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*

ARCHITECTS

Architects Kratochwil-Waldbauer-Zeinitzer

PARTNER & CONSULTANTS

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OWNERS

Bundesimmobiliengesellschaft m.b.H. BIG

TU Vienna, Building and Technology, Gerald Hodecek / TU Univercity 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.

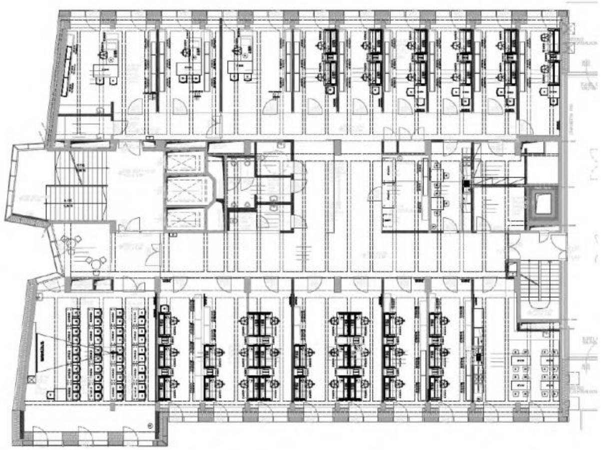
OBJECTIVES OF THE RENOVATION

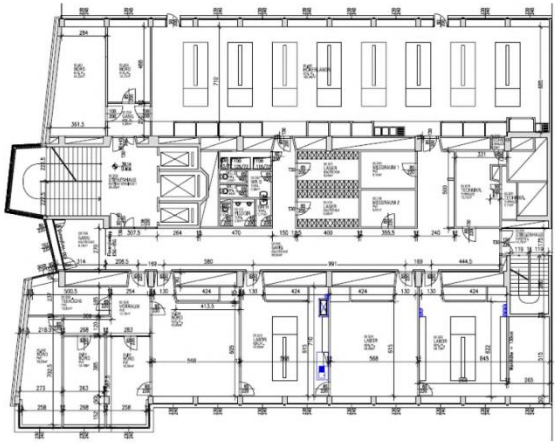
- *Reduction of overall energy consumption by optimization of building shell/envelope and energy efficient technical equipment*
- *Coverage of overall energy demand for technical equipment by photovoltaic system*
- *Application of plus-energy standard in the non-residential building sector*

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)*

before & after renovation





3. DECISION MAKING PROCESSES

- *The Plus-Energy-Building is part of the 'Univercity 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.*

Vienna University of Technology

TU WIEN

Bundesimmobiliengesellschaft BIG

BIG Bundes Immobilien Gesellschaft

Univercity 2015

TU UNIVERCITY 2015 Wir gestalten die Zukunft der Technik

Austrian Federal Ministry of Science and Research

BMWF[a] Austrian Federal Ministry of Science and Research

Building of Tomorrow

HAUS der Zukunft

Austrian Ministry for Transport, Innovation and Technology

bmvit Austrian Ministry for Transport, Innovation and Technology

Timeline for the decision making process

Idea was born
November 2009

↓

First brief project description completed
December 2009

↓

Detailed project description completed
March 2010

↓

Tendering process started
March 2012

↓

Signing of contract with main contractor
April 2012

↓

Start of renovation
April 2012

↓

Renovation completed
Goal: February 2014

↓

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	*~ 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 $W/m^2.K$

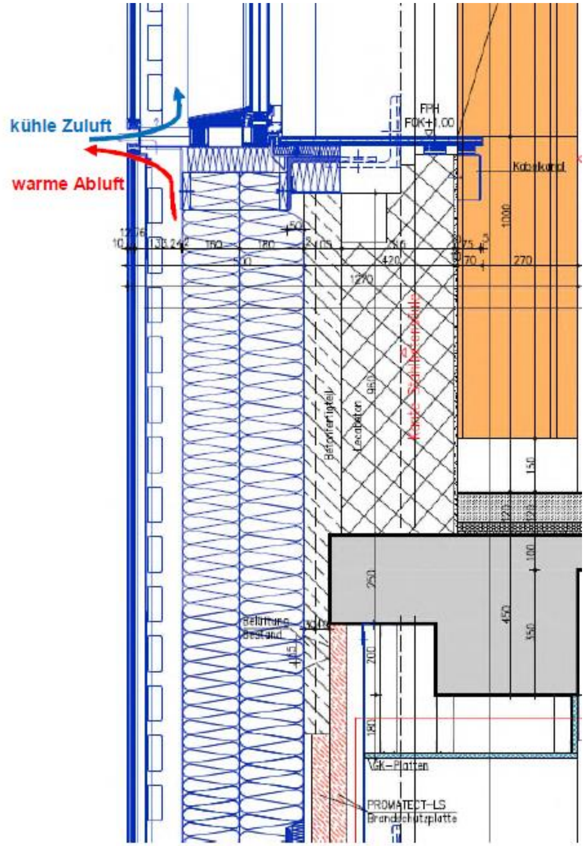
Windows

– glazing (fixed or openable, triple glazed, filled with argon)

U_g-value: 0.62 $W/m^2.K$
g-value: ~ 0.39

Air tightness

n50 ≤ 0.09 1/h
q50 ≤ 0.6 m/h

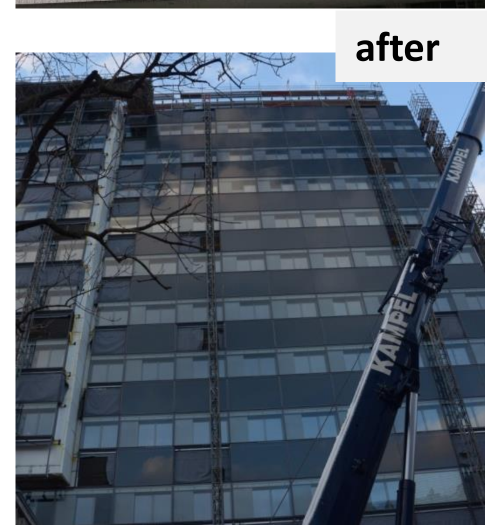


Summary of U-values [W/m²K]

	Before	After
Roof/attic	~0.6	0.066
Floor slab / exposed to air (entrance for fire brigade)	~0.9	0.12
Walls	~0.7	0.088
Windows	~2.5	0.62

before

after



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

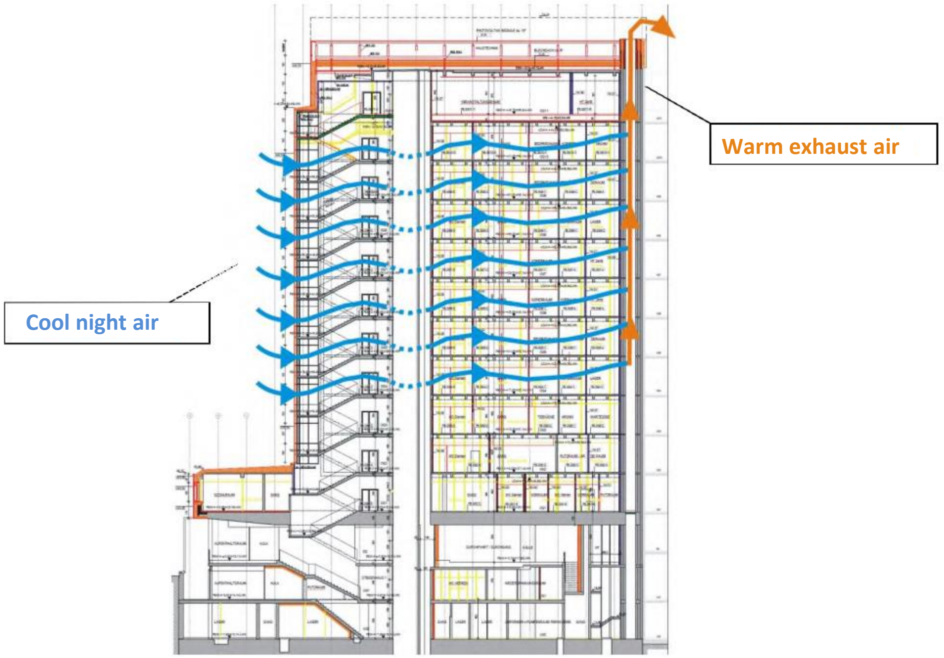
- *Passive (night-time ventilation and external shading)*
- *Thermal activation of components*
- *High efficient cooling unit including rev regulator*

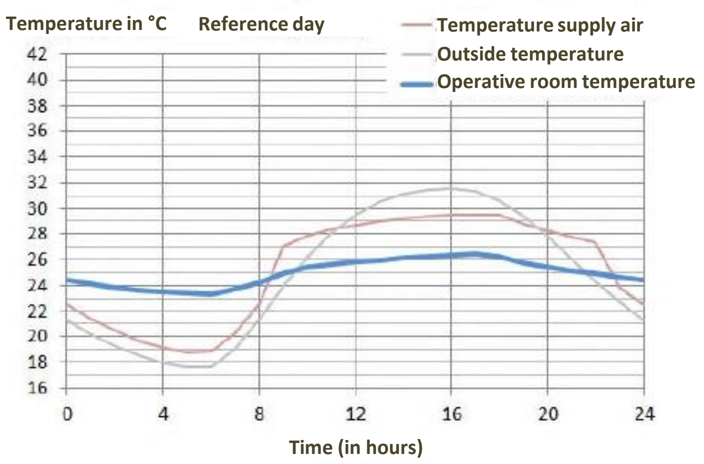
VENTILATION

- *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 kW_P 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

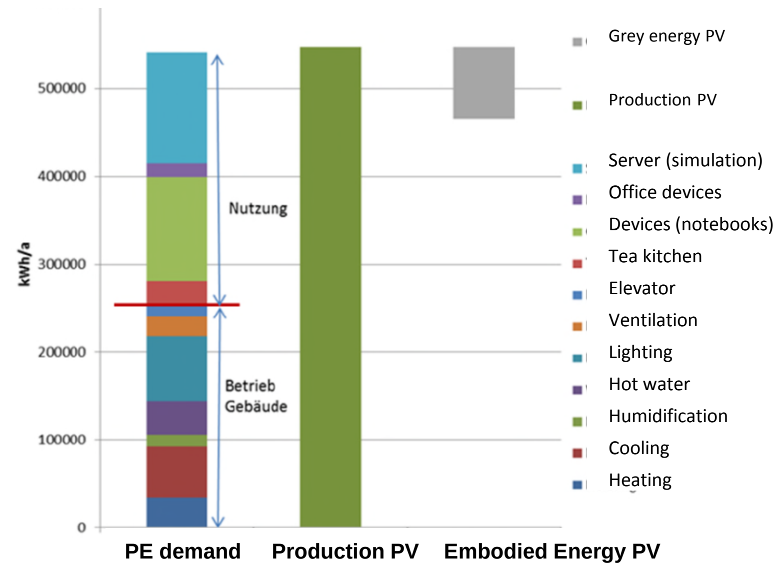
Overall primary energy demand is covered by photovoltaic system.

Summary of Energy Consumption

	2008*	2009*	after renovation**
Electric energy consumption [MWh]	2,098.8	2,066.9	225.9
Thermal energy consumption [MWh]	631.9	676.5	48.1
Electricity produced by PV system [MWh]			226.0
Primary energy consumption [kWh/m².a]	-	-	90.4

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

Primary Energy Demand – Production – Embodied Energy kWh/a



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

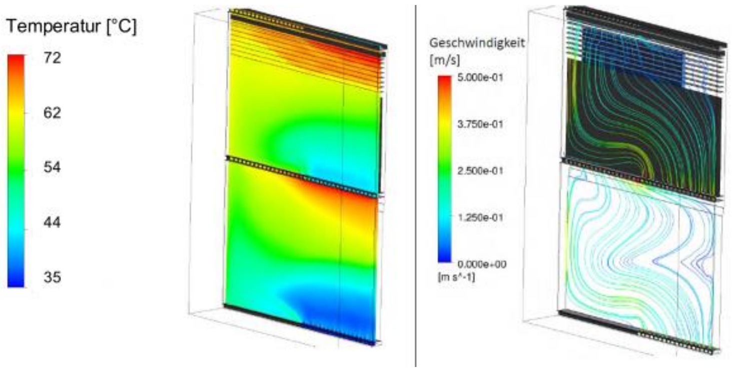
LIGHTING QUALITY

- Enhanced use of daylight
- Low energy demand for artificial lighting

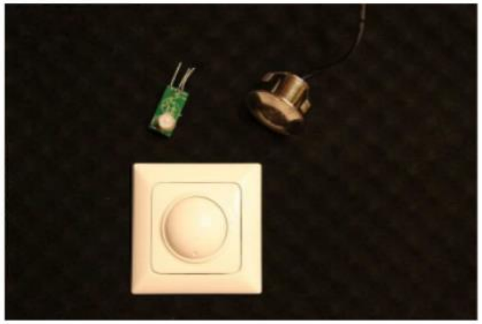
RENEWABLE ENERGY SOURCES

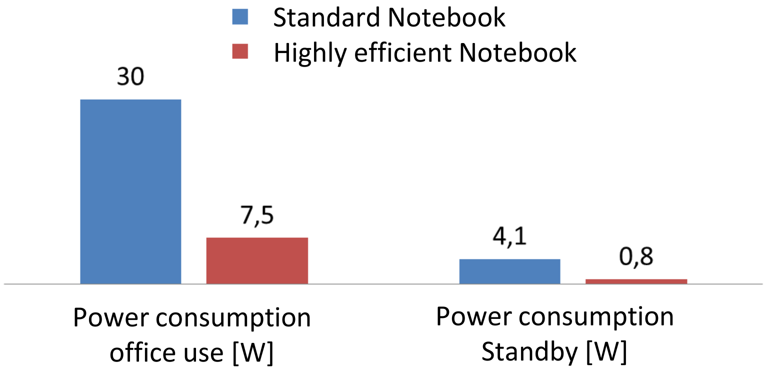
- Façade integrated PV system
- Passive Measures (Shading, Activated Concrete Ceilings in rooms facing the facade)

thermal simulation



motion sensor standby < 0.05 W





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.*