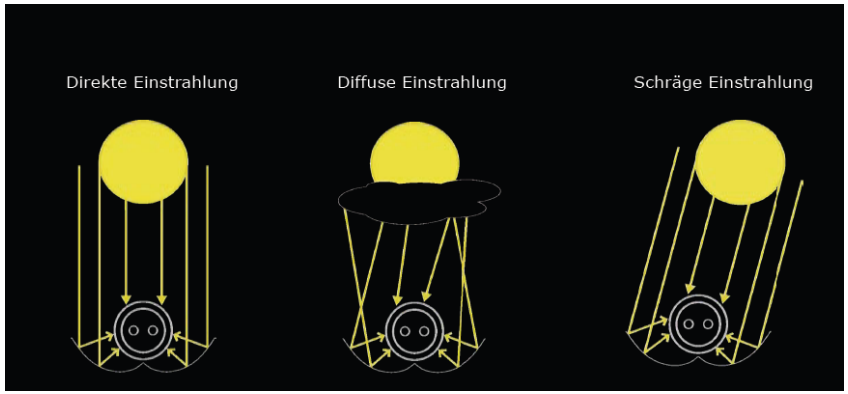
WICTEC CPC – Principle of Function

Measurment series made with CPC 12 OEM and OEM 21with reflection sheet and perforation Grades of none,19%, 30%, 38%, 51%

Collector with and without cover glazing

Energy Gain ~ 250 until 350 kWh/m²a at south elevation, 90° vertical installation and 19% perforation grade



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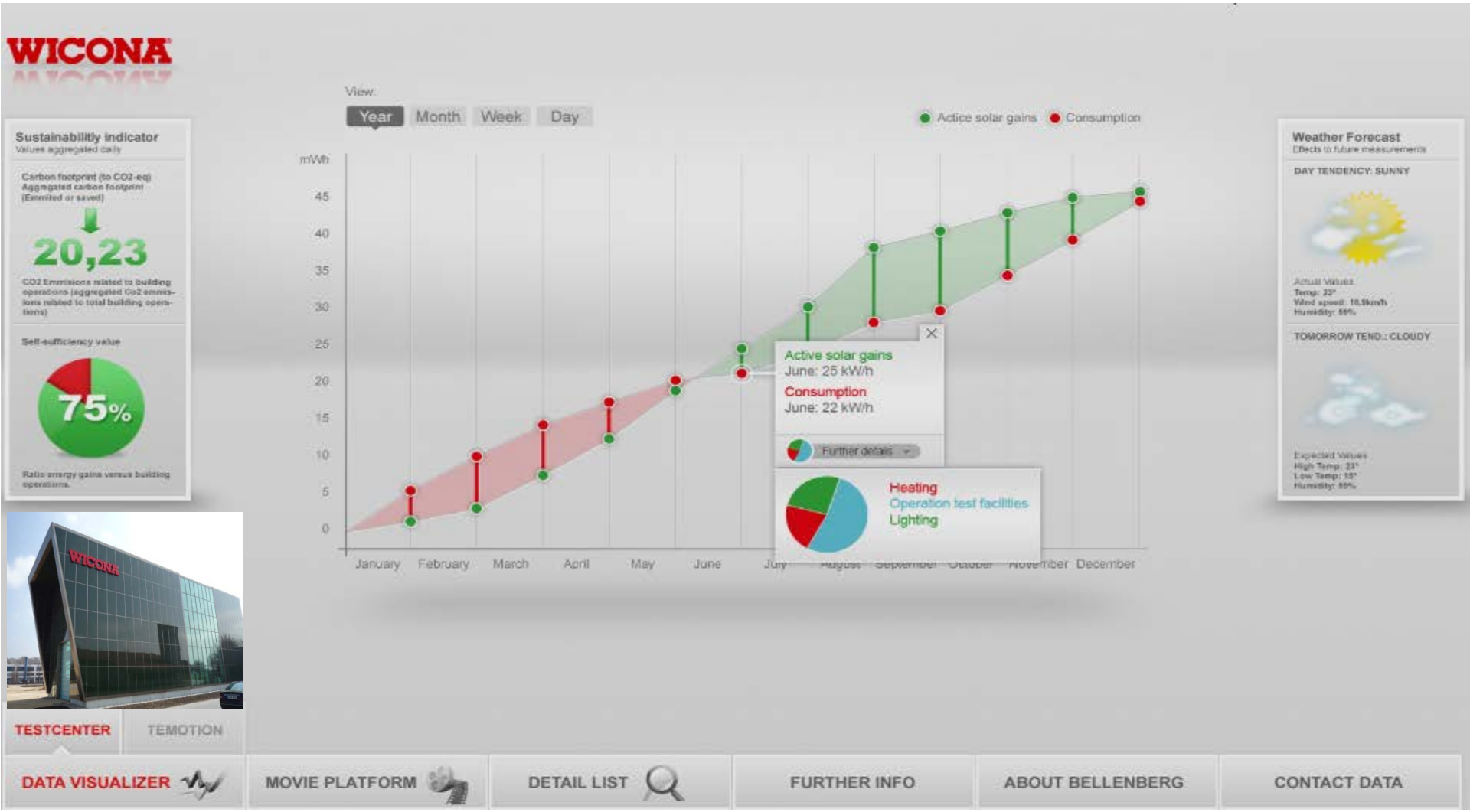
Energy + Building – Do it



www.zeb-bellenberg.com

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Future is ...

... Fushion of Construction and Transportation

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Future is „e“, „autarc“ and „lightweight“

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www.hydro.com