

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



Background

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.



Figure 1: View of building [source: GIWOG]

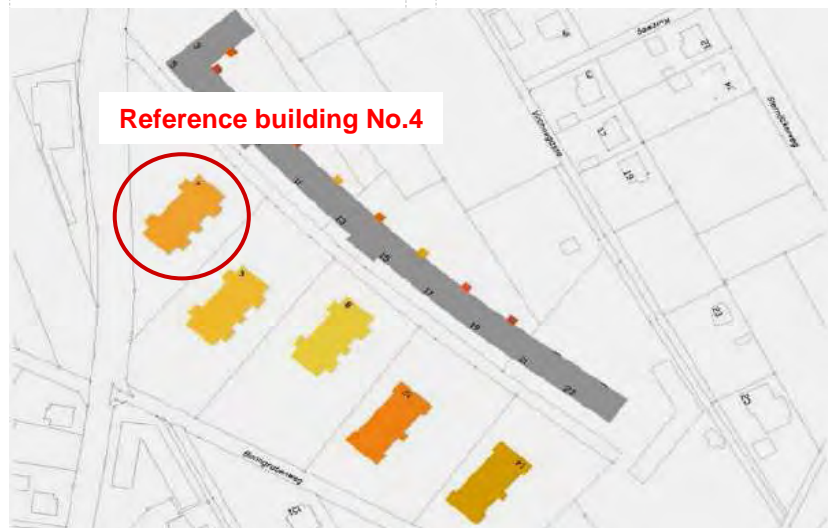


Figure 2: Site plan of the entire area and the specific position of the building “Dieselweg No. 4” [Source: Hohensinn ZT GmbH]

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 m ²
Heat demand	184 kWh/m ² a (PHPP 2004)
Heat supply	13% solid fuel 33% fossil fuel 54% electricity



Figure 3: Exemplary floor plan Dieselweg No.4 [Source: Hohensinn ZT GmbH]

Renovation concept



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

Design data for renovated building

Year of renovation	2008-2009
Number of apartments	16
Net floor area	1.589 m ²
Heat demand	12 kWh/m ² a (PHPP 2004)
Reduction	93 %
Heat supply	Solar thermal plant 3 m ² / apartment 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

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.



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

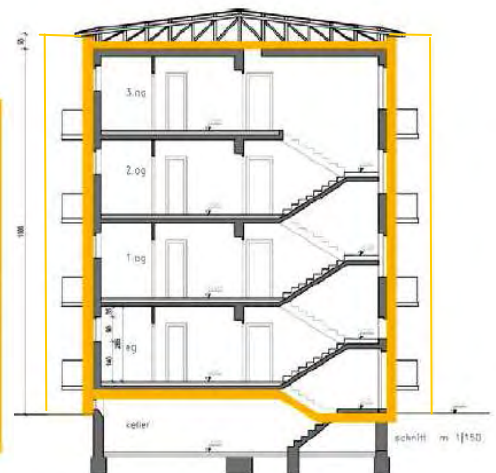


Figure 6: Cross section – new thermal envelope [Source: Hohensinn ZT GmbH]

Prefab Retrofit

Renovation design details

Façade solutions

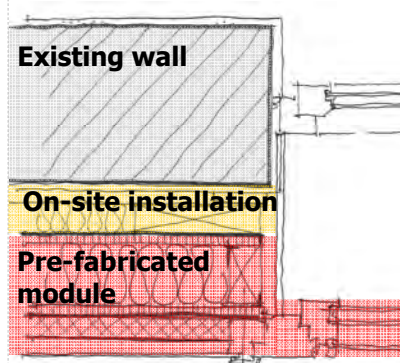


Figure 7: Pre-fabricated façade module

Layer composition of basic facade module

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

Concept of the solar-façade

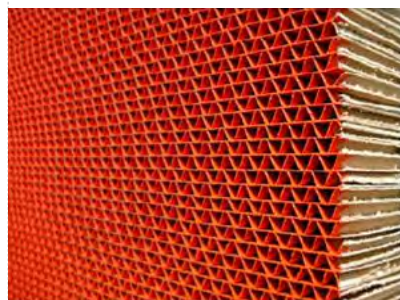


Figure 8: Solar comb
[Source: Gap-Solution GmbH]

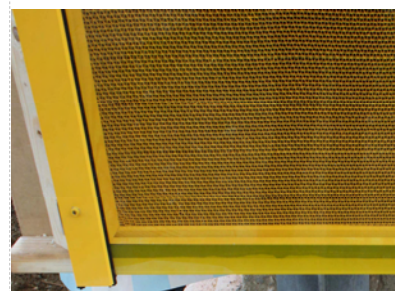


Figure 9: Solar comb protected by a toughened glass panel

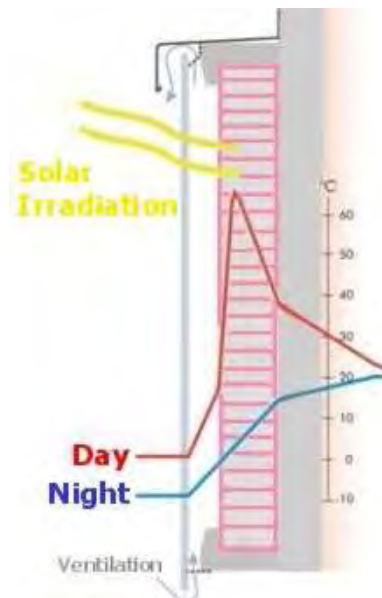


Figure 10: Basic principle of the solar comb
[Source: Gap-Solution GmbH]



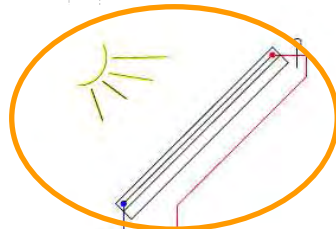
Figure 11: View on facade

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 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).

Energy concept

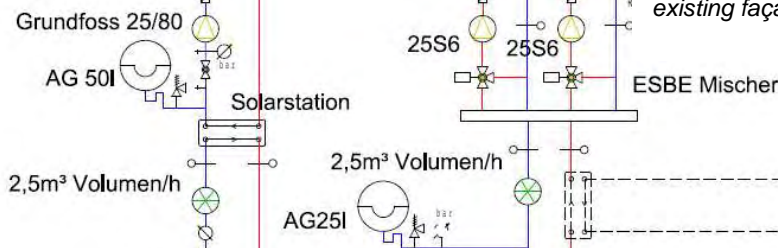
Solar thermal collectors



Heat dissipation



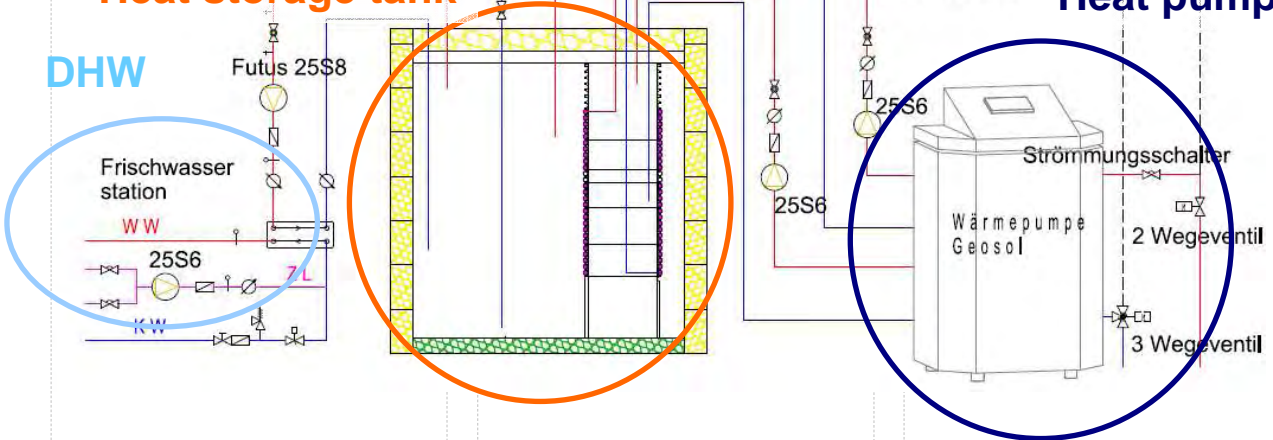
Figure 12: Heat dissipation – XPS-boards installed on existing façade.



Heat storage tank

Heat pump

DHW



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.



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

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.

Construction process

Concept of pre-fabrication



Figure 14: Sequence of pre-fabrication procedure in the fabrication hall [Source pictures 5-6: Gap-Solution GmbH]

Concept of assembly

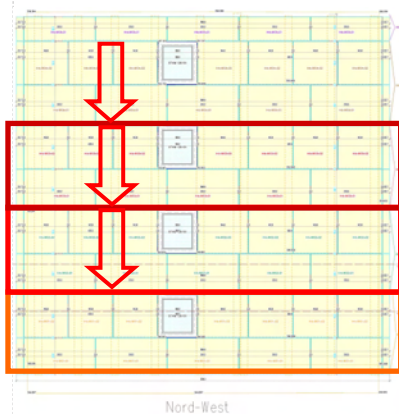


Figure 15: Sequence of assembly of the façade modules [Source view: Kulmer Bau]

Module dimension: 12 x 3 m

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



Figure 16: Assembly of the lowest module



Figure 17: Steel-bearing angles on the plinth.

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.



Figure 18: One building side is closed. [Source: Gap-Solution GmbH]

Performance data

Monitoring system

Evaluation and performance assessment

- 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' s comfort

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

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. Forschungsförderungsgesellschaft GmbH
- klima + energie fonds

- Haus der Zukunft, ÖGUT
- bmvit, bmwfj
- Land Steiermark
- AEE INTEC

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.



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

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 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