# Bruck an der Mur

## Project summary

**Energy concept:**

**Background for the renovation – reasons**

The aim of this project was to gather information and experiences of the pilot project and the research, so that those information and experiences can be directly used in the planning and decision process of the building owner Austrian Real Estate (ARE)

and other building owners. Thereby four main fields of investigation have been identified:

- Subsequent installation of ventilation systems with heat recovery
- Shading, daylight and lighting
- Sustainable cooling and summer comfort
- Innovative façade systems

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| **Site:** | **An der Postwiese 8<br>8600 Bruck / Mur, Austria** |
| Altitude: | 485 m |
| Heating degree days: | 3710 (base temp 20°C) |
| Owner: | **Austrian Real Estate (ARE)**<br>a subsidiary company of BIG |
| Architect: | Architekturbüro Pittino & Ortner |
| Energy concept: | Rosenfelder & Höfler Gmbh & Co KG, TB Köstenbauer & Sixl, Busz GmbH |

| | |
|---|---|
| **Contact Person:** | **Mag. Dirk Jäger<br>BIG** |
| Important dates: | Beginning of the renovation: summer 2010.<br>End of the renovation: summer 2012 |
| Date completed: | February 5th 2014 |

**Building description /typology**

- Built: in 1960s
- Official building which includes the district court, the financial authority and the Federal Office for Metrology and Surveying
- Gross heated floor area: 6486 m² (total)

*View of existing (© e7 Energie Markt Analyse GmbH) and renovated building (© Markus Kaiser, Graz)*

# 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 analyzed building is an official building which includes the district court, the finance authority and the Federal Office for Metrology and Surveying. The building was constructed between 1963 and 1965. The finance authority is situated in a separate section of the building, has four floors and is connected to the other section of the building by a shared staircase.

The building is a typical building from the 1960´s, made of in a precast concrete skeleton construction without insulation. The existing building was heated by a central gas heating system.

The Federal Ministry of Justice, as the main tenant, claimed for a renovation and an enlargement of the existing building. Besides the need of more space (app. 840 m² (NFA)), there was also a desire for functional improvements. Especially public and frequented areas like the entrance hall, hearing rooms and waiting areas did not fulfill today´s requirements and needs. The existing building was not barrier-free accessible due the existing mezzanines.

Essential design parameters were:

- Barrier free access to all parts of the building
- Creating a service center for the court
- It has to be possible to spatially divide the court from the other parts of the building
- Separated entrance for the court incl. double door system
- Renovation resp. renewal of windows, roof and façade based on the state of the art
- Improvement of the natural lighting
- Preservation of the existing parking area

*Building before the renovation (© e7 Energie Markt Analyse GmbH)*

*Building before the renovation*
*(© e7 Energie Markt Analyse GmbH)*

| Element | Area m² | U-Value before renovation W/m²K | U-Value after renovation W/m²K |
|---|---|---|---|
| Façade | 2895 | 1.32 | < 0.155 |
| Ceiling | 1345 | 1.06 | 0.188 |
| Windows, doors | 908 | 3.00 | < 1.380 |
| Roof | 1345 | 0.50 | 0.112 |

# Energy renovation features

## 3 pillars of sustainability

Based on the three pillars of sustainability, criteria and requirements for the renovation were defined. Following points were included:

- Ecological sustainability: high heat protection in summer and winter, low primary energy demand, use of renewable energy sources, monitoring of the energy consumption
- Economic sustainability: adherence of the frame for the investment costs, low LCC
- Sociocultural sustainability: high thermal comfort in summer and winter, acoustic comfort, high ratio of daylight, possibility of natural ventilation

## Building

New developed metal façade elements with solar comb for passive solar gains were used. A thermally insulated interlayer was mounted directly to the existing façade (compensation of e.g. irregularities of the surface). The pre-fabricated façade module with absorber (GAP-Solution) and the window modules were mounted to this interlayer.

The third floor of the district court was new constructed and thermally insulated with 32 cm mineral wool. The u-value of the new roof is 0.112 W/m²K.

The new window modules were already integrated in the new façade. The u-values of the new windows are between 1.03 and 1.38 W/m²K. Every room has minimum one openable casement. The remaining casements of the window modules cannot be opened. The sun protection is integrated in the windows and is controlled based on the solar radiation.

## Systems

**Heating:**

As part of the renovation the existing gas heating was replaced by a biomass district heating. Additionally a two-condition refrigerator with deep drillings (80-100 m deep) is integrated in the ventilation system. In summer the cooling water from the deep drillings is used to condition the supply air (free cooling), in winter the supply air is heated by an additional heat pump.

All components of the HVAC system are controlled by a centralized computer system.

**Ventilation:**

After the renovation of the building two different ventilation zones exist. In the part of the building where the financial authority is located, no mechanical ventilation is installed. In the part of the building where the district court is located, a mechanical ventilation system with high efficient heat recovery is installed. The ventilation of the hearing rooms is separated from the rest and is controlled by CO2-sensors.

The air change rate in the offices is fixed to the minimum required hygienic air change rate (0.4 $h^{-1}$). In summer automatic night ventilation with higher air change rates is performed.

**Lighting:**

In the offices the lighting is controlled automatically according to the available daylight and the presence of the people in the building. The brightness of the luminaires is automatically adjusted to the requirements but can be overruled manually.

**Photovoltaic installation:**

On the roof of the building 140 m² photovoltaic modules were installed with a maximum power of 24 kWp. The calculated energy production of the photovoltaic installation is 22.500 kWh/a.

# Calculated Energy Savings, $CO_2$ reductions and Life Cycle Costs

**Heating energy demand corrected before and after renovation (calculated):**

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|---|---|---|
| before renovation: | 145 kWh/m²year | |
| after renovation: | 24 kWh/m²year | |
| calculated savings: | 121 kWh/m²year | (-83 %) |

**Primary energy demand before and after renovation (calculated):**

| | | |
|---|---|---|
| before renovation: | 464 kWh/m²year | |
| after renovation: | 162 kWh/m²year | |
| calculated savings: | 302 kWh/m²year | (-65%) |

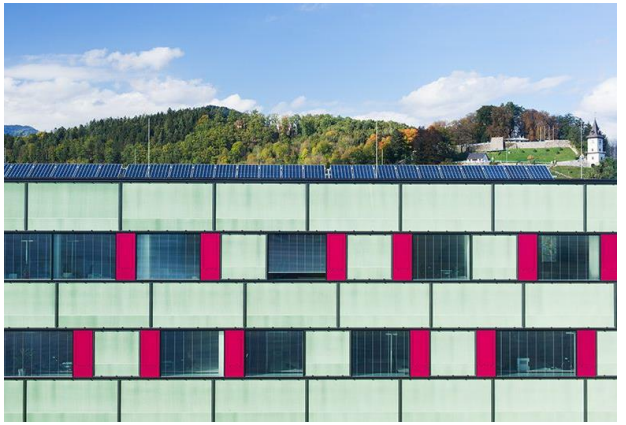
**$CO_2$-emissions before and after renovation (calculated):**

| | | |
|---|---|---|
| before renovation: | 78 $kg_{CO_2}$/m²year | |
| after renovation: | 19 $kg_{CO_2}$/m²year | |
| calculated savings: | 59 $kg_{CO_2}$/m²year | (-75%) |

**Energy production from PV (calculated):** 22.5 MWh/year

**Total construction costs:** 8.0 Mio € (excl. VAT)

*Building after the renovation (© Markus Kaiser, Graz)*



*PV-modules on the flat roof (© Markus Kaiser, Graz)*

# Overall improvements, experiences and lessons learned

## Non-energy benefits

- High thermal comfort in summer
- High thermal comfort in winter
- Acoustic comfort
- High ratio of daylight
- Possibility of natural ventilation

## Indoor climate technical improvements

The indoor climate was improved due to:

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

## Barrier to overcome and solution

Originally it was planned to renovate the pilot project with prefabricated timber elements with solar comb for passive solar gains. But due to the demands in fire protection no timber façade was possible. Therefore new metal façade elements with integrated solar comb had to be developed. This development required a close cooperation of all involved which increased the planning effort and also the costs of the renovation.

*Impressions of the renovated building (© Markus Kaiser, Graz)*

# Summary and Prospect

## Summary of project

The definition of high requirements on the energy efficiency in the planning process enables the planning of a building, which can achieve high energy savings. Other renovations of the Bundesimmobiliengesellschaft (BIG) / Austrian Real Estate (ARE) can profit from these solutions and concepts.

In the planning process it is very important to define the sustainability criteria in an early stage and to check the adherence of the criteria continuously right up to the detailed planning and the tender. Only this ensures that the high quality requirements can be fulfilled.

In the preliminary draft different varieties for optimization have to be considered and checked. The building owner has to make suggestions and recommendations for improvements in the planning stage. Important is also that the building owner can ensure that there are competences in the sector of energy efficiency to check the technical solutions of the planners carefully. A dynamic building simulation can demonstrate critical points. Together with the planning team solutions for an optimized building design have to be developed.

At the same time the building owner and the tenants have to be informed about the construction costs and the future operational costs right from the project start, when the building is defined, or at the latest at the preliminary draft when the first plans are available. The comparison of the life cycle costs (LCC) of the regular renovation and the renovation with high requirements on the energy efficiency is the basis for the tenants to make their decision. The LCC are also very important to guarantee the ecological and economical sustainability. Impacts on the user comfort have also to be highlighted in the planning process.

Nevertheless the limited budgetary capabilities of the tenants have to be considered in all deliberations!

## Prospect for future renovations

The energy efficiency measures planned and realized in this building should be recommended for all future renovations of the BIG-buildings of the 1950s to 1980s. However this quality standard has to be accepted from the ministries and the additional costs of the energy efficiency measures have to be budgeted. The ministries should not be exempted from their duties as well as without the active contribution of the tenants at the implementation and operation of energy efficient buildings such a high energy efficient level is not possible.

**References:**

[1] D. Jäger et al. (2011): Subproject 2: Demonstration building official building Bruck – planning process BIGMODERN SP2; Federal Ministry for Transport, Innovation and Technology; Vienna

[2] rosenfelder & höfler cons. eng. GmbH & CO KG (2012) – energy performance calculation