Design & Operation of Energy Efficient Buildings
- Sustainable refurbishment of city quarters

- Energetic optimizing operations – buildings on test stand

- Net-surplus energy buildings – building as power plant!

- Climate-neutral- residential and commercial quarters

- Export: energy efficiency + using of renewable energies
  Made in Germany
Energy optimized buildings (EnOB)

R+D- Programme

BMWi
... EnOB- a program with big success!!

Project period:
design – construction - operation

concept

design process

cycle of innovation

construction
realisation
quality control

monitoring, evaluation optimizing
operation
Primary-energy consumption < 100 kWh/(m²a)

$\text{CO}_2$ – neutral energy supply
CO$_2$- neutral energy supply

- Sun to solar panel converter
- Eco electricity
- Biogas to BHKW and BW-boiler
- Heat storage
- District heat
- KKM and AKM
- Cooling storage
### South-west Facade

- **Glazing**: Sun protection glazing
- **Sun Shading**: Exterior

### East Facade

- **Glazing**: Sun protection glazing
- **Sun Shading**: Exterior

### North-west Facade

- **Glazing**:
  - a) EG + 1.OG (thermal glazing)
  - b) 2. + 3.OG (sun protection glazing)
- **Sun Shading**: Interior

### Courtyard Facade

- **Glazing**: Sun protection glazing

  - a) EG (1.+2.OG) (thermal glazing)
  - b) Upper level. (sun protection glazing)
- **Sun Shading**: Interior

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Sun protection glazing: $g \leq 0.34; \tau = \text{max}$
Univ. Prof. Dr. -Ing. M.N. Fisch
IGS – Institut für Gebäude- und Solartechnik | TU Braunschweig

office – headquarter building

Sun protection glazing (SSV), external sun shading (SS) with daylight control

office south-west
Concrete core cooling
window ventilation
mech. ventilation

distribution

office north-east
courtyard
Base light
work light
underground convector

SSV, external SS with daylight control

distribution electricity
distribution mech. ventilation
ZU AB
wood - element – facade integrated heating – vacuum isolation panel (VIP)

Mock-up

- **Bottom channel**
- **Ventilation panel with VIP (vacuum-isolation-panel) and acoustic panel**
- **heating - convector**
- **controller**
- **isolation**
- **awning fins**
- **breast panel with VIP (vacuum-isolation-panel)**
- **wood - profile**
Open Space – Arbeitswelten

Mobile Desk --- E - Shuttle
Solon AG Verwaltungsgebäude

comparision of the primary energy (year) for building operating

* the primary energy (year) includes thermal energy (complete), cooling energy (complete) and electricity (lightning + ventilation)
general results

- High energy efficiency is possible (target value: PE < 100 kWh/(m²a))!
- Good user comfort is reachable!
- No higher building costs (KG 300 + 400: 1.100 – 1.400 €/m²_{NGF} pre-tax)
- Regionshaus Hannover PPP (KG 300 + 400: 1.050 €/m²_{NGF} pre-tax)

→ The buildings need quality control for the period of development, building and operating!
EVA – Evaluation of energy concepts

WKSP – heating/cooling-storage in basements

DEAL – local outwall integrated ventilation systems

TwinSkin – twin facades in practice

reality…. performance in operating?
Yearly heat consumption (kWh/(m²a))

Yearly electricity consumption per gross area (kWh/(m²a))

Energieforum Berlin
comprehensive concepts demanding new requirements for design, construction, commissioning and operation
Energy efficiency „Made in UAE“

Primary energy consumption [kWh/m²a]

<table>
<thead>
<tr>
<th>Office buildings in UAE</th>
<th>German energy efficient office buildings</th>
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<tbody>
<tr>
<td>DIC</td>
<td>German average of new office buildings</td>
</tr>
<tr>
<td>Bur Dubai</td>
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<tr>
<td>Deira</td>
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</tr>
</tbody>
</table>

DIC Bur Dubai Deira

German average of new office buildings

German energy efficient office buildings
optimising operations

optimisation:
• New building control technology
• Modification of local ventilation systems

results:
- better comfort
- reduction of energy consumption
- Reduction of energy cost per year: ca. 30.000 € / year
Primary energy consumption [kWh/m²a]

- R+D buildings (EnBau)
- new commercial buildings (EVA)
- with optimized building operation (EnBop)

- saving by optimization potential: 30-40%

- Equipment
- Operation

- Average: 350 kWh/m²a
- EnBop: 100 kWh/m²a
Annual balance:

From energy **consumtived** to **a energy generated** building

Life cycle:

Energy „**pay back“** time is smaller than the buildings lifetime
Net-Surplus energy building, DSM, e-mobility
……for a future society?

Smart Grids

Energetic

Smart Buildings

E-Mobility

Smart Homes

Virtuel power stations

PV

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structural-physical excellent external envelope…….

- **U-value roof**: ca. 0.12 W/(m²K)
- **U-value window**: < 0.9 W/(m²K)
- **U-value wall**: ca. 0.15 W/(m²K)
- **U-value ground**: ca. 0.3 W/(m²K)
Sunshade lathflat 100mm rope guide

WSV : heat absorbing glass $g$
SSV : sun protection glazing
VSG : laminated safety glass
ESG : temperad safety glass
FL : float glass

**Triple WSV (VSG/ESG/VSG)**
$U = 0.8 \text{ W/m}^2\text{K}$
$g = 0.48$
$t = 0.69$

**Triple SSV (VSG/ESG/VSG matt weiß)**
$U = 0.7 \text{ W/m}^2\text{K}$
$g = 0.35$
$t = 0.6$

**Triple SSV (VSG/ESG/VSG)**
$U = 0.6 - 0.7 \text{ W/m}^2\text{K}$
$g = 0.35$
$t = 0.6$
Heat source

Power source

Low temperture - heating

E- heat pump

Controlled Air conditioning
### EnEV-proof 2009

<table>
<thead>
<tr>
<th></th>
<th>EnEV account</th>
<th>Calculated building characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual requirement of primary energy</strong> $Q_p^\prime$</td>
<td>104.2</td>
<td>34.3 (33 %)</td>
</tr>
<tr>
<td>in kWh/(m²a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Spez. Loss transmission</strong> $H_T^\prime$</td>
<td>0.54</td>
<td>0.27 (50 %)</td>
</tr>
<tr>
<td>in W/(m²K)</td>
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</tbody>
</table>
Demand site management - DSM
electricity supply, sunny winter day
electricity supply, night
Cumulation utilisation of own electricity

.....energy charge- management + electricity detention

Utilisation of own electricity in %

Heat pump

freezer

Potential electricity consumers
Surplus-Energy +

E- Mobility
We believe in the sun…

… and our visions!!!