

School in Schwanenstadt, Austria

1. INTRODUCTION

PROJECT SUMMARY

- *building period 1960s*
- *numerous expansions*

SPECIAL FEATURES

- *Renovation to meet Passive House Standard*
- *decentralized ventilation system*
- *expansion from 4,140 m² to 6,214 m² useable area*
- *pellet heating (110 kW)*
- *6.7 kW_p photovoltaic system (68 m²)*

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Neue Heimat Oberösterreich
(developer)

Municipality Schwanenstadt
(owner)



IEA SHC Task 47

Renovation of Non-Residential Buildings towards Sustainable Standards

2. CONTEXT AND BACKGROUND

BACKGROUND

- *secondary school with musical focus*
- *polytechnic school*

OBJECTIVES OF THE RENOVATION

- *increase of building compactness*
- *integrate planned expansion*
- *achieve passive house standard*
- *enhance use of daylight*
- *Construct building envelope of high ecological value*
- *Apply innovative insulation from soil*

SUMMARY OF THE RENOVATION

- *use prefabricated façade elements*
- *Create no significant impacts on school activity during renovation*
- *heating demand = 14.1 kWh/m².a*
- *primary energy demand = 71 kWh/m².a (calculated values, PHPP)*
- *total costs for renovation and expansion = 7,700,000 €, including ...*
 - *~ 700,000 € for passive house technology (9.1 % additional costs)*
 - *~ 185,000 € for other energy related equipment (2.4 % additional costs)*

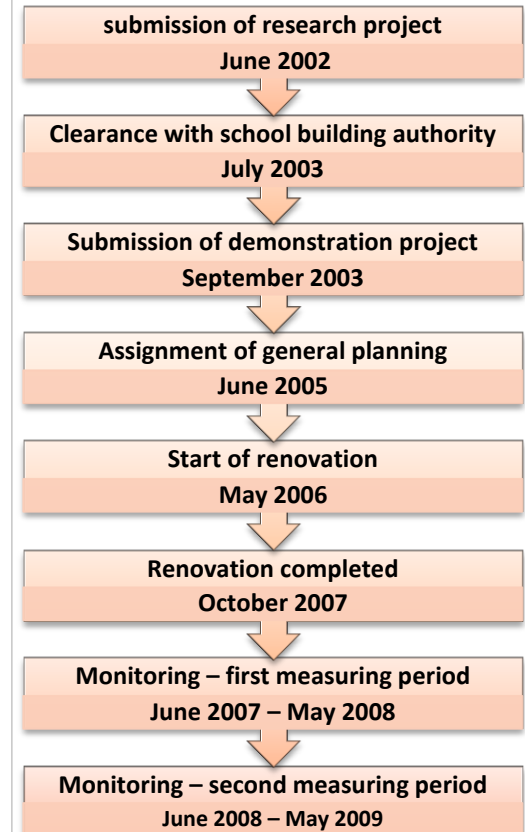


3. DECISION MAKING PROCESSES

- A conventional renovation project for the School of Schwanenstadt was due, plans were ready
- Call for demonstration projects of sustainable refurbishment within the Austrian research programme 'Haus der Zukunft / Building of Tomorrow'
- A study for refurbishment to meet Passive House Standard for the school was submitted as a research project and accepted for funding.
- After finishing the study, the demonstration project was submitted
- Prejudices against mechanical ventilation: the following measures were taken by the project team:
 - Excursion to other Austrian schools with comfort ventilation systems for the decision makers of municipality
 - One year of testing in one prototype class-room (see picture to the right)



Timeline for the decision making process



4. BUILDING ENVELOPE

Roof construction : U-value: $0.101 \text{ W/m}^2\text{K}$

Materials (Interior to exterior):

gypsum filler	3 mm
reinforced concrete	300 mm
vapour barrier	---
insulation	400 mm
oriented strand board	22 mm
EPDM	---
Total	~ 725 mm

Wall construction : U-value: $0.130 \text{ W/m}^2\text{K}$

Materials (Interior to exterior):

concrete	150 mm
reinforced concrete supports and solid wood construction with cellulose insulation	450 mm
cellulose insulation	150 mm
breathable wood panel	15 mm
battening	30 mm
wooden facade	20 mm
Total	~ 815 mm

Slab construction : U-value: $0.154 \text{ W/m}^2\text{K}$

Materials . (Interior to exterior):

flooring	5 mm
bonded screed	45 mm
wooden planks	200 mm
foam glass gravel	600 mm
Total	~ 850 mm

Mounting of façade elements



detailed view – insulation from soil

summary of U-values [$\text{W/m}^2\text{K}$]

	before	after
roof/attic	~ 3.3	0.101
floor/slab	~ 0.6	0.154
walls	~ 2.3	0.130
ceilings	~ 3.3	0.130
windows	~ 1.3	0.8

5. BUILDING SERVICES SYSTEM

OVERALL DESIGN STRATEGY

- expansion from 4,140 m² to 6,214 m² useable area
- achieve passive house standard
- increase building compactness
- use innovative insulation from soil
- Create building envelope of high ecological value

LIGHTING SYSTEM

- *enhanced use of daylight*

HEATING SYSTEM

- before: gas heating
- after: pellet heating

COOLING SYSTEM

- *passive only (night-time ventilation and external shading)*

VENTILATION

- *decentralized ventilation system*

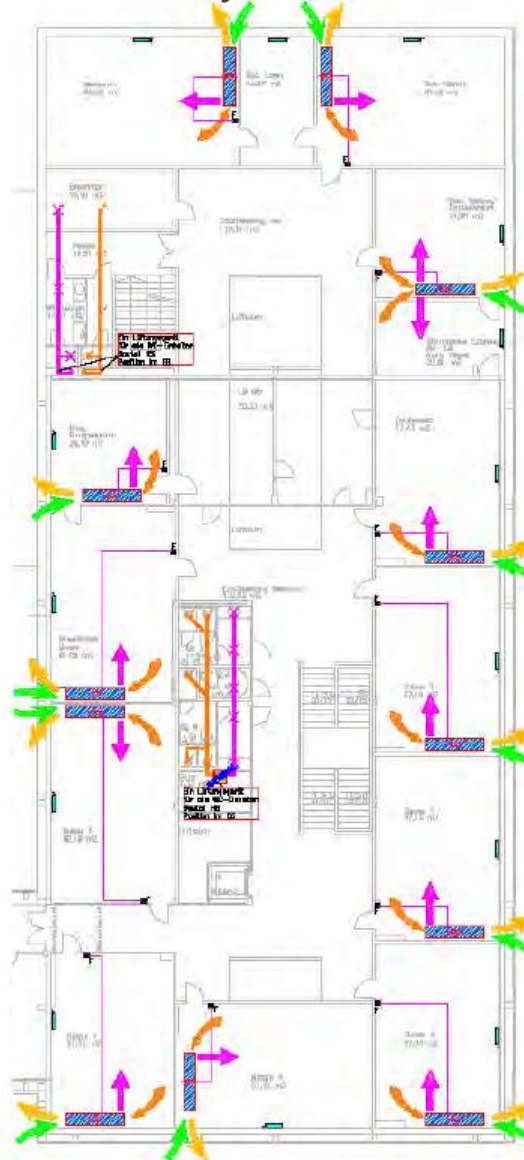
HOT WATER PRODUCTION

- before: gas heating
- after: pellet heating and electric water heater for some tapping points

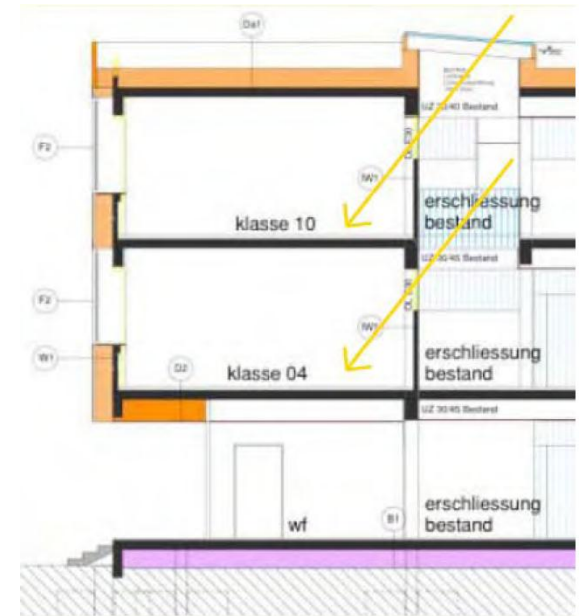
RENEWABLE ENERGY SYSTEMS

- pellet heating (110 kW)
- 6.7 kW_p photovoltaic system (68 m²)

Ventilation system



Daylighting system



6. ENERGY PERFORMANCES

CALCULATED VALUES

- Heating demand = 14.1 kWh/m².a
- Primary energy demand = 71 kWh/m².a
- PHPP, energy reference area = 5,899 m²

MONITORING PERIOD 2 YEARS

Summary of Energy Consumption [kWh/m².a]

	2007 / 2008	2008 / 2009
Heating demand, measured	18.59	21.89
Heating demand, temperature corrected	19.29	18.40
Electricity consumption	20.02	19.58
Final energy consumption	48.44	52.91
Primary energy consumption	59.69	59.64

OVERHEATING IN SUMMER

- 2007 / 2008 = 11.3%
- 2008 / 2009 = 4.6%

Ratio of hours above 26°C during school

Very low energy requirement:

The heating demand of **14.1 kWh/m².a** is **88.5 % lower than in the old building** and 82.4% lower than for a conventional **renovation**.

End energy demand at **33.6 kWh/m².a**, **reduced by 76.5 %**.

Primary energy demand at **59.3 kWh/m².a**, **reduced by 68.1 %**.

All parameters are below limit of passive house standard values, partly to significant floor extension.

CO₂ emissions for energy demand at **10.3 kg CO₂/m².a**, **reduced by 74.7 %**.

CO₂ emissions for “grey energy” in building production were 55 % lower than in **conventional renovation** due to the use of lightweight timber construction elements and optimization according to ecological building principles.

quoted from the final report of the demonstration project

http://download.nachhaltigwirtschaften.at/hdz_pdf/endbericht_0833_passivhaus_schulsanierung.pdf

PEF (electricity) = 2.7 | PEF (heating) = 0.7

7 ENVIRONMENTAL PERFORMANCE

CERTIFICATION / LABELS

- *Total Quality Building Certificate (TQB)*

ECOLOGICAL MATERIALS

- *Cellulose insulation*
- *Prefabricated wooden façade elements*

INCREASING QUALITY OF LIFE

- *7 out of 8 are satisfied*

RENEWABLE ENERGY SOURCES

- *Pellet heating system*
- *Photovoltaic facade*

FAST RENOVATION

- *Prefabricated components*

LIGHTING QUALITY

- *Enhanced use of daylight*

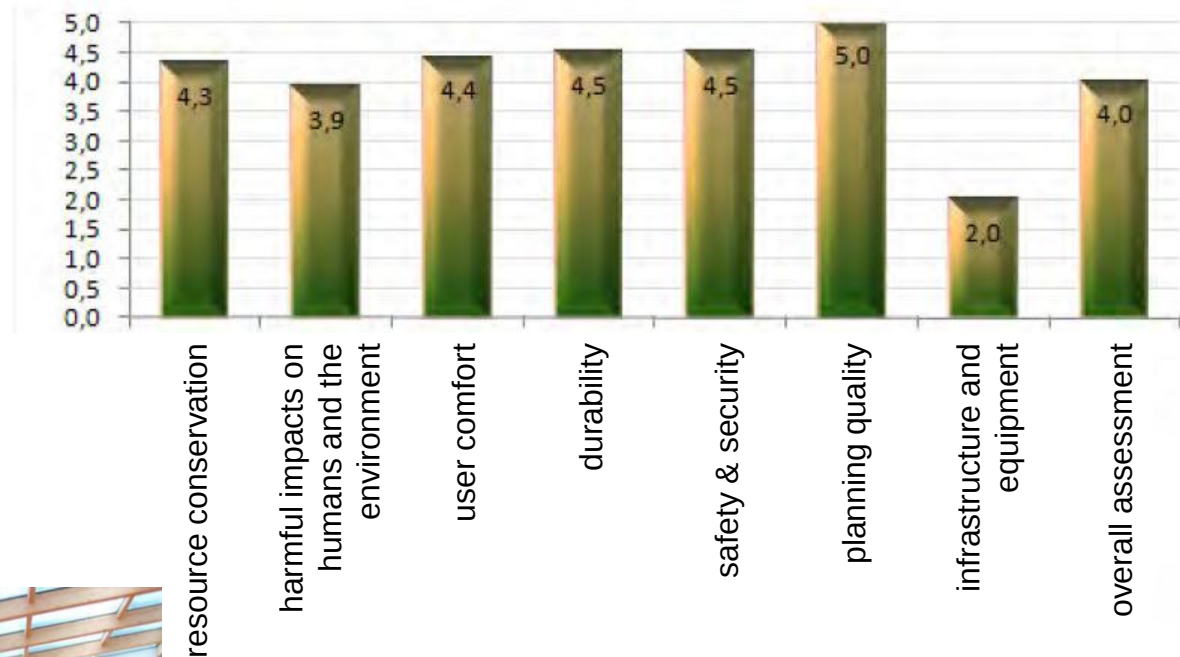


before



after

TQB assessment (Total Quality Building)



8. MORE INFORMATION

RENOVATION COSTS

- expansion (from 4,140 to 6,214 m²)
- achieving passive house quality
- 7 700 000 € including ...
 - ~ 700 000 € for passive house technology (9.1 % additional costs)
 - ~ 185 000 € for other energy related equipment (2.4 % additional costs)

ADDITIONAL BUILDING COSTS

in detail ...

- 142,442 € for sun protection
- 45,63 € for PV system
- 421,245 € for ventilation
- 85,349 € for windows
- 114,048 € for slab construction
- 36,516 € for roof construction
- 95,019 € for wall construction

minus savings of ...

- 53,730 € for heating system

ADDITIONAL TOPICS

- Costs for ventilation systems in schools should not be added to costs for meeting Passive House Standard as ventilation should be standard in classrooms for comfort reasons

Additional costs for meeting Passive House Standard per square meter usable area

