TU Vienna Plus Energy, AUSTRIA

1. INTRODUCTION

PROJECT SUMMARY
- building from the 1970s
- Project as part of larger renovation activities of the TU Vienna

SPECIAL FEATURES
- Austria’s largest plus-energy office building
- biggest façade integrated photovoltaic system

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TU Vienna, Building and Technology, Gerald Hodecek / TU University 2015

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IEA SHC Task 47
Renovation of Non-Residential Buildings towards Sustainable Standards
2. CONTEXT AND BACKGROUND

BACKGROUND
Over the course of the Austrian government’s general refurbishment package for the renewal of universities, the building area at TU Vienna at Getreidemarkt (currently used as office and partly as laboratory) will be renovated to a university office building of plus-energy standard.

OBJECTIVES OF THE RENOVATION
• Reduction of overall energy consumption by optimization of building shell/envelope and energy efficient technical equipment
• Coverage of overall energy demand for technical equipment by photovoltaic system
• Application of plus-energy standard in the non-residential building sector

SUMMARY OF THE RENOVATION
• Integral planning
• Optimization of technical devices
• Innovative cooling concepts
• Monitoring & target-performance-comparison
• Primary energy demand = 90.4 kWh/m².a
• Total costs of renovation: ~ 21 million Euro (including main auditorium)
3. DECISION MAKING PROCESSES

- The Plus-Energy-Building is part of the ‘Universcity 2015’. The goal of this project is to bring high standards for energy efficiency to the university and to create an optimal environment for science and studying.

- This is a flagship project in terms of energy efficiency and sustainable building due to the Austrian government’s general refurbishment package for the renewal of universities and within the research and innovation program ‘Building of Tomorrow – Haus der Zukunft’

- The selected building on Getreidemarkt fulfils the necessary criteria for such a project. It is the highest building on the areal, which is essential for the building integrated photovoltaic system. Its central position in the city demonstrates the concept of energy efficiency not only to the students but to a larger number of people.

- The most important step from planning a Plus-Energy-Building to actually building it is to transfer all the knowledge and high standards from the planning in the tendering process. Therefore, specific requirements for energy demand and efficiency were defined for every component, from motors for blind control systems to elevators.

**Timeline for the decision making process**

1. Idea was born
   - November 2009
2. First brief project description completed
   - December 2009
3. Detailed project description completed
   - March 2010
4. Tendering process started
   - March 2012
5. Signing of contract with main contractor
   - April 2012
6. Start of renovation
   - April 2012
7. Renovation completed
   - Goal: February 2014
8. Evaluation and monitoring of the project
   - Two years after finishing construction works
4. BUILDING ENVELOPE

Wall construction
- parapet wall including PV module
  \( U \)-value: 0.088 W/m\(^2\).K

For example (as illustrated in the sidebar)
Materials (Interior to exterior):
  Render 10 mm
  Light-weight concrete 315 mm
  Concrete compound 105 mm
  Air-proof barrier 2 mm
  Façade-insulating wall panel 180 mm
  Façade-insulating wall panel 160 mm
  Wind-proof barrier 2 mm
  Air Gap 130 mm
  Glazing including PV-module 13 mm
  Total \( \sim 917 \) mm

  - panel construction \( U \)-value: 0.096 W/m\(^2\).K
  - blank sheet façade \( U \)-value: 0.097 W/m\(^2\).K

Roof construction
- flat roof construction
  \( U \)-value: 0.066 W/m\(^2\).K

Windows
- glazing (fixed or openable, triple glazed, filled with argon)
  \( U_g \)-value: 0.62 W/m\(^2\).K
  \( g \)-value: \( \sim 0.39 \)

Air tightness
  \( n_{50} \leq 0.09 \) 1/h
  \( q_{50} \leq 0.6 \) m/h

| Summary of U-values [W/m\(^2\)K] |
|----------------------------------|----------|--------|
| Roof/attic                       | Before   | After  |
| Floor slab / exposed to air      | \~0.9    | 0.12   |
| (entrance for fire brigade)      | \~0.7    | 0.088  |
| Walls                            | \~2.5    | 0.62   |

\( n_{50} \leq 0.09 \) 1/h
\( q_{50} \leq 0.6 \) m/h
5. BUILDING SERVICES SYSTEM

OVERALL DESIGN STRATEGY
- 7,670 m² usable area, 10 storey building
- 360 office rooms, 350 seminar rooms, 50 workstations for students

LIGHTING SYSTEM
- Enhanced use of daylight
- Optimized lighting

ELECTRIC DEVICES
- Optimization of all technical devices
- Green IT (servers, laptops, PCs, network)
- Smart electricity grid
- Voice over IP (VoIP) instead of telephone

HEATING SYSTEM and DHW
- Thermal activation of concrete
- District heating
- DHW: 2 l/capita/day (electric boilers)

COOLING SYSTEM
- Passive (night-time ventilation and external shading)
- Thermal activation of components
- High efficient cooling unit including rev regulator

VENTILATION
- Two centralized ventilation systems for floors 3 to 6 and 7 to 10 (office use), additional ventilation for toilets
- Air Handling Unit (regenerative heat recovery with rotary heat exchangers)

RENEWABLE ENERGY SYSTEMS
- 336 kWp photovoltaic system (2,246 m²)
6. ENERGY PERFORMANCE

CALCULATED VALUES

heating demand = 3.4 kWh/m².a
cooling demand = 2.5 kWh/m².a
ventilation demand = 1.0 kWh/m².a
lighting demand = 5.6 kWh/m².a

The potential of annual energy savings has been calculated for electrical as well as for thermal energy consumption.

Energy performance at a glance

90% of energy savings due to optimization:
- ultra-efficient building service components with low electricity consumption in stand-by and operation mode
- smart electricity grid ensures negligible stand-by power consumption
- enhanced use of daylight and optimized lighting
- ultra efficient ventilation system with optimal heat and moisture recovery
- temperature adjustment within the rooms by highly efficient thermo-active building systems
- night-time ventilation
- thermal activation of components

Overall primary energy demand is covered by photovoltaic system.

Primary Energy Demand – Production – Embodied Energy kWh/a

<table>
<thead>
<tr>
<th>Component</th>
<th>2008*</th>
<th>2009*</th>
<th>after renovation**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric energy consumption [MWh]</td>
<td>2,098.8</td>
<td>2,066.9</td>
<td>225.9</td>
</tr>
<tr>
<td>Thermal energy consumption [MWh]</td>
<td>631.9</td>
<td>676.5</td>
<td>48.1</td>
</tr>
<tr>
<td>Electricity produced by PV system [MWh]</td>
<td>-</td>
<td>-</td>
<td>226.0</td>
</tr>
<tr>
<td>Primary energy consumption [kWh/m².a]</td>
<td>-</td>
<td>-</td>
<td>90.4</td>
</tr>
</tbody>
</table>

PEF (electricity) = 2.62 | PEF (district heating) = 0.3
* overall building
** calculated for storeys 3 to 10 (office area)

CLARIFICATION: the energy calculations and given energy numbers will be according to the national standards which might vary between countries, i.e. numbers are not always comparable
7 ENVIRONMENTAL PERFORMANCE

CERTIFICATION / LABELS
• TQB of ÖGNB Austrian Sustainable Building Council

ECOLOGICAL MATERIALS
• Use of HFC and PVC free materials
• High percentage of products and materials with environmental certificates

LIFE CYCLE ANALYSIS
• OI3 certification with 297 points

INDOOR AIR QUALITY
• Demand-based regulation of the ventilation system for higher air quality and lower energy demand
• Free Cooling

LIGHTING QUALITY
• Enhanced use of daylight
• Low energy demand for artificial lighting

RENEWABLE ENERGY SOURCES
• Façade integrated PV system
• Passive Measures (Shading, Activated Concrete Ceilings in rooms facing the facade)
8. MORE INFORMATION

RENOVATION COSTS
- Total costs of renovation: ~ 21 million Euro (including main auditorium)
- Reduction of energy costs by 90%

FINANCING MODEL
- The additional costs for the plus-energy standard are financed by TU Vienna and are financially supported by the two Austrian ministries bm:wf and bm:vit – ‘Building of Tomorrow’, by the FFG, the KPC and the city of Vienna (energy department MA 20)
- The renovation of the building is financed by the BIG - “Bundesimmobiliengesellschaft” (owner of the building)

OTHER INTERESTING ASPECTS
- One aim of this renovation project is to raise public awareness of plus-energy buildings in the Austrian real estate market.
- Another aim is to demonstrate the low additional costs during the construction phase compared to conventional buildings.
- Neither passive-house nor energy-plus standard have been established in the non-residential sector yet.