TREES
Training for Renovated Energy Efficient Social housing

Intelligent Energy -Europe programme, contract n° EIE/05/110/SI2.420021

Section 3 Case studies
3.2 Dunaújváros, Hungary

Tamas CSOKNYAI
BUTE

Solanova

- **Aims: Realisation of**
  - An ultra efficient renovation of a panel building
  - Demonstration building
  - Technical research on original state
  - Optimised concept for the building envelope and service systems
  - Monitoring
  - Research on ecological impacts
  - Research on social aspects
  - Education and dissemination
- **EU 5th Framework Program**
- **Jan. 2002 - Dec. 2006**
- **Austro-German-Hungarian project**

SOLANOVA - The Consortium

- **Hungary**
  - Budapest University of Technology and Economics
  - District Heating Company, Dunaujvaros
- **Austria**
  - Internorm (Windows)
- **Germany**
  - University of Kassel
  - Passive House Institute,
  - Innovatec

SOLANOVA - Situation 1

- huge stock of old-style multi-flat buildings (Hungary: 800,300 flats -2003) needs to be restored in a sustainable way
- current renovations only result in minimal savings

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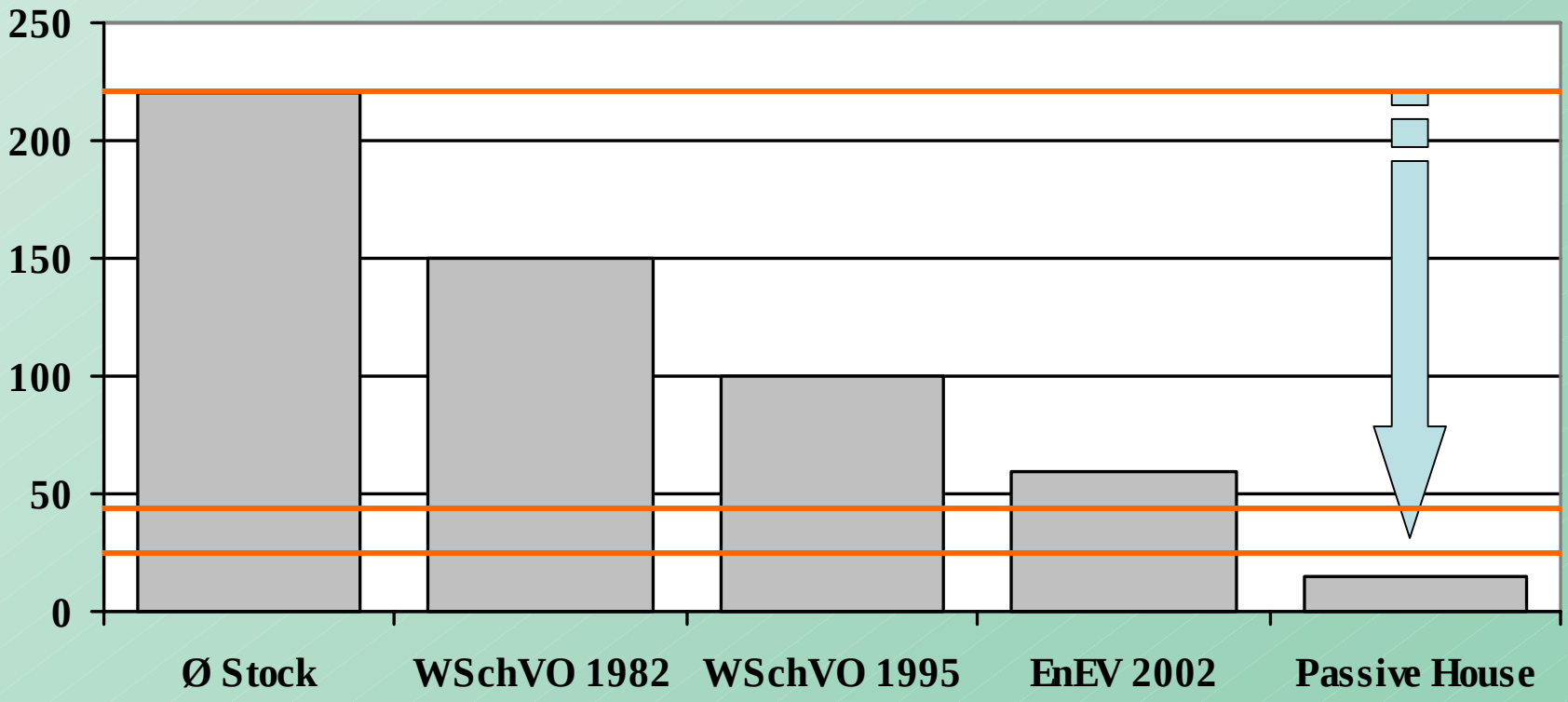
Project idea: SOLANOVA

- **Retrofit from bad state to low energy house standard**



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SOLANOVA - Demo Building

- Located in Dunaújváros, 80 km from Budapest
- 42 flats
- District heating
- During renovation flats are occupied

Demo building – The site

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Demo-building, the site

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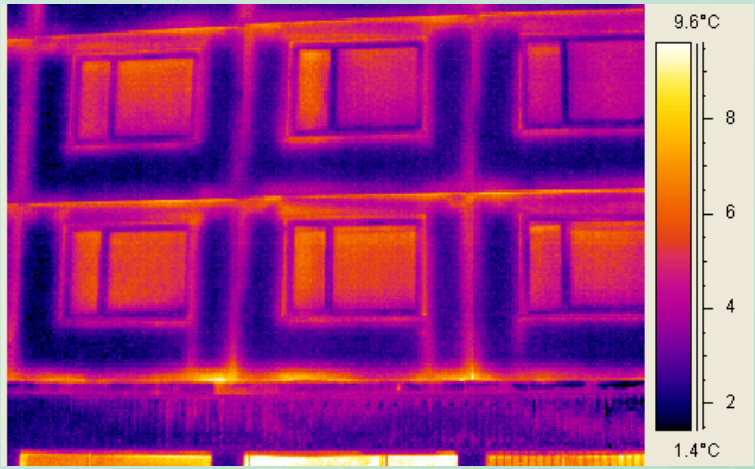
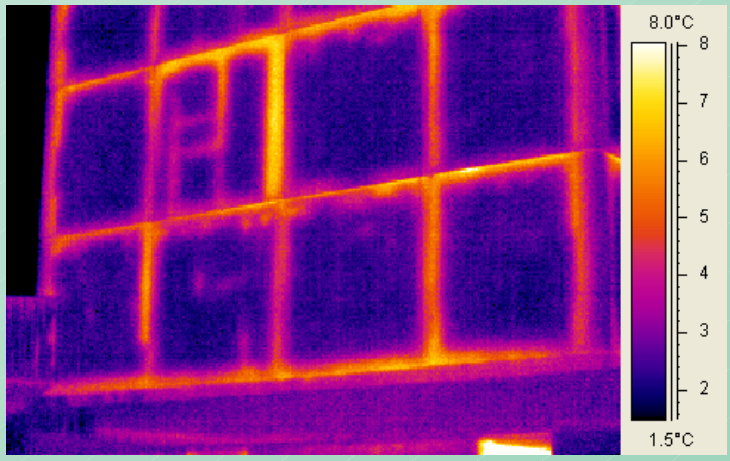
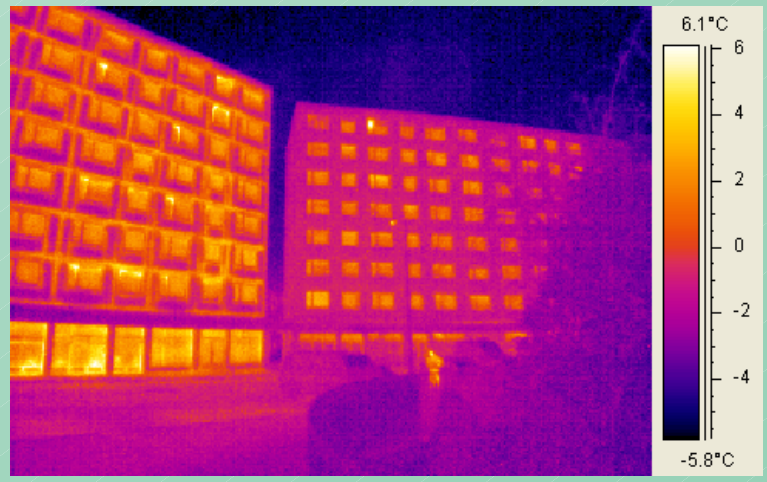
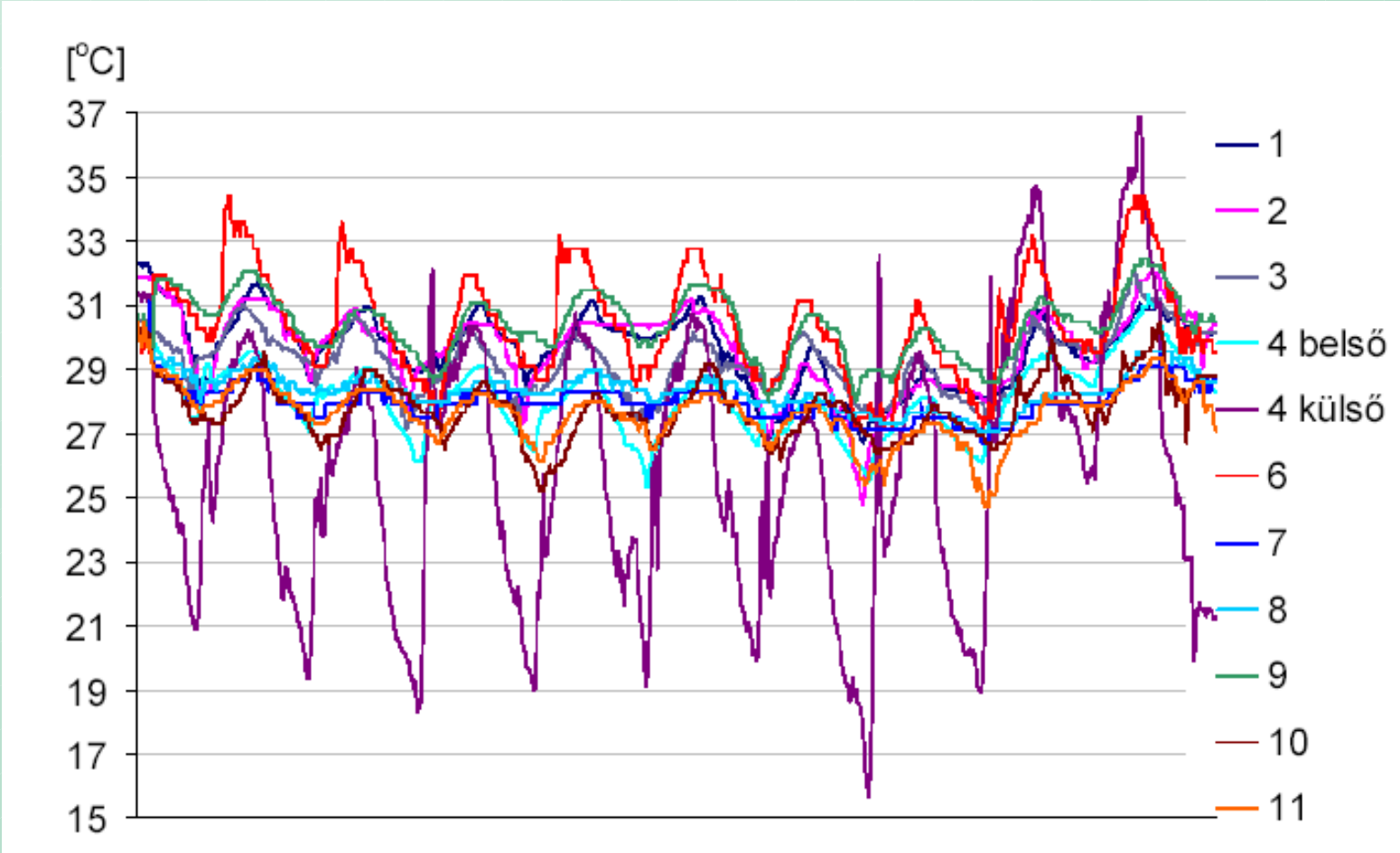
Thermal performance







Thermal comfort - summer



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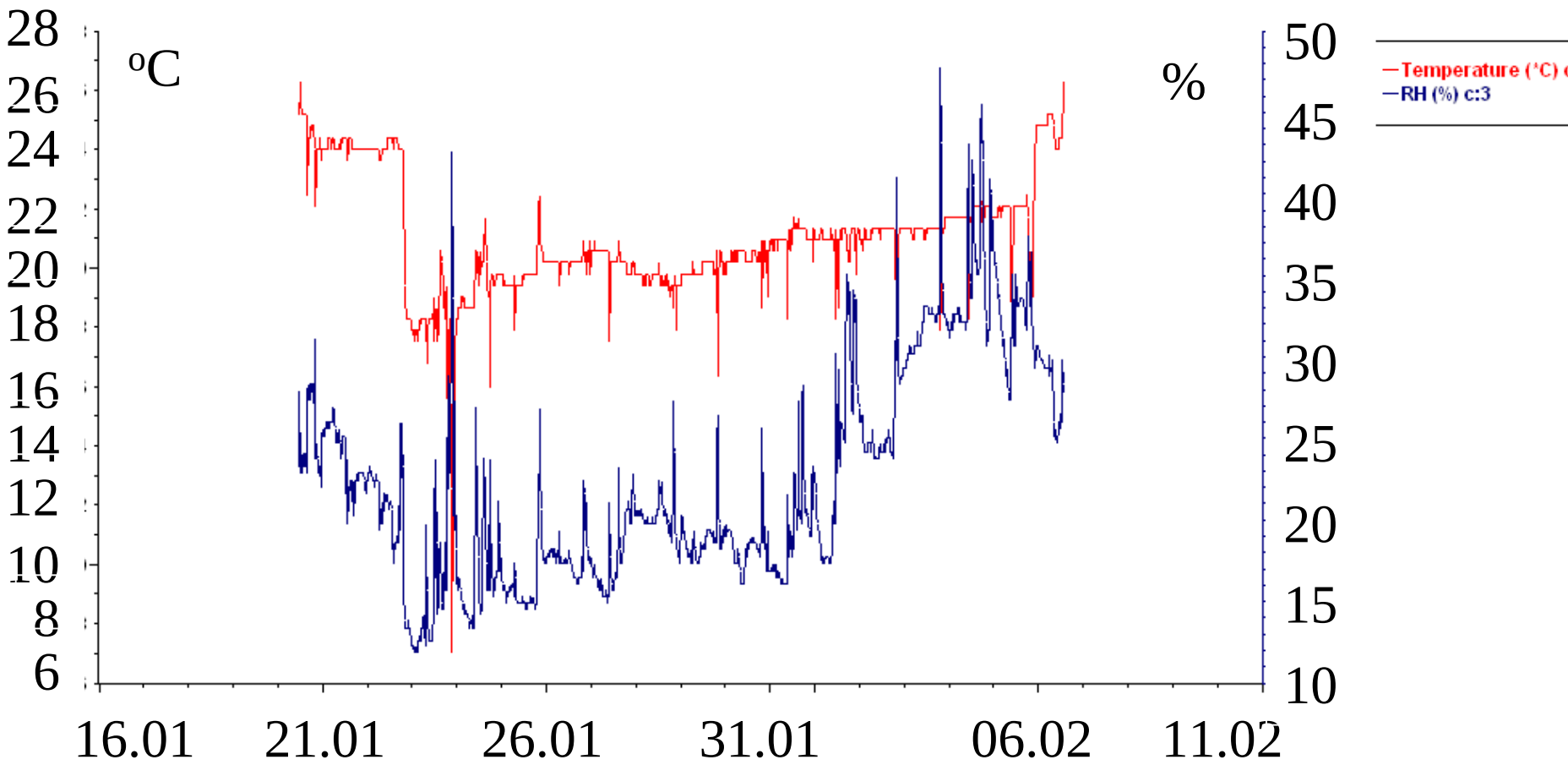
Thermal comfort - winter



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Monitoring

- **Before and after renovation**
- **Summer and winter**
- **Constant registration by PC**
- **Measured parameters:**
  - Climatic data: wind, solar radation, outdoor air temperature
  - Room temperatures
  - Relative humidity
  - Internal wall surface temperatures (incl. joints)
  - Consumptions (heat for heating and DHW, gas, eletricity)

Monitoring

Lajos Király utca 10																
	flat 1					flat 2						flat 3					Staircase
Room No.	1	2	3	4		1	2	5	3	4		1	2	3	4	6
	MUX	kitchen	bathroom	bedroom	living room	MUX	kitchen	bathroom	bedroom	bedroom	living room	MUX	kitchen	bathroom	bedroom	living room	
7th floor	M14	Temp 78	Temp 58	Temp 82	Temp/Moist 43	M18	Temp 81	Temp 60	Temp 51	Temp 48	Temp/Moist 80	M22	Temp 10	Temp	Temp 6	Temp/Moist 3	Temp 88
6th floor					Temp 59						Temp 45					Temp 56	
5th floor					Temp 49						Temp 21					Temp 62	
4th floor	M15	Temp 27	Temp 4	Temp 34	Temp/Moist 29	M19	Temp 35	Temp 24	Temp 14	Temp 8	Temp/Moist 5	M24	Temp 68	Temp 7	Temp 11	Temp/Moist 83	Temp 87
3th floor					Temp 74						Temp 20					Temp 22	
2th floor	M16				Temp 13	M20					Temp 63	M25				Temp 1	
1th floor	M17	Temp 19	Temp 54	Temp 57	Temp/Moist 77	M21	Temp 33	Temp 18	Temp 67	Temp 31	Temp/Moist 32	M26	Temp 69	Temp 55	Temp 64	Temp/Moist 40	Temp 86
ground floor	COM- 6					COM- 7						COM- 8					Temp 85

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Renovation measures

- External thermal insulation of walls (16 cm PS)
- Thermal insulation of roof (30-40 cm) and cellar ceiling (10 cm)
- Double glazed windows in the southern side flats (U=1,2 W/m^{2}K) and shops, PVC frames
- Triple glazed windows with integrated shading in southern side dwellings
- Flatwise ventilation system with balanced heat recovery
- Solar collectors supporting hot water supply (72 m^2)
- New low performance double pipe heating system
- Water saving taps and shower heads
- Green roof

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Heating energy consumption

- ORIGINAL

- 220kWh/m²year

- RENOVATED

- 39 kWh/m²year

2005-2006: 85% saving

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Facades

ORIGINAL

U= 1,8-2,0

W/m²K

Original sandwich panels:

- **15 cm reinforced concrete – 7 cm PS – 7 cm reinforced concrete**
- **Theoretic U-value: 0,44 W/m²K**
- **Real U-value in thermal bridge free zones : 0,8-1,1 W/m²K**
- **U-value incl. Thermal bridges: 1,8-2,0 W/m²K**

Insulation:

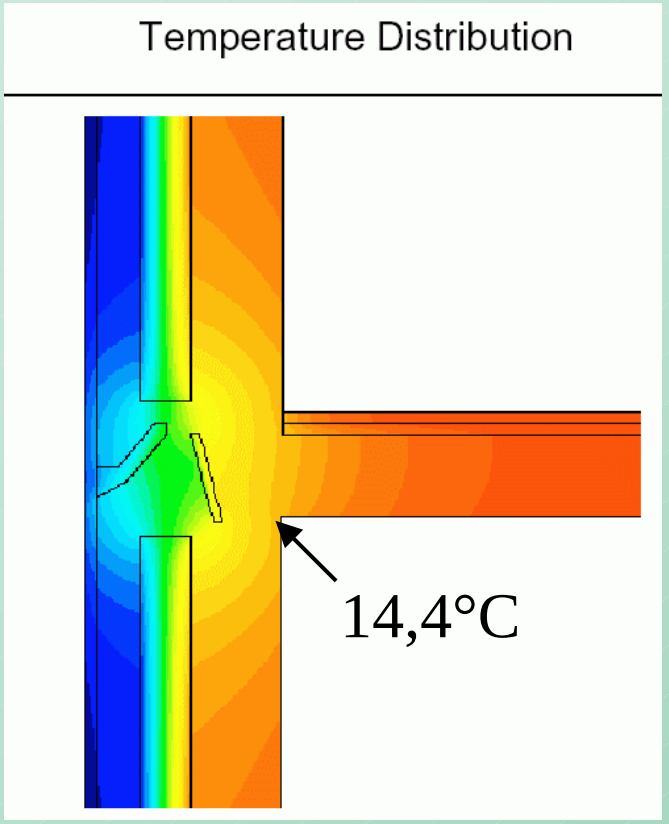
- **16 cm polistyrene**

RENOVATED

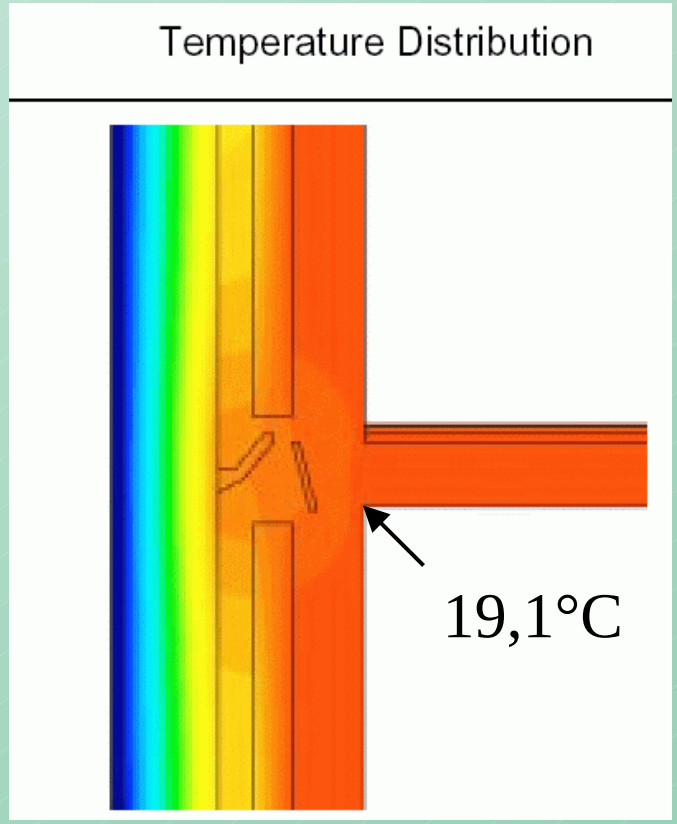
U= 0,22 W/m²K

Thermal bridges

ORIGINAL



RENOVATED



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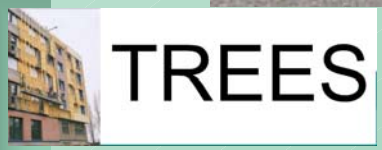
Insulation works



Windows

ORIGINAL

U-value element: 2,3 W/m^{2}K

U -value installed : 3,2 W/m^{2}K

U -value staircase : 5..6 W/m^{2}K

U -value ground floor : 5..6 W/m^{2}K

RENOVATED

U-value South, West: 0,9 W/m^{2}K

U-value North: 1,4 W/m^{2}K

U-value ground floor: 1,4 W/m^{2}K

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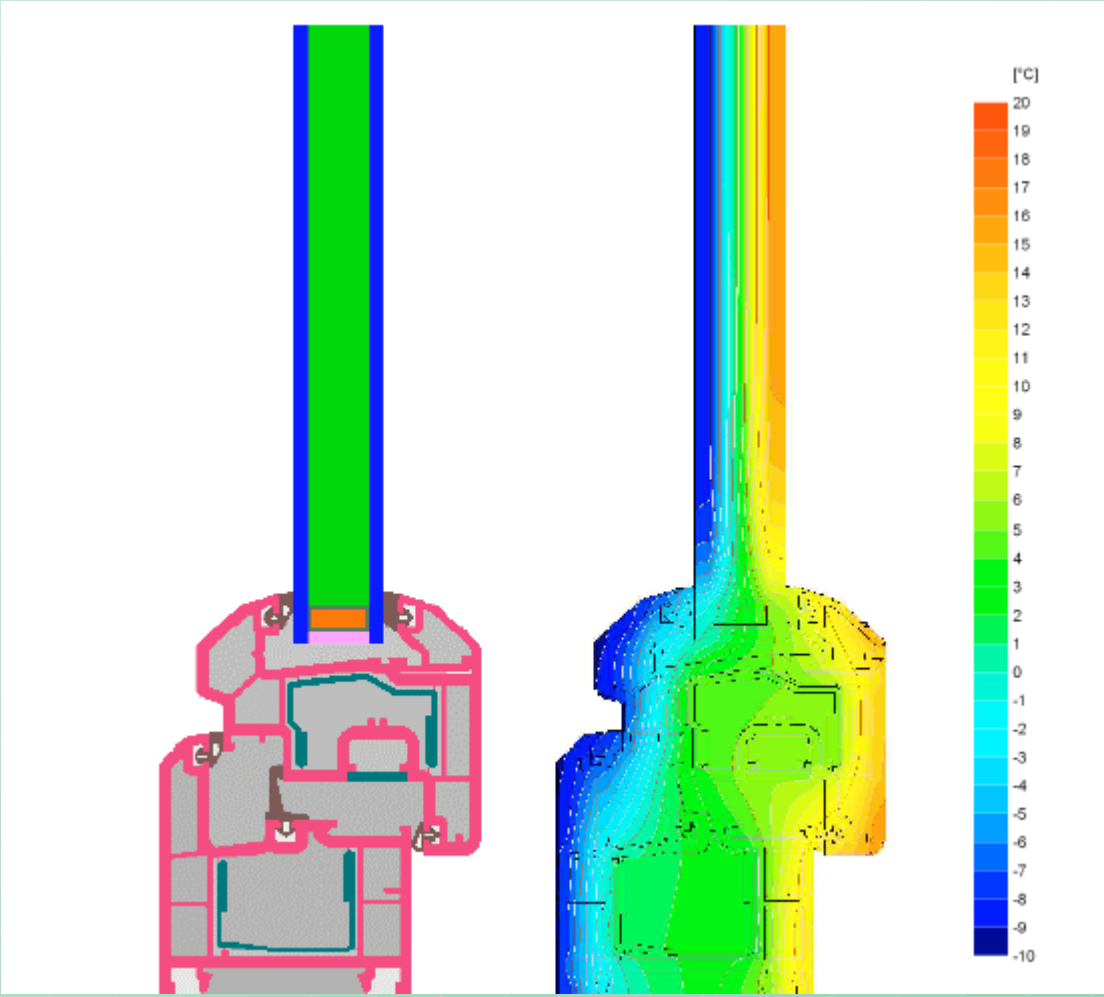
Windows



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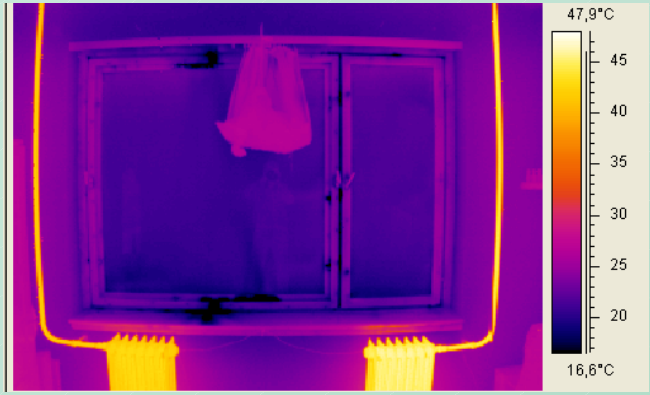
Air tightness – blower-door

ORIGINAL



Measurement in 4 flats:

5/1	n_{50} =7,1 h^{-1}
5/2	n_{50} =8,8 h^{-1}
5/3	n_{50} =9,1 h^{-1}
7/3	n_{50} =12,0 h^{-1}

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Flat roof

ORIGINAL

U= 1,3 W/m²K

RENOVATED

U= 0,12 W/m²K

21-29 cm PS

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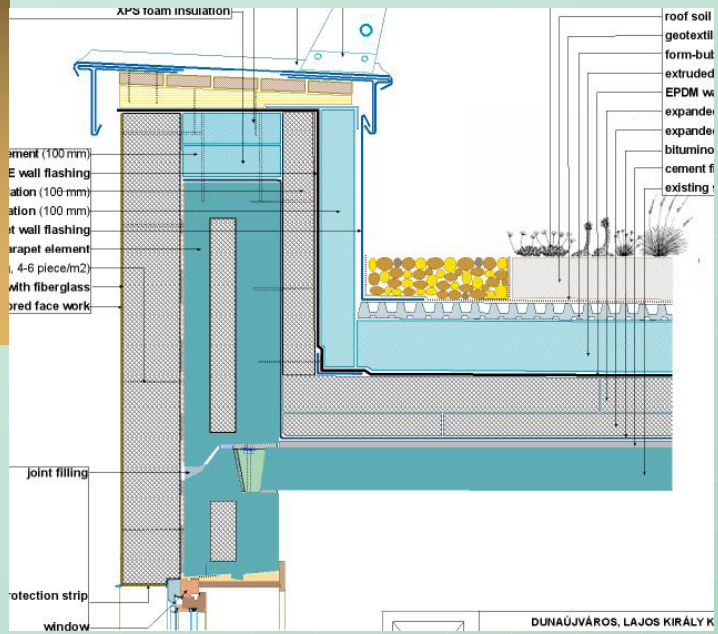
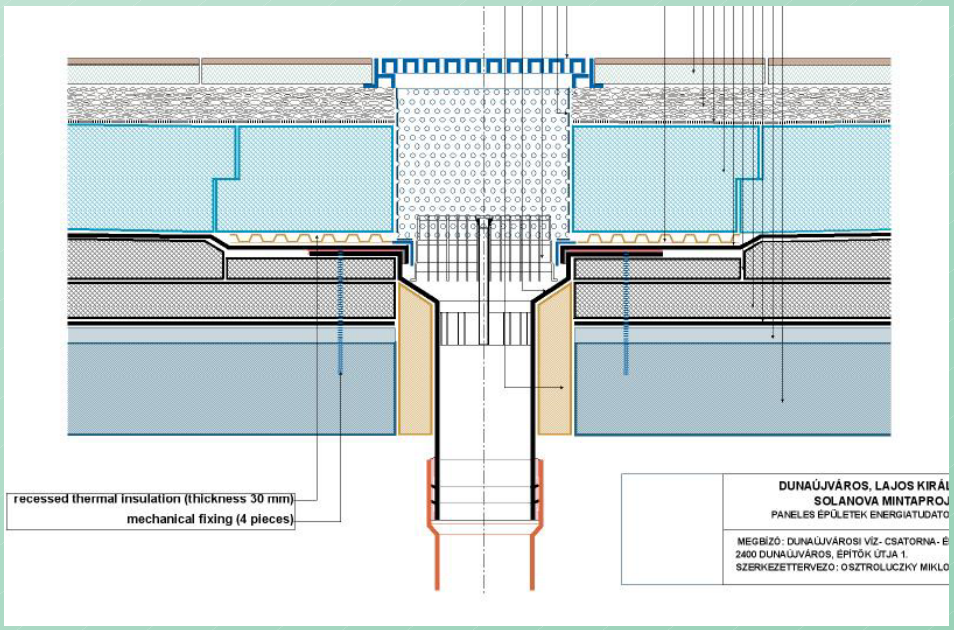
Roof details





Ground floor works

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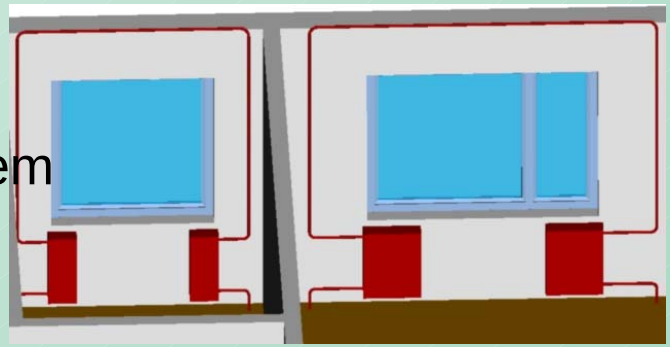
Heating system

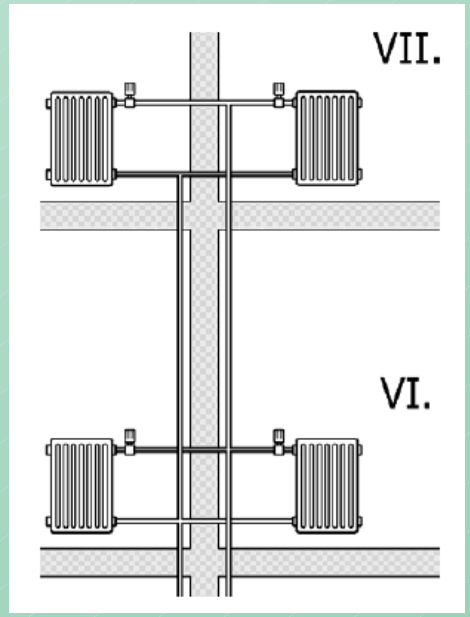
ORIGINAL

- Vertical single pipe system
- Not controlable

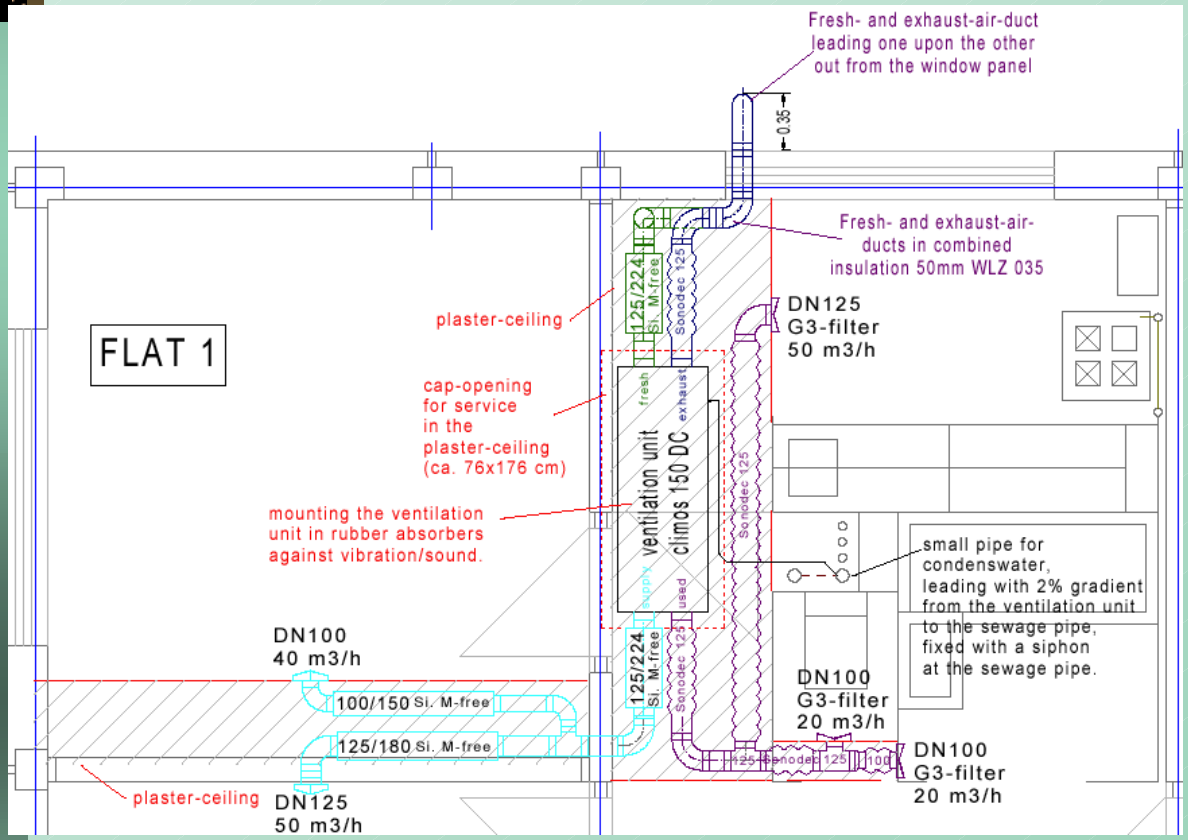


RENOVATED

- Much smaller radiators
- One instead of two in each rooms
- Thermostatic valves
- Risk of overheating due to the uncontrolled heat flow of pipes
- Minimised total pipe length
- Unheated staircase



Ventilation system



NEW SYSTEM

- Balanced system with heat recovery
  - Fresh air: rooms
  - Exhaust air: kithcen, bathroom, toilet
- 100-180 m^3/h,flat
- $N=0,68\ h^{-1}$
- Flatwise control

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Ventilation system

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Water saving units

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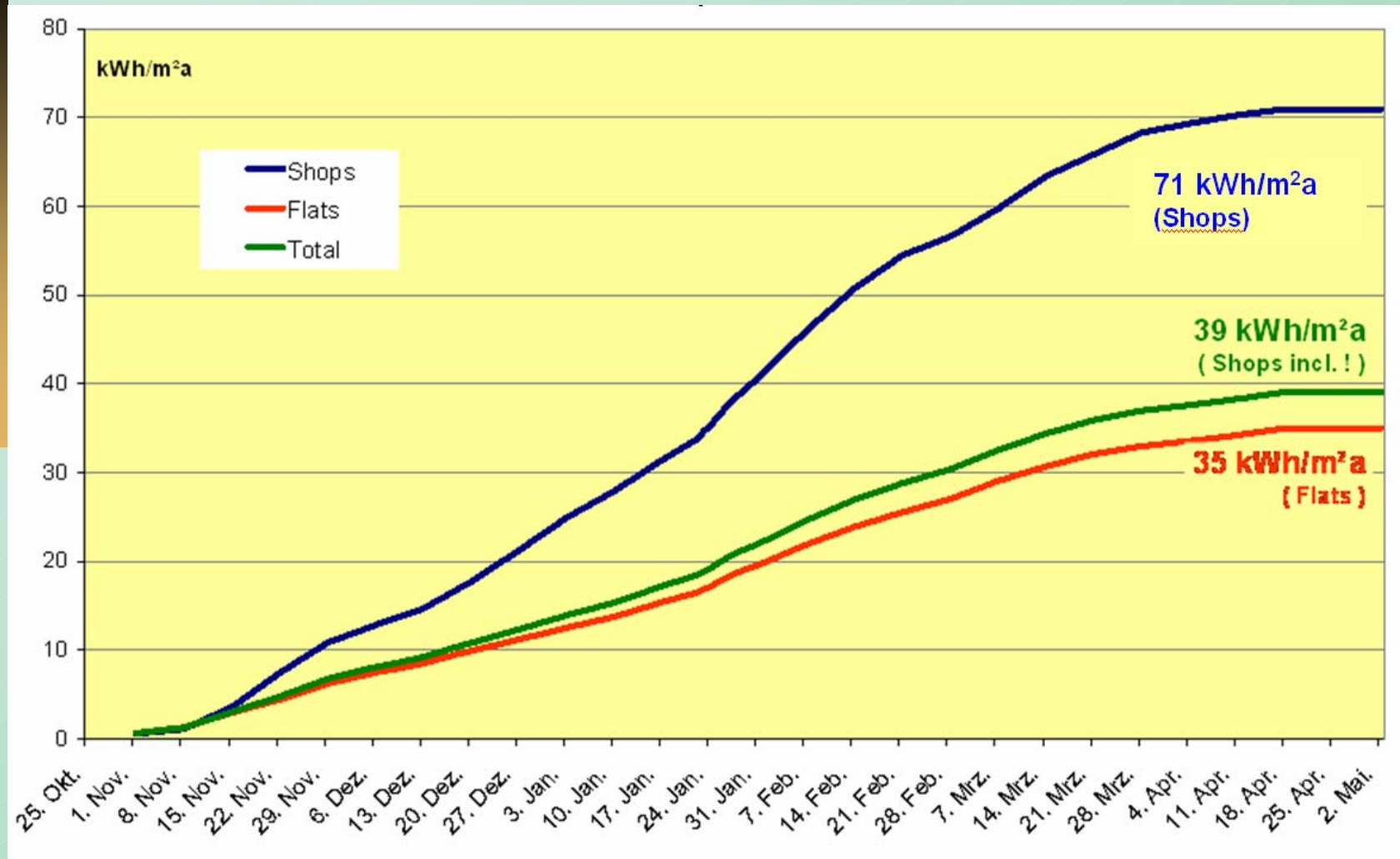
Solar system

- Canopy integrated system on the Southern side: double function, shorter pay-back time
- 72 m^2
- supports DHW production
- Solar+water saving: 50% DHW energy saving

Cumulated energy consumption after renovation



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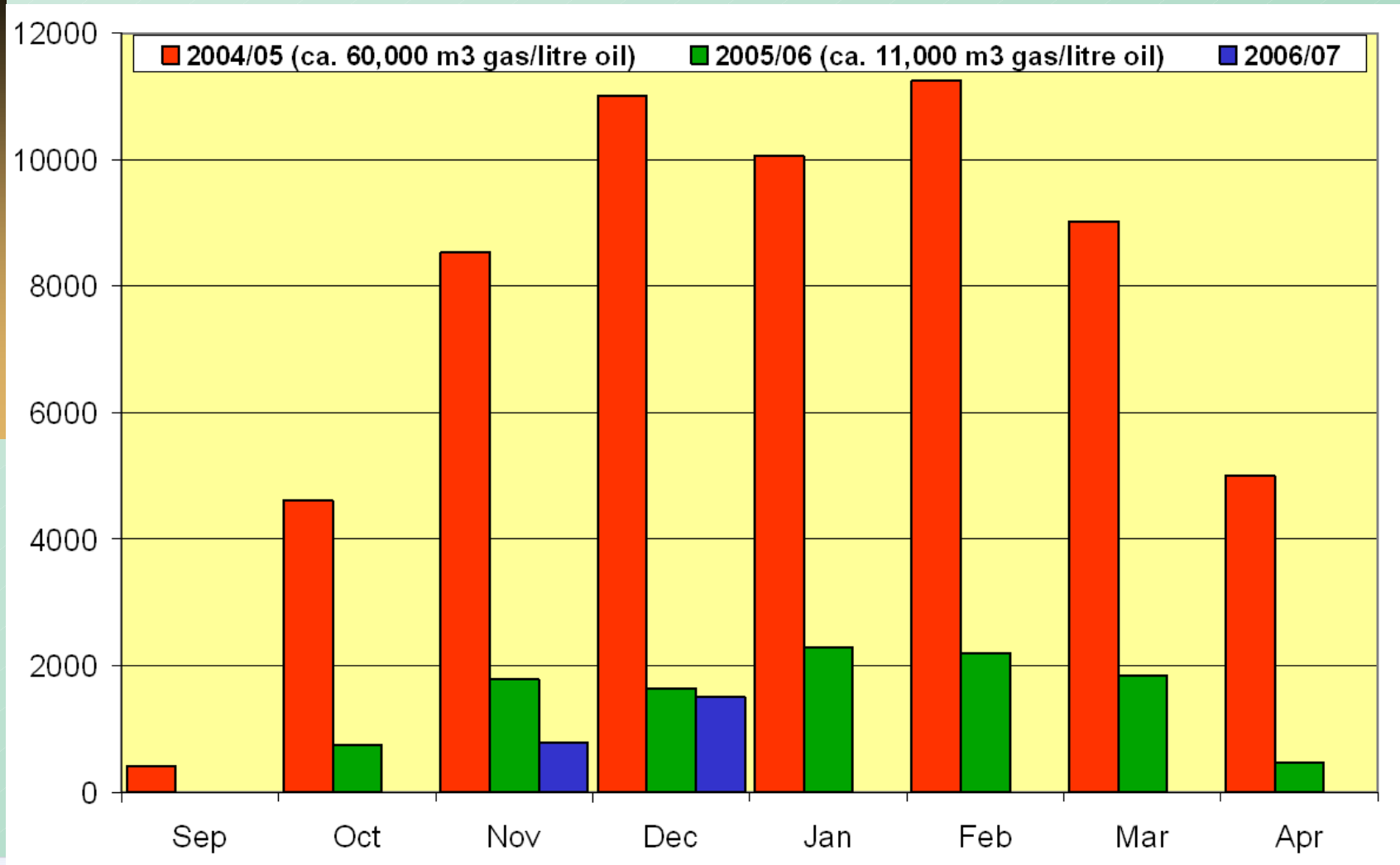
Monthly energy consumption before and after renovation



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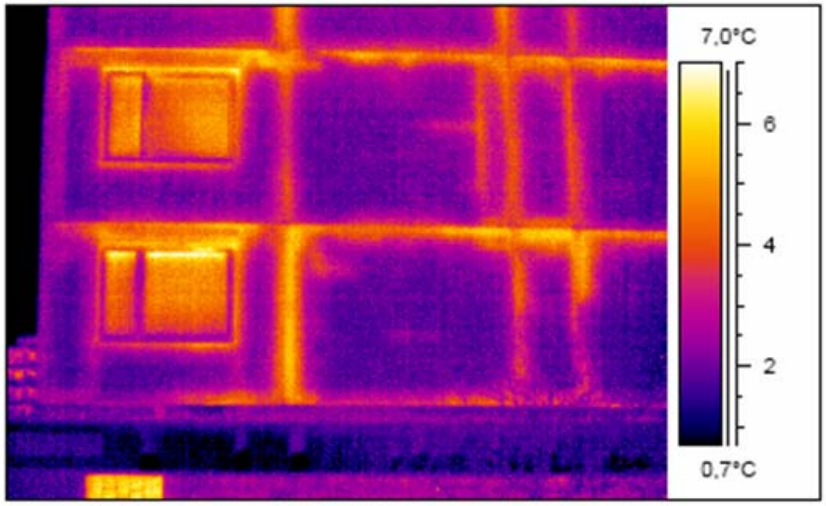
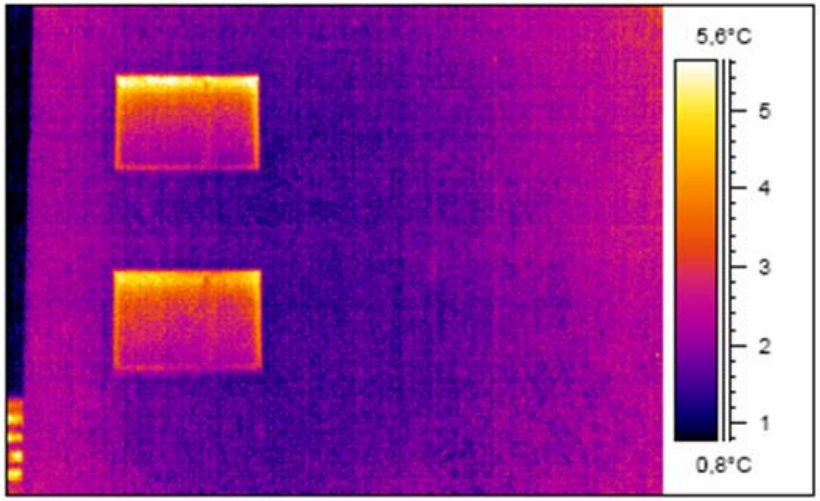
Thermography before and after renovation

Dátum/Date	2004.02.11.
Időpont/Time	9:04:27
T külső/T outside	-0,8°C



Dátum/Date	2006.01.13.
Időpont/Time	7:49:34
T külső/T outside	-3,5°C



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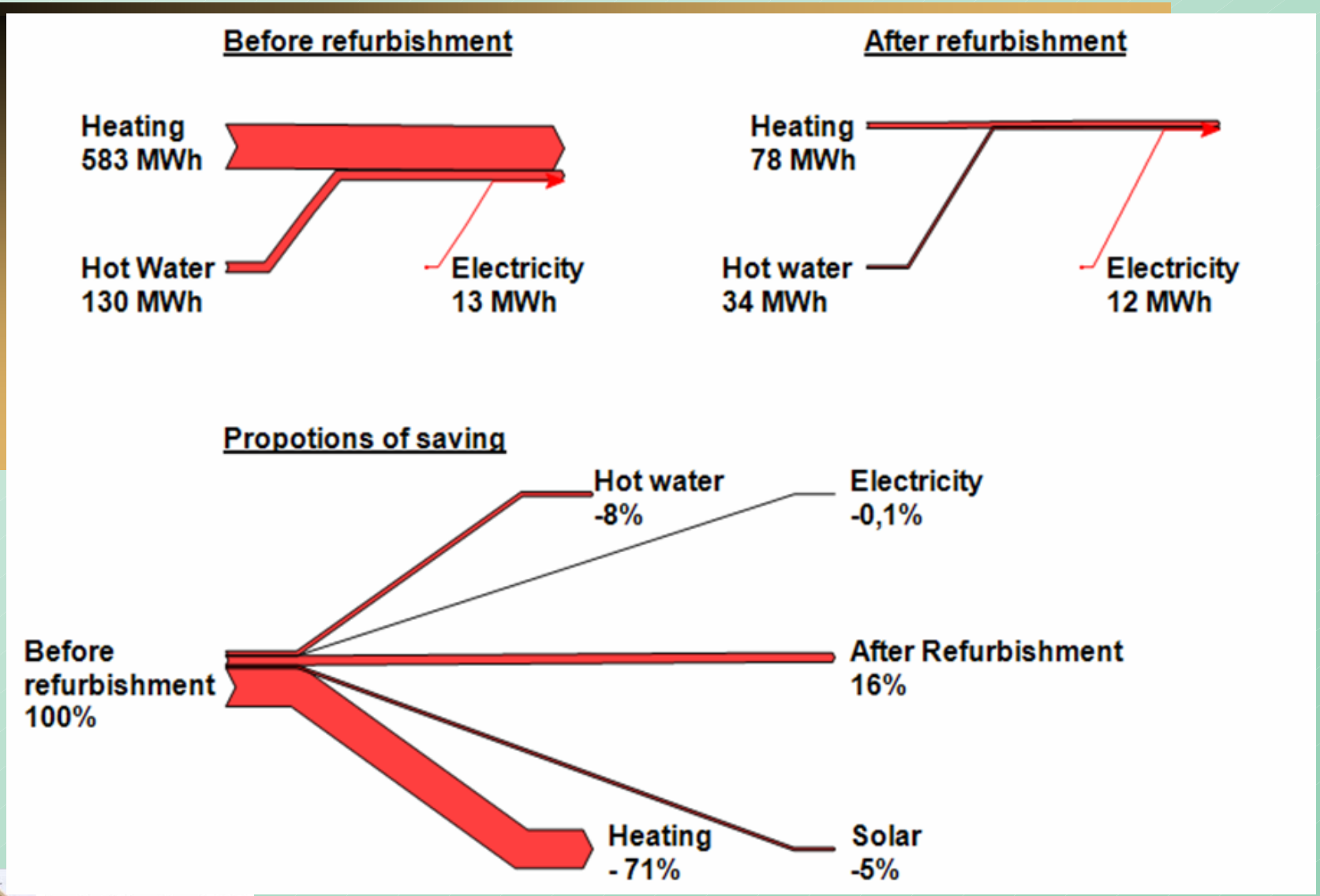
Sankey diagrams



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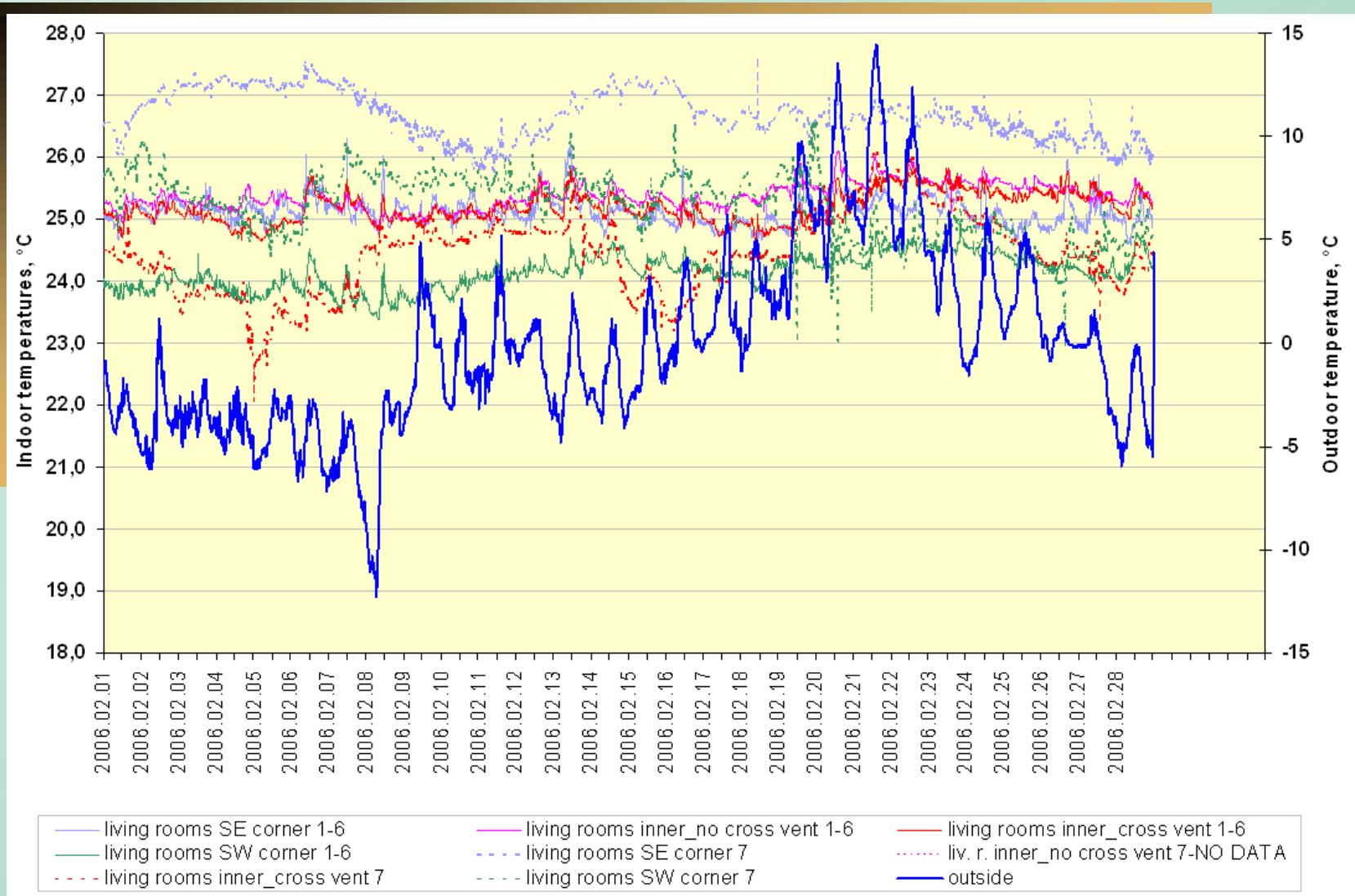
Thermal comfort in winter, February 2006



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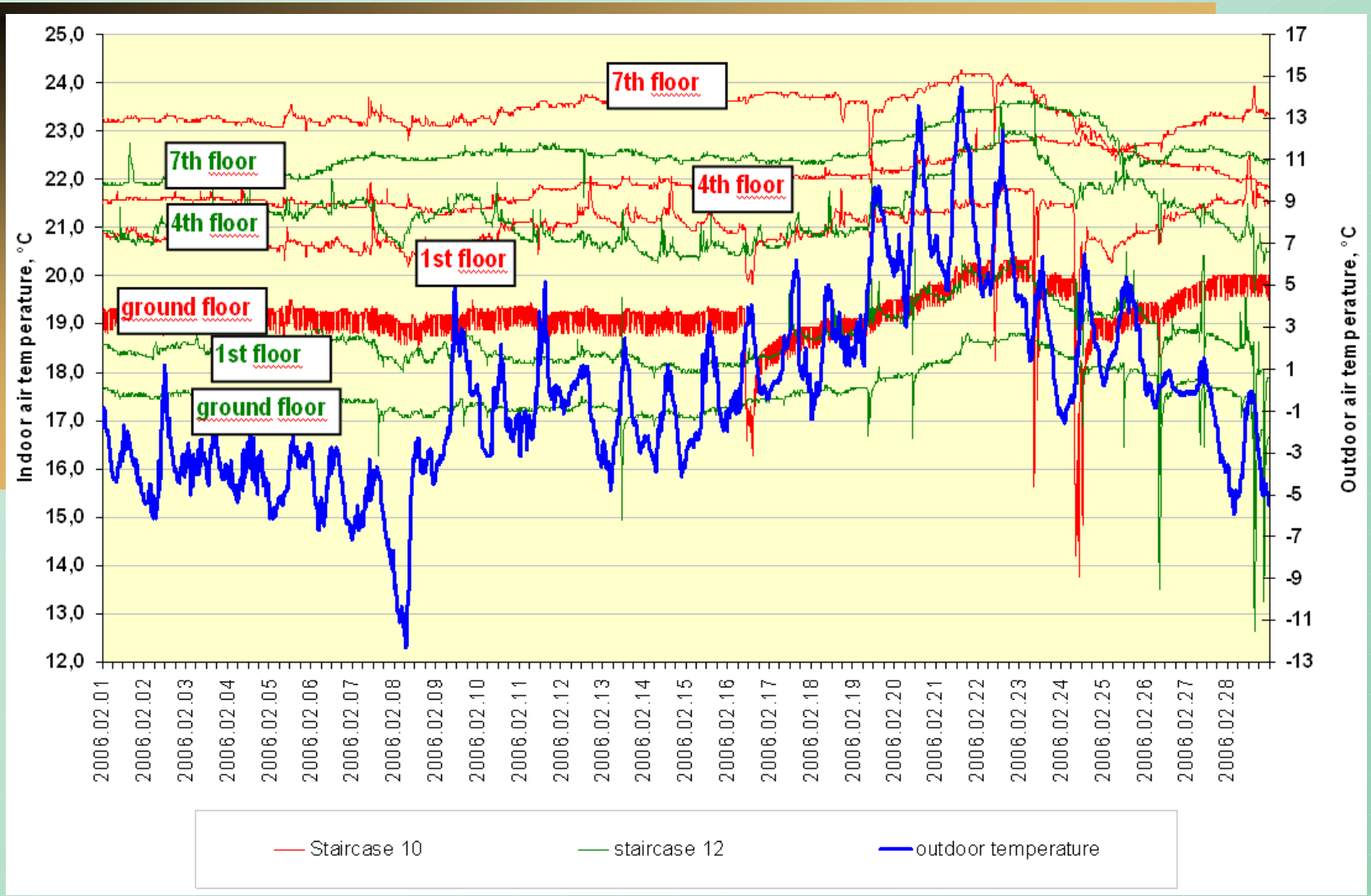
Temperature in staircases after renovation, February 2006



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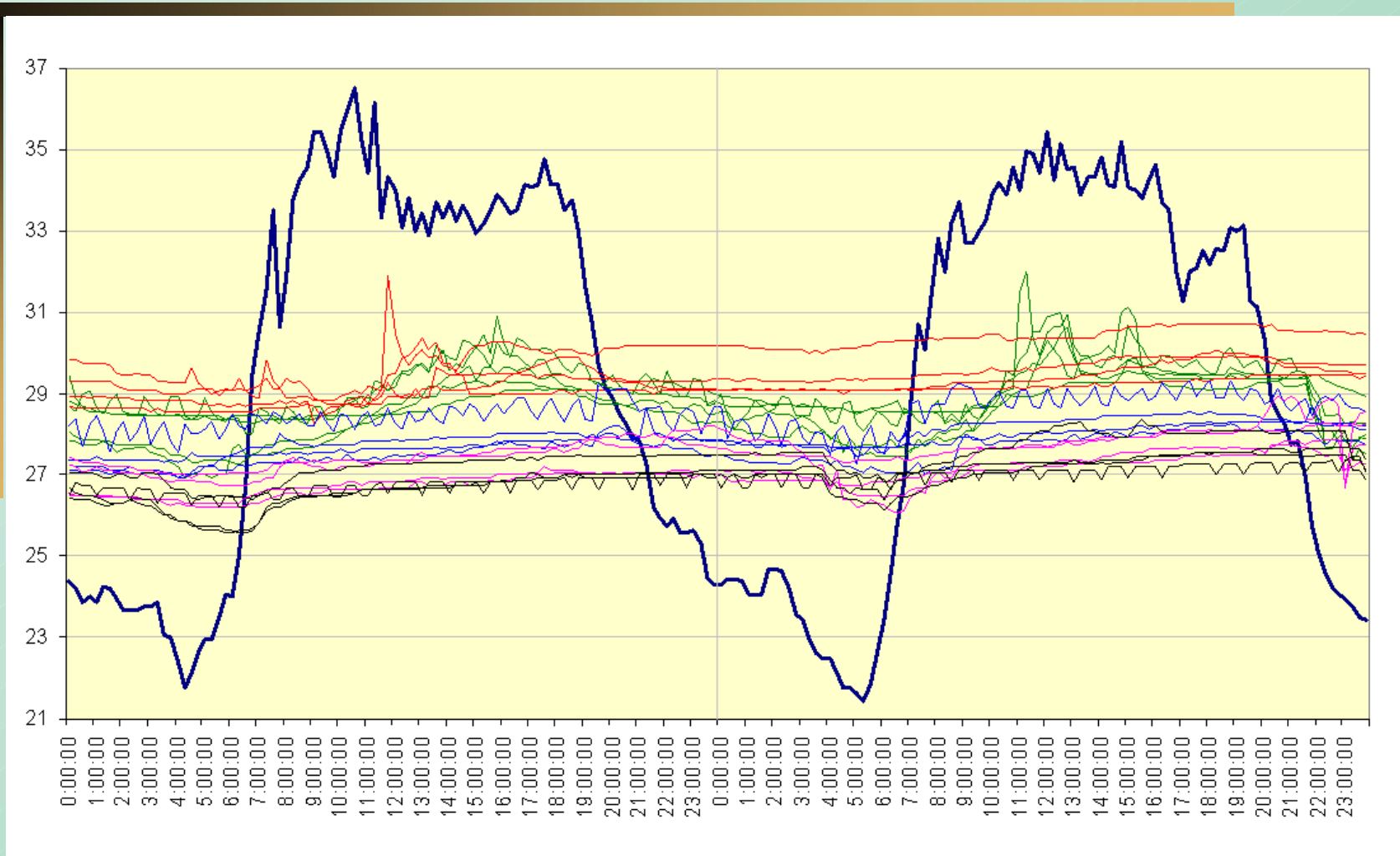
Air temperatures in 22-23 July 2006



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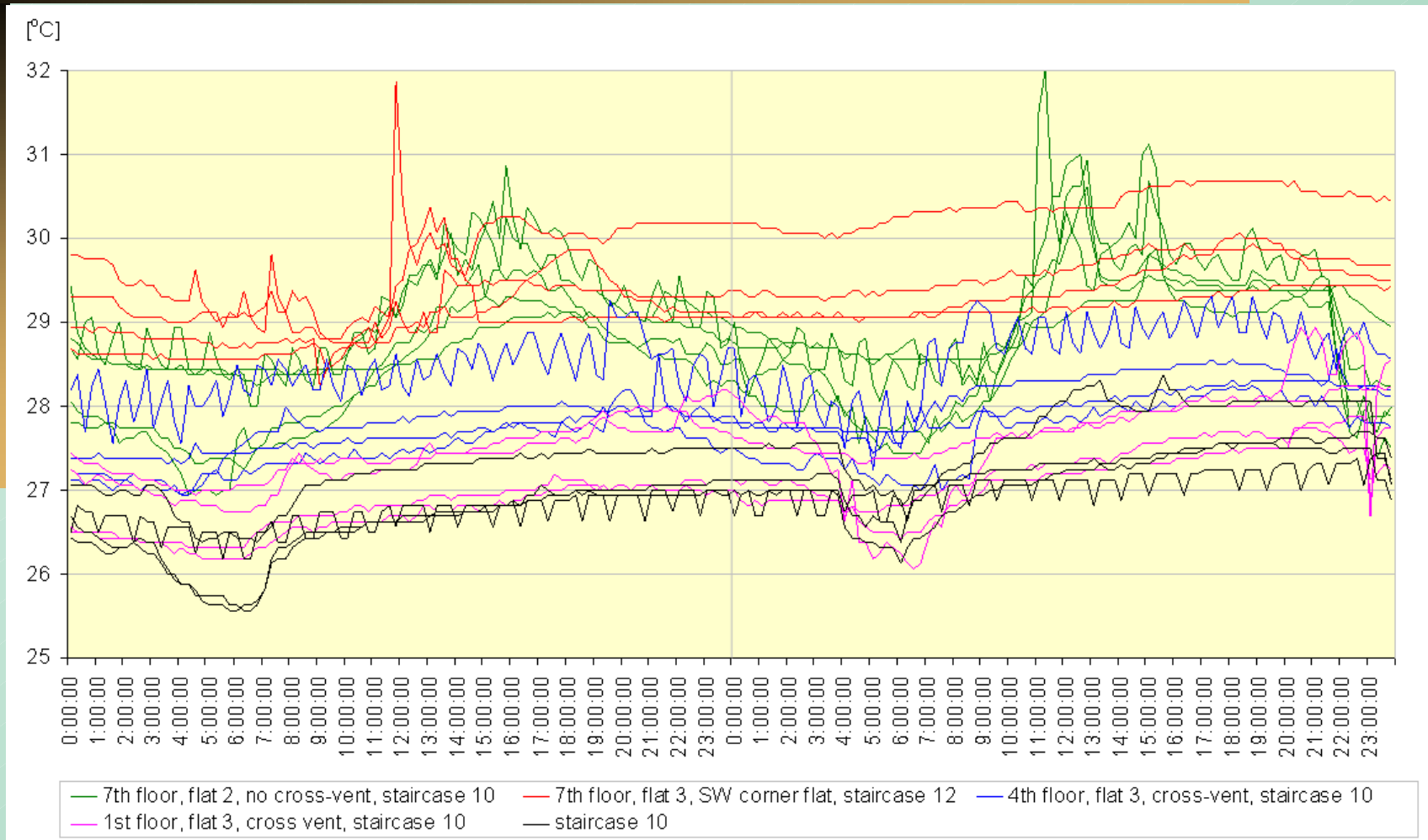
Air temperatures in 22-23 July 2006



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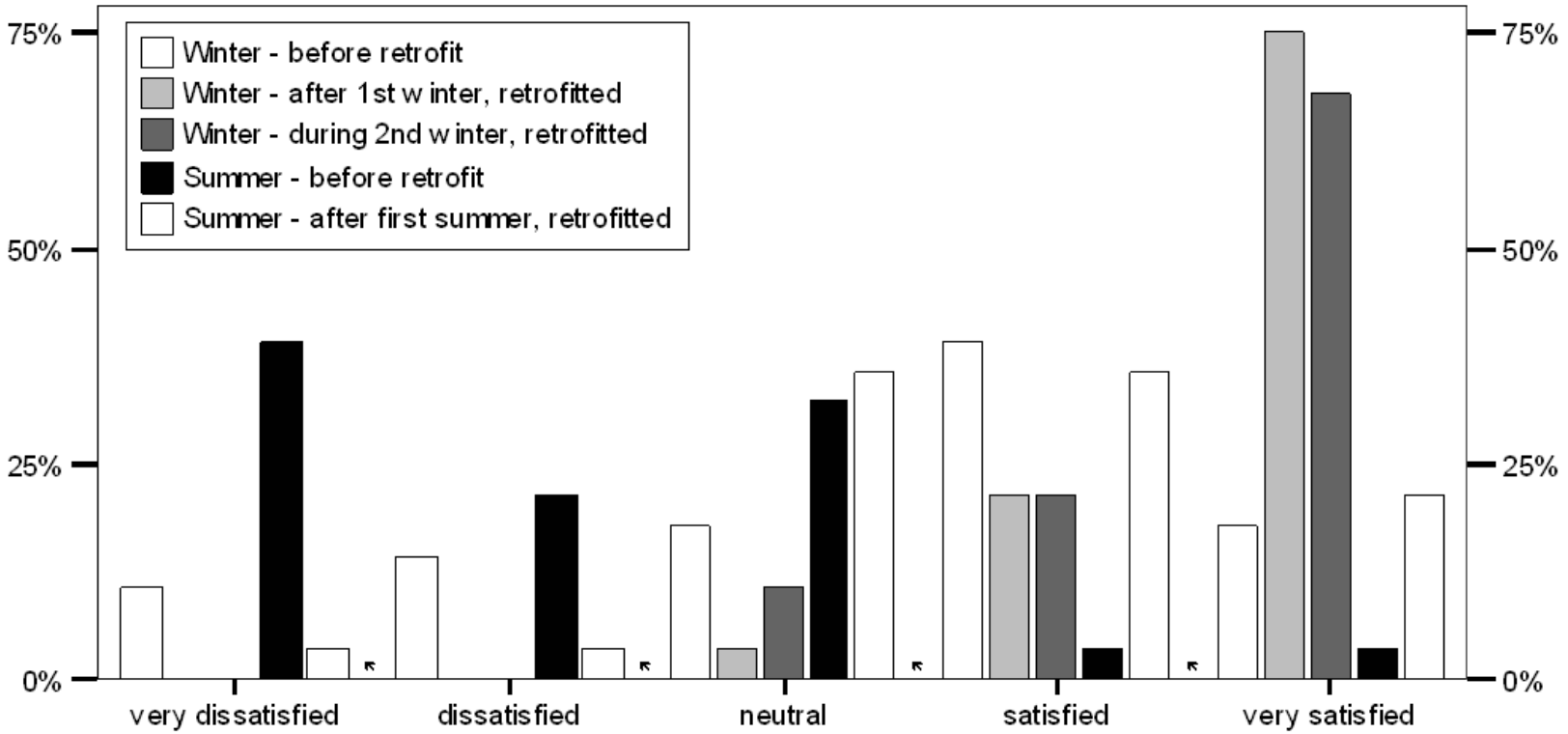
Satisfaction with flat



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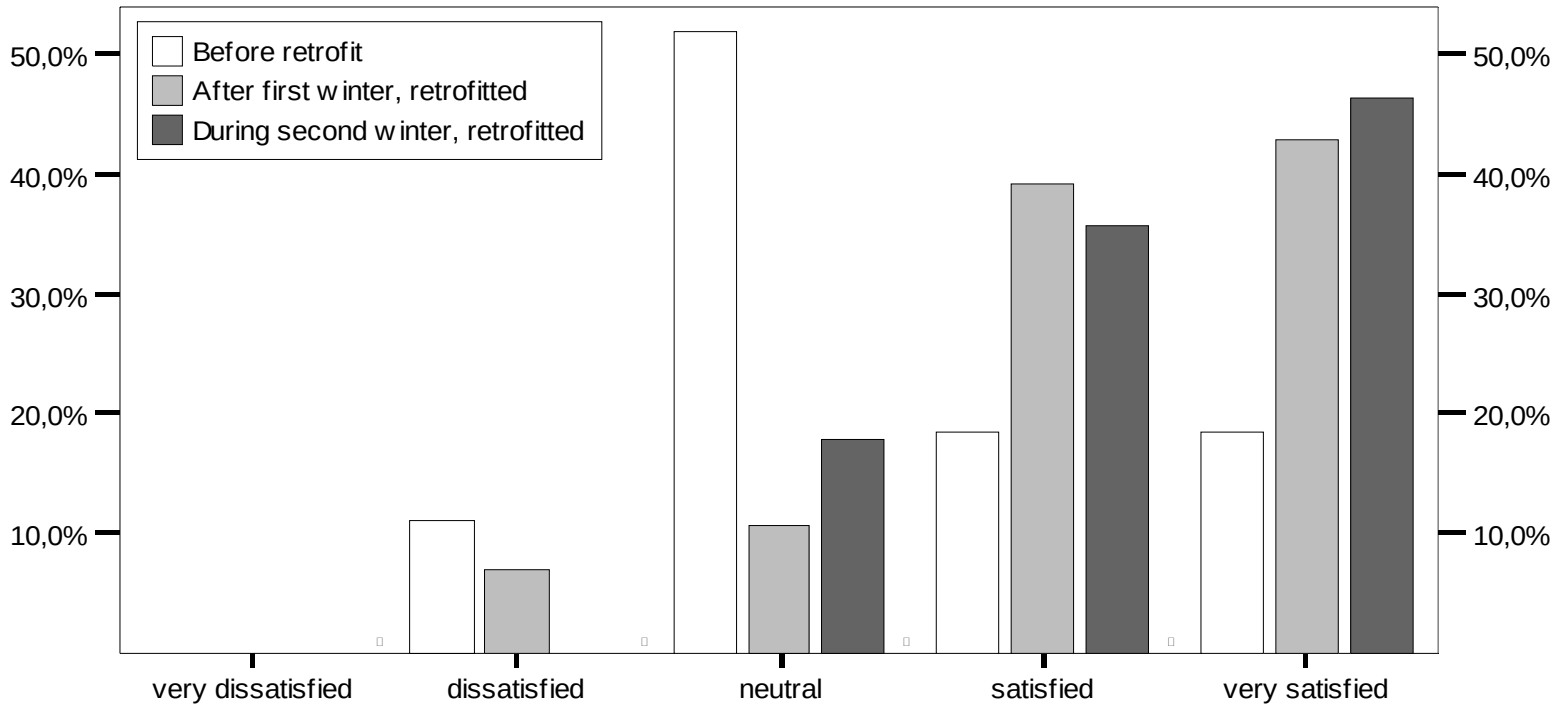
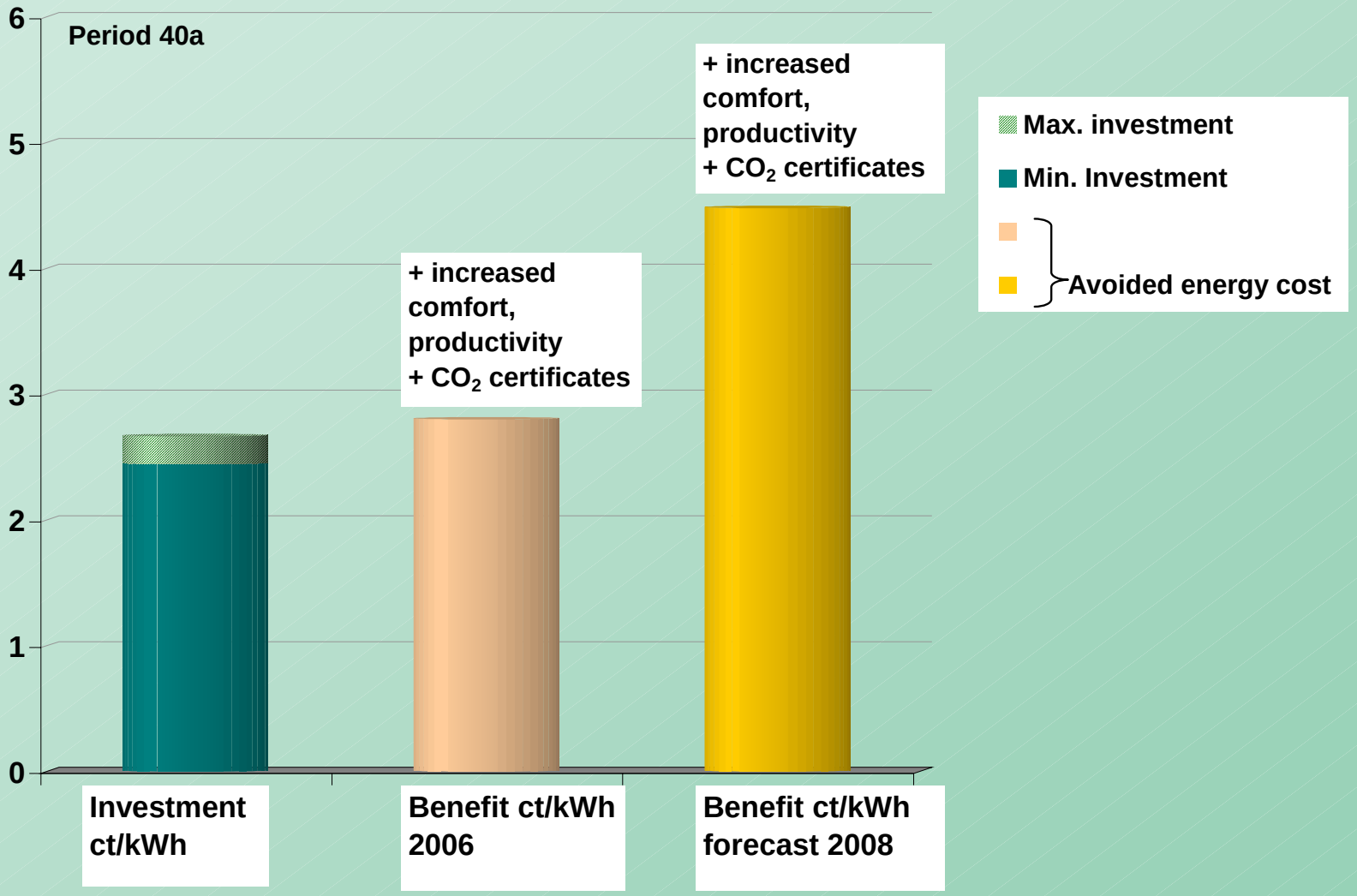
Satisfaction with temperature



Investment and benefit of the refurbishment measures



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Thank you for your attention!