Apartment building “Tevesstraße” in Frankfurt am Main, DE

PROJECT SUMMARY
Renovation of two apartment buildings built in the postwar period. 94 % reduction of annual heat energy demand (according to PHPP). Almost met the Passive House Standard

SPECIAL FEATURES
Ventilation with heat recovery (efficiency >85%) in each apartment.
Solar collectors

ARCHITECT
faktor 10, Gesellschaft für Siedlungs- und Hochbauplanung mbH

OWNER
ABG Frankfurt Holding, Wohnungsbau- und Beteiligungsgesellschaft mbH

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

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

Before

Afterwards

BACKGROUND

The two buildings with a typical basic structure of the postwar period were in a bad state. For the complete renovation of the former 60 apartments (in 2005 - 2006) only components appropriate for the PassivHaus Standard were used. The energy improvement of the building technical systems and reduction of thermal bridges were further key elements of the modernisation.

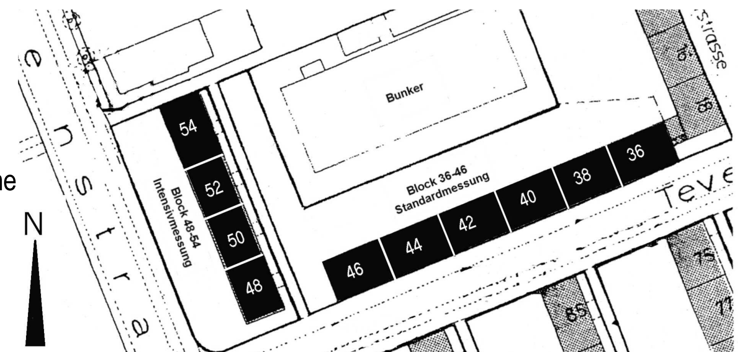
The energy balance of the buildings was computed using the Passive House Planning Package (PHPP). After renovation the apartment buildings almost met the Passive House Standard and achieved an annual heat energy demand of 17 kWh/(m²a) (according to PHPP).

MONITORING

After refurbishment the buildings were monitored, using more than 100 sensors for in excess of two years (June 2006 to July 2008).

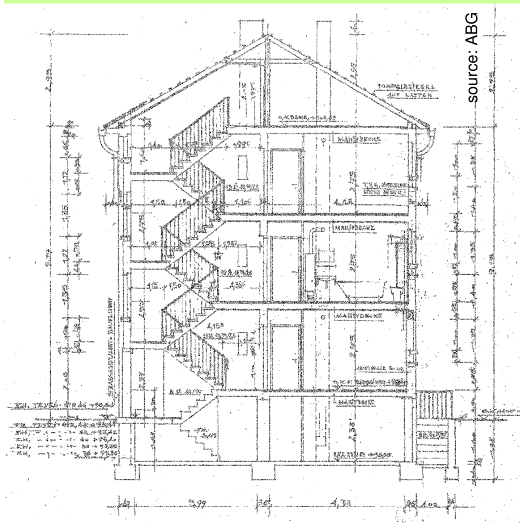
The monitoring confirmed that it is possible to almost achieve the Passive House Standard by the refurbishment of existing buildings.

Site plan of the two appartment buldings



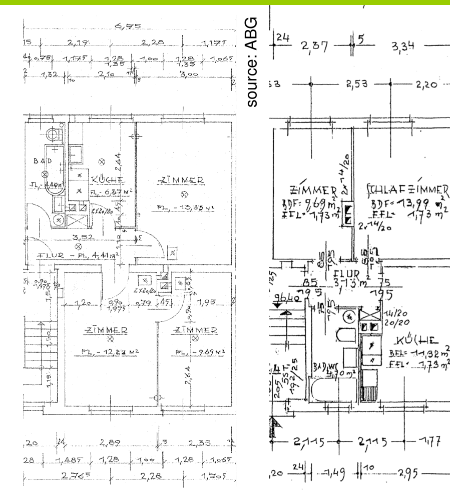
source: faktor10

section before



SUMMARY OF THE RENOVATION

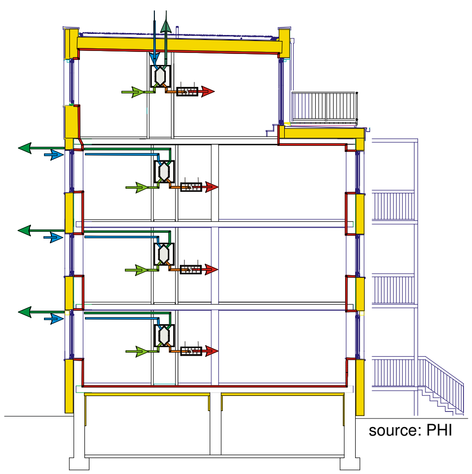
- exterior insulation and finish system, 260 mm
- insulation of basement ceiling
- modification of the ground plans
- new attic floor, wooden light-weight construction, completely insulated
- passive house suitable windows (triple glazing)
- decentral ventilation appliances with heat recovery
- improved efficiency of the air tight layer
- efficient reduction of thermal bridges
- new electrical and sanitary installation



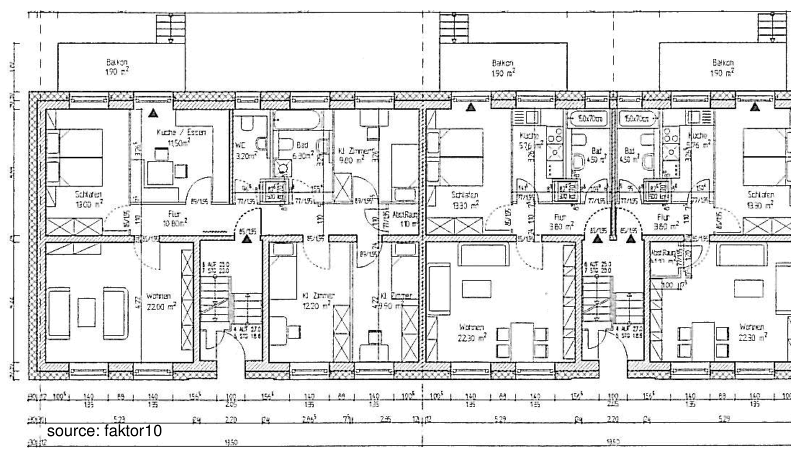
ground floor before

Before the refurbishment six apartments of 50 m² on average could be reached by one staircase. By modifying the ground plans several of these small flats were combined, so that after renovation the buildings consisted of 53 apartments of 33 m² to 100 m² with an average of 65.3 m².

The old attic floor was completely removed and a new penthouse in prefabricated wooden light-weight construction was added, covering approx. 2/3 of the former roof area.



section after



ground floor after

Air tight connection of the wooden light-weight construction to the existing top floor ceiling. The air tight sheathing of the exterior wall between gypsum plaster board and OSB-board was pushed into a mortar bed at the base of the wall.

drawing: faktor10

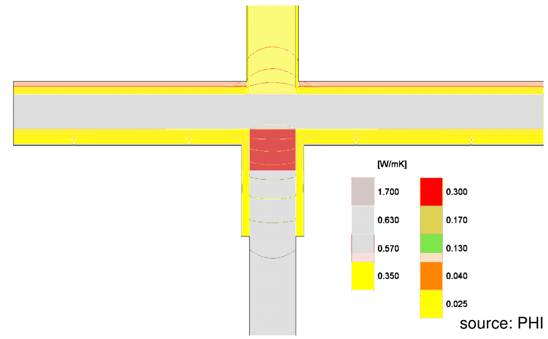
THERMAL BRIDGES

Reducing thermal bridges is an important means for cutting the heat load and avoiding structural damage. This topic was a key aspect of the refurbishment. New windows were installed, penetrations of insulation and thermal bridge to the basement ceiling were eliminated and the air-tightness of the envelope were undertaken. The air tight layer was positioned at the inner surface of the exterior building elements, This required renovating the interior plaster and the basement caulking the basement ceiling with a thin fluid primer and an anhydrite agent.

The pressure test of the existing building indicated an average air change rate of 4.4 1/h. After refurbishment the average was reduced to only 0.46 1/h

Air tight and thermal bridge-free connection of old massive building to the new attic floor in wooden construction. The waste water pipe is covered by the thermal insulation installed later (shown red in the drawing above). Outside air tubes of the ventilation system are shown in black.

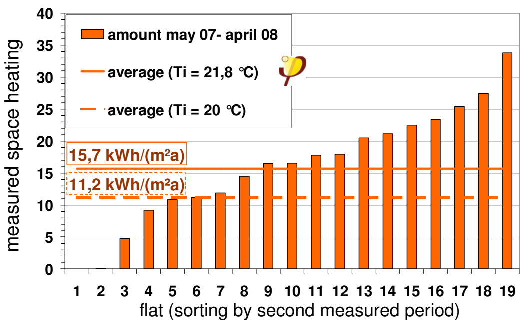
Calculated thermal bridge:
Interior wall in the basement with flanking insulation
$U_{Basement\ Ceiling} = 0.177\ W/(m^2K)$.
Result:
ψ_e (IWBC) = 0.185 W/(mK). $\vartheta_{min} = 15.7°C$.

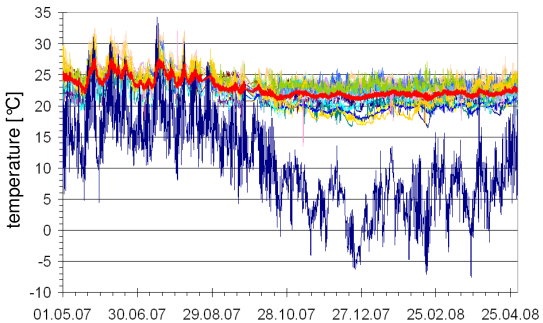


source: PHI

Flanking insulation of the interior wall in the basement with polyurethane boards of 40 mm.

Heating energy consumption of the 19 flats of the smaller block in the second period of monitoring with an average room temperature of 21.8 ℃ and converted to a room temperature of 20 ℃ . (source: PHI).





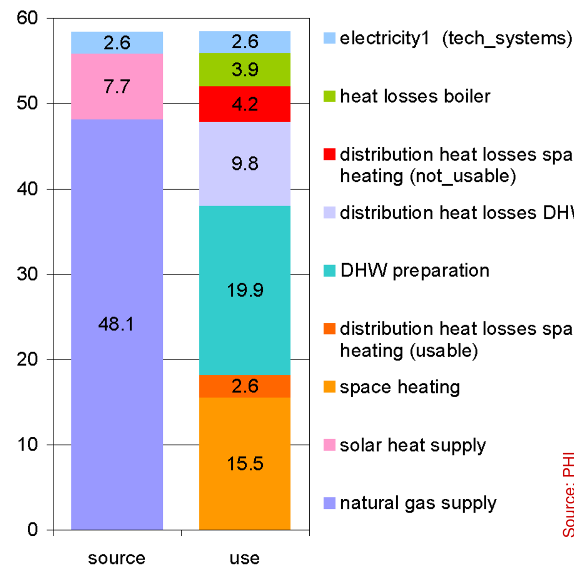
Data of outside and room temperatures of the 19 flats of the smaller block in the second monitoring period. The average is weighted to area and shown by the red line (source: PHI).

MONITORING

Both buildings were monitored. In the smaller block, in addition to the energy consumption for heating and domestic hot water, the energy consumption of each apartment was measured. Thus, the distribution heat losses forheating and domestic hot water could be determined. Also, the room temperature and electricity consumption were monitored in each dwelling. The outside temperature and the solar radiation data were taken from the German Meteorological Service (DWD) data for Geisenheim.

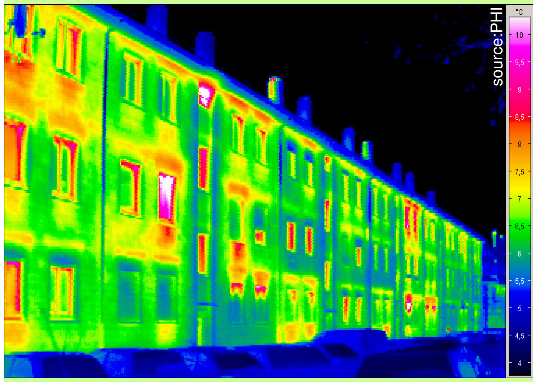
In the second monitoring period (winter 2007 / 2008) the heat energy consumption was 15.7 kWh/(m²a). Considering the usable fraction of distribution heat losses, the heating energy consumption added up to 18.1 kWh/(m²a).

The average room temperature for all apartments in the building was found to be 21.8 °C. To compare the actual heat energy consumption with the design data of the PHPP calculation, the measured data were converted to the design room temperature of 20 °C. Were the apartments heated to this temperature, the calculated heating energy consumption would have been only 13.6 kWh/(m²a). Without the usable part of distribution heat losses the consumption would have been 11.2 kWh/(m²a).



Monitored energy balance : Total final energy consumption (for heating, domestic hot water and technical systems electricity) of the smaller block and its distribution in the second monitoring period.

Before



After

CONSTRUCTION

Roof construction (top down)	*U-value: 0.11 W/(m²·K)*
MDF-board	20 mm
insulation / wood	400 mm
OSB-board	15 mm
gypsum plaster board	20 mm
total	455 mm

Wall construction (interior to exterior)	*U-value: 0.12 W/(m²·K)*
interior plaster	15 mm
cavity block (existing)	300 mm
exterior plaster (existing)	20 mm
expanded polystyrene	260 mm
exterior plaster (new)	20 mm
total	615 mm

Basement ceiling (top down)	*U-value: 0.17 W/(m²·K)*
timber flooring	20 mm
impact sound insulation	10 mm
insulation	40 mm
reinforced brick floor (existing)	180 mm
insulation	80 mm
stopping	20 mm
total	350 mm

Thermal-bridge-free fitting of windows. Mineral wool perimeter strips are used because polystyrene can melt and drip down in case of fire.

Plinth insulation without an end profil. The downpipe is conducted through a cavity in the insulation. The thermal bridge (ψ_a = 0.025 W/(mK) is acceptable if the remaining insulation is at least 100 mm.

bright rooms due to generous windows in the new penthouse

ventilation appliance in the bathroom

solar collectors

Summary of U-values W/(m²·K)

	Before	After
Attic floor	1.6*	0.11**
Walls	1.3	0.12
Basement ceiling	1.3	0.17
Windows	2.2	0.87***

- Ceiling to unheated attic floor

** new attic floor

*** incl. installation thermal bridges

BUILDING SERVICES

In each apartment mechanical ventilation with heat recovery (efficiency >85%) and a towel radiator are installed. The ground floor apartments have a small additional radiator to compensate the higher heating load caused by the remaining thermal bridges to the basement.

Solar collectors meet part of the domestic hot water heating demand. The remaining demand is covered by a gas condensing boiler in each building. One apartment has a compact heat pump unit.

RENEWABLE ENERGY USE

Solar collectors (7.5 m² each) are placed on the sloped roofs of the six staircases leading to the new attic apartments.

ENERGY PERFORMANCE

Heat energy demand (according to PHPP)

Before:	290 kWh/m²a
After (PHPP):	17 kWh/m²a
Reduction:	94 %

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

Before:	375 kWh/m²a
After (PHPP):	49 kWh/m²a
Reduction:	87 %

INFORMATION SOURCES

Passive House Institute, Darmstadt, DE.
Download research report (building stock, refurbishment, monitoring)
at www.passiv.de

faktor 10, Gesellschaft für Siedlungs- und Hochbauplanung mbH
www.faktor10.com

ABG Frankfurt Holding, Wohnungsbau- und Beteiligungsgesellschaft mbH
www.abg-fh.de

Brochure authors

Dipl.Ing. Susanne Winkel, Dr. Berthold Kaufmann,
Passive House Institute