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and Energy

ENERGY EFFICIENCY
made in Germany

Energy Efficient Buildings in Germany – An Introduction

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Contents

- Introduction
- Statutory provisions and targets
- From research and demonstration projects to marketable buildings
- Designing of energy efficient buildings is a holistic task

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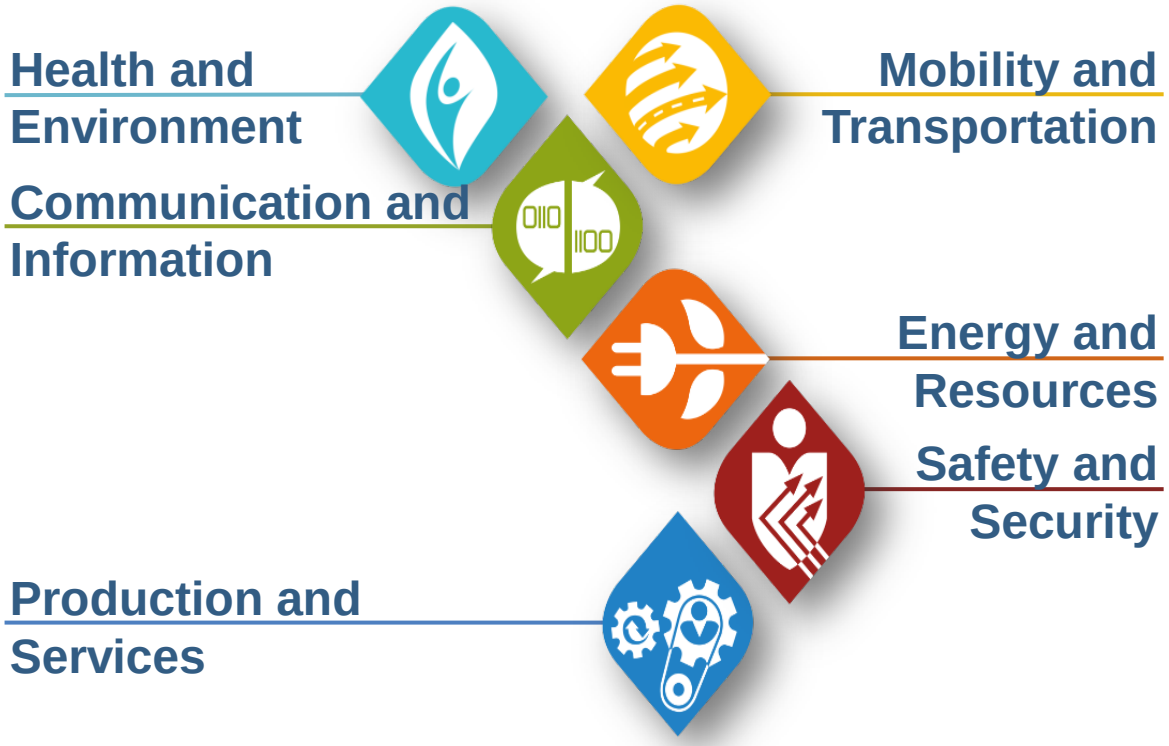
Introduction

The Fraunhofer-Gesellschaft

24 000
employees

66 Institutes



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Introduction

Fraunhofer Institute for Building Physics

Established: 1929

Employee: 400

Budget: € 24 million

Competence in Building Physics

- Acoustics
- Building Chemistry, Biology, Hygiene
- Energy Efficiency and Indoor Climate
- Hygrothermics
- Life Cycle Engineering

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Introduction

60 years of field tests
= long-term durability observation

IBP field test site in Holzkirchen

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Introduction

Natural and artificial weathering





Ageing and microbial growth analysis

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VERU test building to determine energy consumption required to meet comfort conditions

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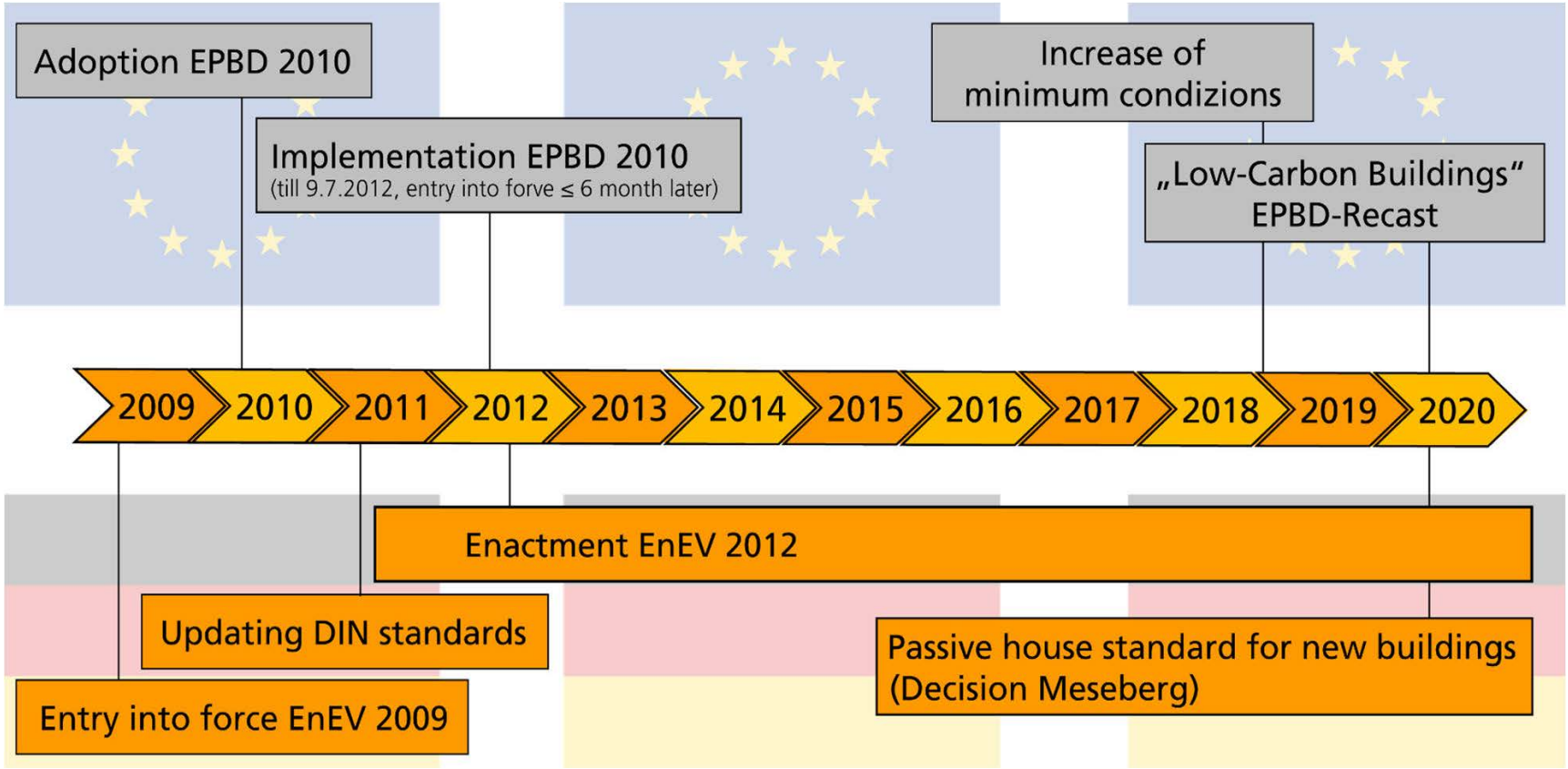
Development of Energy Standards for Buildings in the EU and Germany



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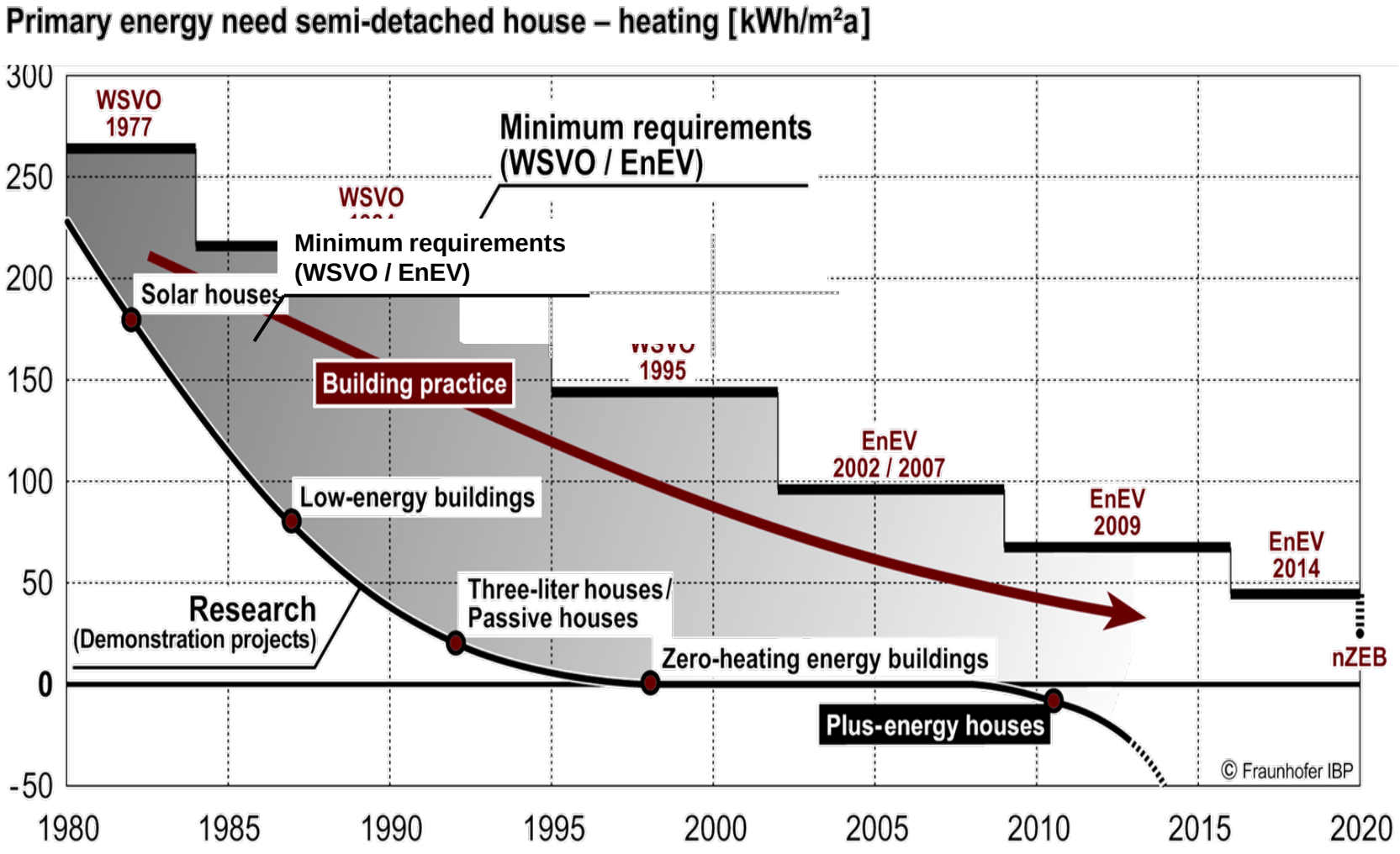
Development of energy efficiency requirements



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References for Components and Systems – Residential Buildings 2016

Roof

U_{ref} = 0,20W/(m²K)

Outside wall

U_{ref} = 0,28 W/(m²K)

Thermal bridge

ΔU_{WB} = 0,02 - 0,04 W/(m²K)

Basement wall

U_{ref} = 0,35 W/(m²K)

Floor plate / Basement ceiling

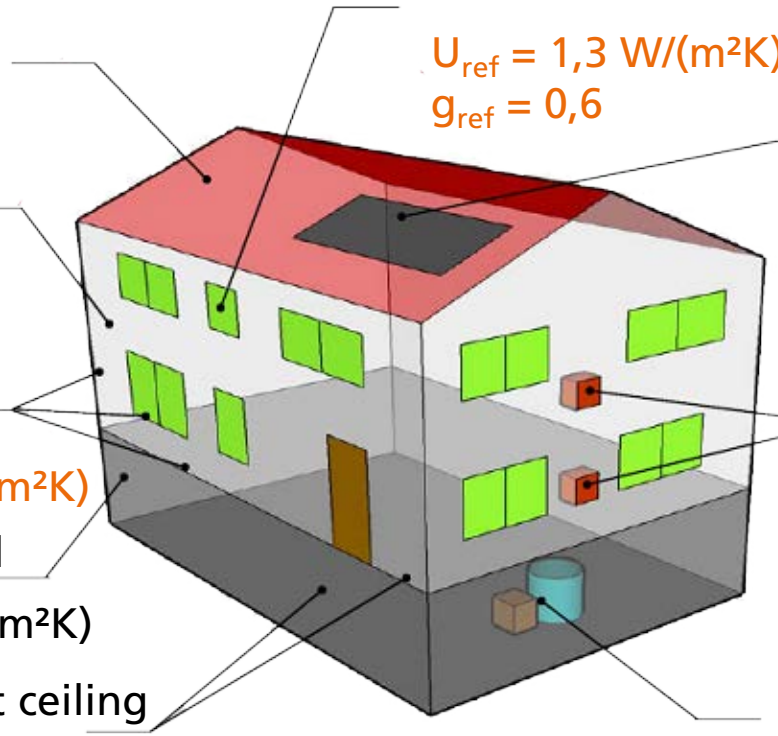
U_{ref} = 0,35 W/(m²K)

Window

U_{ref} = 1,3 W/(m²K)

g_{ref} = 0,6

Solar collector supporting hot water supply



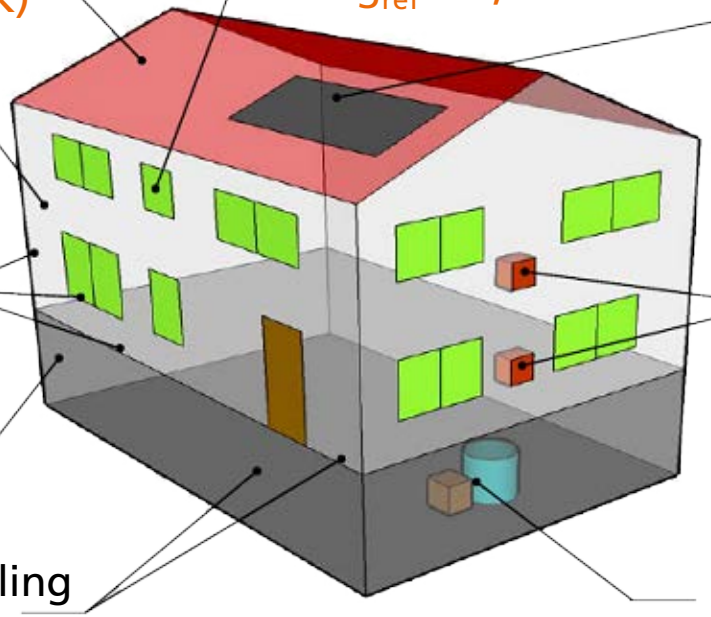
Ventilation systems with heat recovery

Heating and hot water

Condensing technology

55/45 ° C

Possible References for Components and Systems – Residential Buildings 2020



Window

U_{ref} = 0,8 W/(m²K)

g_{ref} = 0,4

Roof

U_{ref} = 0,15 W/(m²K)

Outside wall

U_{ref} = 0,2 W/(m²K)

Thermal bridge

ΔU_{ref} = 0,02 W/(m²K)

Basement wall

U_{ref} = 0,2 W/(m²K)

Floor plate / Basement ceiling

U_{ref} = 0,2 W/(m²K)

Solar collector supporting hot water supply

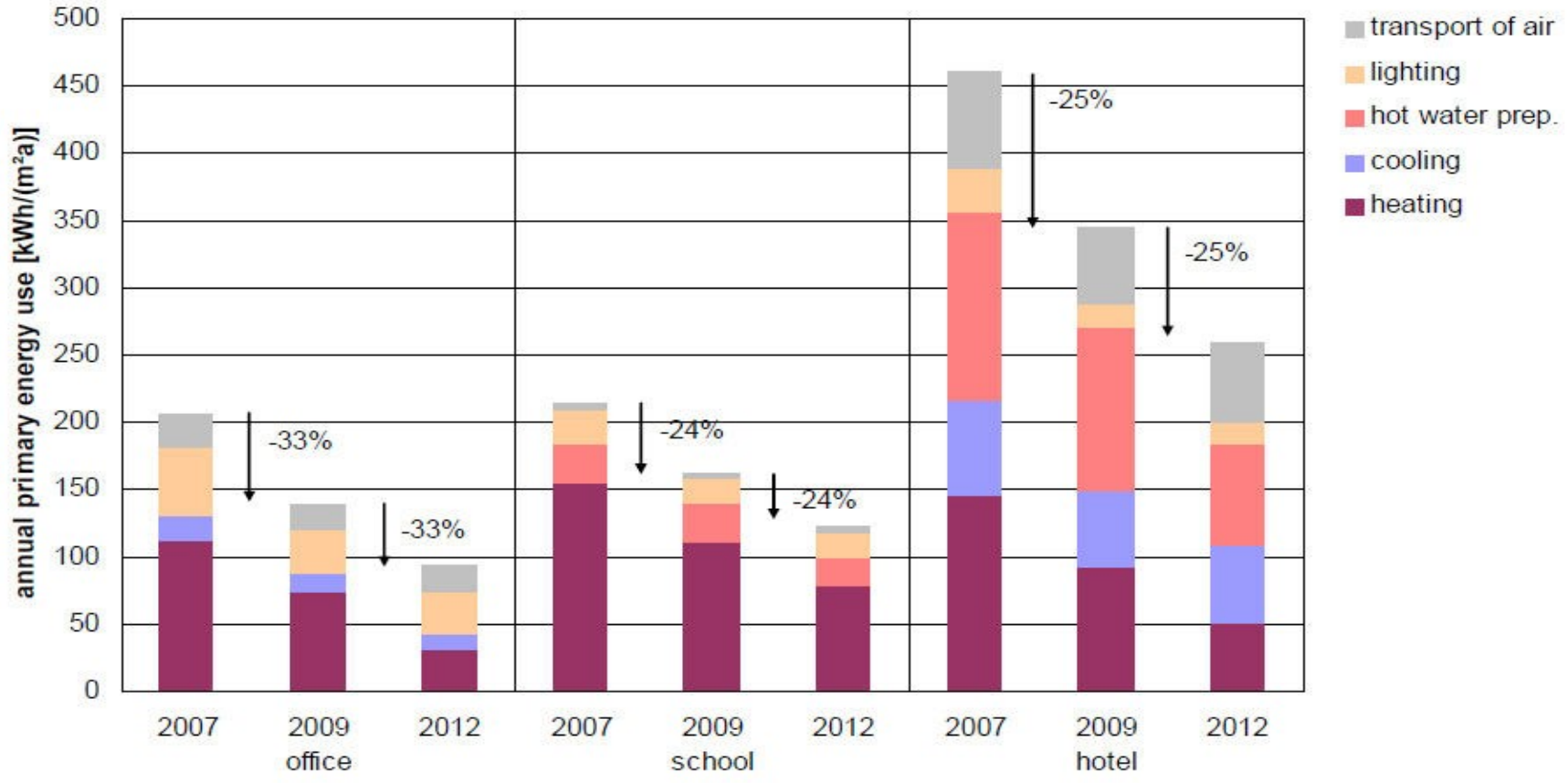
Ventilation systems with heat recovery

Heating and hot water

Use of renewable energies:

heat pump, PV, bio-mass

Requirements in Germany According to the Energy Regulations



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References for Components and Systems – Non-residential Buildings 2016

Roof

U_{ref} = 0,20 W/(m²K)

Outside wall

U_{ref} = 0,28 W/(m²K)

Window

U_{ref} = 1,3 W/(m²K); g = 0,55

Thermal bridge

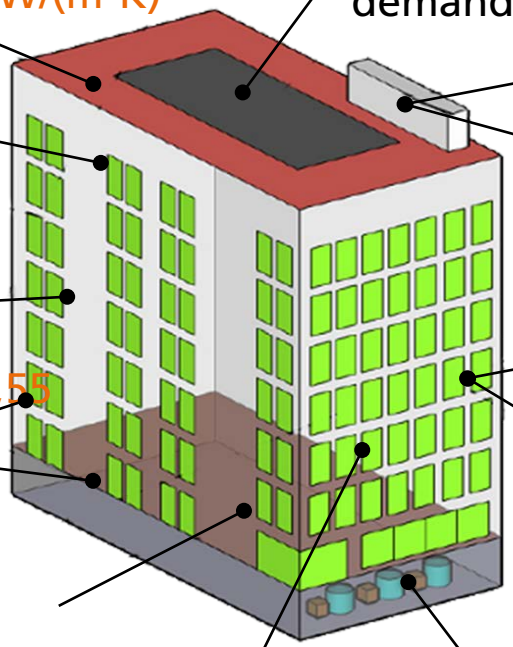
ΔU_{wb} = 0,05 W/(m²K)

Basement ceiling (basement not heated)

U_{ref} = 0,35 W/(m²K)

Curtain wall

U_{ref} = 1,4 W/(m²K); g = 0,48



Solar collector (in case of high heat demands, hot water available)

Air-conditioning

⇒ reduced pressure losses, improved heat recovery

Lighting

⇒ daylight dependent control

Heating and hot water

⇒ additional / alternative renewable energies

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Possible References for Components and Systems – Non-residential Buildings 2020

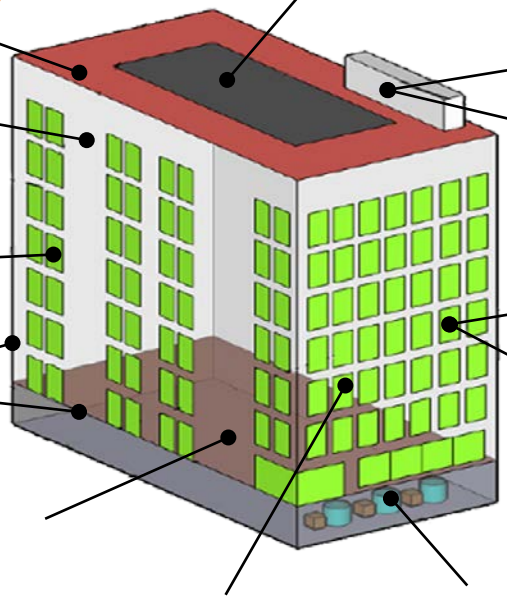
Roof
U_{ref} = 0,15 W/(m²K)

Outside wall
U_{ref} = 0,20 W/(m²K)

Window
U_{ref} = 0,8 W/(m²K);
g = 0,55

Thermal bridge
ΔU_{WB} = 0,02 W/(m²K)

Basement ceiling
(basement not heated)
U_{ref} = 0,2 W/(m²K)



Curtain wall
U_{ref} = 1,0 W/(m²K);
g = 0,55

Solar collector (in case of high heat demands, hot water available)

Air-conditioning
⇒ Ventilation systems with heat recovery for special cases, passive methods, use of renew. energy

Lighting
⇒ LED, improved control

Heating and hot water
Condensing technology 55/45 ° C
⇒ use of renewable energy: heat pumps, PV, bio-mass

Energy Concept 2050<

Target: **reduction of energy consumption of buildings**
2050: **by approximately 80 %**

increased usage of renewable energies in buildings

→ increasing the energetic renovation rate from 1 % to **2 %**

implementation by:

- **market incentive program (Marktanreizprogramm)**
- **financial stimulation (KfW-Förderung)**
- **tax stimulus**

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Prediction

From 2020 onwards,

all new residential buildings in Europe

will be more or less

plus energy buildings!

=

mini-power-stations!

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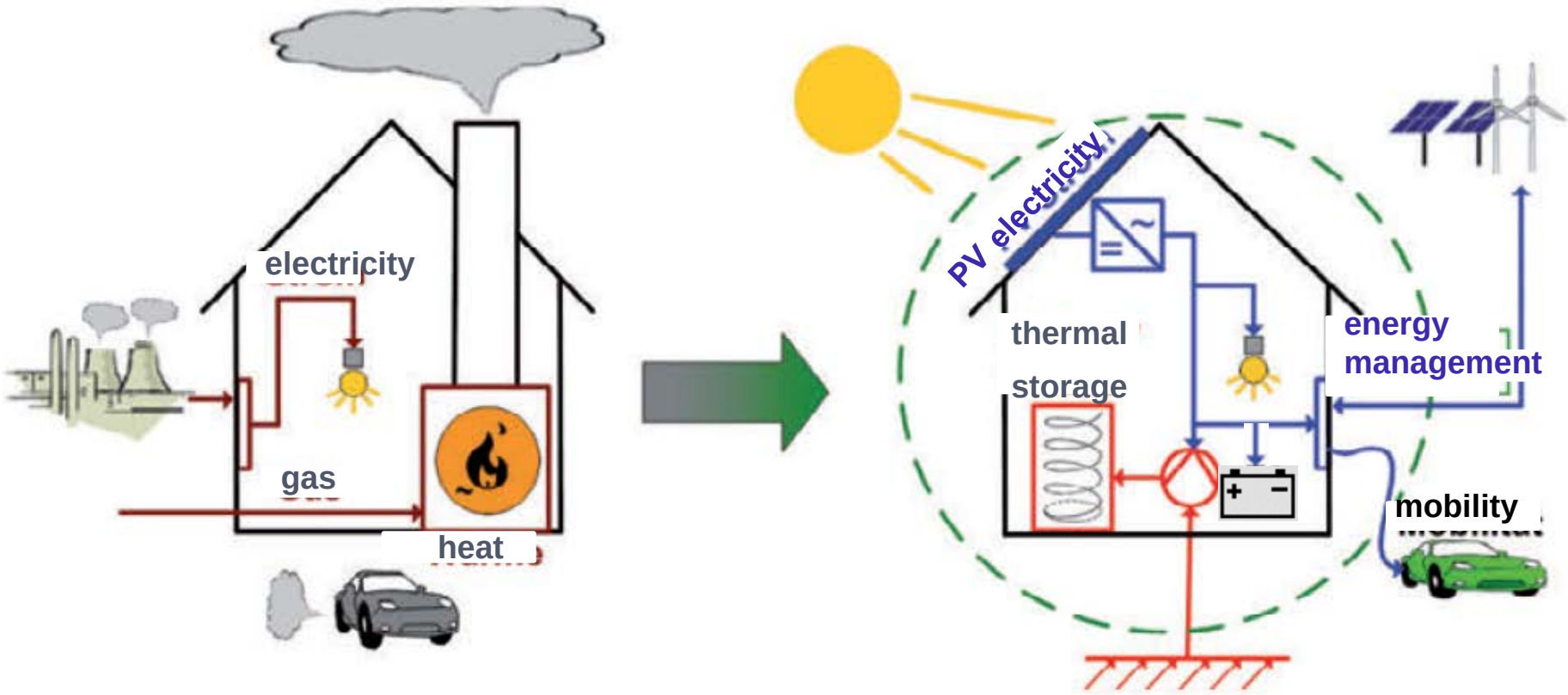
From energy consumer to energy producer



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Plus Energy – what is that?

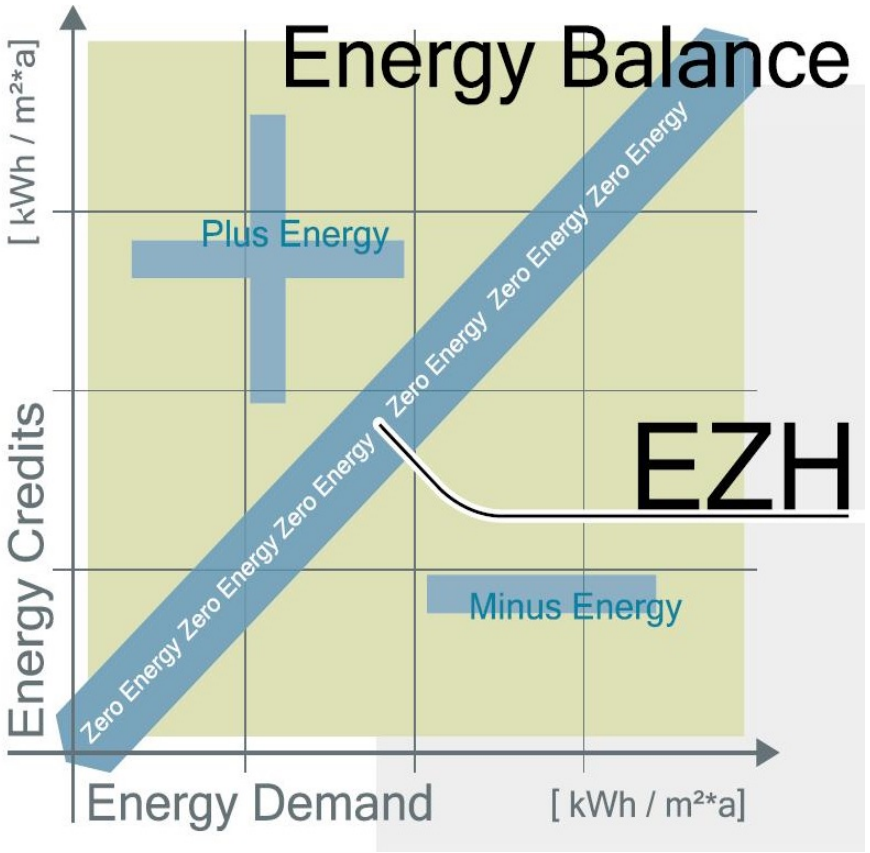
Balance of

total energy demand

Equals

Renewable energy

generation



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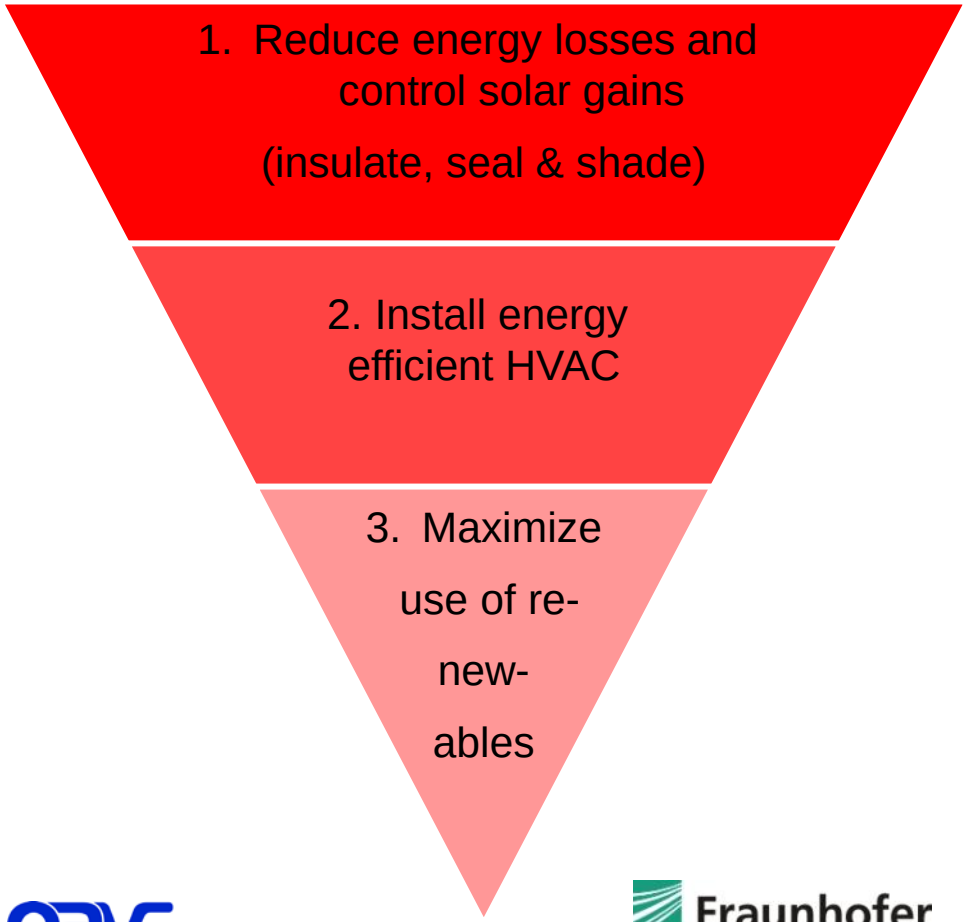
Plus Energy – how to get there?

Three steps:

- **Radical reduction of energy demand for heating, cooling, lighting and ventilation compared to conventional design**

- **Use of renewable sources to cover the remaining energy demand**



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Winner of the Solar Decathlon 2007

Winner of the Solar Decathlon 2009

Solar Decathlon Europe 2010 building of University of Applied Sciences of Rosenheim

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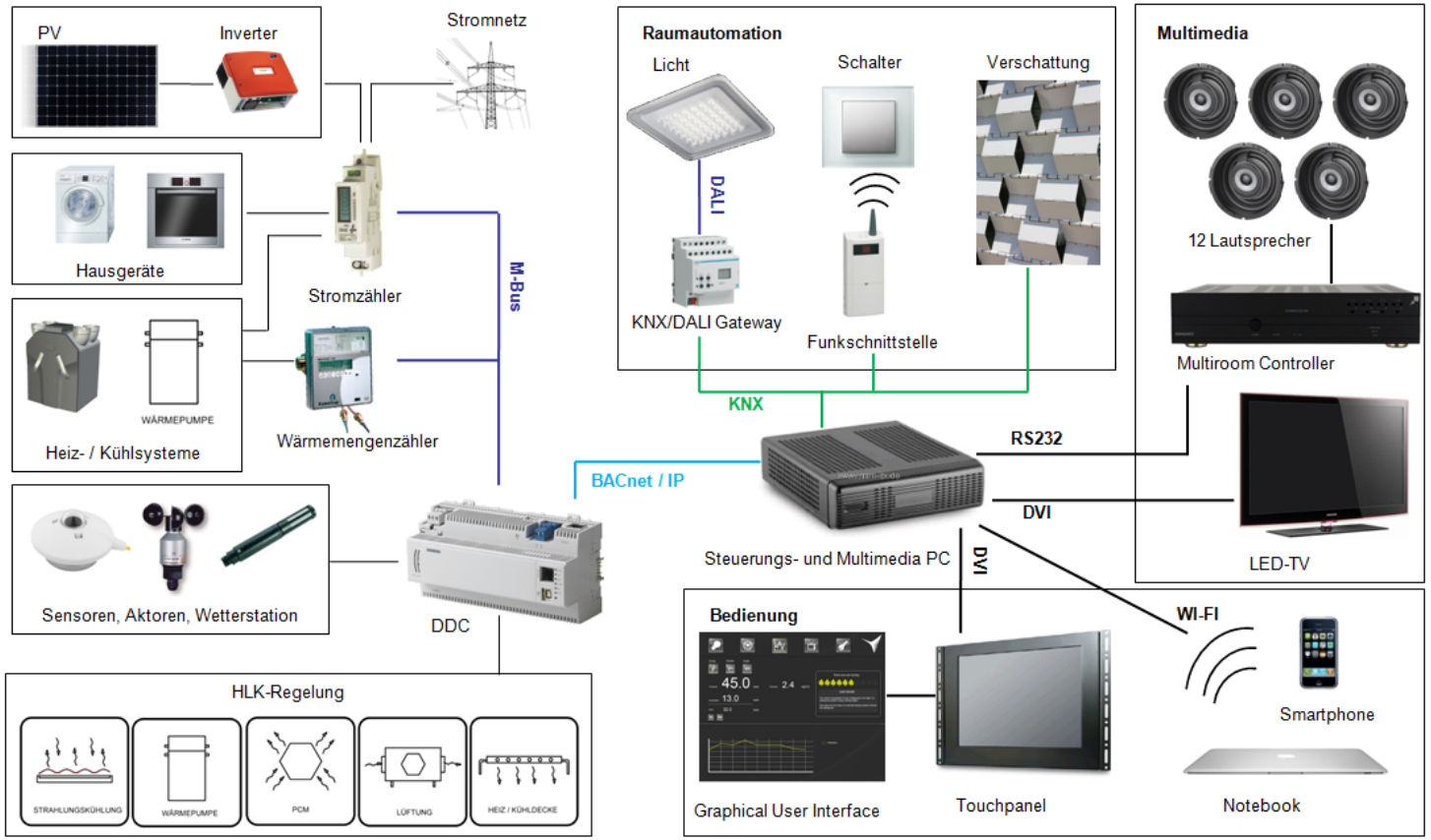
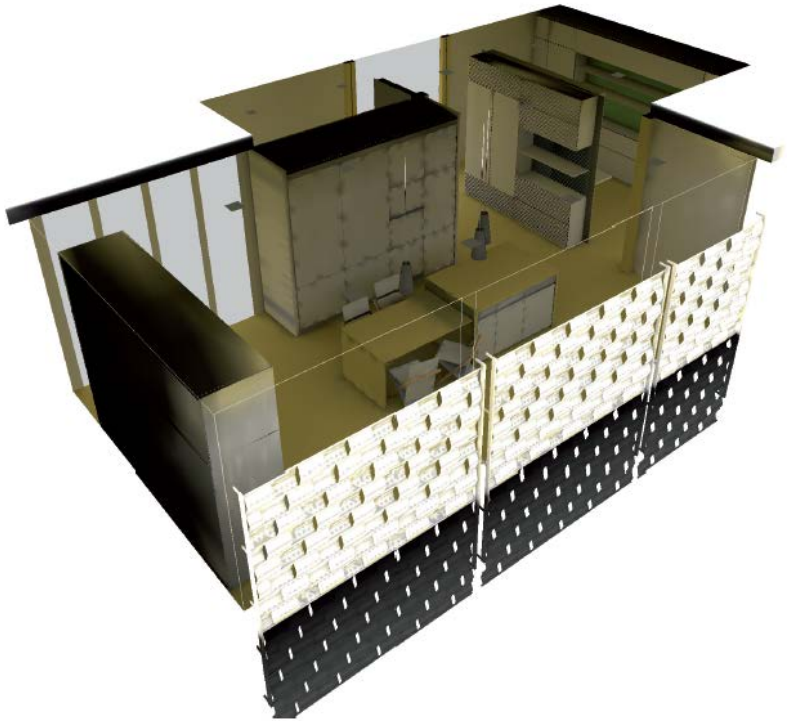
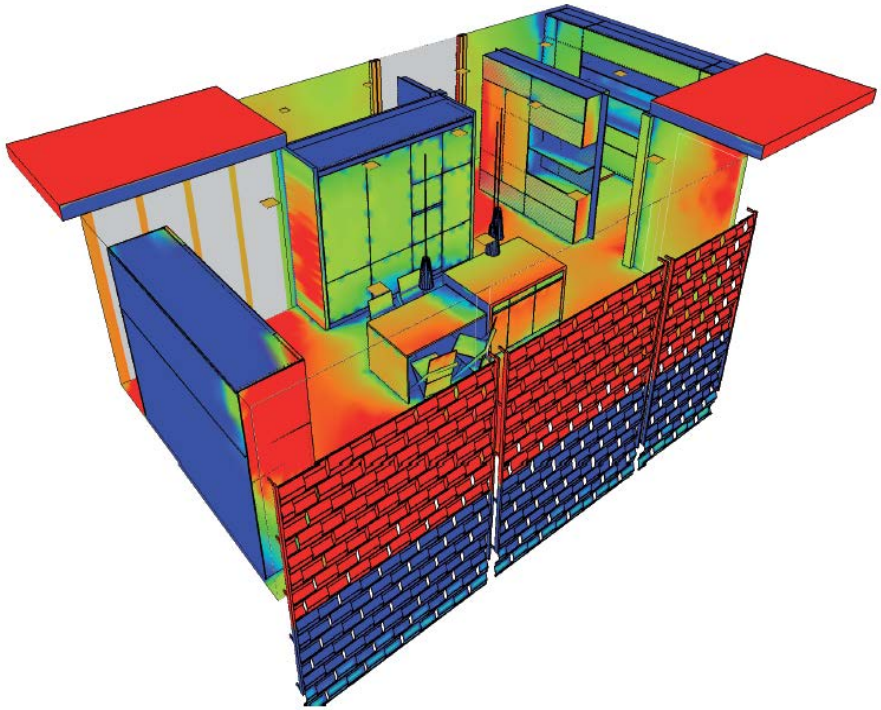
Elements of plus energy buildings – Buildingautomation



Quelle: University of Applied Sciences Rosenheim

Elements of plus energy buildings – Daylight





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Source: University of Applied Sciences Rosenheim

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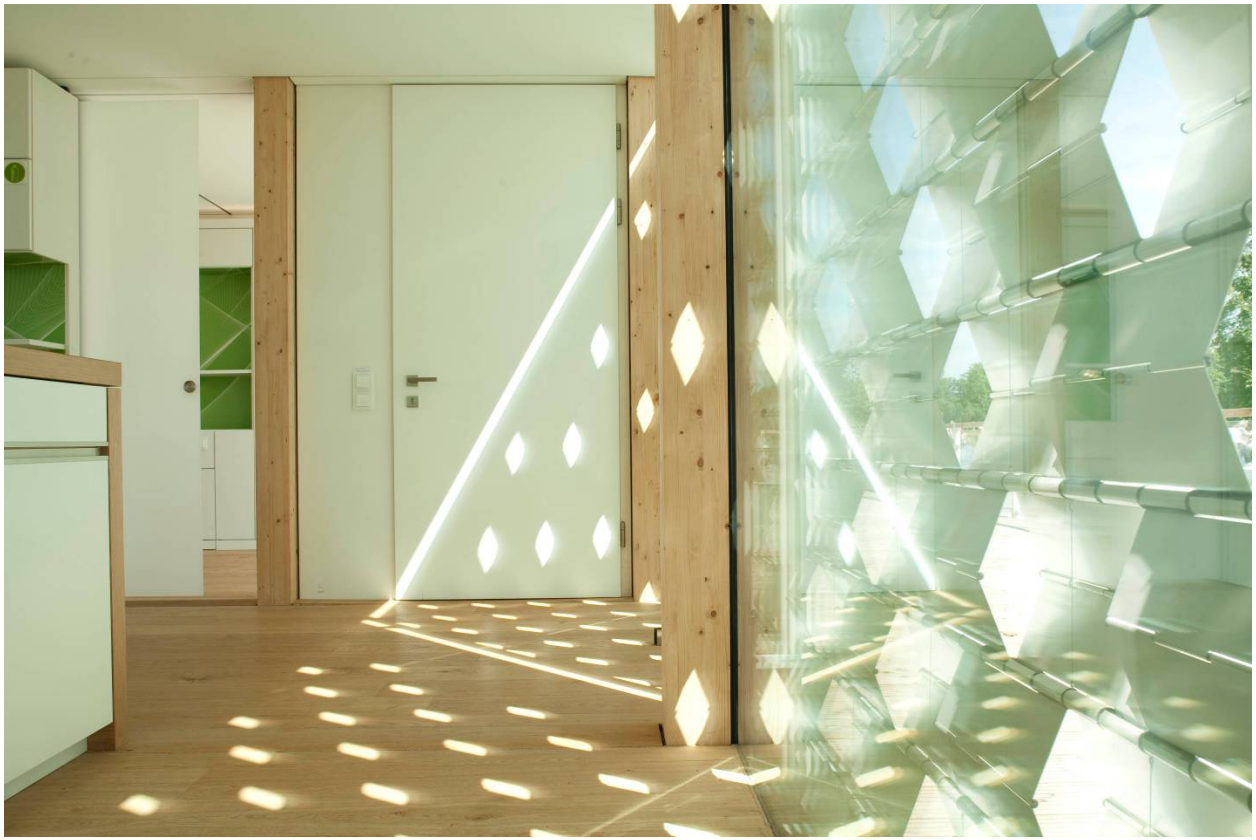
Elements of plus energy buildings – Facade



Source: University of Applied Sciences Rosenheim

Plus Energy Building & E-Mobility

To enforce the use in large quantities

the

German Federal Ministry of Transport, Building and Urban Affairs

launched a competition on a

marketable Plusenergy one-family house.

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Plus Energy Building & E-Mobility

Quelle: Institut für Leichtbau und Entwerfen (ILEK), Stuttgart, 2010

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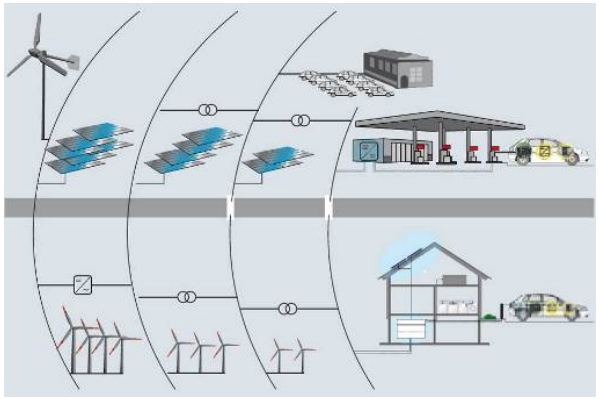
Plus Energy Building & E-Mobility

- Increase the marketability of Plus Energy buildings
- Interface between building and mobility
- Decentralization of power generation
- Electric cars and smart grids for temporary storage of energy
- Intelligent network planning and network use
- Realization of this model building in Berlin-Mitte was on December 6th 2011



PLUSENERGIE HAUS + ELEKTRO MOBILITAET

ZukunftBAU | BMVBS | BBR

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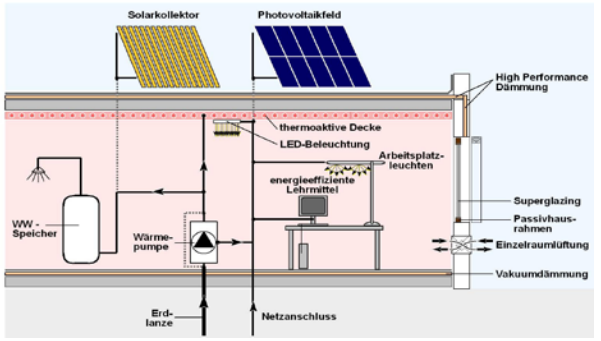
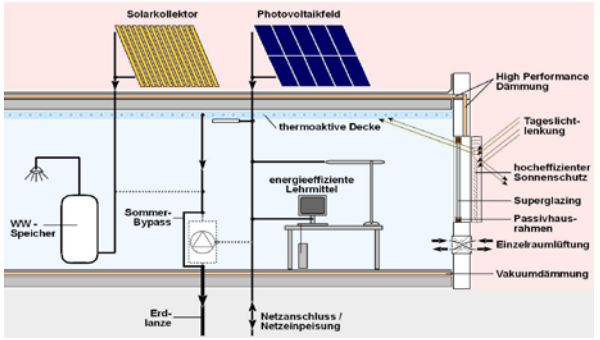
Plus Energy Building & E-Mobility





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Energy Active High Rise Building in Germany

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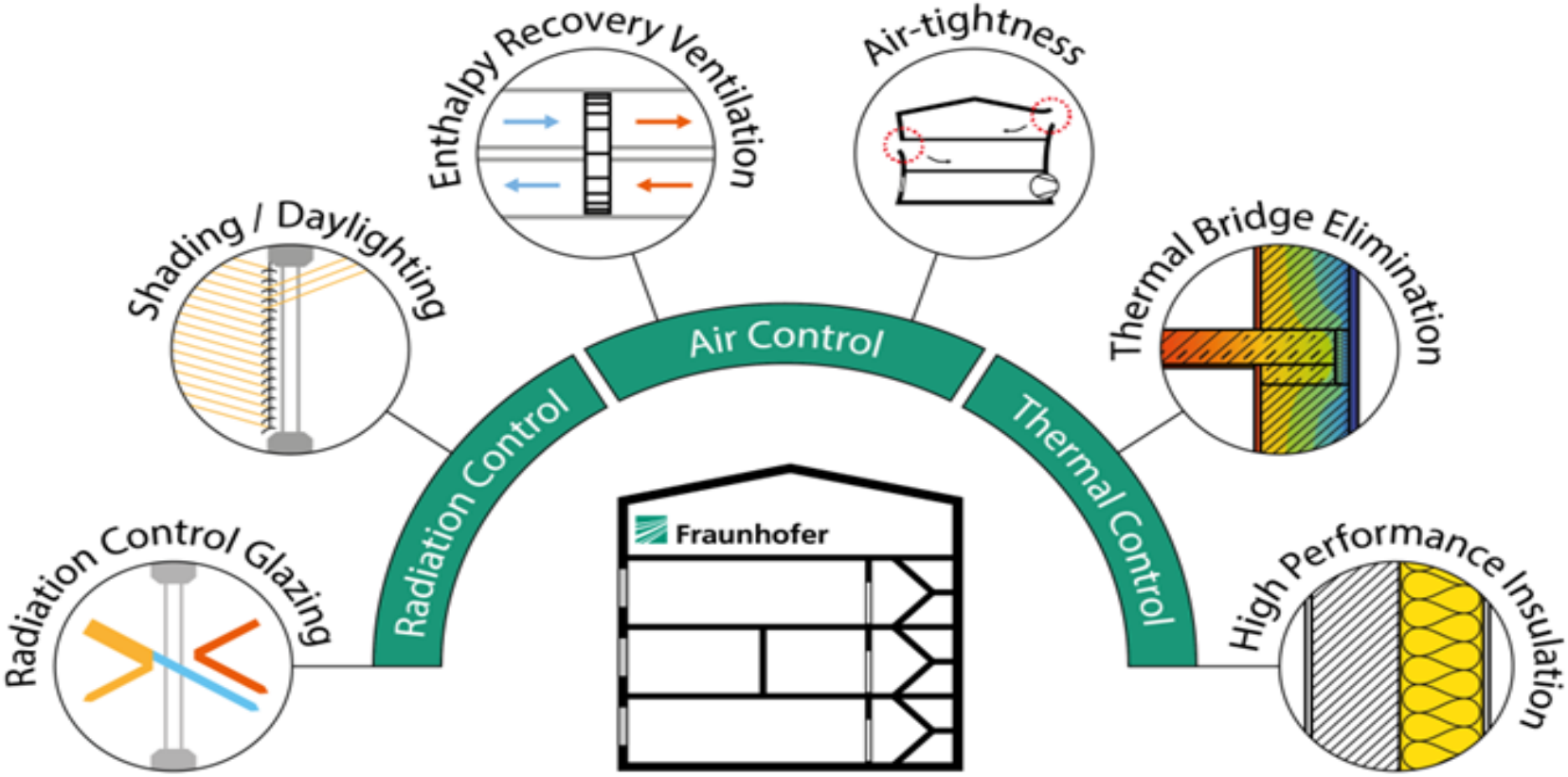
Passive Design Principles for Energy Efficient Buildings



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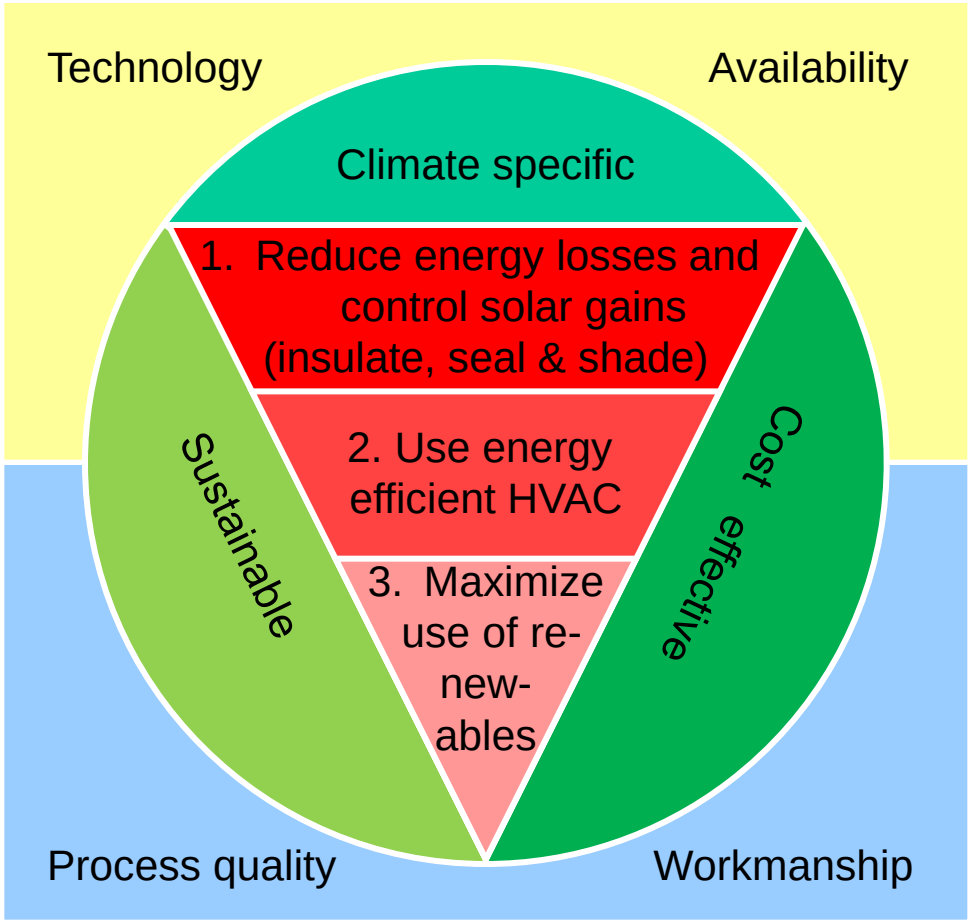
Designing Energy Efficient Buildings – A Holistic Task

- A holistic building energy concept addresses comfort, hygiene, and durability
- Passive measures are indispensable and may be supported by efficient HVAC system and renewable energies
- Climate-specific and economical solutions require individual design
- Availability of technology to be considered
- Workmanship quality to be carefully planned and supervised



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Source: Fraunhofer IBP

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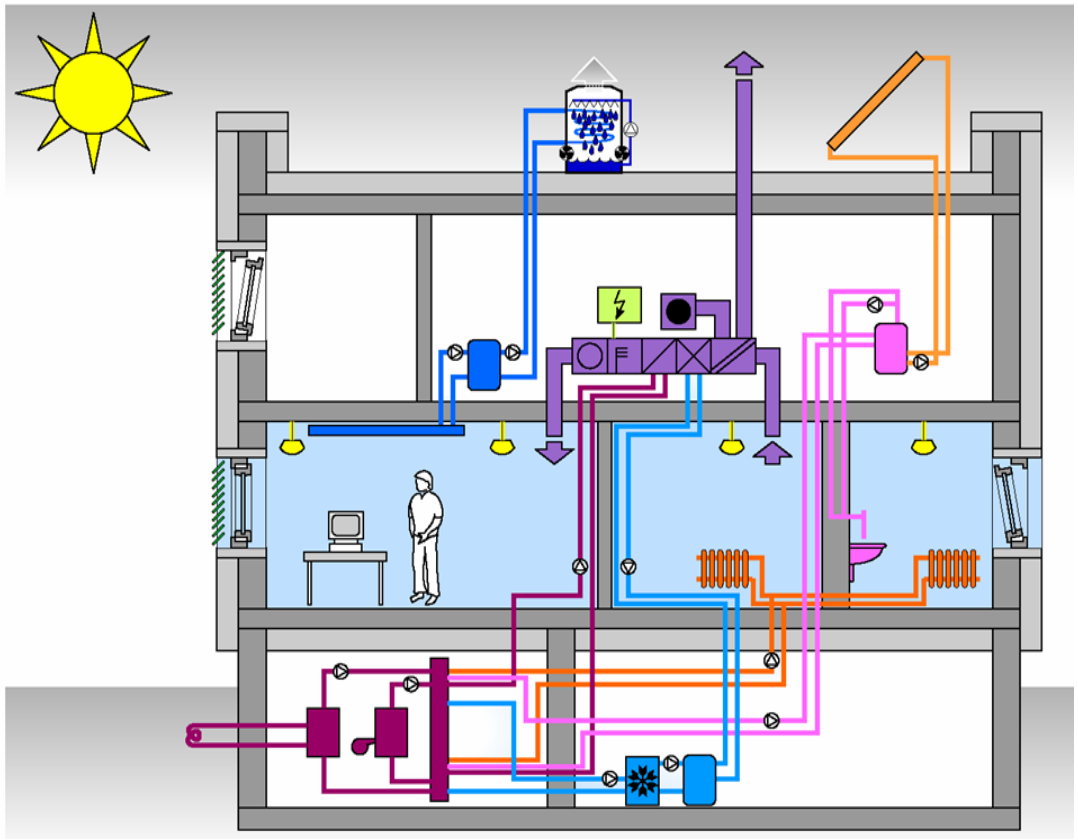
Modern building design requires appropriate tools



Accounting for interaction of building envelope, HVAC systems, weather conditions and occupants behavior requires powerful building simulation tools

Moisture control issues may require hygrothermal simulations (WUFI®Plus)

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Moisture Control

Visible mold caused by high surface humidity

High indoor humidity provokes mold growth on thermal bridges in cold climates. In hot and humid climates unconditioned spaces are at risk

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Moisture control

Invisible mold due to high humidity within the building envelope

Mold caused by vapor diffusion from hot to cold

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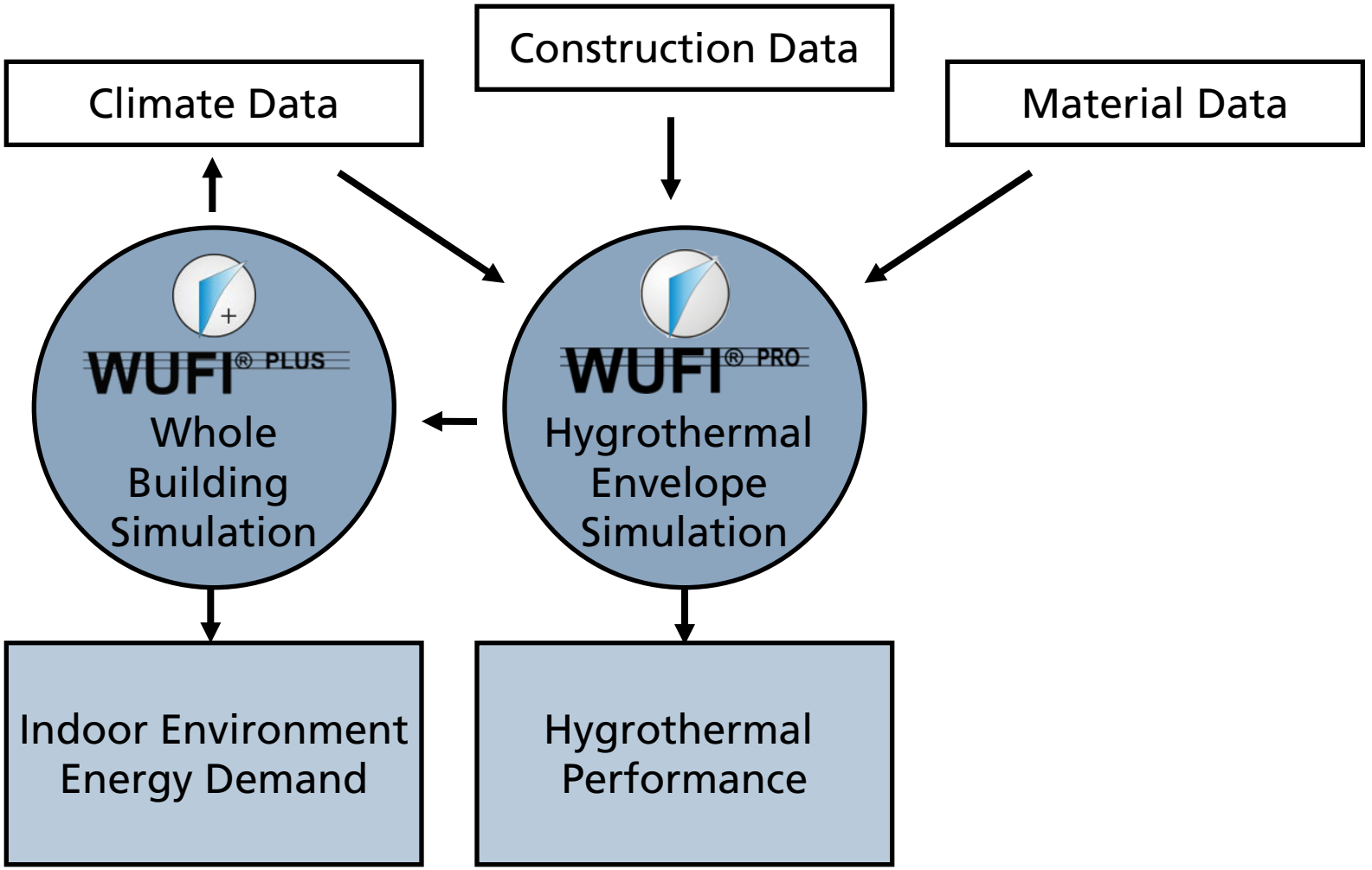
Hygrothermal Whole Building Simulation



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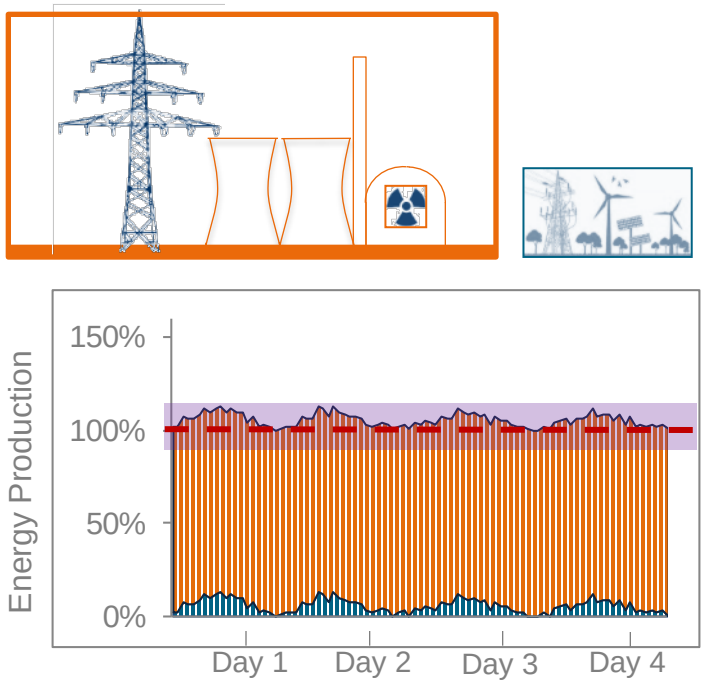
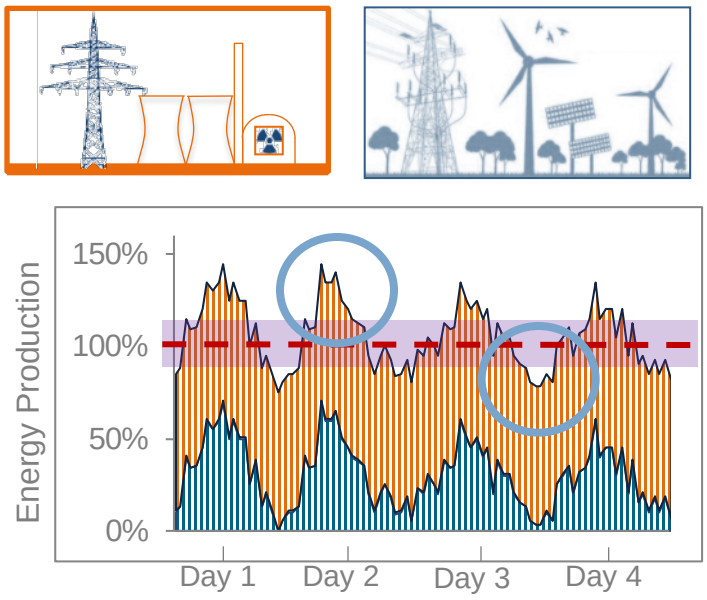
Energy supply of tomorrow

Increasing amount of renewables leads to fluctuating supply

Year 2000
Renewables: 6 %



Year 2020
Renewables: 35 %



Conventional Energy

Renewable Energy

Energy Demand

Grid flexibility

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Energy Management for buildings:
Save energy in times of low energy supply
– consume and store when supply is high

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Innovation necessary

Improved energy storage and management systems

“Thanks to progress in technology, buildings of the future will adapt automatically both to weather conditions and to comfort requirements of the inhabitants.”

“Buildings will not only act as energy producers. They will also respond to grid fluctuations by smart energy management (energy consumption and storage control).”

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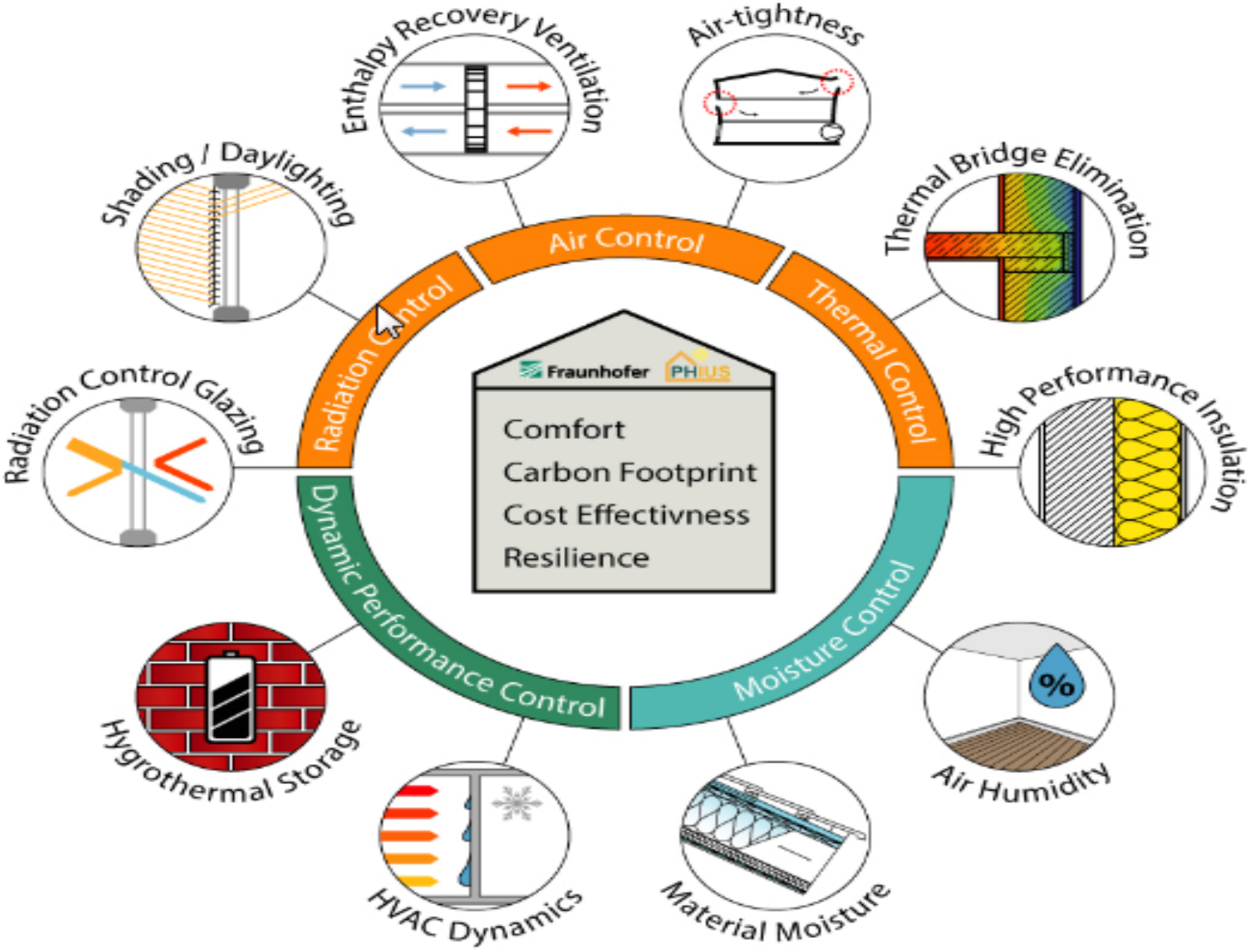

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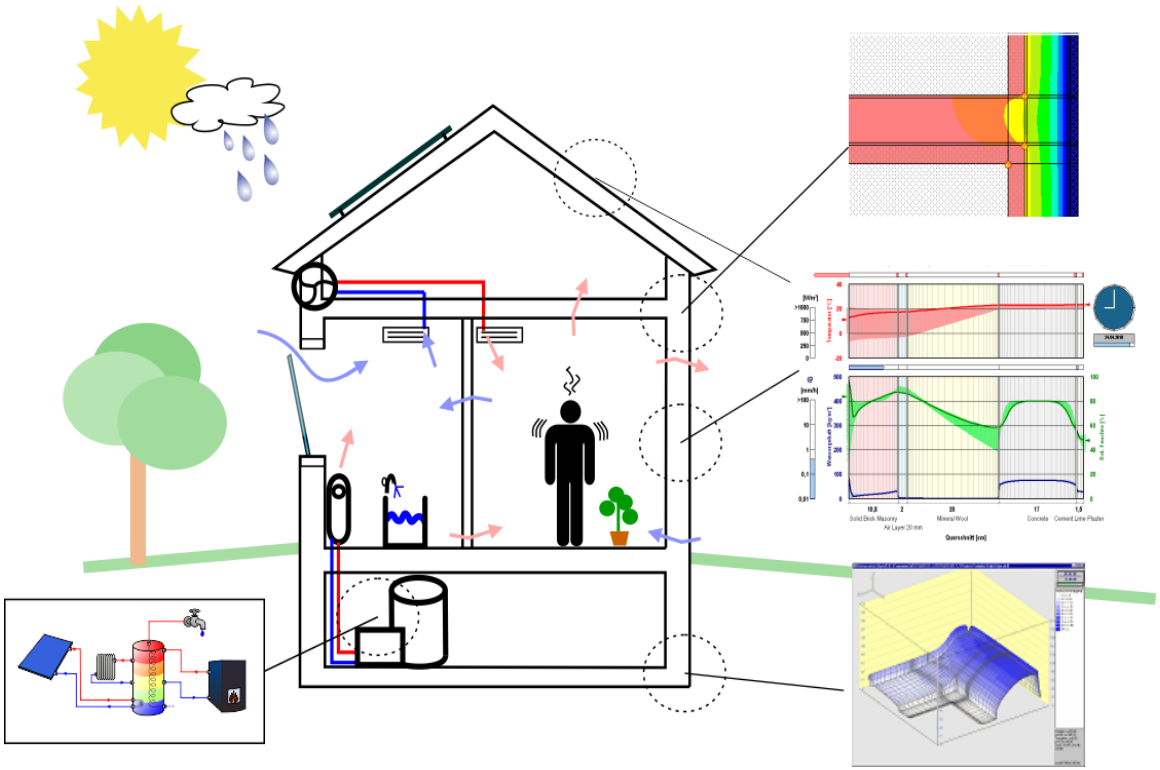
Hygrothermal whole building analysis



Hygrothermal models (e.g. WUFI® Plus) include all heat and moisture exchange processes between the interior spaces and the building envelope, furniture, etc.

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Conclusions

Energy efficient building operation and indoor comfort depend on appropriate passive measures and HVAC design

Moisture and indoor humidity control are important parameters for building envelope durability and healthy indoor conditions

Dynamic temperature & humidity conditions in buildings or building assemblies can be reliably predicted by hygrothermal simulation

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Conclusions – cont.

Standard building energy simulation tools do not adequately account for the moisture exchange processes

Validated hygrothermal building simulation tools reproduce moisture transfer & storage correctly and therefore help to assess e.g.

- effect of moisture buffering interior lining materials
- appropriate strategies to remove moisture
- mold prevention methods in intermittently operated spaces

Challenge: designing buildings that are **energy efficient**, **healthy** and **durable** at the designated location (climate specific)

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