Renovation of residental area Dieselweg 3-19 / 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

Background

The residential area Dieselweg is located in the south of Graz (Styria, Austria). In from days the residential area was called „Steyr-Daimler-Puch settlement“. (The famous car-company built apartments for theirs workers.

Since the time of construction no improvement measures have been carried out, therefore 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. Some of the old windows were replaced by PVC-Windows already, some were in since the 1950s. 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 3-19, Graz
Altitude	345 m
Heating degree days HGT$_{12/20}$	3.500 Kd
Year of construction	1952
Number of apartments	126
Net floor area	7.722 m²
Heat demand	142 kWh/m²a (PHPP 2004)
Heat supply	13% solid fuel 33% fossil fuel 54% electricity

Figure 1: View of “Dieselweg 3-19”

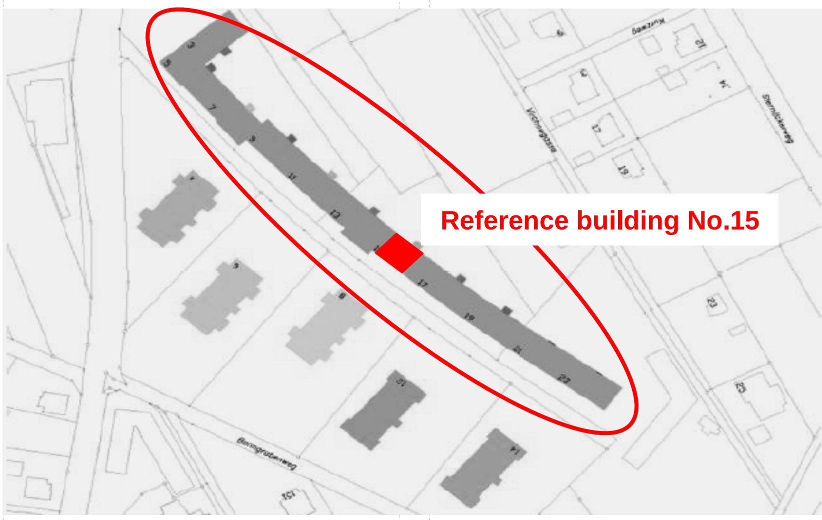

Figure 2: Site plan showing the entire area and location of building “Dieselweg 3-19” [source: Hohensinn ZT GmbH]

Figure 3: Exemplary floor plan of building Dieselweg No.15 [Source: Hohensinn ZT GmbH]

Renovation concept

The renovation concept for the "Dieselweg" was mainly based on following aspects:

• The essential improvement of the thermal envelope with pre-fabricated façade modules.

• The integration of a series of components into the pre-fabricated façade module system like windows, ventilation devices and sola thermal collectors.

• The implementation of a new and innovative solar-active energy concept.

This concept should lead to a significant reduction of the heat demand (about 90%) and the greenhouse gas emissions.

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.

Figure 4: Dieselweg 13 and 15 – covered with new façade modules

Figure 5: Overview site plan – Dieselweg No. 13 and 15 are marked in red [Source: Hohensinn ZT GmbH]

Design data for renovated building

Year of renovation	2008-2010
Number of apartments	134
Net floor area	7.889 m²
Heat demand	14 kWh/(m²a) (PHPP 2004)
Reduction	90 %
Heat supply	Solar thermal plant $3m^2$/ apartment Ground water heat pump

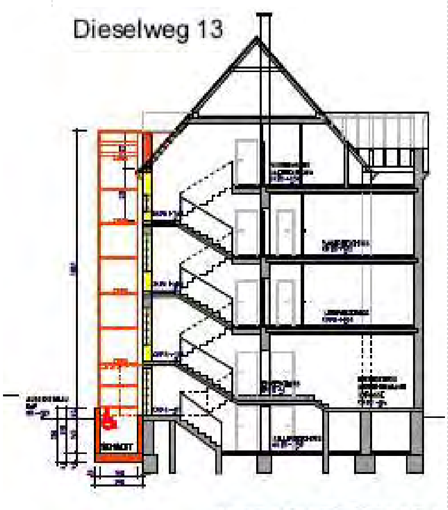

Figure 6: Cross section of Dieselweg No. 13 [Source: Hohensinn ZT GmbH]

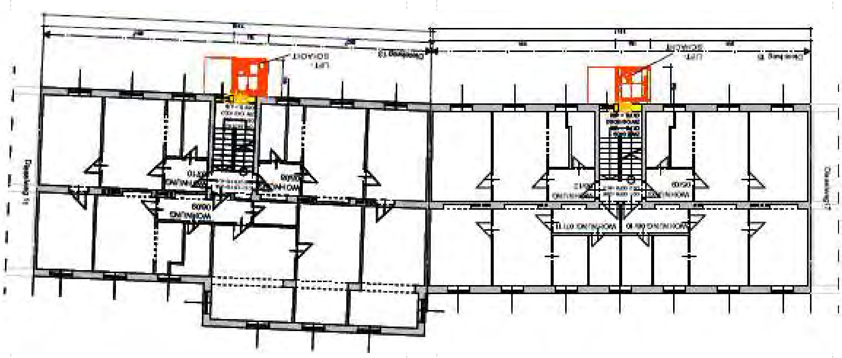

Figure 7: Floor plan of Dieselweg 13 and 15 – new lifts are marked in red [Source: Hohensinn ZT GmbH]

Renovation design details

Façade solution

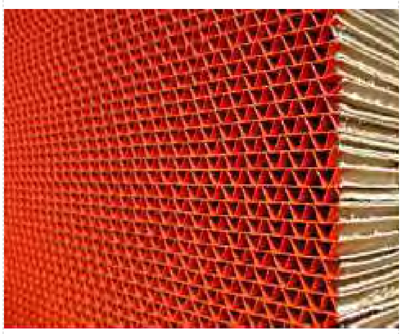

Figure 8: Detailed view of solar comb

Figure 9: Solar comb protected by a toughened glass panel

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 air space. 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).

Figure 10: Basic principle of the solar comb [Source: Gap-Solution GmbH]

Integrated components – windows, shading devices, ventilation ducts

Figure 11: Boreholes in the existing wall – no penetration before completion

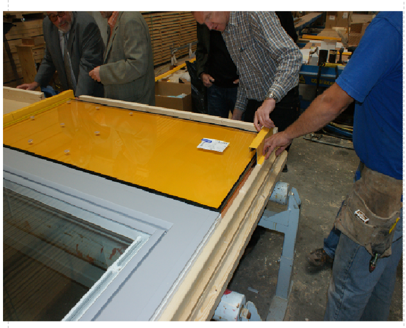

Figure 12: Integration of window and ventilation ducts in the module

Figure 13: Window with integrated shading device and opaque field beside the window – covering supply and exhaust air ducts for ventilation

The apartments are equipped with decentralized single room ventilation devices with a heat recovery (efficiency factor about 73%). The ducts for supply air and exhaust air are integrated in the module.

The existing wall was penetrated with boreholes for the air ducts to the ventilation device inside the apartment. But the existing wall was not penetrated totally at once. After the modules have been mounted, the penetration and installation was completed.

The ventilation systems are positioned beside the windows – on the outside the ducts are covered with opaque glass panels. These are visible within the façade structure (see figure 13).

The supply air is now sucked in the bottom of the field and the exhaust air on the top.

Energy concept

Solar thermal energy

Core of the innovative energy concept is the integration of solar thermal collectors to a great extend.
The façade of the long building row (Dieselweg 3-19) which is facing south and southwest got integrated collectors.
The roof of the carport was also covered with collectors.
Additional collectors were installed on the flat roofs of the five single buildings.
So the entire plant provides a collector area of 3m² per apartment.

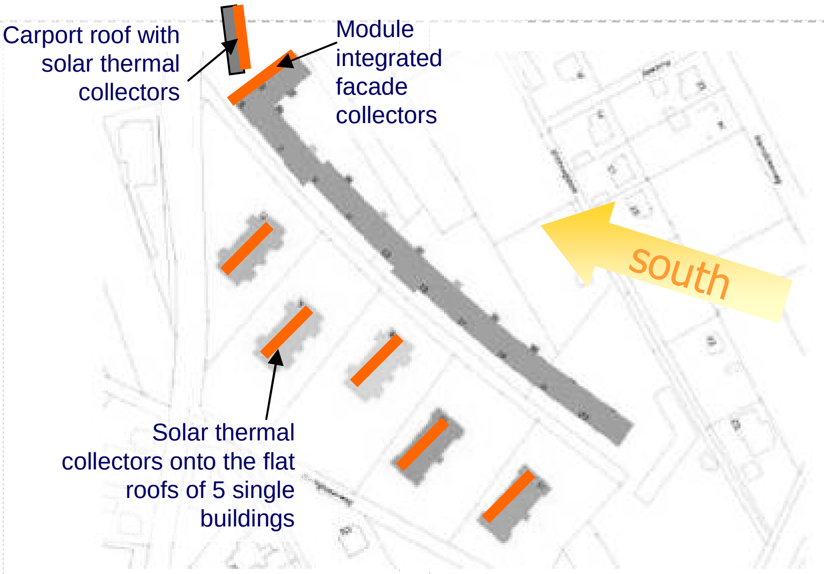

Figure 14: Site plan showing the solar thermal collector areas. [Source site-plan: Hohensinn ZT GmbH]

Heat storage

Heat storage tanks (5 m³) are installed in the cellar – three of them in the long building row (Dieselweg 3-19). The are supplied by the solar thermal plant and a ground water heat pump.

Figure 15: Site plan showing the position of the heat storage tanks. [Source site-plan: Hohensinn ZT GmbH]

Heat dissipation

The heat distribution is done by heating pipes which are running in the space between leveling laths.
The heat dissipation is done by small heating pipes which are inserted in XPS insulation boards and mounted on the existing walls. So these walls are warmed from the outside.

Figure 16: Heat dissipation on the outside of the existing walls.

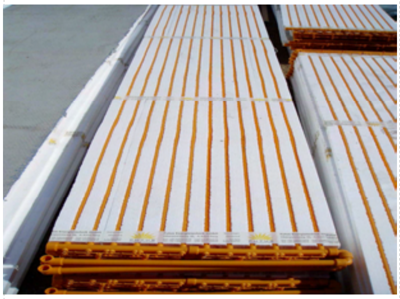

Figure 17: Heating pipes are inserted in XPS insulation boards.

DHW

The DHW preparation is done decentralized in the apartments, but supported by the heat storage tanks. The supply pipes are running - like the heating pipes in the space between old and new façade.

Construction process

Figure 18: The preparation on-site is done by levelling laths. In-between the dissipation system and supply pipes are installed

Figure 19: The solar collectors were integrated into the pre-fabricated modules [Source: Gap-Solution GmbH]

The renovation proceeded very smart :

The preparation on-site comprised the installation of the levelling laths, where in-between the heat disspation panles and supply lines were mounted. Afterwards the remaining space was filled with rock-wool. The modules were brought by a low-loader to the building site, lifted by a truck-mounted crane to the facade. Additionally on each side two assembly operators supported the fitting procedure. After the entire facade was covered with the new modules the old windows were removed from the inside, the vapor barriers were sealed (building´s angles, window-reveal,..) and the collectors were connected to the supply pipes.

Figures 20-22: Sequence of assembly of the modules on the south-oriented façade. [Source: Gap-Solution GmbH]

Performance data

Monitoring system

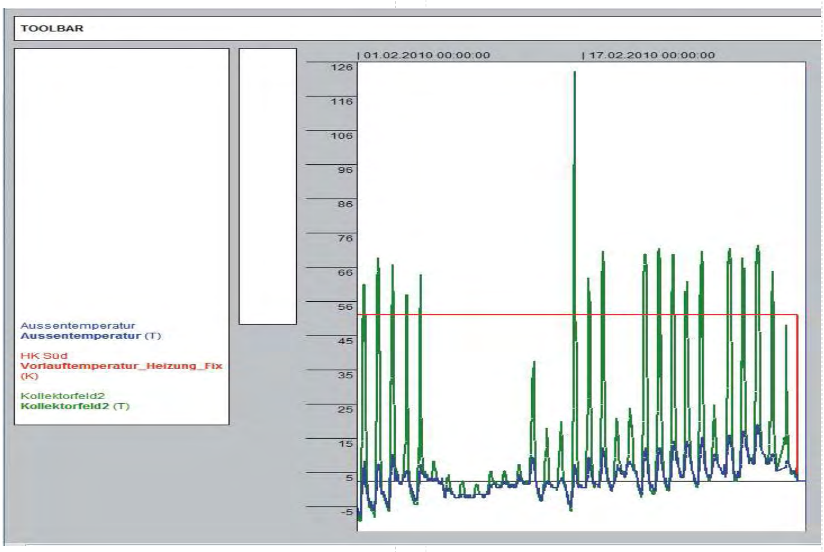

Figure 23: Control and remote maintenance via controllcenter [Source : FUTUS Energiesysteme GmbH]

Evaluation and performance assessment

- Energy consumption and flows
- Spot measurements of relevant comfort parameters: Room temperature, room humidity and CO_2 concentration
- Evaluation of the renovation concept concerning the building physics
- Indoor quality in winter as well as in summer
- Questionnaires on users´s comfort

Renovation costs

Complete Investment

- € 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 Österr. Forschungs-förderungsgesellschaft GmbH
- klima + energie fonds
- Haus der Zukunft, ÖGUT
- bmvit, bmwfj
- Land Steiermark
- AEE INTEC

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%. CO_2 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.

Figure 24: View of the renovated building from the back showing the additionally installed passenger lift.

Figure 25: View on a renovated part (left) and a former part of the façade (right)

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 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 a 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.

Georg Pilarz (CEO) GIWOG AG