Kapfenberg, Austria

Project summary

Energy concept: Insulation, mechanical ventilation, solar thermal and PV-system

Background for the renovation – reasons

The existing residential building was in high need of renovation. The overall intentions were:

- 80% energy efficiency – 80% reduction of the energy demand of the existing building
- 80% ratio of renewable energy sources – 80% of the total energy consumption of the renovated building should be provided by renewable energy sources
- 80% reduction of CO_2 emissions – 80% reduction of the CO_2 emissions of the existing building

Site:	**Johann Böhm Straße 34/36 8605 Kapfenberg, Austria**
Altitude:	502 m
Heating degree days:	3794 (base temp. 20° C)
Cooling degree days:	0
Owner:	ennstal SG
Architect:	Nussmüller Architekten ZT-GmbH
Energy concept:	AEE INTEC

View of existing (small picture) and the renovated building (large picture) (west elevation)

Contact Person:	Dir. Wolfram Sacherer ennstal SG
Important dates:	Beginning of the renovation: March 2012. End of the renovation: Jan, 2014
Date completed:	Dec. 18, 2013

Building description /typology

- Built: 1960-1961
- Residential building with four floors
- On each floor six flats were located
- The living space varied from 20 to 65 m^2
- Total gross heated floor area: 2845 m^2

Building envelope, heating, ventilation, cooling and lighting systems before the energy renovation

Description of building (building situation, building system, renovation needs and renovation options)

The analysed building is a residential building which was built between 1960 and 1961. The four-story building has a length of 65 m (east and west façade) and a depth of 10 m (north and south façade). On each floor nine apartments were located which varied from 20 to 65 m^2 living space. These apartments didn´t meet the current way of living because they were too small. For this reason not all flats were rented.

Building envelope

The existing building was a typical building from the 1960's made of prefabricated sandwich concrete elements without an additional insulation. Only the wood wool panels of the prefabricated concrete elements performed as a slight thermal insulation.

The basement ceiling was insulated with approx. 6 cm polystyrene. The old roof was a pitched roof with no insulation. The ceiling to the unheated attic was insulated with 5 cm wood wool panels.

The existing windows were double glazed windows with an U-value of 2.5 W/m^{2}K. The missing airtightness of the existing windows caused high infiltration losses.

Heating, ventilation, cooling and lighting systems before retrofit

In the existing building a variety of different heating systems was installed: a central gas heating, electric furnaces, electric night storage heaters, oil heaters, wood-burning stoves and coal furnaces.

The ventilation of the existing building was accomplished by opening the windows; no mechanical ventilation system was installed.

The enormous energy demand caused very high heating and operating costs. A high quality refurbishment of the building with a change in the layout of the apartments should make the building more attractive to new residents and young families.

Facade – before and after the renovation

Facade during the renovation

Element	Area m^2	U-Value before renovation W/m^{2}K	U-Value after renovation W/m^{2}K
Façade	1463	0.87	< 0.17
Ceiling	711	0.39	< 0.30
Windows, doors	349	2.50	< 0.90
Roof	711	0.74	< 0.10

Energy renovation features

Overall Energy Saving Concept

The retrofit concept is based on energy efficiency measures (reduction of transmission, infiltration and ventilation losses), on a high ratio of renewable energy sources and on an intelligent integration in the existing heat and electricity grid.

Building

Instead of conventional insulation systems the façade in this project is covered with large-sized active and passive façade elements.

These façade elements include on the one hand traditional rear-ventilated constructions (various surfaces possible) and on the other hand active elements to produce energy like solar thermal or photovoltaic panels.

The old pitched roof is removed and a new flat roof is established. The roof is highly insulated with approximately 35-40 cm. The windows are already integrated in the prefabricated façade modules and are of high thermal quality (triple glazing).

Inside works include among other things also the change of the layout of the flats to make them more attractive to new residents.

Prefabricated façade elements with integrated active energy production (photovoltaic and solar thermal panels)

Building Services

Heating: The basic heat supply of the renovated building is accomplished by the local district heating. Additionally 144 m² solar thermal panels are installed on the south facade. Heat provided by district heating and solar thermal system is stored in a 7500 liter buffer storage. From the buffer storage a 2-pipe-system (flow and return) brings the heat to the 32 flats where the heat for domestic hot water is stored in a small boiler. Radiators emit the heat in the flats.

Ventilation: A new mechanical ventilation system with heat recovery is installed (heat recover efficiency 65% / SFP 0.45 Wh/m³). The ventilation units are positioned on the flat roof and the existing stacks and installation ducts of the building are used for the ventilation ducts. In one half of the flats the ventilation system is controlled automatically based on the CO_2 concentration, in the other half of the flats the residents can control the ventilation system by a three-stage controller individually.

Photovoltaic: Photovoltaic panels with a size of 550 m² resp. 80 kWp are installed on the roof on a steel construction in form of a wing. Additionally 80 m² resp. 12 kWp are installed on the south facade.

Mounting of the photovoltaic panels on the roof (left picture), pv and solar thermal panels on the south façade (right picture)

Calculated Energy Savings, CO_2 reductions and Life Cycle Costs

Electricity demand before and after renovation:		
before renovation:	**79 MWh/year**	**33 tCO2/year**
after renovation:	**47 MWh/year**	**20 tCO2/year**
calculated savings:	**32 MWh/year**	**13 tCO2/year**
Energy demand for heating and hot water before and after renovation:		
before renovation:	**337 MWh/year**	**80 tCO2/year**
after renovation:	**85 MWh/year**	**4 tCO2/year**
calculated savings:	**252 MWh/year**	**76 tCO2/year**

Left building part already renovated – right building part in the middle of the renovation

Calculated energy savings:

The transmission heat losses from the building envelope can be reduced from 337 MWh/year (existing building) to 85 MWh/year (renovated building). This means energy savings of 252 MWh/year.

The infiltration heat losses can be reduced from 89 MWh/year (existing building) to 47 MWh/year (renovated building). This means energy savings of 42 MWh/year.

In total 294 MWh/year can be saved for heating and domestic hot water.

As a result of the renovation the usable energy gains in the building (internal and solar gains) are reduced from 126 MWh/year to 84 MWh/year. This means 42 MWh/year less energy gains are usable after the renovation.

As a consequence of that the calculated total energy savings are 252 MWh/year.

Calculated energy production:

The calculated energy production of the solar thermal system is 39.5 MWh/year; the energy production of the photovoltaic panels is about 80 MWh/year.

Total Renovation Costs: **4.3 Mio €**

Solar thermal and PV panels on the south facade

Overall improvements

Non-energy benefits

- New and larger balconies for all flats:
  - Improvement of the reputation of the building
  - New functional area for the residents
  - Improved thermal quality by reduction of thermal bridges
- Barrier-free access to all flats by the installation of an elevator and an arcade
- Changed layout of the flats enables new modern living with windows to both, east and west, sides
- Better indoor climate by mechanical ventilation system with heat recovery
- Renewal of old heating and domestic hot water systems improve the operational comfort by a new centralized and automatically controlled system

Different steps of the building renovation process: installation of the building services, assembling of the prefabricated façade modules, almost finished building envelope (f.l.t.r.)

Indoor climate technical improvements

The indoor climate is improved due to:

- mechanical balanced ventilation with heat recovery and a carefully adjusted supply temperature
- Less heat losses and draught through walls, windows and doors

Assembling of the prefabricated façade modules on the west facade

Barriers to overcome and solutions:

- The financing of the renovation was a barrier because due to governmental regulations it was not possible to excessively increase the rental price for the apartments. Therefore other funding and financing solutions were necessary to realize the renovation.
- Additionally, the renovation works inside the building, such as the change of the layout, made a resettlement of the residents necessary. Due to the fact that there were no apartments available in Kapfenberg at the time of the renovation, this process could only be put into practice in two different construction phases in order to guarantee the residents an apartment during the renovation period.

Summary and Lessons Learnt

Summary

The existing residential building is renovated with a new façade (prefabricated active and passive elements), new windows, new roof (flat roof instead pitched roof) and new building services.

A new heating system (local district heating and solar thermal system on the south façade of the building) and a new mechanical ventilation system with heat recovery are installed.

Photovoltaic panels on the roof and on the south façade for the electric energy production were also installed.

By those measures following objectives of the renovation should be achieved:

- 80% energy reduction
- 80% ratio of renewable energy sources
- 80% reduction of CO2-emission

Lessons Learnt

All asked tenants lived in the building before the renovation and 85% also during the renovation of the building.

The expectations of the tenants to the retrofit were generally satisfied. The tenants were also satisfied with the housing association and the different companies which carried out the renovation.

Assessing their housing situation some tenants criticized the natural lighting in the apartments, the temperatures at the beginning (too cold) and the noise because of the renovation works of the second construction phase.

The tenants were satisfied with the information they received regarding the mechanical ventilation system and the heating and domestic hot water preparation.

References: all AEE INTEC

Left building part: finished renovation; right building part: still in renovation

A few days later – building envelope of the right building part almost finished