Apartment building "Sodastraße 40" in Ludwigshafen, DE

PROJECT SUMMARY
Renovation of an apartment building with exposed brickwork, built in 1892. 78% reduction of annual heat energy demand with interior insulation (according to PHPP).

SPECIAL FEATURES
Monitoring addressing interior insulation.

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SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

IEA – SHC Task 37
Advanced Housing Renovation with Solar & Conservation

Before

After

BACKGROUND

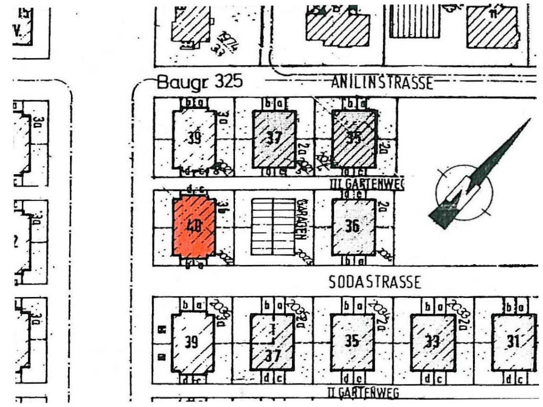
Between 1872 and 1912 BASF built this workers' housing estate "Hemshof - Siedlung" in Ludwigshafen, DE. During 2005 one of these buildings with four apartments was extensively renovated as a pilot project. Where possible Passive House components were used. To preserve the character of the exposed brickwork 80 mm of interior insulation were used.

The previous annual heat energy demand of about 250 kWh/m²a could be reduced to 54 kWh/m²a, calculated by the Passive House Planning Package (PHPP).

After the renovation the building was monitored for 1 1/2 years to study the interior insulation.

SUMMARY OF THE RENOVATION

- interior insulation
- insulation of basement ceiling (above ceiling)
- insulation of the roof (new roof)
- passive house suitable windows (triple glazing)
- decentral ventilation appliances with heat recovery
- new electric and sanitary installation
- balconies (stand-alone)



Site plan

Reduction of thermal bridges by constructing new stand-alone balconies.

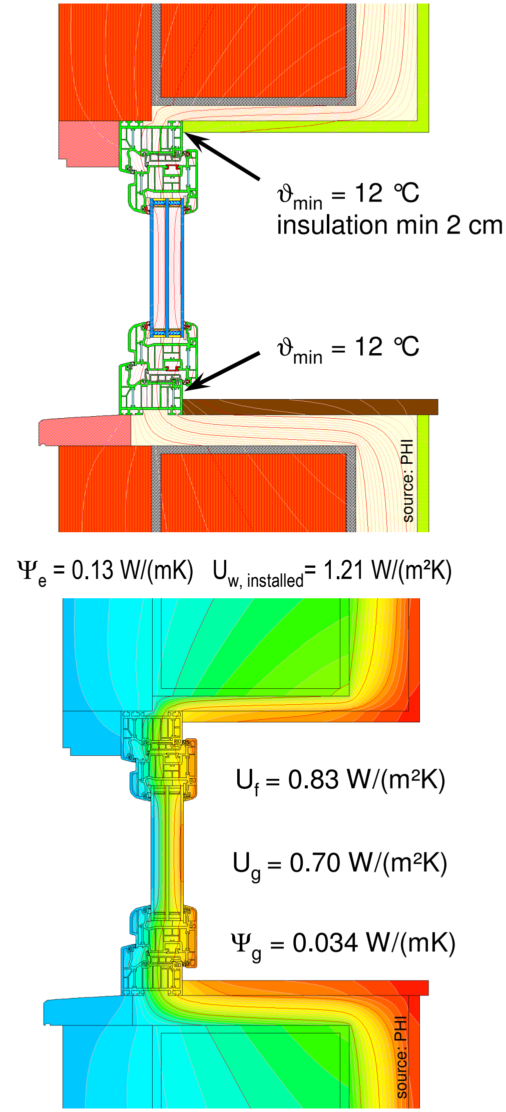
Insulated window frame at the same position. Reduction of thermal bridges by connecting the interior insulation (see page 5)

CONSTRUCTION

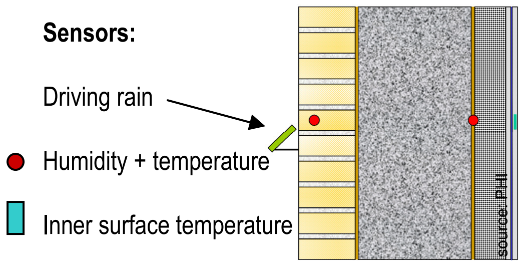
Roof construction (top down)	*U-value: 0.09 W/(m²·K)*
MDF-board	20 mm
expanded polystyrene / wood	400 mm
OSB-board	15 mm
phase change (PCM) board	15 mm
total	450 mm

Wall construction (interior to exterior)	*U-value: 0.32 W/(m²·K)*
gypsum plaster board	15 mm
vapour barrier	
gypsum plaster board	15 mm
expanded polystyrene	80 mm
interior plaster (existing)	15 mm
solid brick (existing)	240 mm
mortar (existing)	12 mm
expanded brickwork (existing)	120 mm
total	497 mm

Basement ceiling (top down)	*U-value: 0.15 W/(m²·K)*
cement floor	50 mm
expanded polystyrene	100 mm
reinforced brick floor (existing)	145 mm
expanded polystyrene	100 mm
filling	20 mm
total	415 mm



Wall build-up with driving rain sensor



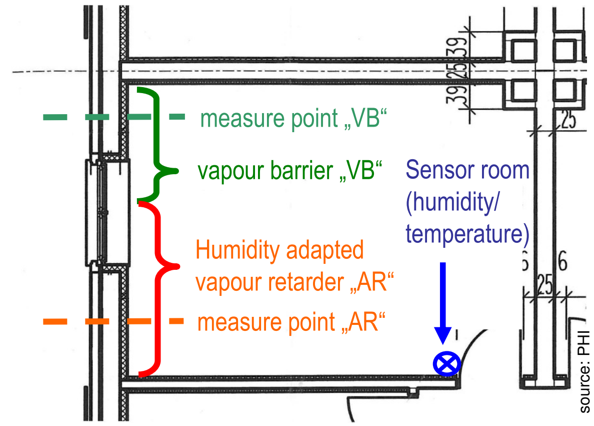
Position of the two driving rain sensors

MONITORING

After renovation from 2005 to 2009 the thermal and moisture behaviour of the exterior wall was monitored and analyzed by dynamic simulation.

In one first floor room the interior insulation was partially covered with a vapour barrier over gypsum board. The other part was covered with a humidity adapted vapour retarder. In both parts sensors were installed at the depth of the former interior plaster. After 19 months the relative humidity at this depth dried to 70 % in the area of the humidity adapted vapour retarder. In the vapour barrier area this value was reached after 32 months.

At the exterior wall two driving rain sensors were installed. The existing brickwork showed an extremely high hygroscopicity. Therefore the humidity in the expanded brickwork, in spite of the normal double hydrophobization of the façade, increased considerably after driving rain. It dried slowly over several months, which is inadequate for an interior insulation regardless of the vapour barrier or vapour retarder. The dynamic simulation showed, that in case of this brickwork an adequate protection against driving rain is provided with a fourfold hydrophobization.
This analysis shows the need of a preliminary inspection to ensure the efficiency of hydrophobization especially with the use of interior insulation.

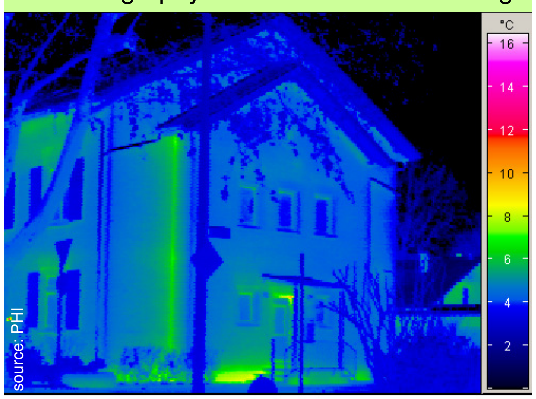


Floor plan of the analyzed room

Analyzed room with opened areas for the installation of the sensors.

Installation of the vapour barrier

Thermography of the refurbished building



CONNECTING THE INTERIOR INSULATION

The vapour barrier or retarder covering an interior insulation has to be meticulously air tightly bonded to the adjoining surfaces below, at the ceiling and at inner walls to avoid infiltration of the room humidity into the interior insulation.

SUMMARY OF U - VALUES W/(m²·K)

	Before	After
roof	0.52	0.09
Walls	1.30	0.32
Basement ceiling	0.64	0.15
Windows	2.80	0.88
Windows installed		1.26

BUILDING SERVICES

The building was equipped with a decentral mechanical ventilation with heat recovery (efficiency 85%). Solar collectors provide energy for domestic hot water. The remaining heat is covered by a gas-fired condensing boiler.

RENEWABLE ENERGY USE

Solar collectors supply heat for domestic hot water.

ENERGY PERFORMANCE

Heat energy demand (according to PHPP)

Before: 235 kWh/m²a
After (PHPP): 53 kWh/m²a
Reduction: 78 %

Primary energy demand (heating, hot water, auxiliary and household electricity according to PHPP)

Before: 387 kWh/m²a
After (PHPP): 83 kWh/m²a
Reduction: 79 %

INFORMATION SOURCES

Passive House Institute, Darmstadt, DE
www.passiv.de
LUWOGE Ludwigshafen am Rhein
www.luwoge.de

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