



## LUDWIGSHAFEN (Germany)

**94 % energy saving**

**Total living expenses after renovation should stay the same**

**Innovative technologies: Passive House standard, Block CHP, LT heating, HE Heat recovery on ventilation air, PV system**

### Project data

Location, address:	Hoheloogstrasse 1 and 3 Ludwigshafen
Region:	Rheinland-Pfaltz
Surroundings:	Central-west Germany, close to Mannheim city, low hilly landscape
Climate:	Continental
Heating degree days:	Not known
Year of construction and renovation:	1960 - 62 (constructed); 2005 (renovated)
Typology:	Apartment building
No of dwellings:	12 dwellings in two flats
Total floor area:	736 m <sup>2</sup>
Owner:	GAG Ludwigshafen am Rhein (housing association)
Architect and Builder:	Architekt Walter Braun
Costs of energy saving measures to Passive House standard:	€16.667 per apartment (incl. VAT) The project is subsidized by the Experimenteller Wohnungs- und Staedtebau-Programm with € 220.000
Renovation financed by:	The owner



Figure 1: Renovated apartments in Ludwigshafen (Photo: ECN)

### Objectives and Results

GAG Ludwigshafen wants to show that "Energy- Win Houses" are feasible in the social rental sector. Two complexes of each 12 dwellings are renovated: one according to passive house standards, the other one to the EnEV 2002 (Energy Savings Act 2002). The results will be monitored and compared.. According to the calculations, the "Energy- Win House in the social rental sector" will use 15 kWh/m<sup>2</sup> floor area per year for space heating. The PV system produces 49 kWh per square metre floor area per year, so the result is 35 kWh/m<sup>2</sup>a net. The EnEV apartments will use 80 kWh/m<sup>2</sup>a for space heating and before renovation the apartments used 250 kWh/m<sup>2</sup>a for space heating.

### Renovation concept

#### Key renovation features

- Insulation of façade cellar and attic floors (roofs)
- High efficiency insulating triple glazing and frames
- Combined heat-power on block level with heat storage
- Low temperature heating
- Balanced mechanical ventilation with high efficiency heat recovery
- Space heating through ventilation air (water to air heat exchanger)
- PV system

## State-of-the-art

### Before renovation

#### Constructions [U-values: $W/m^2K$ ]

- Insulation of roof: [0,63] (6 cm mineral wool)
- Non-insulated ground floor
- Non-insulated façades
- Single glazing [5,1]<sup>1</sup>

#### Installations

- Individual heating boiler for heating and DHW with conventional efficiency
- Natural ventilation

### After renovation

#### Constructions [U-values: $W/m^2K$ ]

- Insulation of attic floors (roof): [0,114]
- Insulation of ceiling of cellar (ground floor) [0,175]
- Insulation of façades [0,107]
- High efficiency triple glazing [0,83] and frames
- Removal of thermal bridges (balconies separated from main construction and enlarged)
- Removal of common chimneys

#### Installations

- CHP system per block 43 kW<sub>el</sub>, 75kW<sub>th</sub>, hot water storage in tanks 250 kW<sub>th</sub>
- PV system of 140 m<sup>2</sup> (18 kWp, 18.000 kWh/a)
- Low temperature heating (water to air heat exchanger)
- Balanced ventilation with heat recovery 85% efficiency

## Energy saving and monitoring

Energy consumption before renovation:  
kWh/m<sup>2</sup>: 250 (space heating)

Energy Index<sup>2</sup>: unknown

Energy consumption after renovation:  
kWh/m<sup>2</sup>: 15 (space heating)  
Energy index: unknown  
Percentage saving<sup>3</sup>: 94%  
Energy consumption in the renovated Apartment buildings and the identical adjacent EnEV buildings will be monitored and later evaluated.



Figure 2 and 3: Thick insulation layer on the façade exterior and a new ventilation system. (Photos: ECN)

## Additional information

- The constructional state of the building was good, but technical state regarding occupancy conditions and energy was considered as bad. Except for radical energy saving measures, aesthetic and accessibility measures have been taken, like new balconies, fresh new paintwork, interior renovation and surroundings upgrade. The major group of tenants are low-income groups.
- A PV system compensates the energy consumption. As the yield of the system is higher than the (calculated) energy consumption, the building is an "Energy-Win House"
- The renovation and differentiation of flats has contributed to the attractiveness of the residential area.

## Lessons learned and conclusions

- The GAG Ludwigshafen has proved that it is possible to renovate apartments radically, reach high energy savings and prevent raising of total living expenses (rent, energy and maintenance costs) of tenants.

## References

- [1] Passivhaus im Mietwohnungsbestand. Exposé. Brochure about the project Hoheloogstrasse 1 & 3, Ludwigshafen. GAG Ludwigshafen am Rhein,
- [2] <http://www.GAG-lu.de>
- [3] Excursion zur 9. Passivhaustagung Rhein-Neckar -Dreieck. 1 Mai 2005

<sup>1</sup> Total U-value of glazing and the window frame

<sup>2</sup> Calculated by EPA - Energy performance Advice programme

<sup>3</sup> Compared to the situation before renovation