Prefabrication, deep retrofits and the municipal perspective

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Energy Management Da-Di-Werk
Outline

• Who we are
• School buildings’ specifics
• Retrofit examples
• Prefabricated wooden constructions for new school buildings
• Wishes to OutPHit
County Darmstadt-Dieburg in numbers ...

- 290,000 inhabitants
- 81 schools with 475 buildings

Sustainability

- 2008 School building and retrofit program
- Guidelines for sustainable buildings: Built to the PH standard

Da-Di-Werk: 80 office workers, 80 caretakers, Energy management 4 employees
School buildings’ specifics

High occupation density (Hohe Belegungsdichte)
- Head load per person: 80..100 W → 2-2,5 kW

Ventilation:
- Large air exchange rates (compared with residential buildings) 3-4 h⁻¹
- Intermittent operation: 7-17 Uhr
- Ventilation during summer → window ventilation

Time of use
- During daytime of working days only
- Longer holidays – partly used only
- Oppupaction phase expanding – all-day school
**CO₂ concentration in class room with minimal ventilation**

- Window ventilation during brakes not sufficient
- Measured concentrations up to 3500 ppm

**Goal CO₂ <1000-1200 ppm**
CO$_2$-concentration with mech. ventilation (heat recovery)

Volume flow: 450 m$^3$/h

Goal CO$_2$ <1000-1200 ppm

- Very good air quality with mech. ventilation

CO$_2$ Konzentration, 30 Schüler + 1 Lehrer

CO$_2$ Gehalt
Anwesenheit
Lüftungslaufzeit

Luftvolumenstrom:
450 m$^3$/h Während Unterricht
School buildings’ specifics
Summer comfort – heat fluxes

Heat transported by air
\[ n = 2 \text{ h}^{-1}, \quad T_e = T_i + 5 \text{ K} \]

Solar gains
Mean daily solar radiation, small window area

IHS: pupils presence
Summer comfort with consequent shading, night ventilation and thermal masses

Example: Hessenwaldschule
User recommendations

Gutes Raumklima in Sommer und Winter

Stets eine frische Wiese

Da-Di-Werk Gebäudemanagement

O. Ottinger, Energiemanagement

www.ladadi.de/
Aktuelles – Gutes Raumklima in Sommer und Winter
Economics for new build project

Max-Planck-Gymnasium

- New PH building with classrooms
- Hybrid construction with wooden elements
# Economics

<table>
<thead>
<tr>
<th></th>
<th>Cost overrun</th>
<th>Lower costs</th>
<th>Overall balance</th>
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<tr>
<td>Invest for improved efficiency</td>
<td>82,000 €</td>
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<td>Funding state of Hesse*</td>
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<td>398,900 €</td>
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<td>Energy savings</td>
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<td>84,000 €</td>
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<td></td>
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<td>482,900 €</td>
<td>400,900 €</td>
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* Funding compensates ventilation being necessary anyway

*Kommunalrichtlinie Hessen 2017, Zuwendungsbescheid vom 04.10.2018*
Retrofit examples

Albrecht-Dürer-Schule

Full retrofit to EnerPHit standard

Built in 1970/74

Area: 10,670 m² (1500 m²)

20 Mio. €, KG 300+400

Pellet district heating
Retrofit examples

Albrecht-Dürer-Schule

Construction period: 2015-2018

Heating demand: 25 kWh/m²a

Air tightness: $n_{50} = 0.63 \text{ h}^{-1}$

Outer view during construction

Finished out view
Retrofit examples

Ventilation units > 35,000 m³/h
Tripple glazed windows
Exterior insolation U 0,105 W/m²K
Roof insulation U=0,13 W/m²K
LED lighting

Old facade with baldy insulated aluminium windows
New facade with tripple glazed wood-aluminium windows in PH-quality (Uw≈0,8 W/m²K)
NEW Class room building in Schaafheim

Framework contract for „better containers“ was upgraded here to a permanent school building

- Ventilation
- Tripple windows
- Heat pump heating system

Corridor with staircase in contrast colours

Class room with integrated ventilation unit in furnitures at left side
NEW Class room building in Schaafheim

Framework contract for „better containers“ was upgraded here to a permanent school building

• Ventilation
• Tripple windows
• Heat pump heating system
NEW Class room building in Schaafheim

Wooden element construction, outer shell complete

Interior construction onsite
School cafeteria building J.-F.-Kennedy school

Cafeteria for 100 pupils

Warm-up kitchen for 300 meals

Prefab communal perspective

Cafeteria area with ventilation ducts

Hood above washing machine – contrast between wooden construction and kitchen
Primary school in planning phase

• 2-story school building including mensa and office area
• Approx. 6000 m²
• Passive House standard
• Wooden space cells
• Central part as massive construction
SaP Retrofit?

- Built in 1970s
- Concrete sandwich construction
- Complete retrofit necessary

Prefab communal perspective

Facade elements uninsulated
Windows partly out of order
Building services to be renewed
Fire protection issues
Wishes to OutPHit

Constriction time 6 weeks (holidays)

Integration of

• Ventilation
• Heating & Cooling
• Electric installation...

How to renew our SaP
THANKS

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Working for our future