School Schwanenstadt, Austria

1. INTRODUCTION

PROJECT SUMMARY

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

SPECIAL FEATURES

- *Renovation meeting 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)*

Heinz Plöderl, PAUAT Architekten (architect)
Günter Lang, Lang consulting (manager research project)

E-Plus (building equipment)
team gmi (passive house technology)
Obermayr Holzkonstruktionen (timber construction)

Municipality Schwanenstadt (owner)

Thomas Steffl, Susanne Supper, Claudia Dankl
office@oegut.at

IEA – SHC Task 47
Renovation of Non-Residential Buildings towards Sustainable Standards

SHC SOLAR HEATING & COOLING PROGRAMME INTERNATIONAL ENERGY AGENCY

2. CONTEXT AND BACKGROUND

BACKGROUND

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

OBJECTIVES OF THE RENOVATION

- *increase of building compactness*
- *integration of planned expansion*
- *achieving passive house quality*
- *enhanced use of daylight*
- *building envelope of high ecological value*
- *innovative insulation from soil*

SUMMARY OF THE RENOVATION

- *use of prefabricated façade elements*
- *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

- *Call for demonstration projects in sustainable refurbishment of the Austrian research programme 'Haus der Zukunft' / 'Building of Tomorrow'*
- *A conventional renovation project for the School of Schwanenstadt was due, plans were ready*
- *A study for refurbishment meeting Passive House Standard for the School was submitted and accepted for funding.*
- *After finishing the study, the demonstration project was submitted*
- *Excursion to schools with ventilation systems with decision makers from municipality*
- *Prejudices against mechanical ventilation: one year of testing in one prototype class-room*

Timeline for the decision making process

submission as research project
June 2002

Clearence with school building authority
July 2003

Submission as demonstration project
September 2003

Assignment of general planning
June 2005

Start of renovation
May 2006

Renovation completed
October 2007

First measuring period
June 2007 – May 2008

Second measuring period
June 2008 – May 2009

4. BUILDING ENVELOPE

Roof construction : *U-value: 0.101 W/m².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 W/m².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 W/m².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 [W/m²K]

	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*
- *achieving passive house quality*
- *increase of building compactness*
- *innovative insulation from soil*
- *building envelope of high ecological value*

LIGHTING SYSTEM
- *enhanced use of daylight*

HEATING SYSTEM
- *before: gas heating*
- *after: pellet heating*

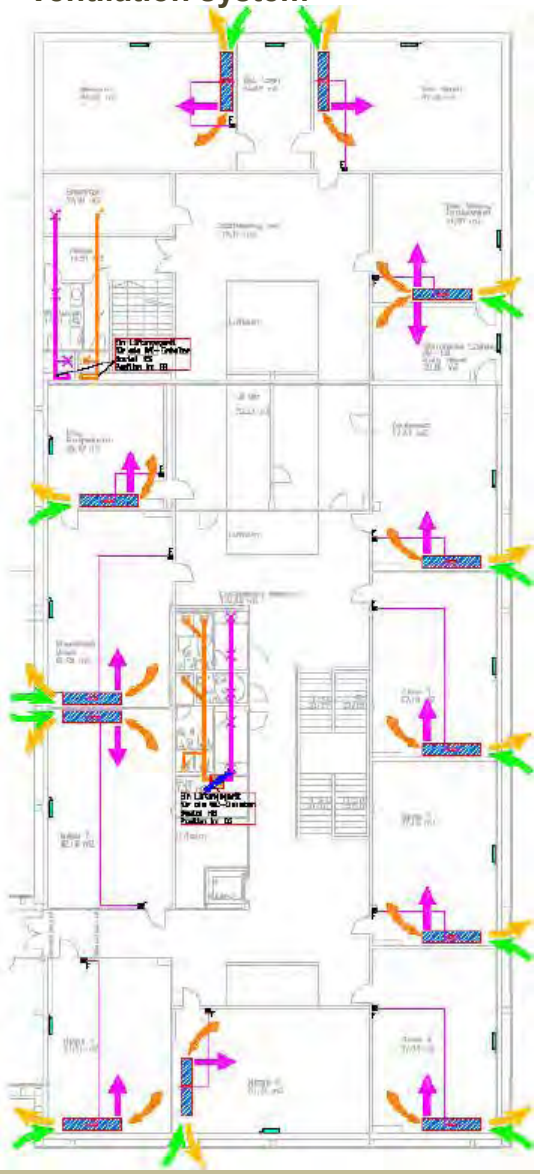
COOLING SYSTEM
- *passive only (night-time ventilation and external shading)*

VENTILATION
- *decentralized ventilation system*

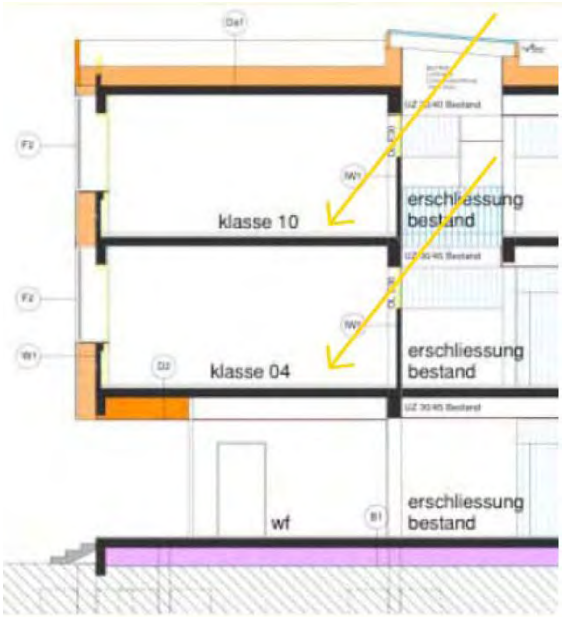
HOT WATER PRODUCTION
- *before: gas heating*
- *after: pellet heating and electric water heater for some tapping points*

RENEWABLE ENERGY SYSTEMS
- *pellet heating (110 kW)*
- *6.7 kW_P photovoltaic system (68m²)*

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 = 5,899m²*

MONITORING PERIOD 2 YEARS

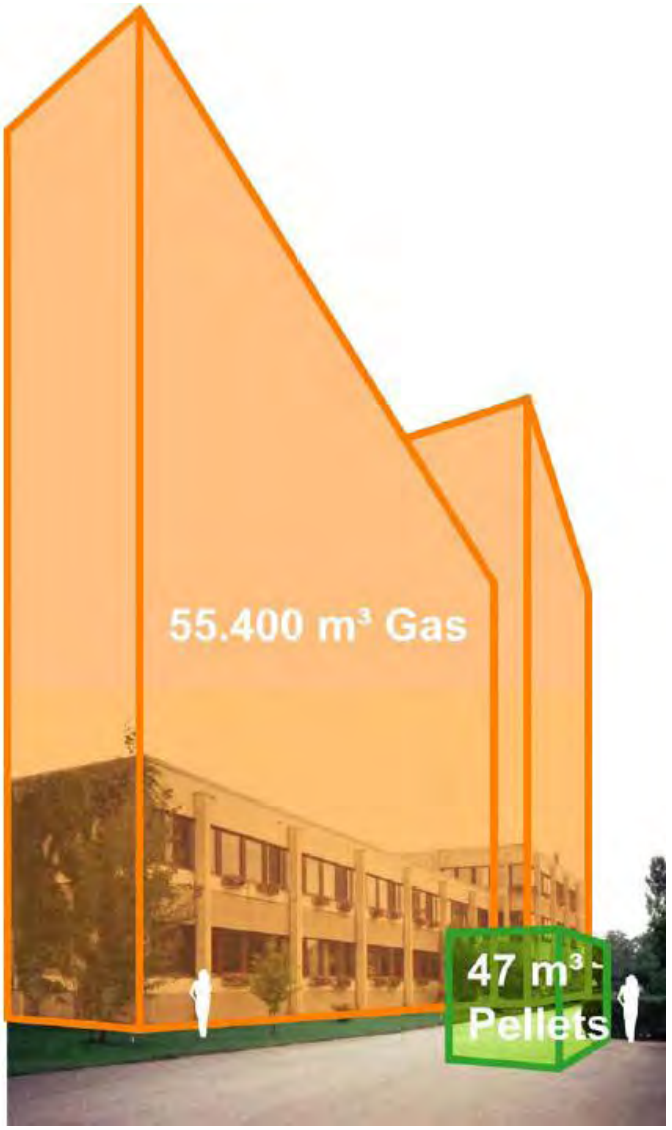
Summary of Energy Consumption [kWh/m².a]

	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

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

OVERHEATING IN SUMMER

- *2007 / 2008 = 11.3%*
- *2008 / 2009 = 4.6%*
- *Ratio of hours above 26°C during school*



7 ENVIRONMENTAL PERFORMANCE

CERTIFICATION / LABELS
- *Total Quality Building Certificate (TQB)*

ECOLOGICAL MATERIALS
- *Cellulose insulation*

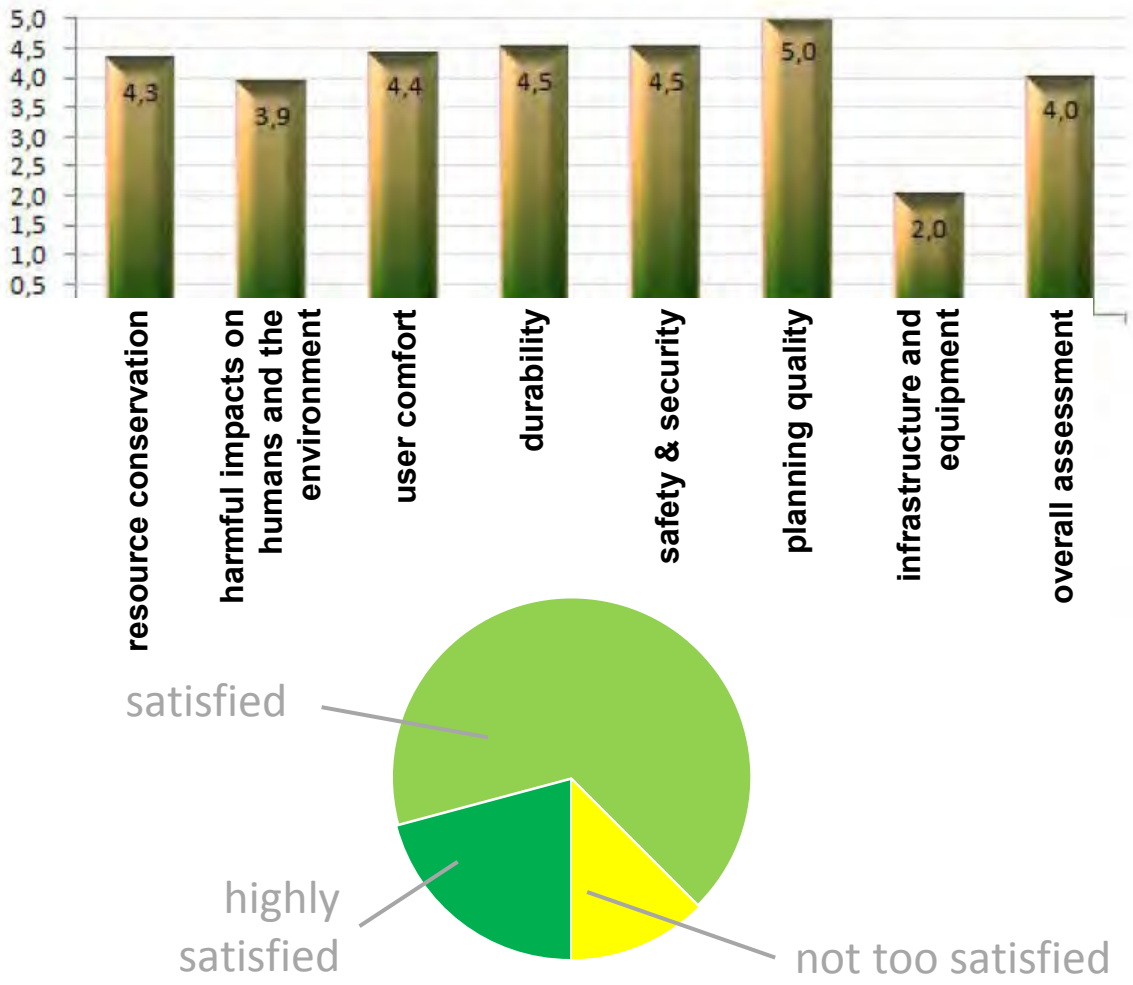
INCREASING QUALITY OF LIFE
- *7 out of 8 are satisfied*

RENEWABLE ENERGY SOURCES
- *Pellet heating system*
- *Photovoltaic facade*

FAST RENOVATION
- *Prefabricated components*

LIGHTING QUALITY
- *Enhanced use of daylight*

TQB assessment

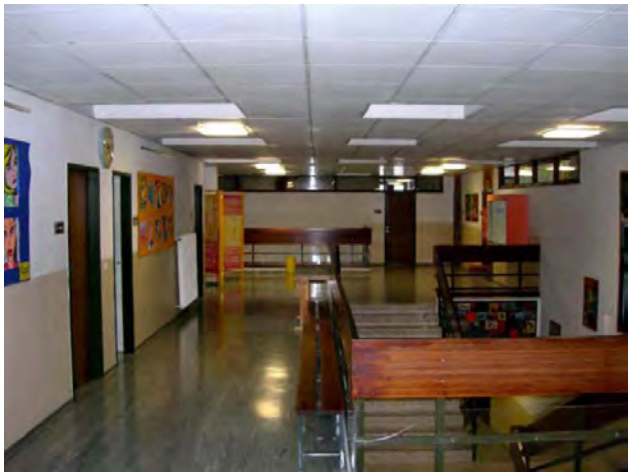


7 ENVIRONMENTAL PERFORMANCE

LIGHTING QUALITY

- *Enhanced use of daylight*

before



after

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

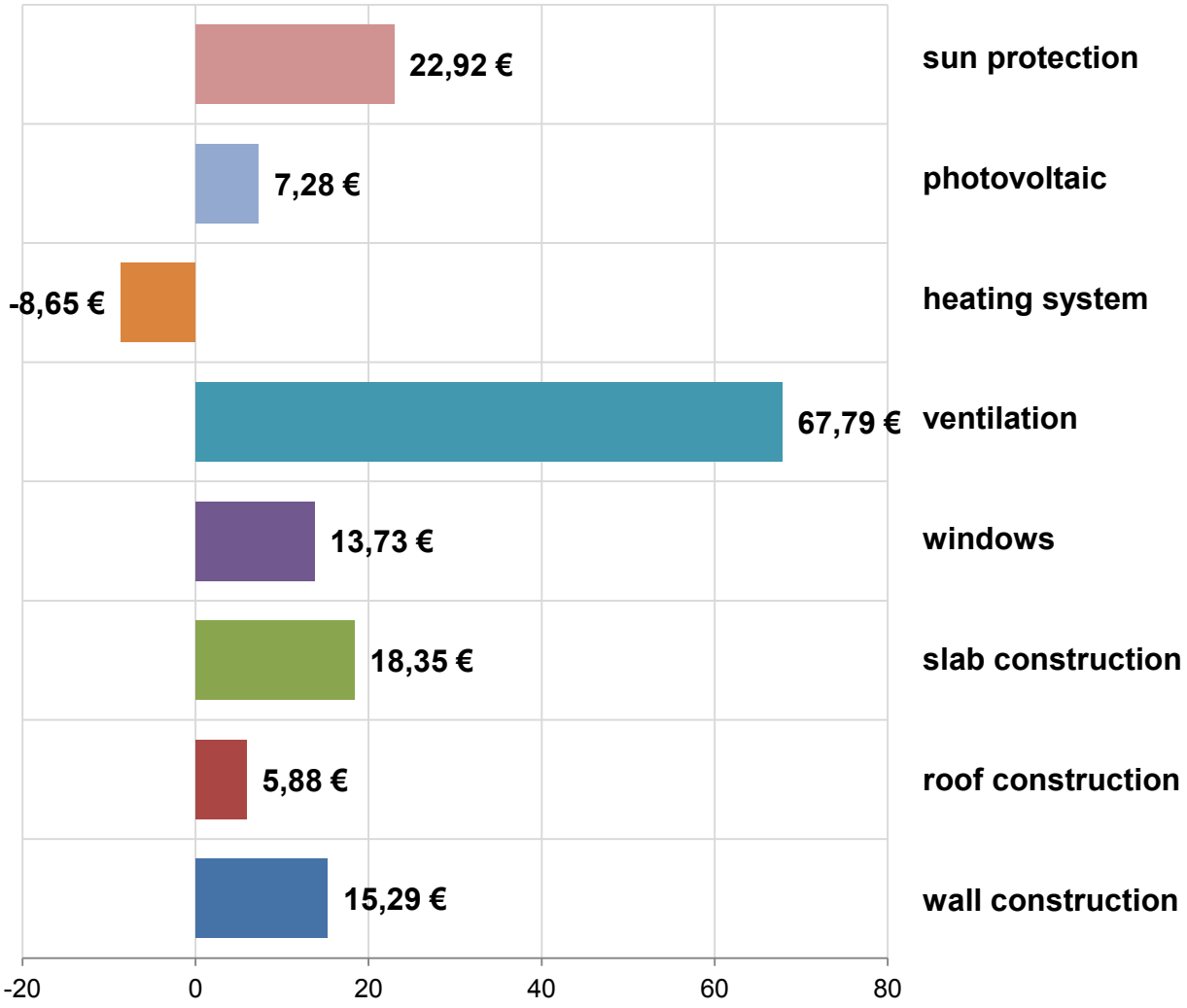
in detail …

- *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 costs for meeting Passive House Standard per square meter usable area

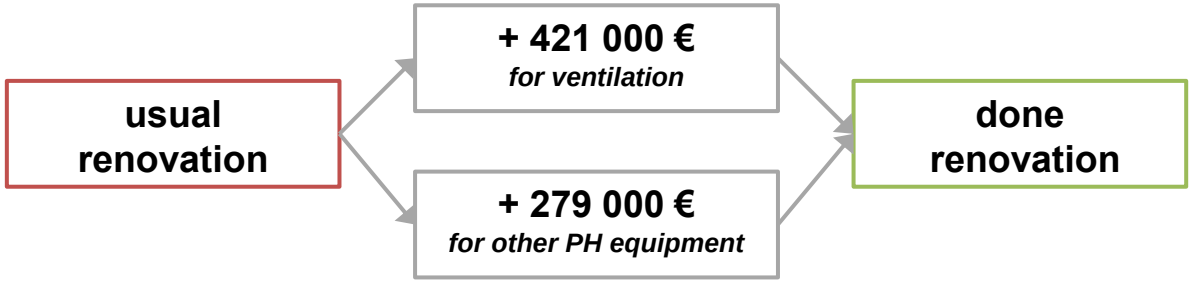


8. MORE INFORMATIONS

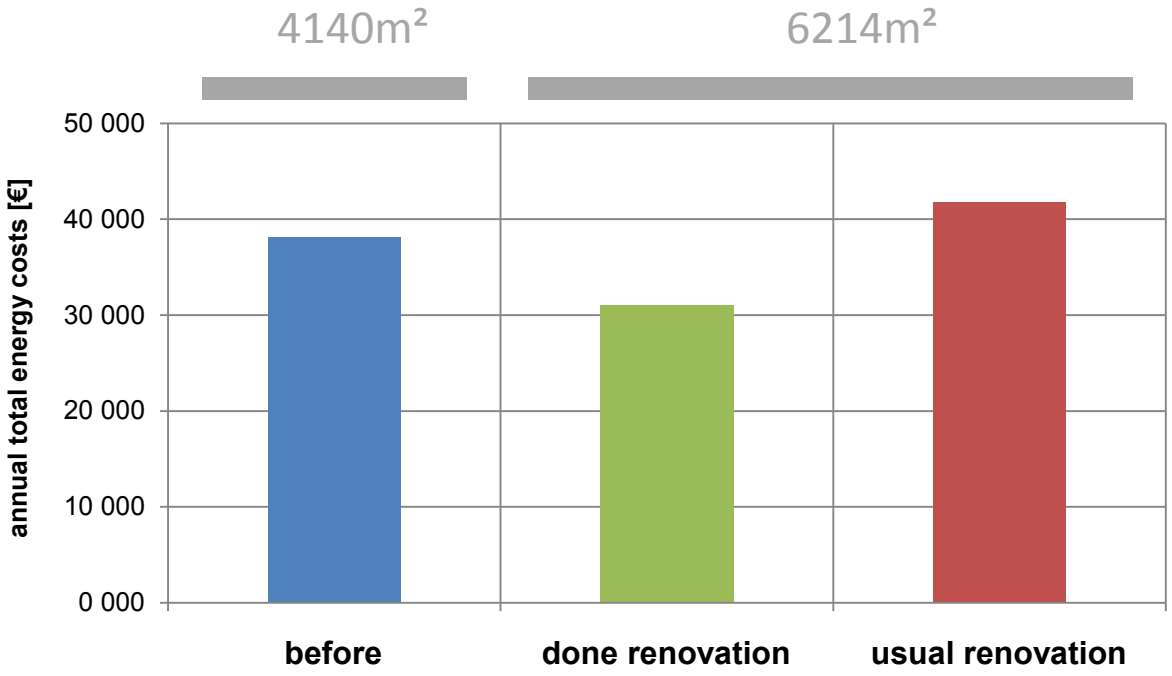
ADDITIONAL TOPICS

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

Additional costs for meeting Passive House Standard



Total yearly energy costs



Thank you for your attention!

Claudia Dankl
ÖGUT – Austrian Society for Environment and Technology
claudia.dankl@oegut.at
Vienna, Austria

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