



FLUIDGLASS

Solar Thermal Glass Facades with Adjustable Transparency

3.11.2015

Positive Buildings for a Sustainable Future

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Resource Depletion and Global Warming

From Eco-efficiency to Eco-Effectiveness

Positive Buildings:

- Energy-Plus-Home E-Mobilie, Hallbergmoos
- Energy Efficiency Center, ZAE Bavaria, Würzburg



Buildings account for 1/3 of the global CO₂ emissions

Source: Building Research & Information, [Volume 35, Issue 4, 2007. Special Issue: Climate Change: National Building Stocks](#), mitigating CO₂ emissions from energy use in the world's buildings. Diana Ürge-Vorsatz, L. D. Danny Harvey, Sevastianos Mirasgedis & Mark D. Levine, pages 379-398. Published online: 08 Feb 2011.

A photograph of an industrial facility, likely a power plant or refinery, with several tall smokestacks. Thick, dark smoke is being emitted from the stacks, rising into a sky that is a vibrant, fiery orange and yellow, suggesting a sunset or sunrise. The industrial structures are silhouetted against the bright sky.

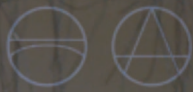
**60% of the world's
electricity needs are
related to the building
sector**

Source: World Energy Outlook 2009. International Energy Agency, Paris.

An aerial photograph of a city skyline, likely Los Angeles, featuring several prominent skyscrapers. The text is overlaid on the image in a large, bold, blue font.

The construction sector is responsible for around 1/3 of the world's resource consumption.

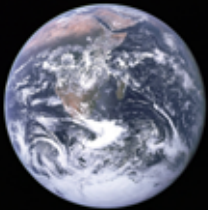
Source: http://www.unep.org/greeneconomy/Portals/88/documents/ger/9.0_Buildings.pdf, retrieved on 9.6.2014



**This includes around
12% of the global water
consumption and
approximately 40% of
the world's waste**

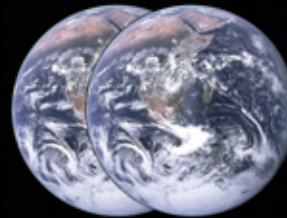
Source: http://www.unep.org/greeneconomy/Portals/68/documents/ger/9.0_Buildings.pdf, retrieved on 9.6.2014

Limits of global CO₂ emissions



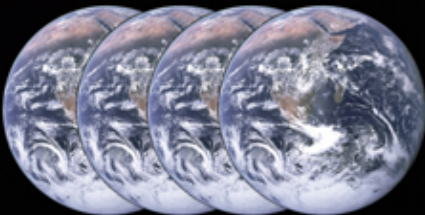
Limits

To keep global warming below 2°C it is required to limit the overall man-made emissions of CO₂ to 14,5 billion tons/year



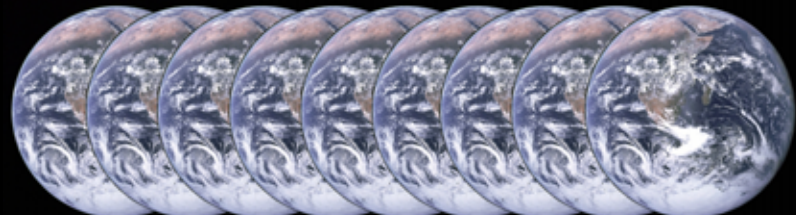
Global average

Currently, with 7 billion people living on this planet, man-made CO₂ emissions are above 30 billion tons/year. We would need **2 planets** to sustain our current life style.



Germany

If all people on this planet caused as much CO₂ emissions as the average German, we would **need 4 planets**

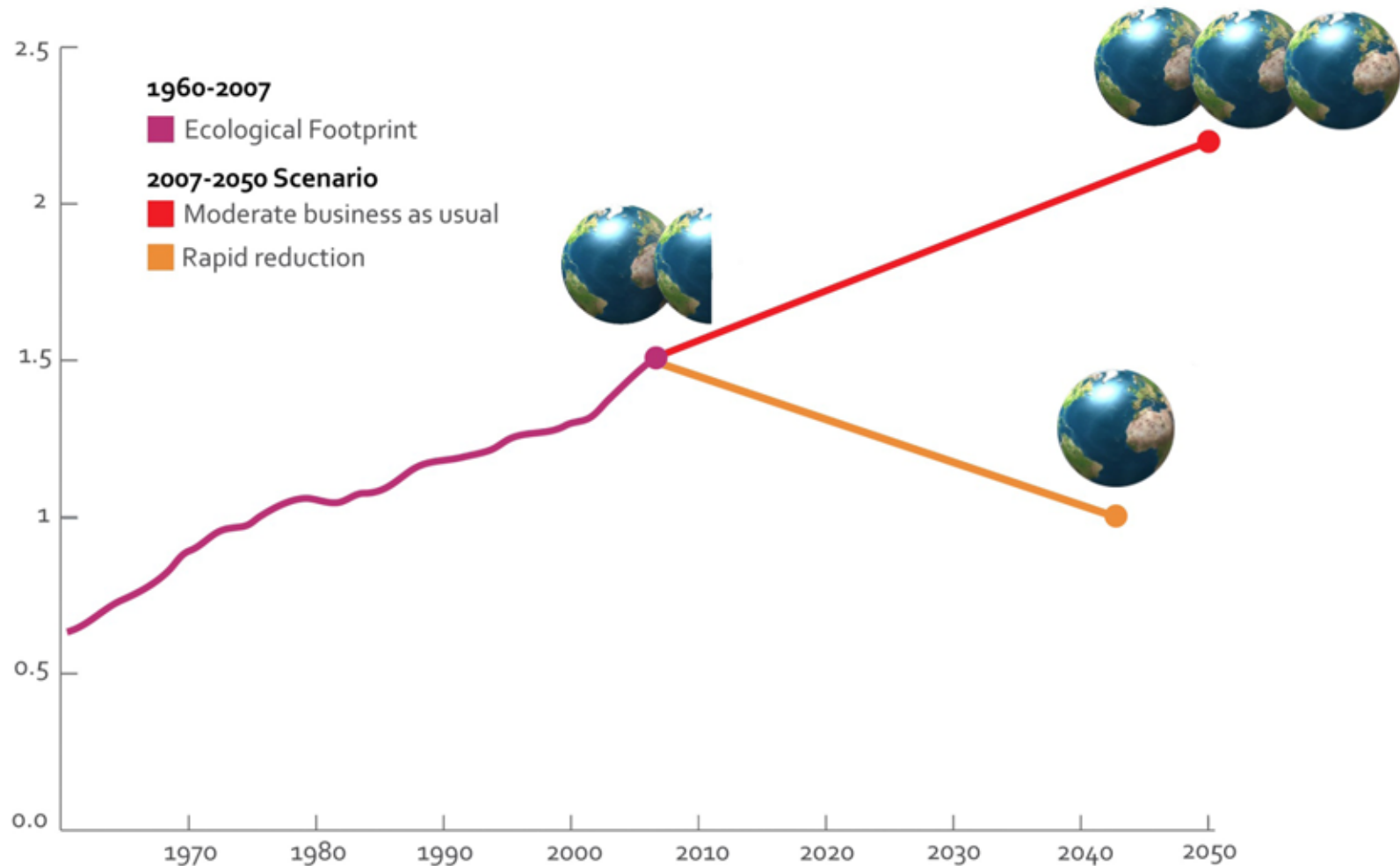


USA

... or even **9 planets**, if every inhabitant of this planet adopted the life-style of the average US American citizen

Source: <http://images.zeit.de/wissen/umwelt/2009-12/42-klima-infografik.pdf>

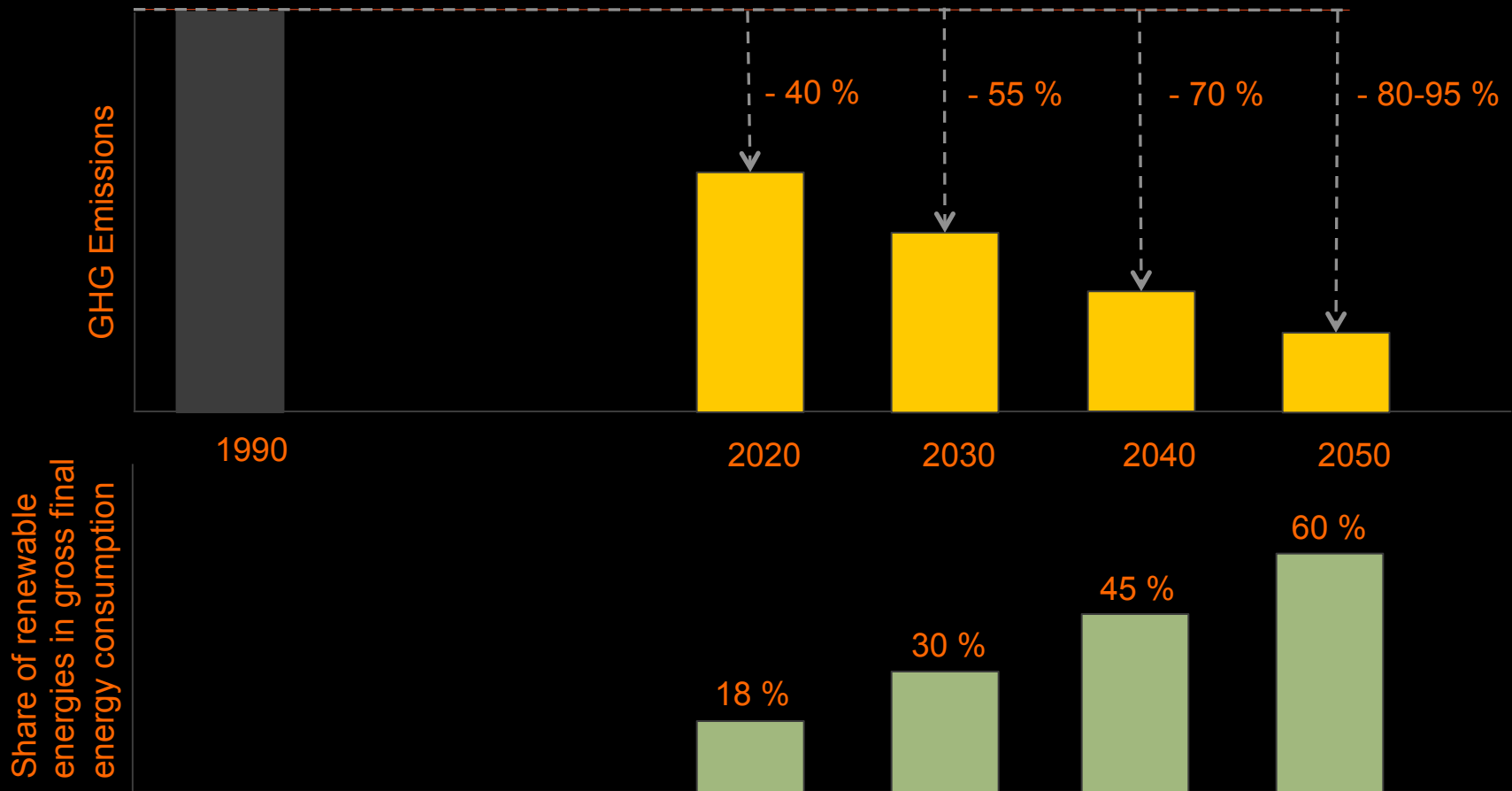
Sustainable Ecological Footprint



y-axis: number of planet earth, x-axis: years

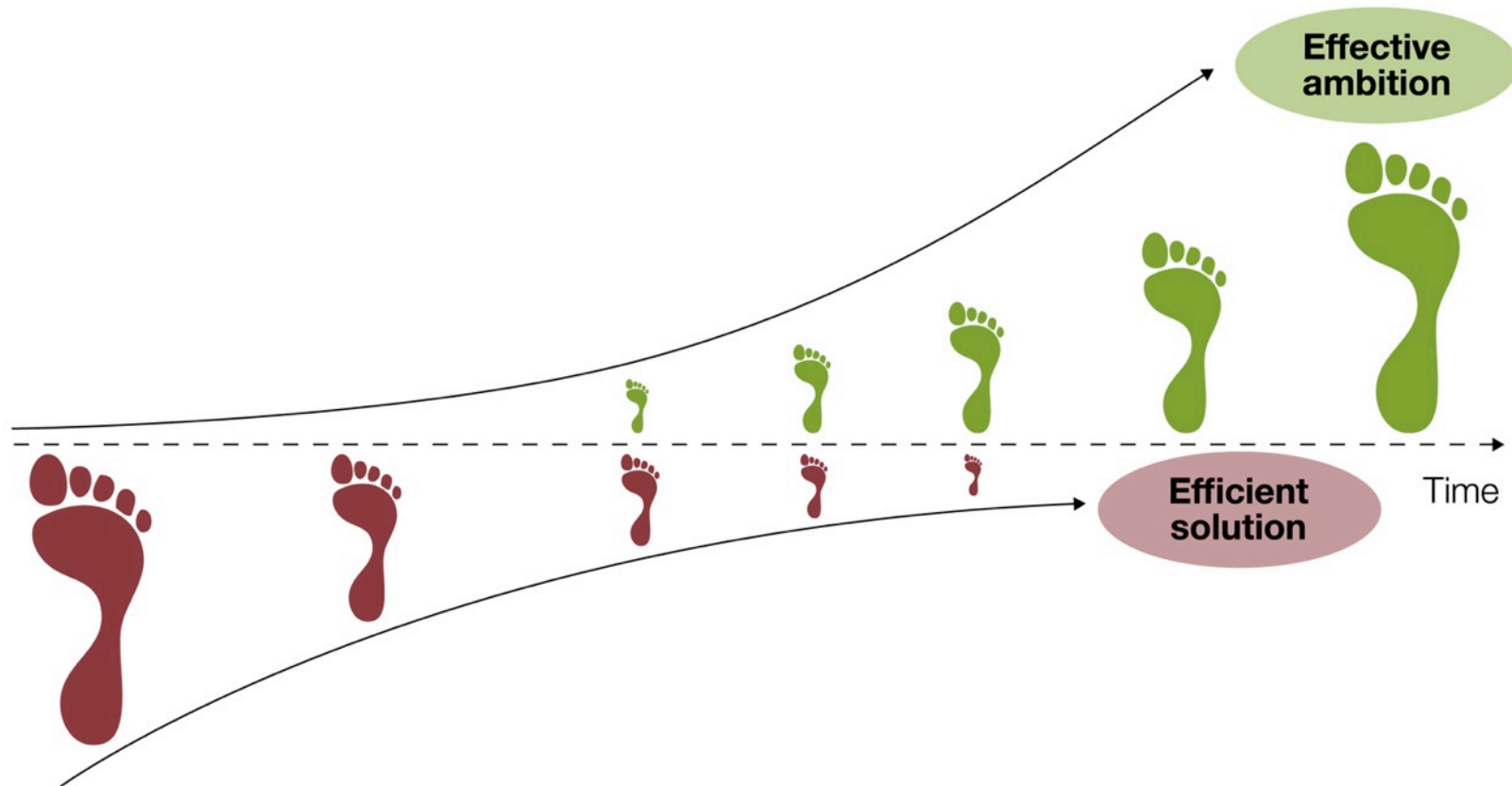
Quelle: www.footprintnetwork.org

Energy Concept of the German Government / European Directive 2012/27/EU



Source: Bundesministerium für Wirtschaft und Technologie, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit: Energiekonzept – für eine umweltschonende, zuverlässige und bezahlbare Energieversorgung. Berlin, 2010 and <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:FULL:EN:PDF>, retrieved on Sept. 7, 2013

Vision of a Positive Future: The transition from eco-efficiency to eco-effectiveness



Source: http://www.c2cn.eu/sites/default/files/C2C_PS_buildC2C_.pdf, retrieved on Sept.7, 2013



Vision of a Positive Future: Cradle to Cradle[®]

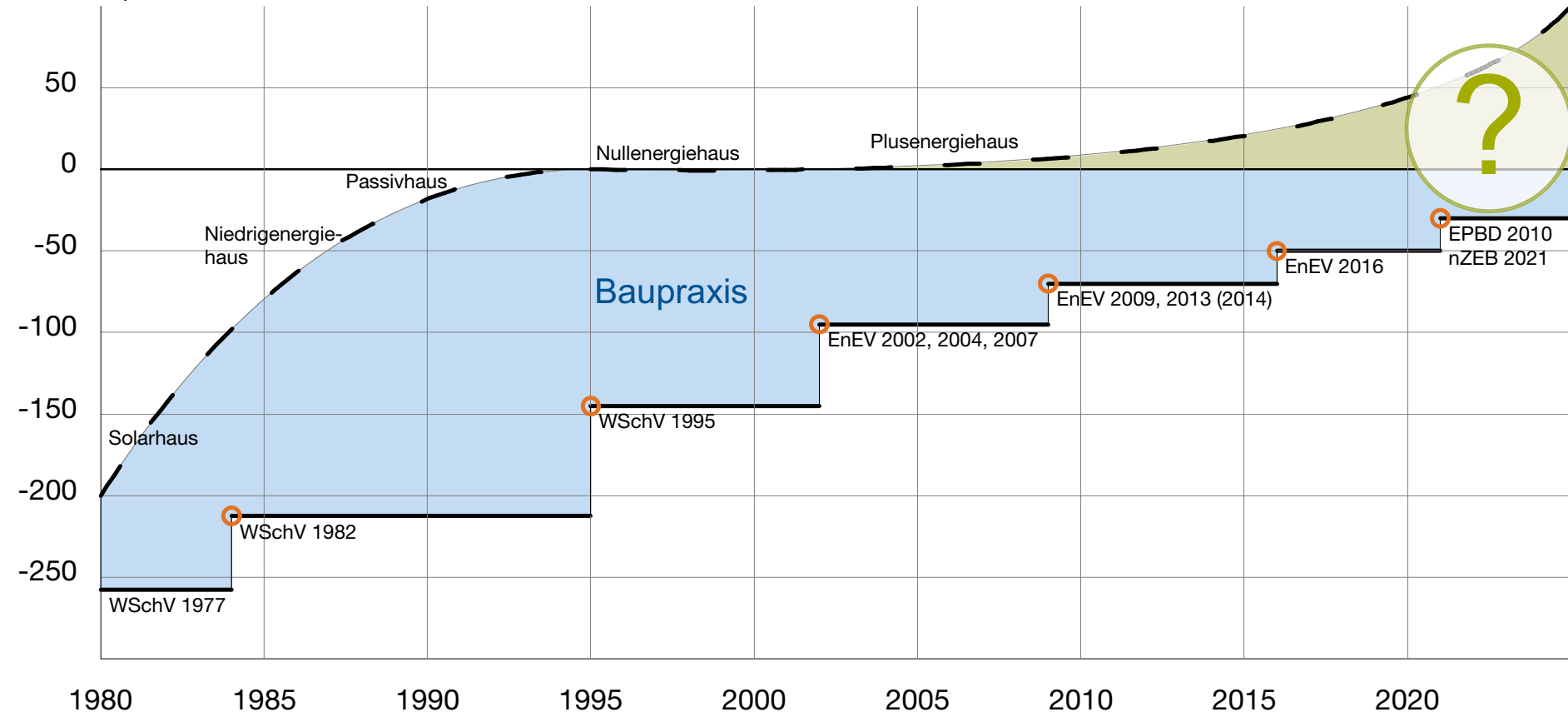
3 fundamental principles:

- Waste equals food
- Use current solar income
- Celebrate diversity

Source: <http://epea-hamburg.org/en/content/principles-and-implementation>, retrieved on Sept.7, 2013

Development of the energy demand of an average semi-detached home

Q_p (kWh/m²a)



Quelle: Fraunhofer IBP

Darstellung & Ergänzung: Michael Keltsch

EPBD: Energy Performance of Buildings Directive

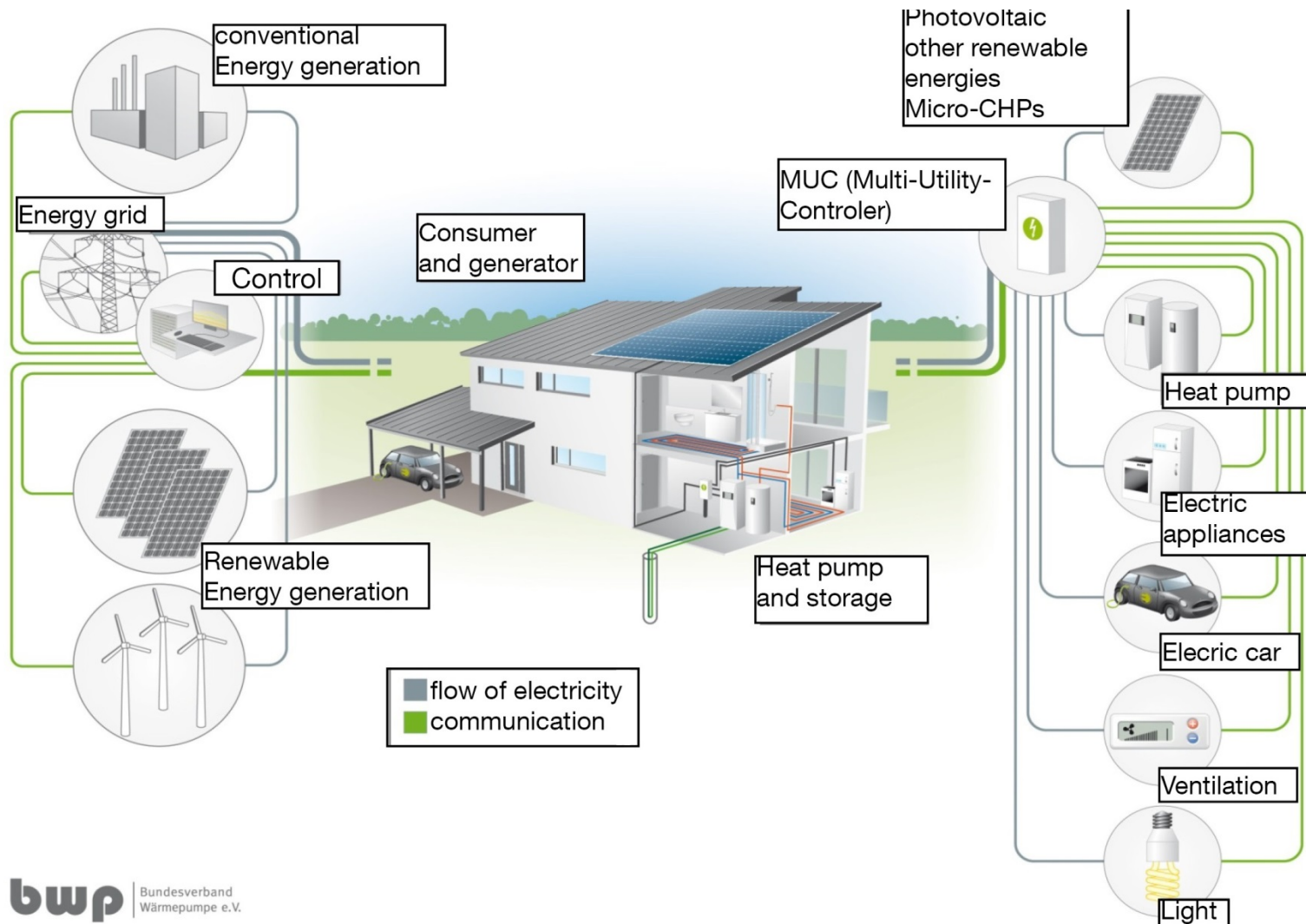
Positive Buildings:

Energy-Plus-Home:

E-Mobilie - Energy self-sufficient
electromobility in the Smart-Micro-Grid

Project partners: BMW AG, SMA Solar Technology AG TUM, Dynahaus GmbH

Energy management system / Smart-Micro-Grid

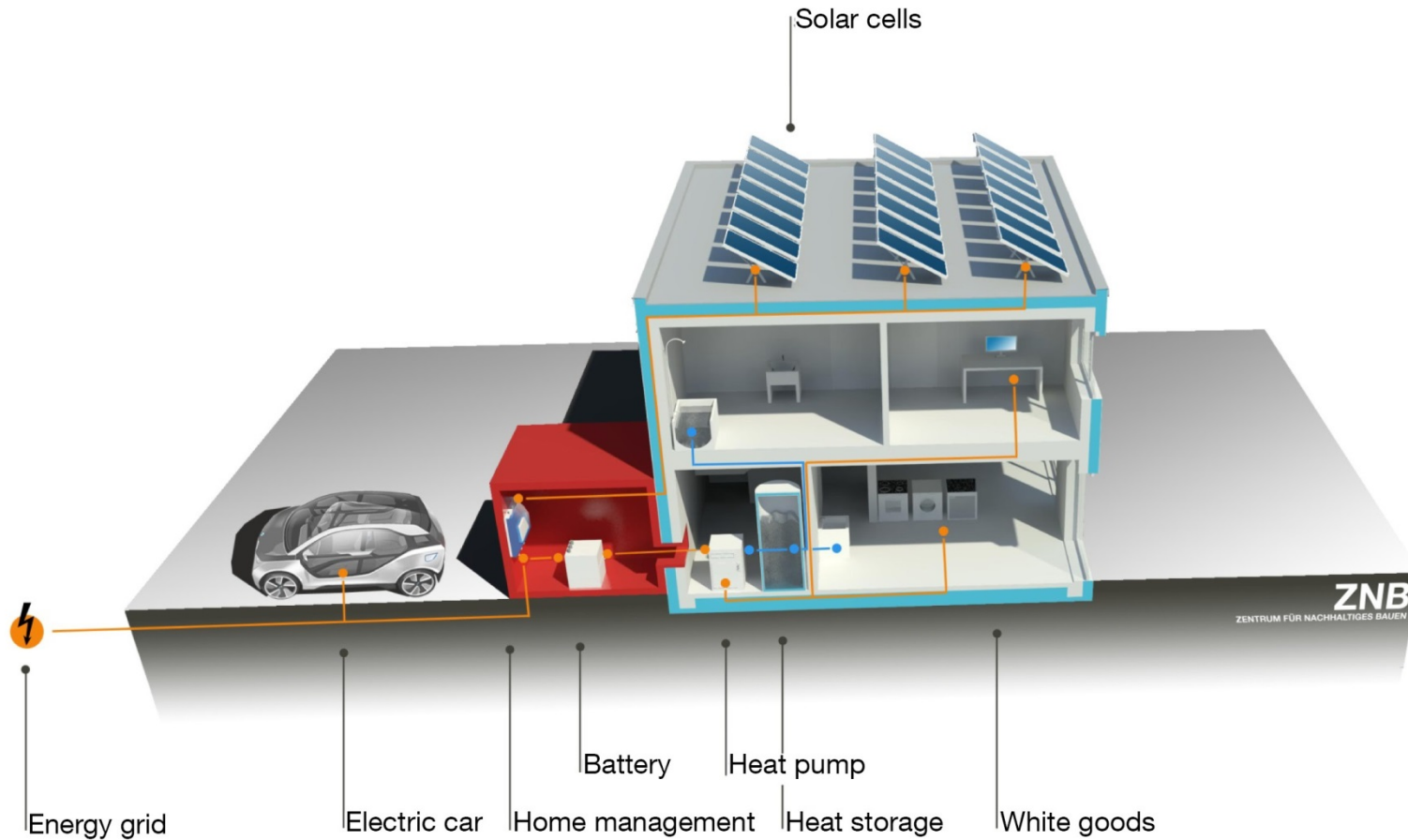




Plus energy house in Hallbergmoos

Completion: Dec. 2014





PV unit

PV unit with approx. 8 kWp

High efficient and smart inverter
(company: SMA)

Two options for PV:

- East-west orientation for high personal energy usage without energy storage
- South orientation for maximum PV-Input (if electrical energy storage existing)



Bildquelle: SMA AG

Heat pump

Stiebel Eltron WPL15

Ability to communicate for the use of Demand-Side-Management

COP: 3,89

Adjustment of the heating power to the caloric requirement of the building

Flow temperature: $\sim 35\text{ }^{\circ}\text{C}$

Control strategies for optimal planning of the heat-pump are currently in development



Bildquelle: Stiebel Eltron

Storage at the Dynahaus

- PCM-Storage (48 kWh thermal)
- High thermal mass of the building
- Electrical storage (~10 kWh electric)
- Electric car (~32 kWh electric)

Possibility of using only the thermal mass and storage during 5 days of working week
No heating requirement from Monday to Friday

Surplus PV-energy can be stored in the thermal storage
Heating in winter and hot-water generation in summer

High financial benefit for the inhabitants

Battery storage

Communication via SMA Sunny Island 6.0H

AC-Power maximal: 6000 W

AC-Power permanent: 3700 W

Level of efficiency: 95%

Sony Li-Ion Battery Storage

Capacity: 9,6 kWh

Durability: > 10 Years (declared by manufacturer)

Charging- and discharging-strategies are in development



Bildquelle: SMA AG

Electric car with Wallbox

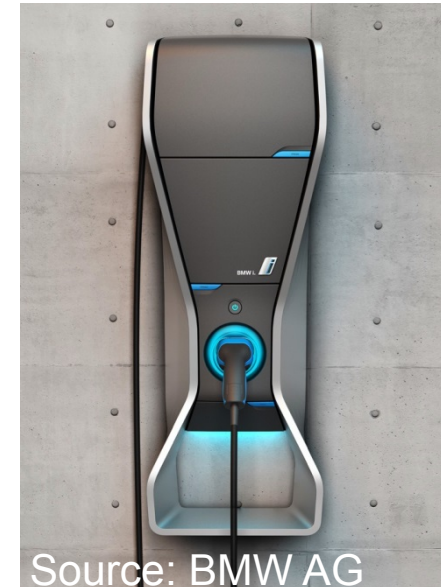
BMW ActiveE

Battery capacity: 32 kWh

Range: 160 km

Active communication between Wallbox and energy management for optimal including of the car charging

Including and preconditioning of the car



Source: BMW AG



Source: BMW AG





Energy Efficiency Center Center for Applied Energy Research, ZAE Bavaria, Würzburg

Building level

Energy Efficiency Center
Of the Bavarian center for Applied Energy Research in Würzburg

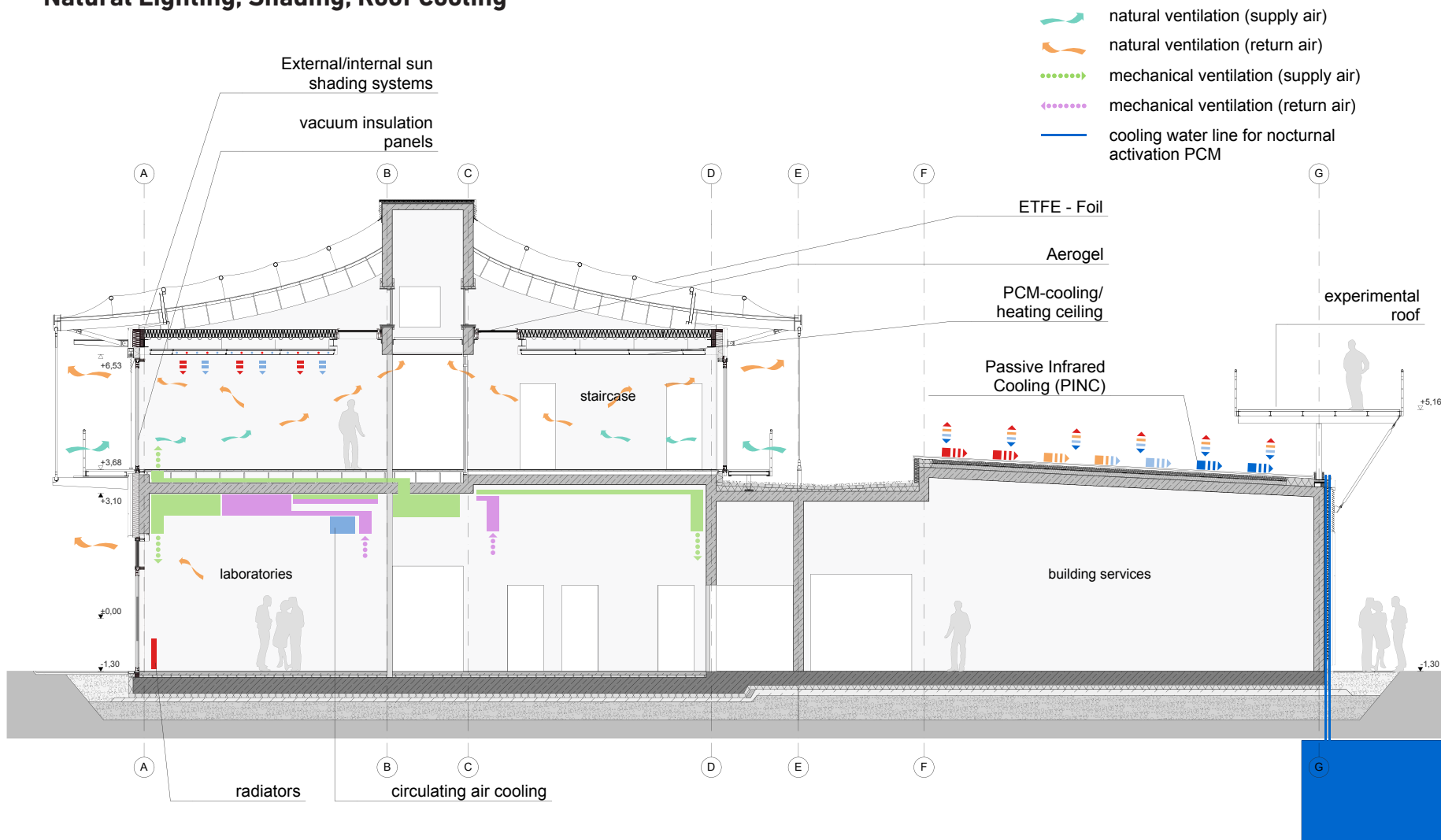
Lightweight building envelopes for smart buildings and technologies



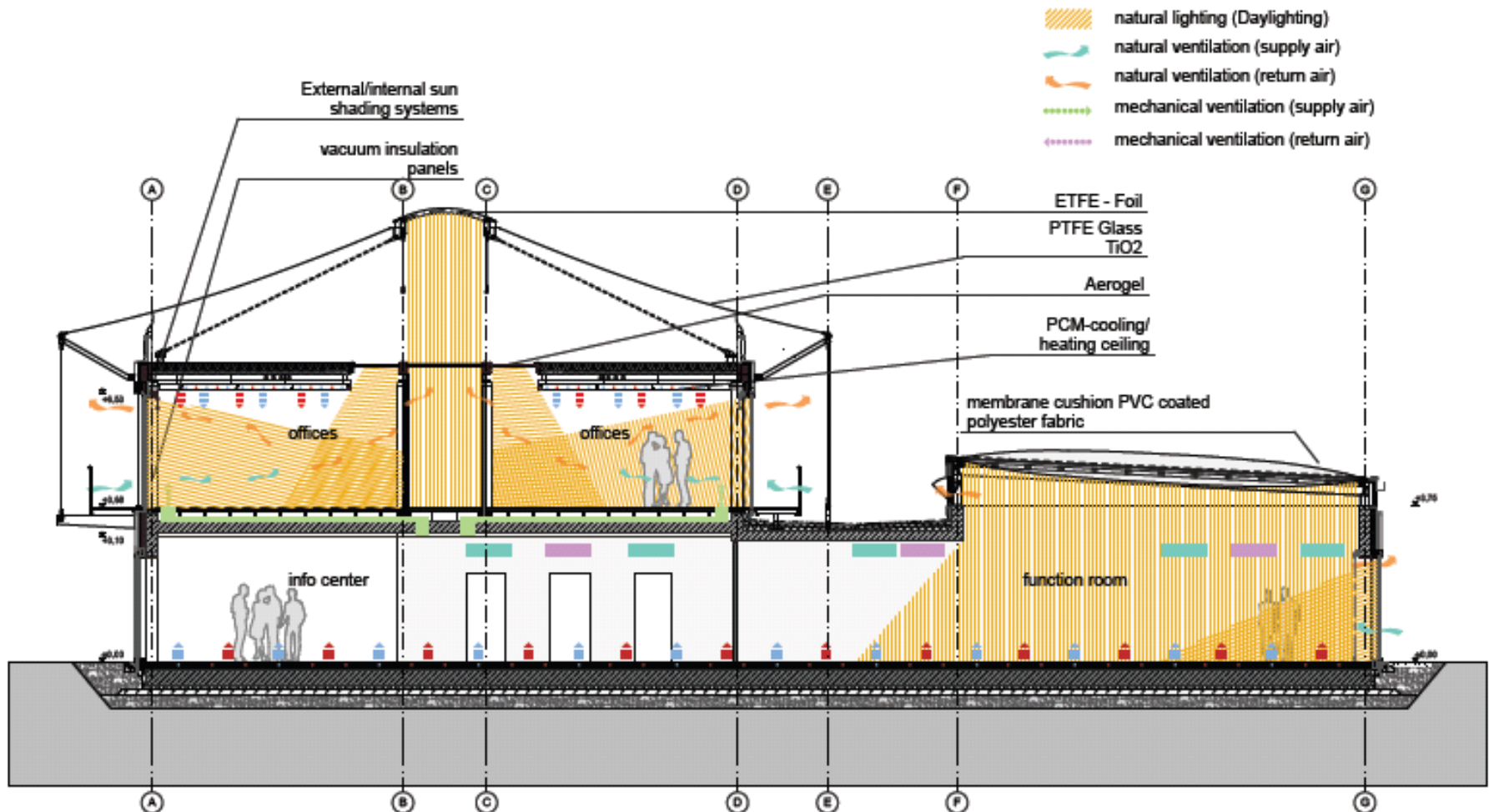
- ultra-thin, energy-efficient façades
- energy efficient textile architecture
- low-e textiles
- passive infrared cooling
- phase change materials for heat storage
- open cycle desiccant cooling system
- building automation



Natural Lighting, Shading, Roof Cooling



NATURAL LIGHTING AND SHADING





post and beam construction

transparent glazing

heat insulation glazing
Neutralux advance
 $U_g = 0,6 \text{ W/m}^2\text{K}$
filling: argon
Psi-value: 0,061
g-value = 47 %

solar protection glazing
Solarlux platin
 $U_g = 0,7 \text{ W/m}^2\text{K}$
filling: argon
Psi-value: 0,061
g-value: 27%

The heat- protective
glazing with integrated
louvres
 $U_g = 0,7 \text{ W/m}^2\text{K}$
filling: argon
Psi-value: 0,061
g-value: 50%

opaque, vapor proof panel

structure:
marine ply
weatherproof
aluminium plate
insulation core made of
PUR-foam
insulation core vacuum
insulation board
fleece
aluminium plate
u-value = ca. $0,15 \text{ W/m}^2\text{K}$

window elements

transparent glazing

Stickling TopTherm90
with heat insulation
glazing
triple insulated glazing
 $U_w \text{ value} = 0,8 \text{ W/m}^2\text{K}$

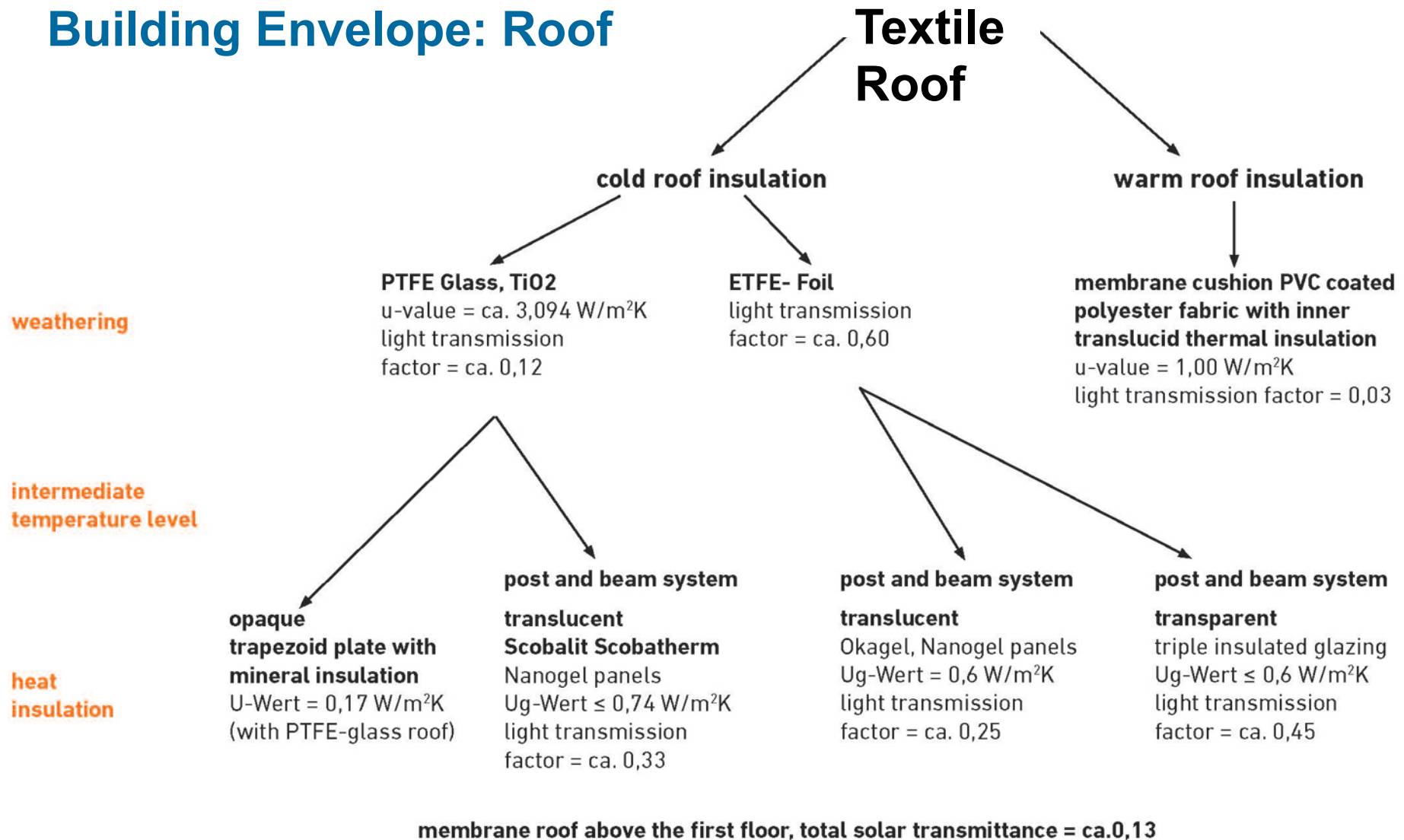
ventilated facade

ventilated metal panel facade

u-value = $0,25 \text{ W/m}^2\text{K}$

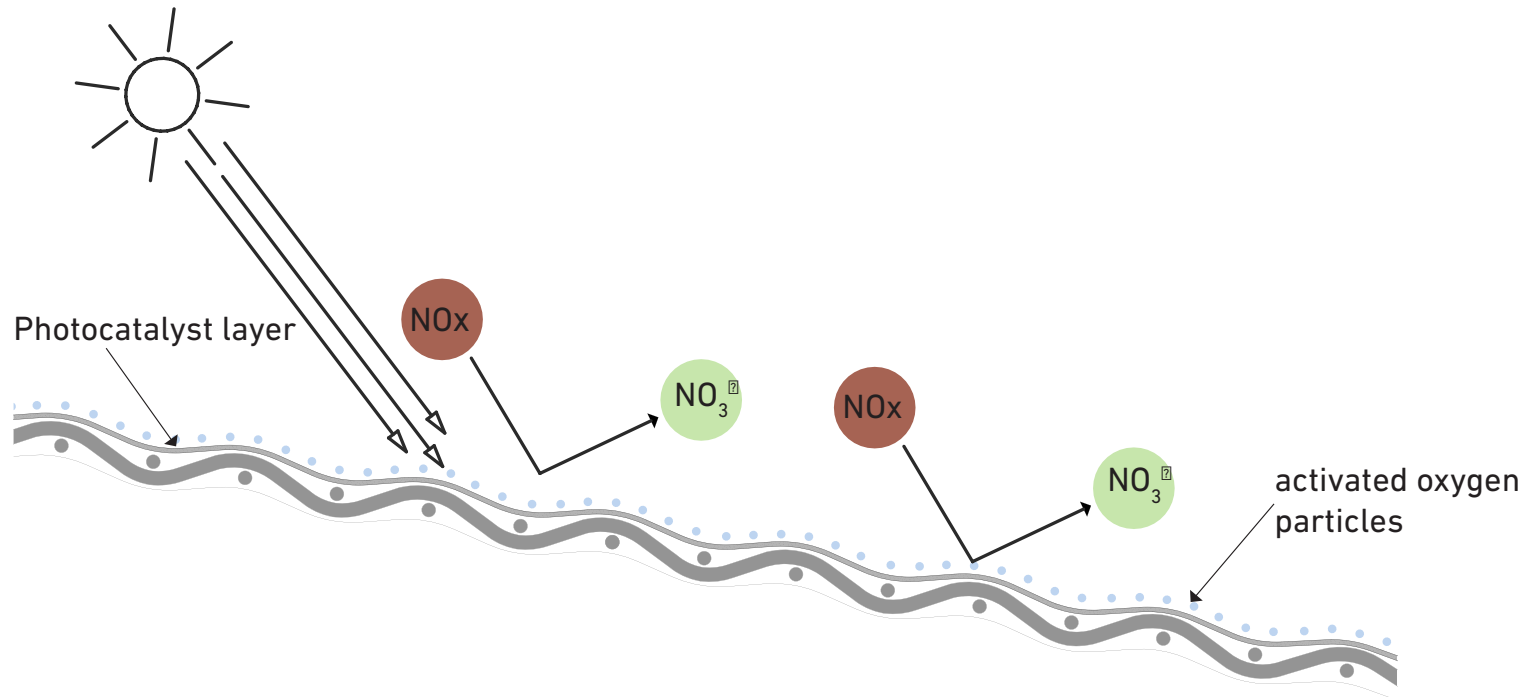
Building Envelope: Facade

Building Envelope: Roof



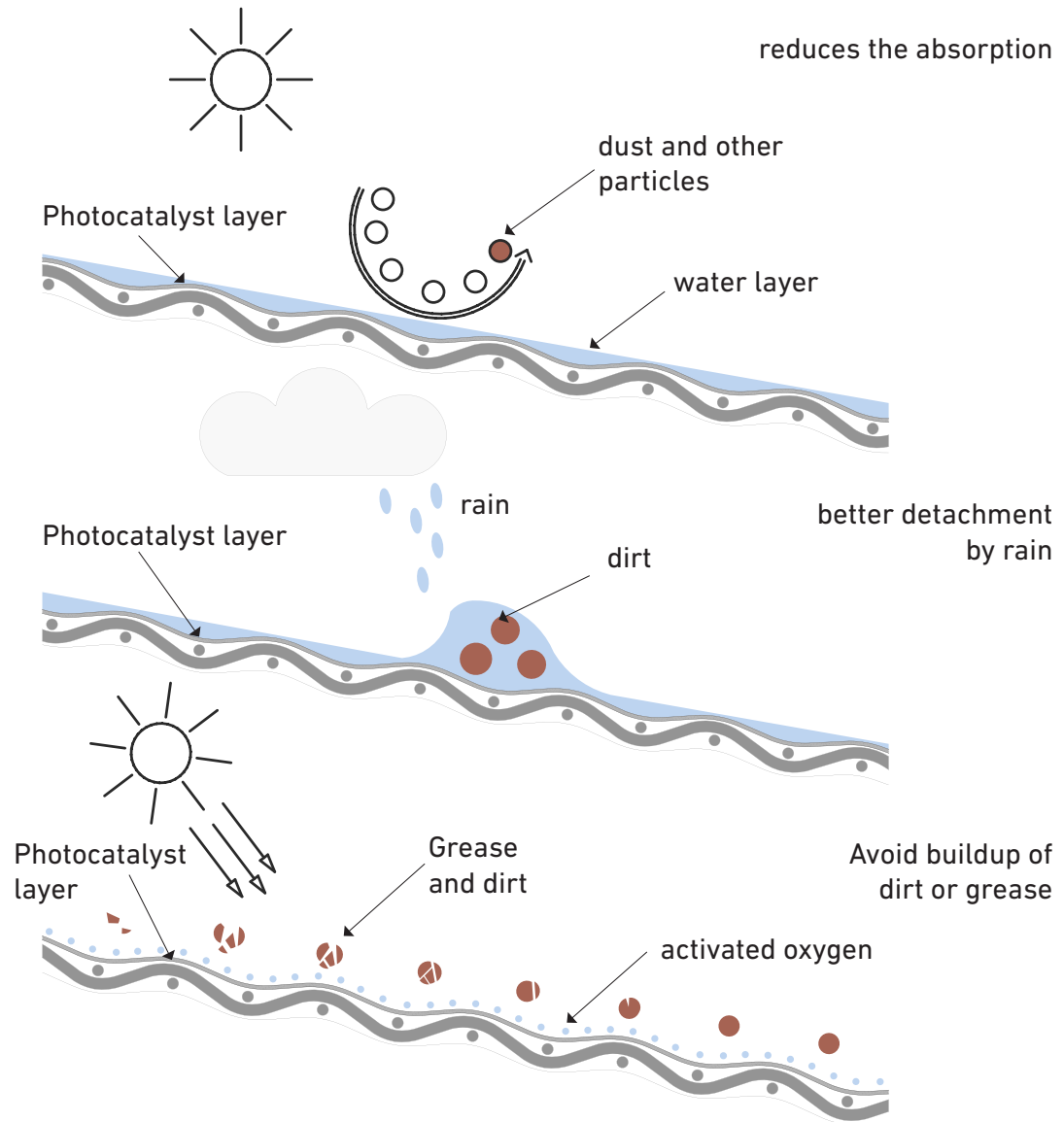
Air cleaning

Roof: Membrane

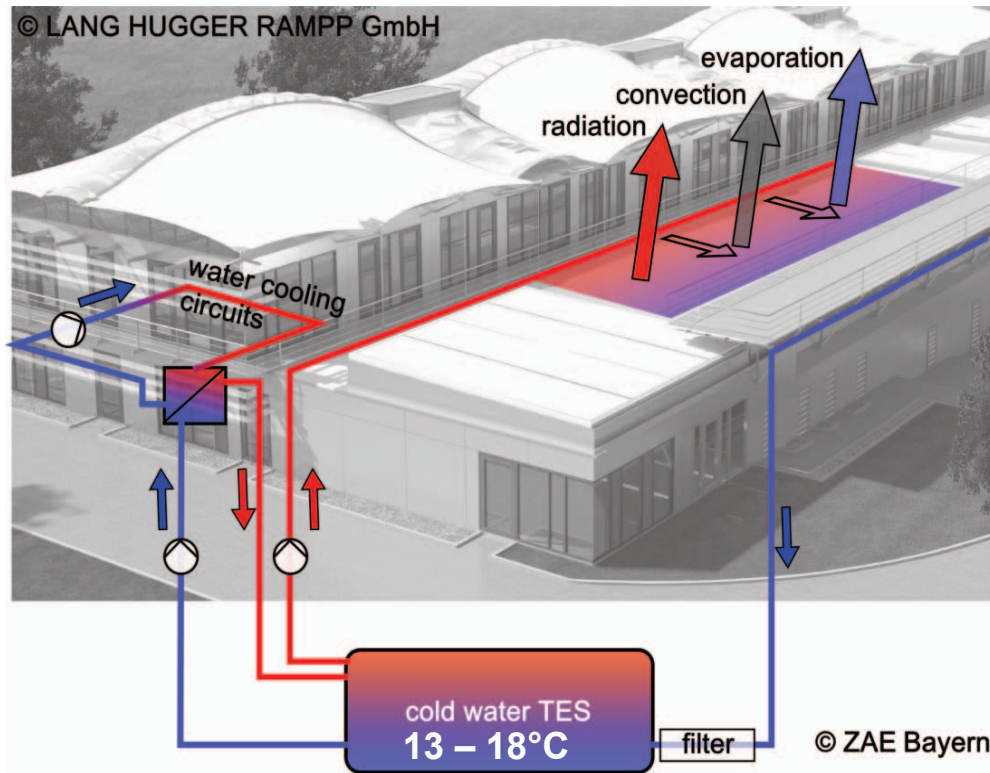


Purifies the atmosphere by removing NO_x and SO_x

Self-cleaning



PASSIVE INFRARED COOLING



Parameter	Value
storage volume	104 m ³
roof area	300 m ²
average cooling demand	14.1 kW
volume flow	6 m ³ /h

COP > 20 because energy is only needed for the water pumps







Thank you

Further information:

[http://www.elektromobilitaet-verbundet.de/
projekte/energieautarke-elektromobilitaet.html](http://www.elektromobilitaet-verbundet.de/projekte/energieautarke-elektromobilitaet.html)

<http://www.energy-efficiency-center.de>