Renovation of residential area Dieselweg 4 / Graz

Owner: GIWOG Gemeinnützige Industrie Wohnungs AG
General planer: gap-solution GmbH
Architect: Architekturbüro Hohensinn ZT GmbH
Energy concept: ESA - Energie Systeme Aschauer GmbH
Report: AEE INTEC
Location: Graz, Austria
Date: 2010

Key technologies
• Solar façade
• Pre-fabrication of facade modules
• Energy concept based on renewable energy sources (mainly solar thermal energy)
• New heating- and DHW supply system installed between the façade and existing wall
• Decentralized ventilation systems with heat recovery
• Control and remote maintenance via internet
The residential area Dieselweg is located in the south of Graz (Styria, Austria). The buildings were built in the 1960s.

Due to the fact that since the time of construction no improvement measures have been carried out the building stock showed a very energy inefficient and poor situation. The existing building structure had no insulation of exterior walls, the cellar ceiling or the floor to the attic. The balcony slabs reached out without thermal separation and caused significant thermal bridges.

Furthermore the apartments were heated with single heating devices – using solid or fossil fuels or electric heating devices.

Due to poor structural condition and energy performance the heating costs were high and the thermal comfort and living quality were low. But the most challenging circumstance was the fact that it was considered to be impossible to resettle the tenants during constructions works.

**Project data of building before renovation**

- **Location**: Dieselweg 4, Graz
- **Altitude**: 345 m
- **Heating degree days**: HGT_{12/20} 3,500 Kd
- **Year of construction**: 1970
- **Number of apartments**: 16
- **Net floor area**: 1,240 m²
- **Heat demand**: 184 kWh/m²a (PHPP 2004)
- **Heat supply**: 13% solid fuel, 33% fossil fuel, 54% electricity
**Renovation concept**

The renovation concept for the “Dieselweg” was mainly based on two facts:

- The essential improvement of the thermal envelope with pre-fabricated façade modules
- The implementation of a new and innovative solar-active energy concept.

Both should lead to a significant reduction of the heat demand (about 93%) in order to reach passive house standard within renovation and thus contribute to an increased thermal comfort and living quality. Furthermore the decrease of running costs for space-heating and DHW-preparation should spare an increase of rents. Moreover the housing association predicted lower resulting monthly charges for the tenants.

The integration of the balconies into the new thermal envelope contributed to the elimination of the thermal bridges and an added value – increased living space for the occupants.

### Design data for renovated building

- **Year of renovation**: 2008-2009
- **Number of apartments**: 16
- **Net floor area**: 1,589 m²
- **Heat demand**: 12 kWh/m²a (PHPP 2004)
- **Reduction**: 93 %
- **Heat supply**
  - Solar thermal plant
  - Ground water heat pump

### The renovation strategy

- Pre-fabricated façade modules
- “Climate wall concept”
- Integration of balconies
- Innovative energy concept
- Innovative heat dissipation system
- “Inhabited construction site” – No resettlement of occupants

**Figure 4**: View of building (rendering) [Source: Hohensinn ZT GmbH]

**Figure 5**: Exemplary floor plan of renovated building – showing new thermal envelope, integrated balconies and new lift. [Source: Hohensinn ZT GmbH]

**Figure 6**: Cross section – new thermal envelope [Source: Hohensinn ZT GmbH]
Renovation design details

Façade solutions

Layer composition of basic façade module

<table>
<thead>
<tr>
<th>Existing wall</th>
<th>10 mm</th>
<th>Internal plaster</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>300 mm</td>
<td>Existing exterior wall</td>
</tr>
<tr>
<td></td>
<td>25 mm</td>
<td>External plaster</td>
</tr>
<tr>
<td>On-site installation</td>
<td>100 mm</td>
<td>Levelling laths</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In-between rock-wool</td>
</tr>
<tr>
<td>Pre-fabricated module</td>
<td>19 mm</td>
<td>OSB-board</td>
</tr>
<tr>
<td></td>
<td>120 mm</td>
<td>Timber frame between rock wool</td>
</tr>
<tr>
<td></td>
<td>15 mm</td>
<td>OSB-board</td>
</tr>
<tr>
<td></td>
<td>19 mm</td>
<td>MDF-board</td>
</tr>
<tr>
<td></td>
<td>30 mm</td>
<td>Solar comb</td>
</tr>
<tr>
<td></td>
<td>29 mm</td>
<td>Rear ventilation</td>
</tr>
<tr>
<td></td>
<td>6 mm</td>
<td>Toughened safety glass</td>
</tr>
</tbody>
</table>

Concept of the solar-façade

The façade modules are equipped with further integrated components like windows, shading appliances (blinds arranged between the glass panels of the windows) and ventilation ducts. The ducts are in the fields beside the windows (more bright yellow glass panels – to avoid look-through).

The basic principle of the solar façade is the solar comb. It is arranged on the OSB board, covered by a glass panel. In-between is a rear ventilated airspace. Sunlight falls through the glass and leads to an increased temperature in the airspace and the solar comb. This increased temperatures lowers the difference between inside and outside temperature in winter and leads therefore to reduced heat losses and an improved effective U-value (compared to the static U-value).
Energy concept

Solar thermal collectors

Heat supply concept

• 3 m² thermal solar collector area per apartment (installed within façade, onto flat roofs and onto car port – feeds a heat storage tank
• Groundwater coupled heat pump – feeds additionally into the heat storage tank
• DHW in each apartment supplied by the heat storage tank, supply lines running in the space between existing façade and new module.

Heat storage, distribution and dissipation, DHW

• Heat storage tank (5 m³) is installed in the cellar.
• Supply pipes are running in the space between existing façade and new façade modules.
• Heat dissipation system is mounted on the outside of the exterior wall. The heating pipes integrated in the insulation boards.
• The DHW preparation is done decentralized in each apartment, but supplied by the heat storage tanks.

Heat storage tank

Heat dissipation

Heat pump

DHW

Figure 12: Heat dissipation – XPS–boards installed on existing façade.

Figure 13: Heating pipes are inserted in XPS boards, which are mounted onto the existing wall.
Construction process

Concept of pre-fabrication

Module dimension: 12 x 3 m

Dimension of modules is fixed by the line of the intermediate floor and the window lintel.

Concept of assembly

First module is the lowest one. It is mounted on steel-bearing angles, which are fixed on the plinth. All other modules rest on the previous one. Therefore all joints are horizontally designed.
Performance data

Monitoring system
- Energy consumption and flows
- Spot measurements of relevant comfort parameters: room temperature, room humidity and CO₂ concentration
- Evaluation of the concept concerning the building physics
- Indoor quality in winter as well as in summer
- Questionnaires on users´ comfort

Evaluation and performance assessment

Figure 19: Control and remote maintenance via controlcenter [Source: FUTUS Energiesysteme GmbH]

Renovation costs
- € 8.8 Mio. excl. of VAT (without external works)
- € 816 per m² (net floor area after renovation)
- € 862 per m² (net floor area before renovation)

Financing
- € 7.3 Mio. GiWOG Gemeinnützige Industriewohnungs AG (including subsidies from the Styrian Government)
- € 1.0 Mio. funding by Federal Government of Austria
- € 0.5 Mio. funding by Styrian Government, Department of Environmental Affairs

Running costs

Heating
- Before renovation about € 2.00 m² net floor area / month (calculated for an apartment heated by electric heating device)
- After renovation about € 0.11 m² net floor area / month

DHW
- Before renovation about € 0.40 m² net floor area / month
- After renovation about € 0.10 m² net floor area / month

Cooperation
- GiWOG Gemeinnützige Industrie Wohnungs AG
- Gap-Solution GmbH
- Hohensinn ZT GmbH
- Klima Aktiv Partner
- ESA Energiesysteme TB Aschauer
- FFG Österreichische Forschungsförderungsgesellschaft GmbH
- klima + energie fonds
- Haus der Zukunft, ÖGUT
- bmvi, bmwfj
- Land Steiermark
- AEE INTEC
IEA ECBCS Annex 50
Prefab Retrofit

Summary

At this showcase project for the high-performance renovation of a large-volume residential building, the passive house standard was achieved and the heating costs could be significantly decreased by about 90%. CO₂ emissions were also reduced by the use of renewable energy sources, e.g., solar thermal energy.

Pre-fabricated large-scale façade modules with integrated windows and ventilation systems were used. In this way, an essential increase of the thermal and user comfort was achieved. The indoor environment was improved.

Georg Pilarz (CEO) GIWOG AG

Practical Experience

Our reconstruction project in Graz, Dieselweg is remarkable for many reasons:

All 204 flats were rented before and throughout all the construction time. The room heating was based on electricity, oil and coal. There were no elevators and a majority of senior inhabitants. The buildings were in a very poor condition according to their age.

Aiming a sustained, global technical solution - passive house standard, sustainable energy based heating, barrier free access, healthy room climate - we also had to provide a perfect financial solution in order to convince the inhabitants to accept all the interference and disturbances.

Supported by the Austrian system of public housing aid, by additional research funds and by special support provided by the governor of environmental affairs of Styria and the non-profit organisation “Wohnungsgemeinnützigkeit” of the GIWOG Corporation we found a solution, that kept the social rental fees low and allows an amortization of the investments within reasonable time.

We achieved affordable sustainability. The evaluation of the first results makes us confident, that we can keep our promises, given as well to our customers as to the aiding institutions and our shareholders.

Figure 20: Façade detail of renovated building

Figure 21: View on the finished façade – showing the new façade structure with integrated windows and balconies, and the solar thermal collectors on the flat roof.