TREES
Training for Renovated Energy Efficient Social housing

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

Intelligent Energy Europe

Section 3 Case studies
3.4 Montreuil, France

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ARMINES – CEP

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Context and objectives of the project

- **Large social housing stock from the 60's and 70's in France, with a poor performance**
- **High potential for improving environmental quality**
- **Objectives of the project :**
  - reduce by 25% CO_2 emissions
  - Contribute in a municipal sustainability project
  - Exchange knowledge about technical, social, environmental and financial aspects in the frame of a European project, REGEN LINK (8 countries) coordinated by PATRIMONIUM (The Netherlands)
  - Demonstrate innovation and promote replication

Improvement compared to standard renovation

- **Improved insulation : 10 cm instead of 6 cm**
- **advanced glazing : U = 1.3 instead of 3 W/m2/K**
- **humidity-controlled ventilation**
- **air preheating in glazed balconies**
- **Solar water heaters were studied but not installed due to lack of local support at that time (implemented in a more recent project)**
- **low flow rate sanitary equipment**

Building before and after renovation

Construction : 1969, not insulated, single glazing heating load : 150 kWh/m²/a (2,700 degree days base 18)

Photos : B. PEUPORTIER

Heating load reduced by 32%, possible 50% reduction if indoor temperature = 20°C
Cost : 5,000 € (standard Renovation) + 3,500 € per unit
- 76 tons CO_2 yearly (-26%)

Contents

- **Objectives and project presentation,**
- **Building before renovation,**
- **Decision process,**
- **Refurbishment concepts and design study,**
- **Realisation,**
- **Monitoring results,**
- **Environmental assessment,**
- **Costs,**
- **Conclusions.**

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Introduction, objectives of the project

- **Improve environmental quality in social housing renovation**
- **Reduce by 25% CO_2 emissions compared to a standard renovation**
- **Implement replicable techniques**
- **Contribute in a municipal sustainability project**
- **Exchange knowledge about technical, social, environmental and financial aspects in the frame of a European project, REGEN LINK (8 countries)**

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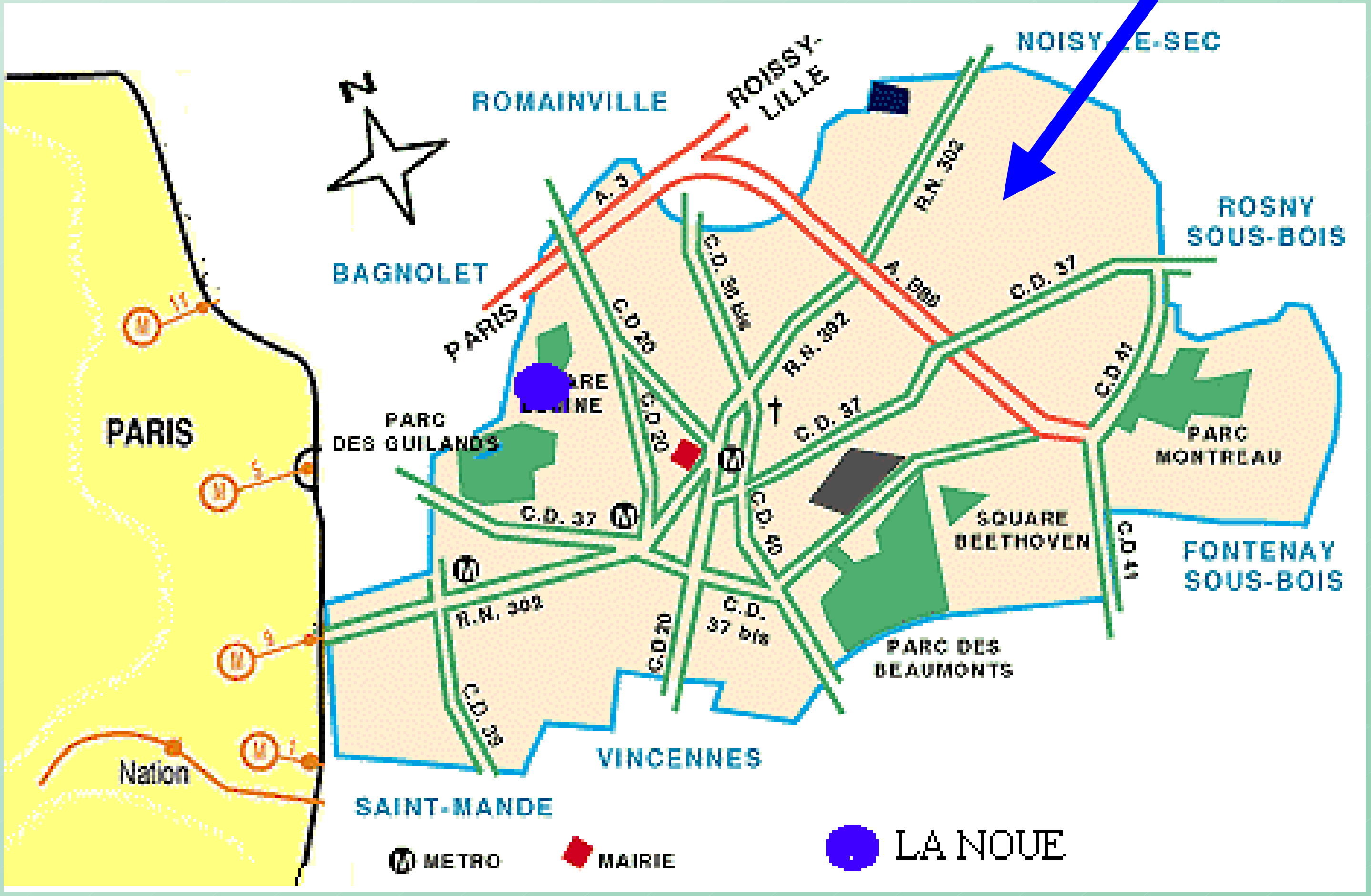
Location

Montreuil



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the building before renovation


Photos : B. PEUPORTIER

Construction : 1969, not insulated, single glazing

Heating load : 150 kWh/m2/a (2,700 degree days base 18)

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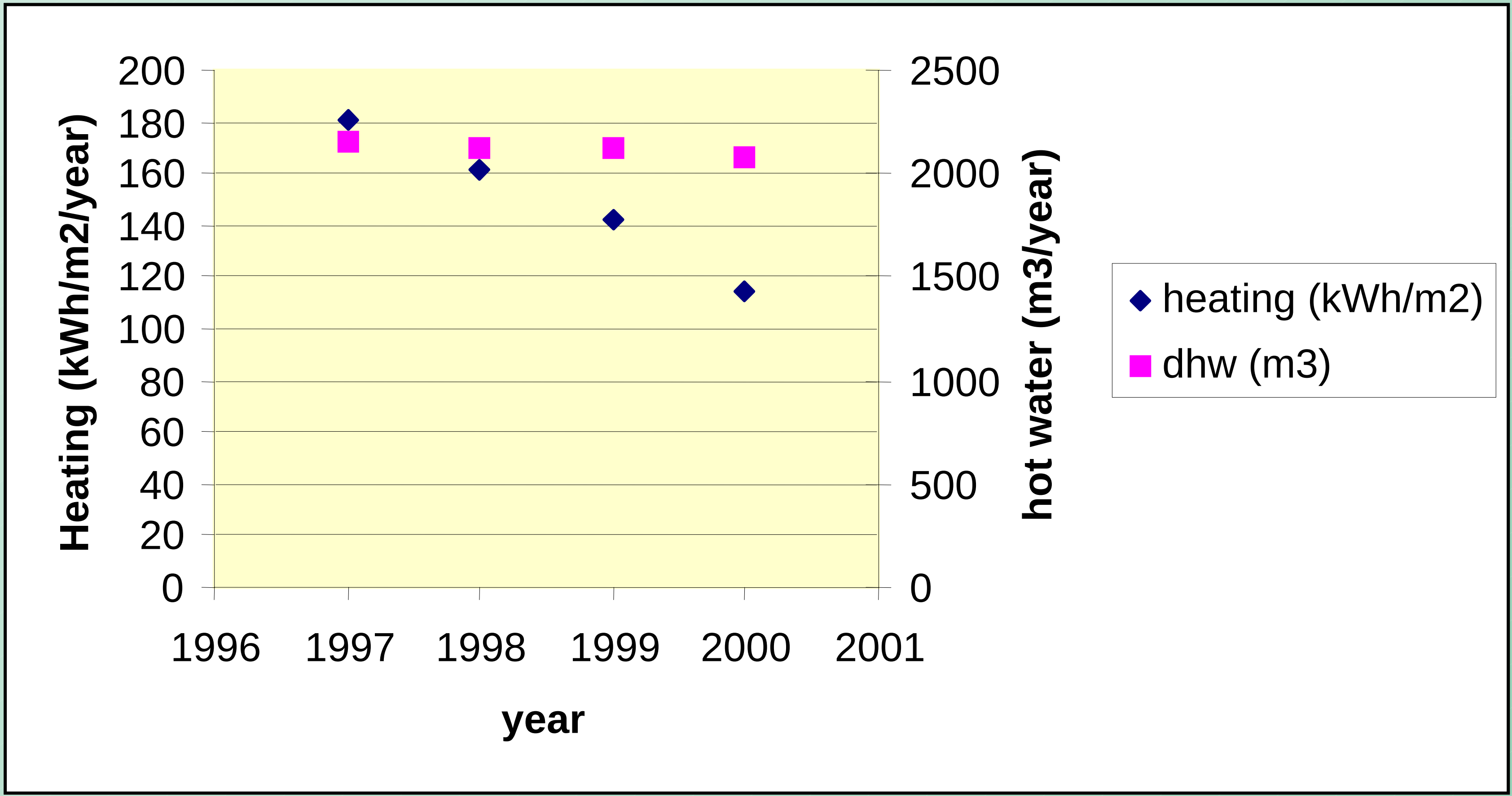
Energy needs before renovation



The variation of the heating load is related to climatic variation, and a different use of the ground floor

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Energy retrofit is part of a global strategy

- **Multicriteria approach (energy, environment, comfort, costs, image of the building and neighbourhood...)**
- **Integrated design involving the architect, engineer and contractors in charge of renovation works and maintenance**
- **Energy efficiency : insulation, efficient systems**
- **Energy moderation : thermostat set point at 20°C instead of 23°C, shower rather than bath etc.**
- **Integration of renewable energy systems**
- **Participatory approach involving the residents**

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First steps : site analysis + residents survey

- possibilities for investment
- analysis of the residents' needs, their wishes and preference regarding technologies
- compatibility with their way of life (e.g. glazed balconies or sunspaces)
- analysis of the existing building and site, solar resource : facade orientation, shading
- ability for an efficient maintenance
- system size and architectural integration

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Choosing the main design options

- **is the solar exposure high enough to integrate passive and active components ?**
- **how thick should be the insulation ?**
- **how to reduce ventilation heat losses ?**
- **which is the most appropriate glazing type ?**
- **what are the priorities according to the budget ?**
- **are the proposed technical solutions acceptable by the tenants ?**
- **-> iterative process architecture – techniques – costs – users' acceptance**

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Participation of the residents

Glazed balconies

Glazing area,
Demand side management
Neighbourhood workshops

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Site analysis, evaluation of solar exposure

Is this building suitable for solar retrofit ?

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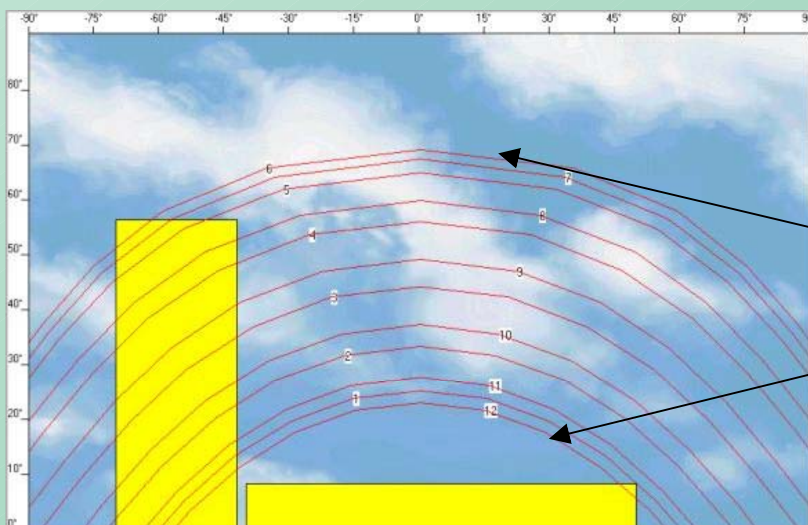
Site analysis, evaluation of solar exposure

Height
0° = horiz.
90° = vert.



azimuth, 0° = south
90° = west

June

December

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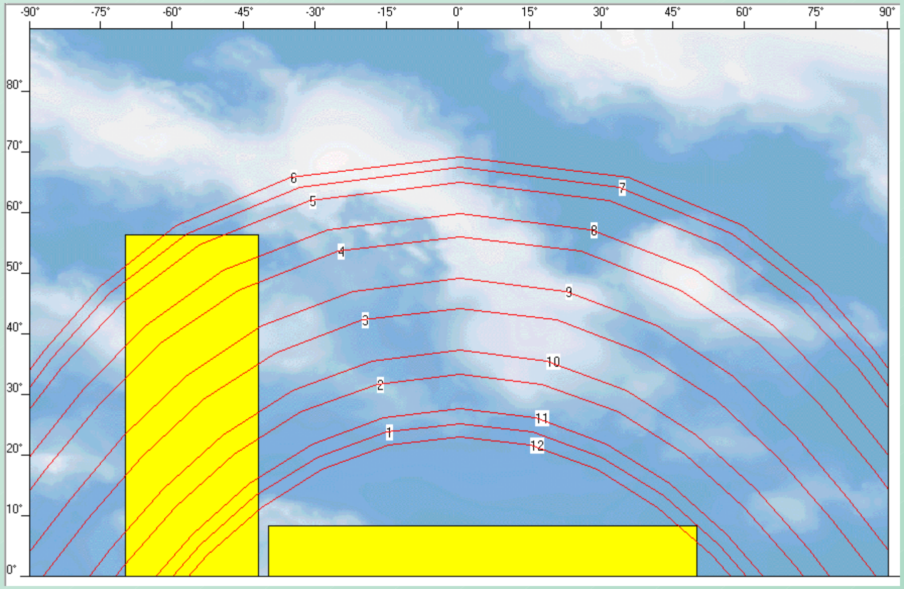
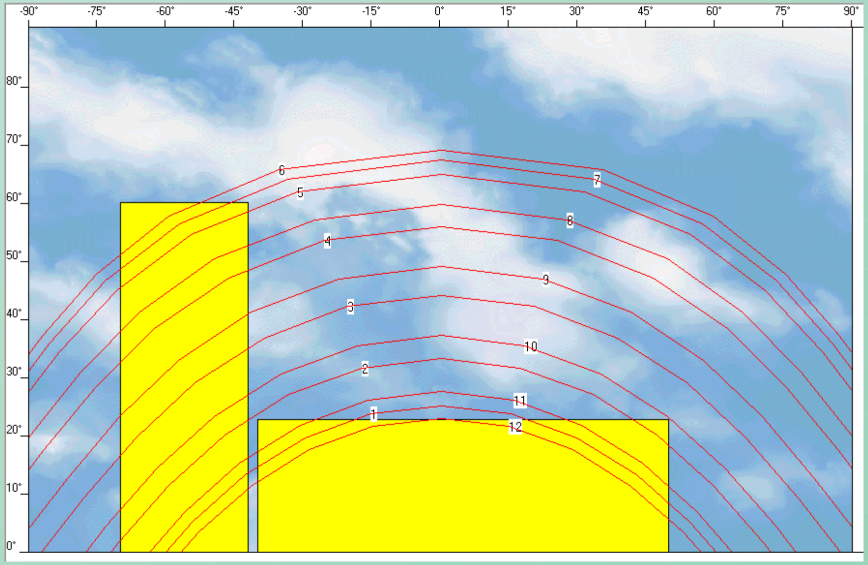
Shading from other buildings



Roof level



Ground level

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Technologies

- **Improved insulation**
- **advanced glazing**
- **humidity-controlled ventilation**
- **air preheating in glazed balconies**
- **Solar water heaters**
- **low flow rate sanitary equipment**

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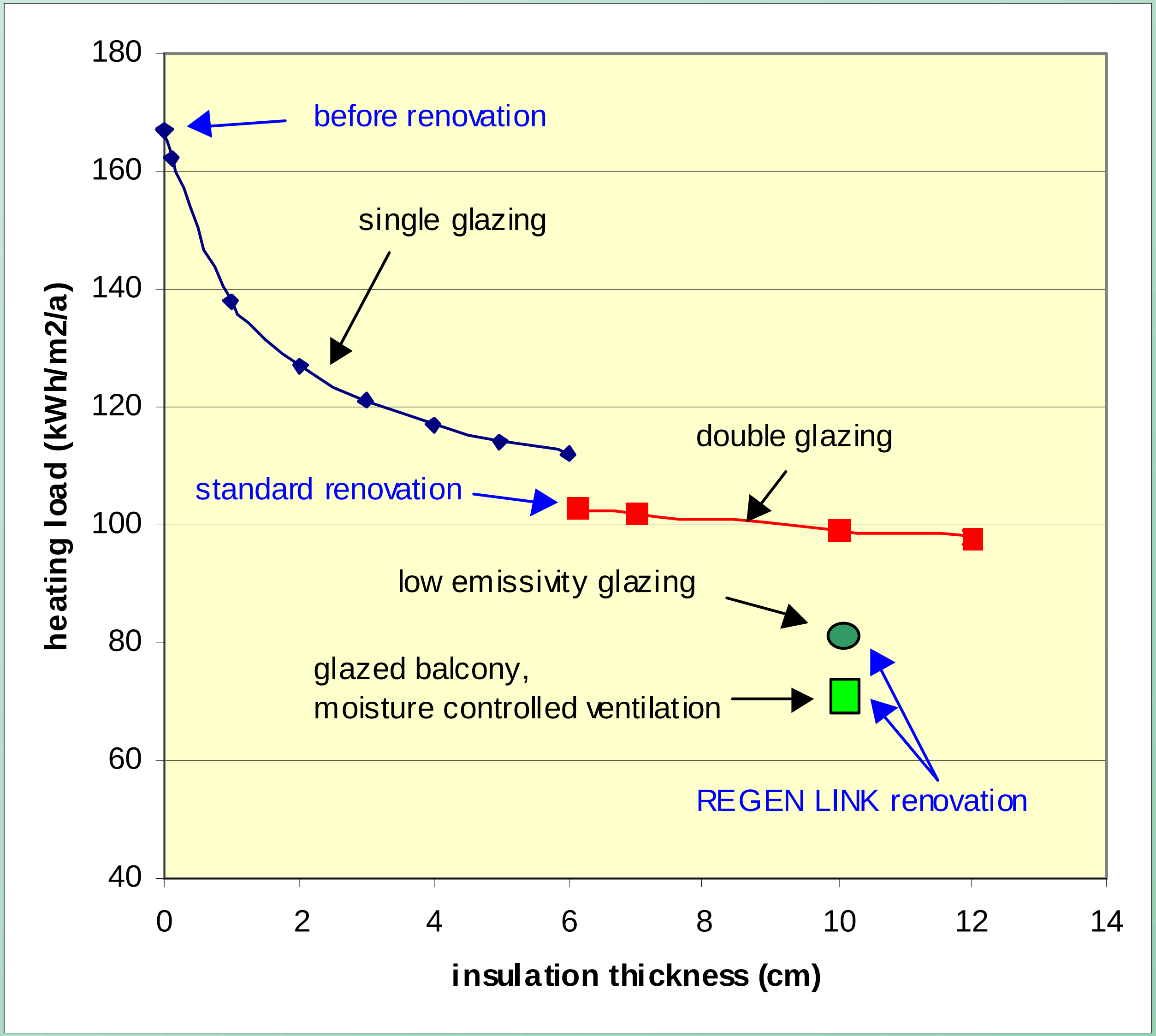
Results of thermal simulation, COMFIE



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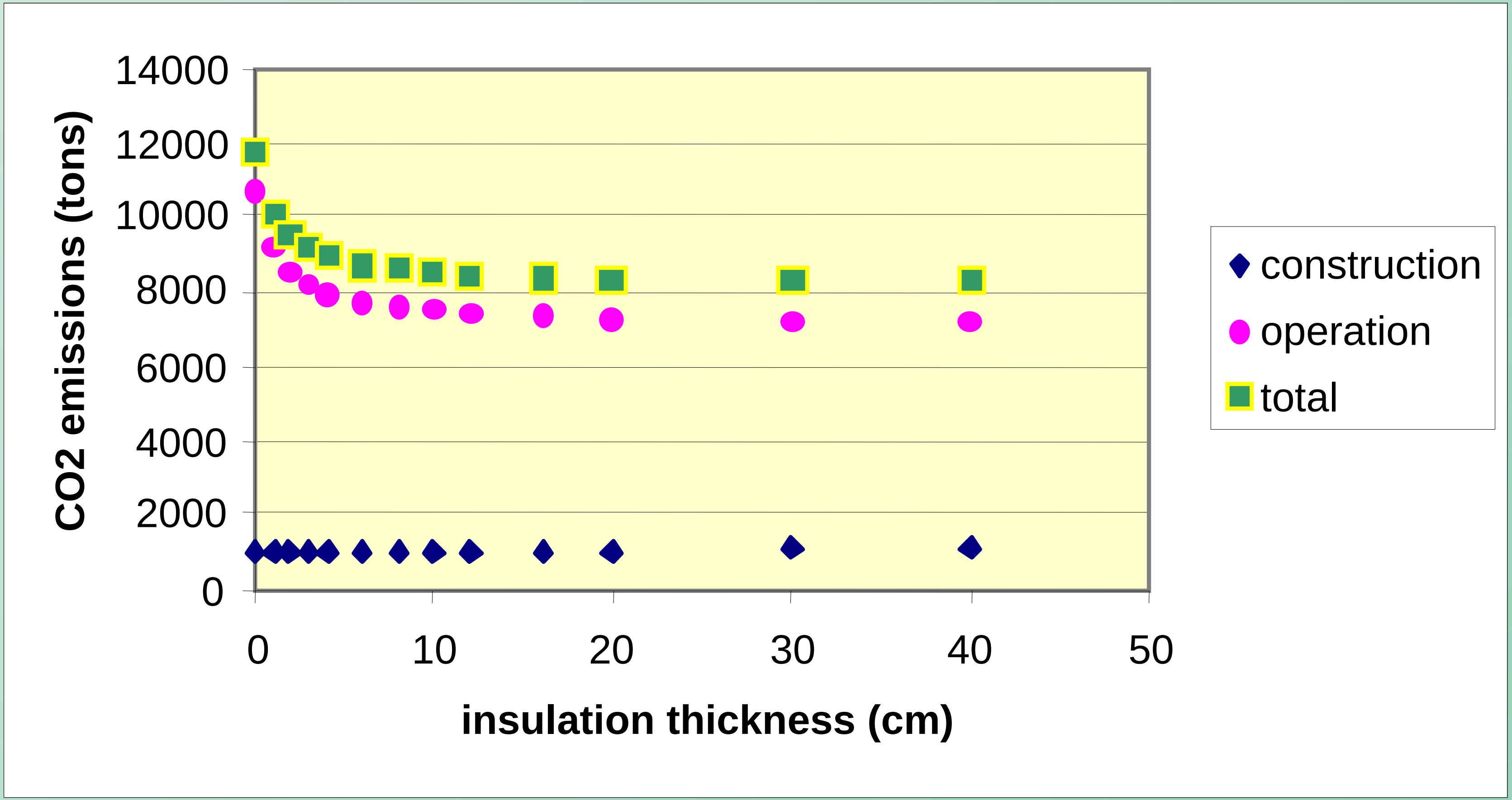
Facade insulation



Life cycle assessment, example : CO_2 emissions
Optimum 20-40 cm (CO_2), 10 cm (cost)

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External insulation

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The existing facade was not flat
-> use of mineral wool

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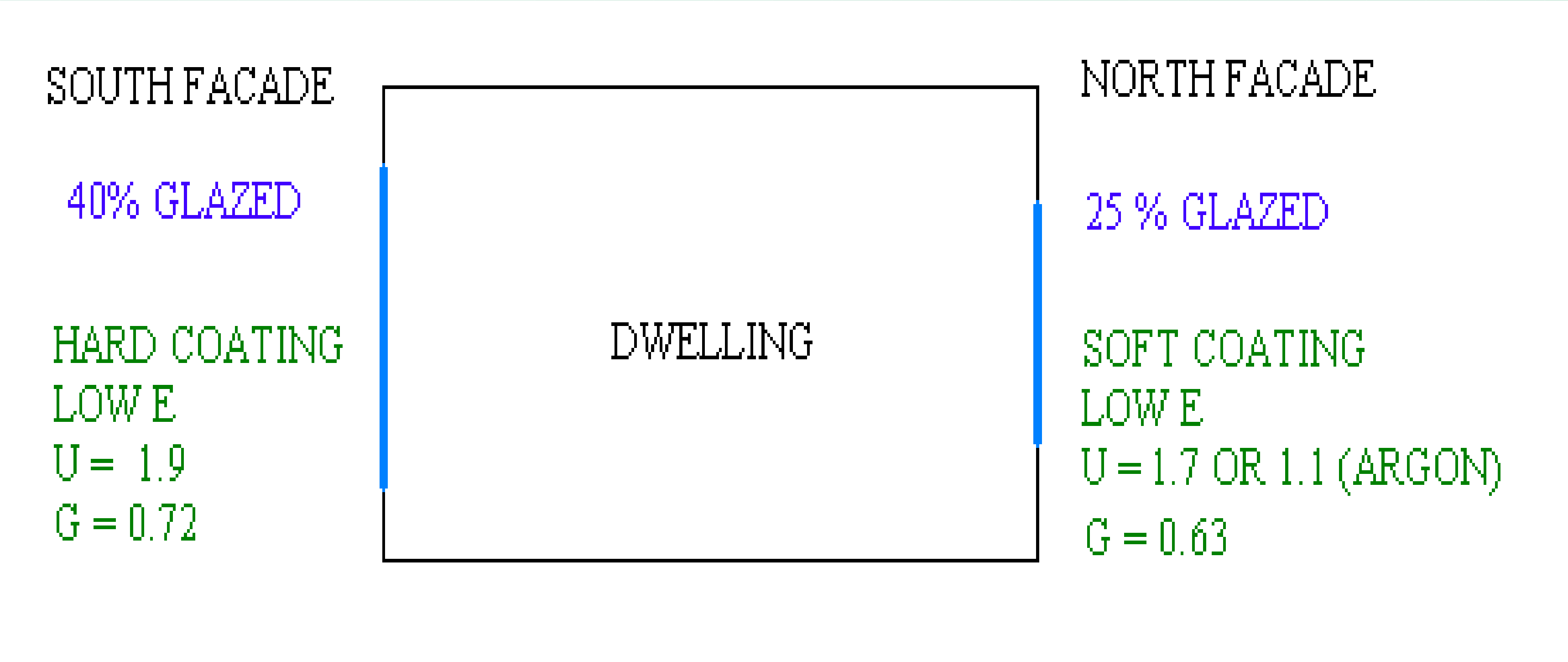
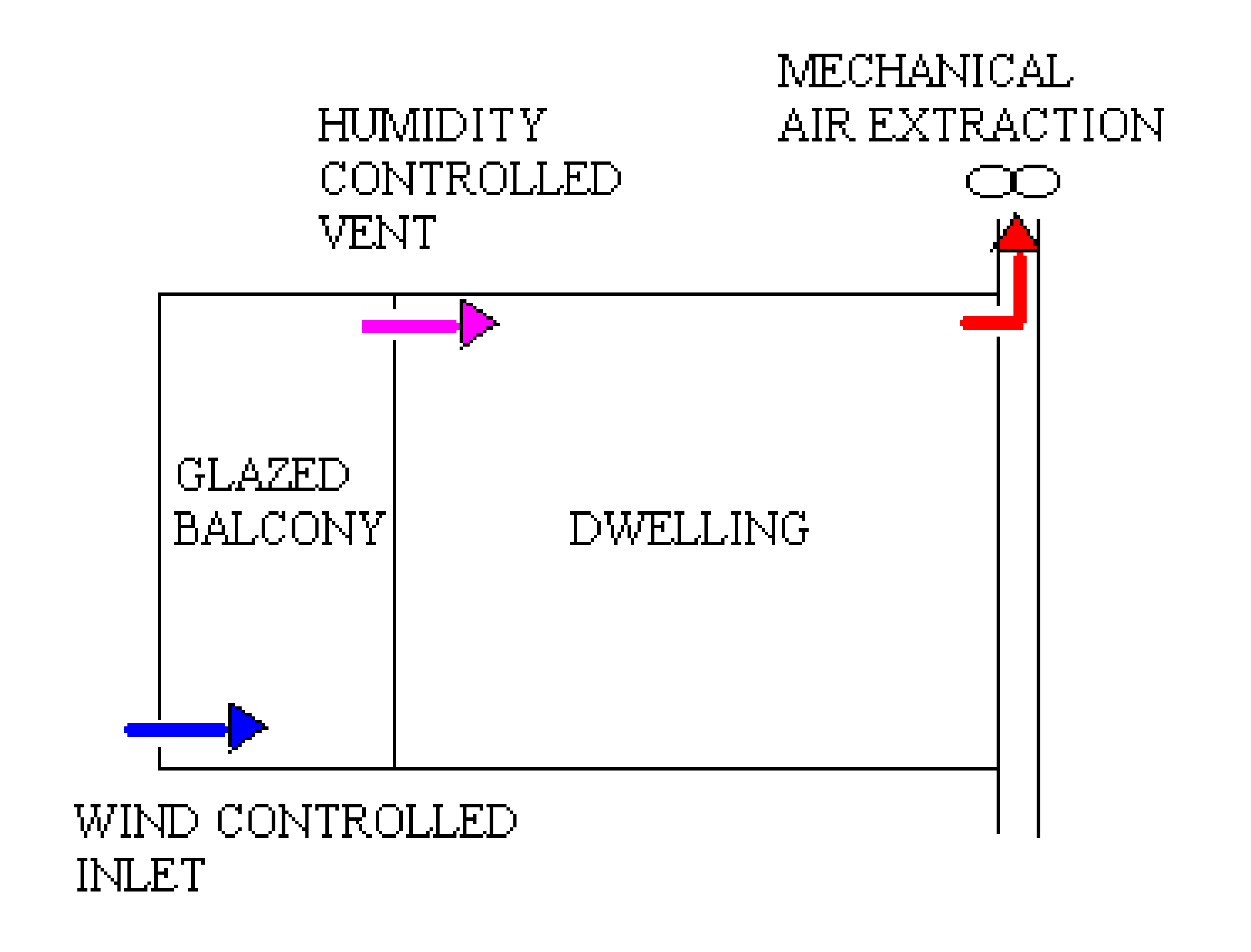
Glazing area and solar gain



Compromise between costs (opaque wall is cheaper than glazing), energy performance (high glazing area in south facades, low in north), functionality (more day-light in living rooms than bedrooms) and tenants wishes (higher glazing area).

No hard coating low e glazing from Saint Gobain -> Pilkington glazing

Solar preheating and ventilation control



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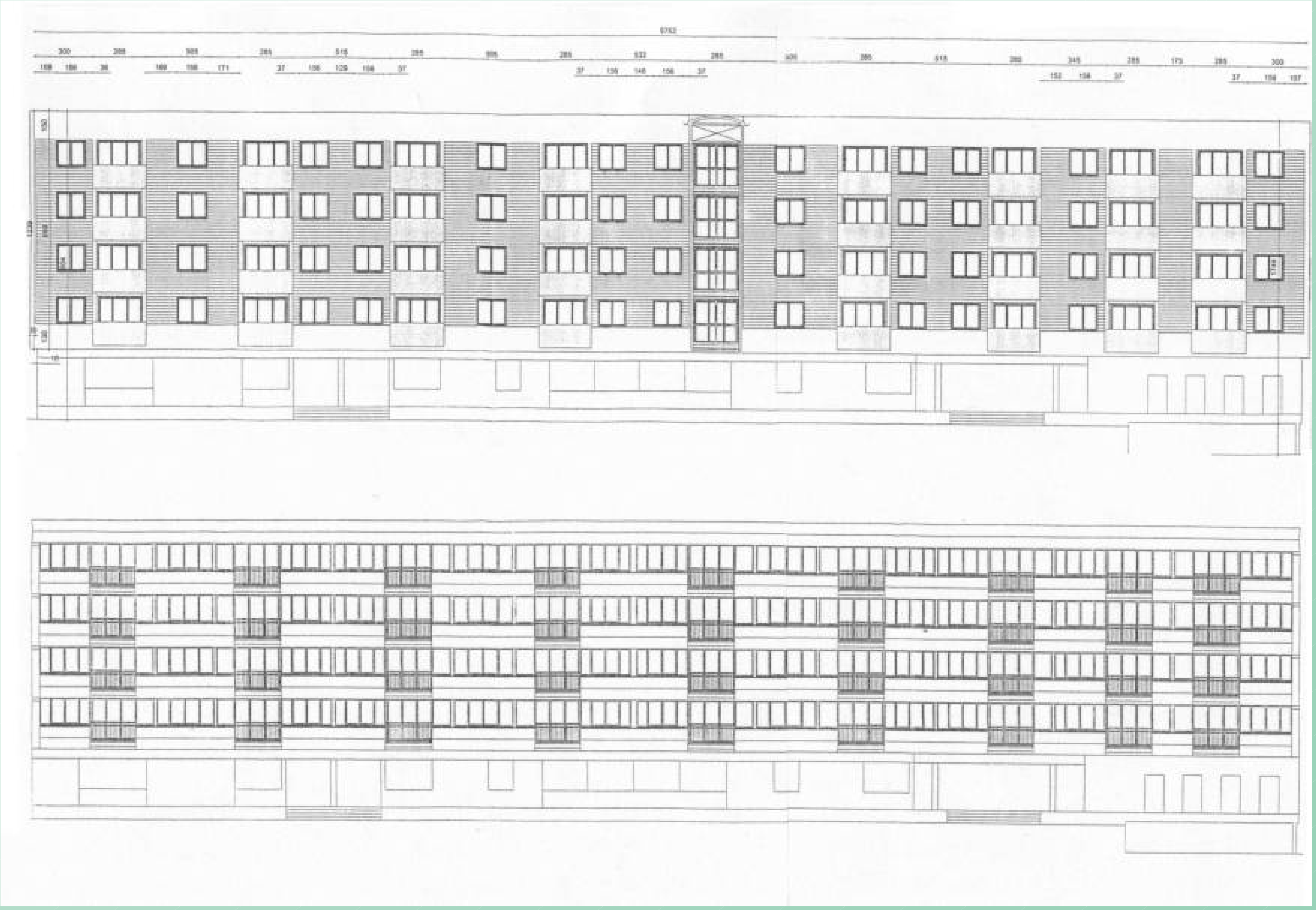
Architect's sketch



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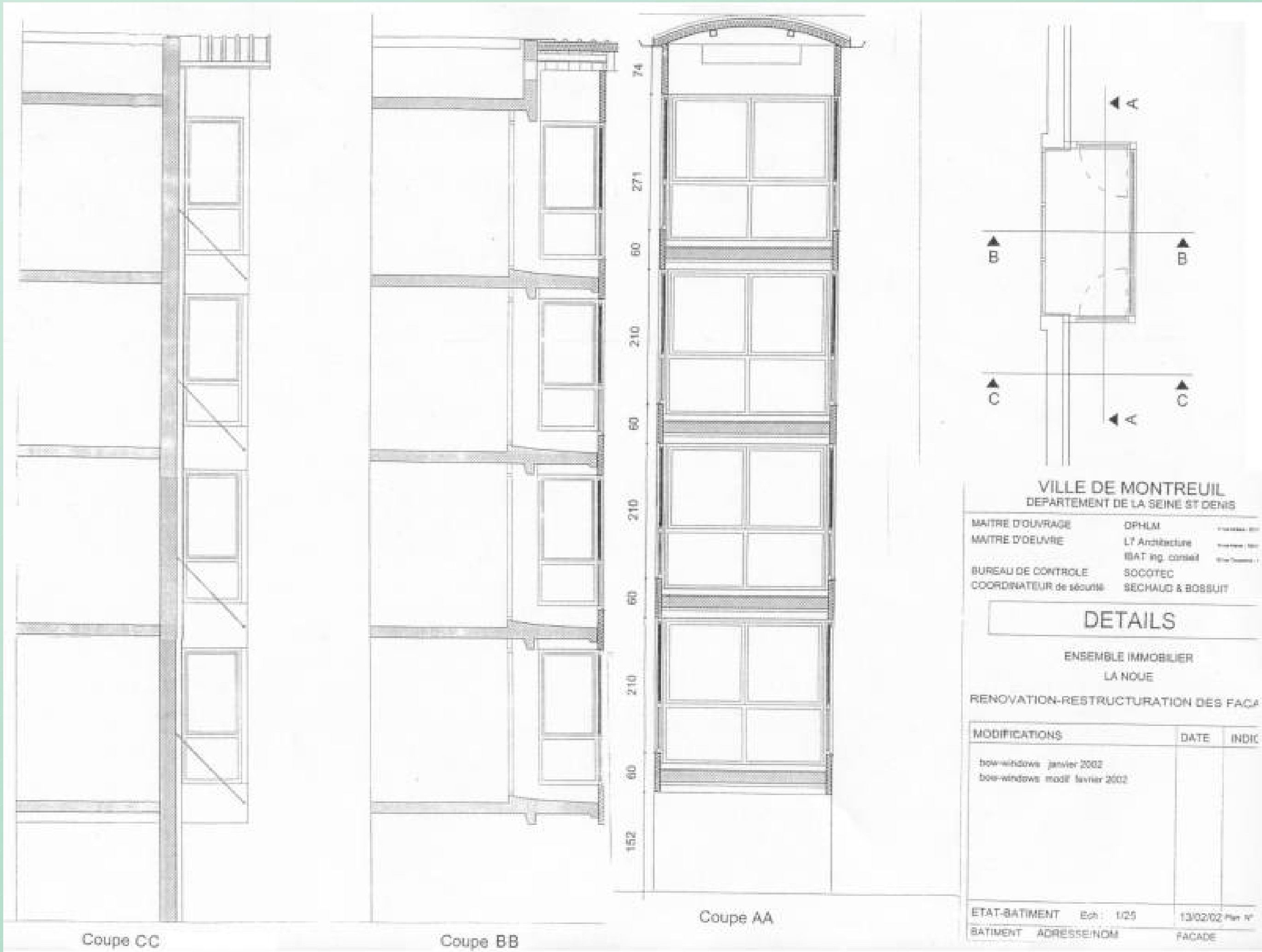
Design of the glazed balconies



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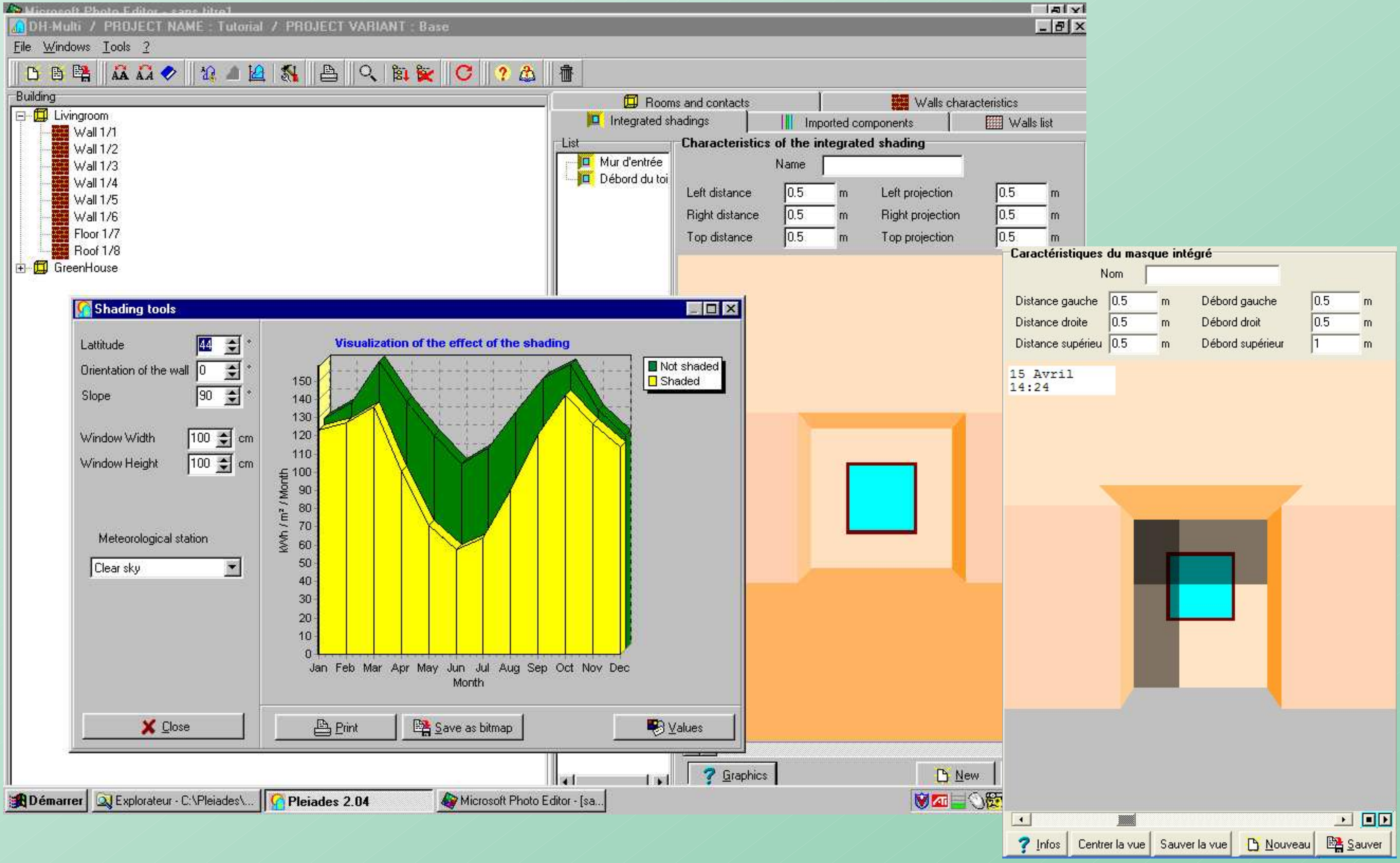
Studying solar protection



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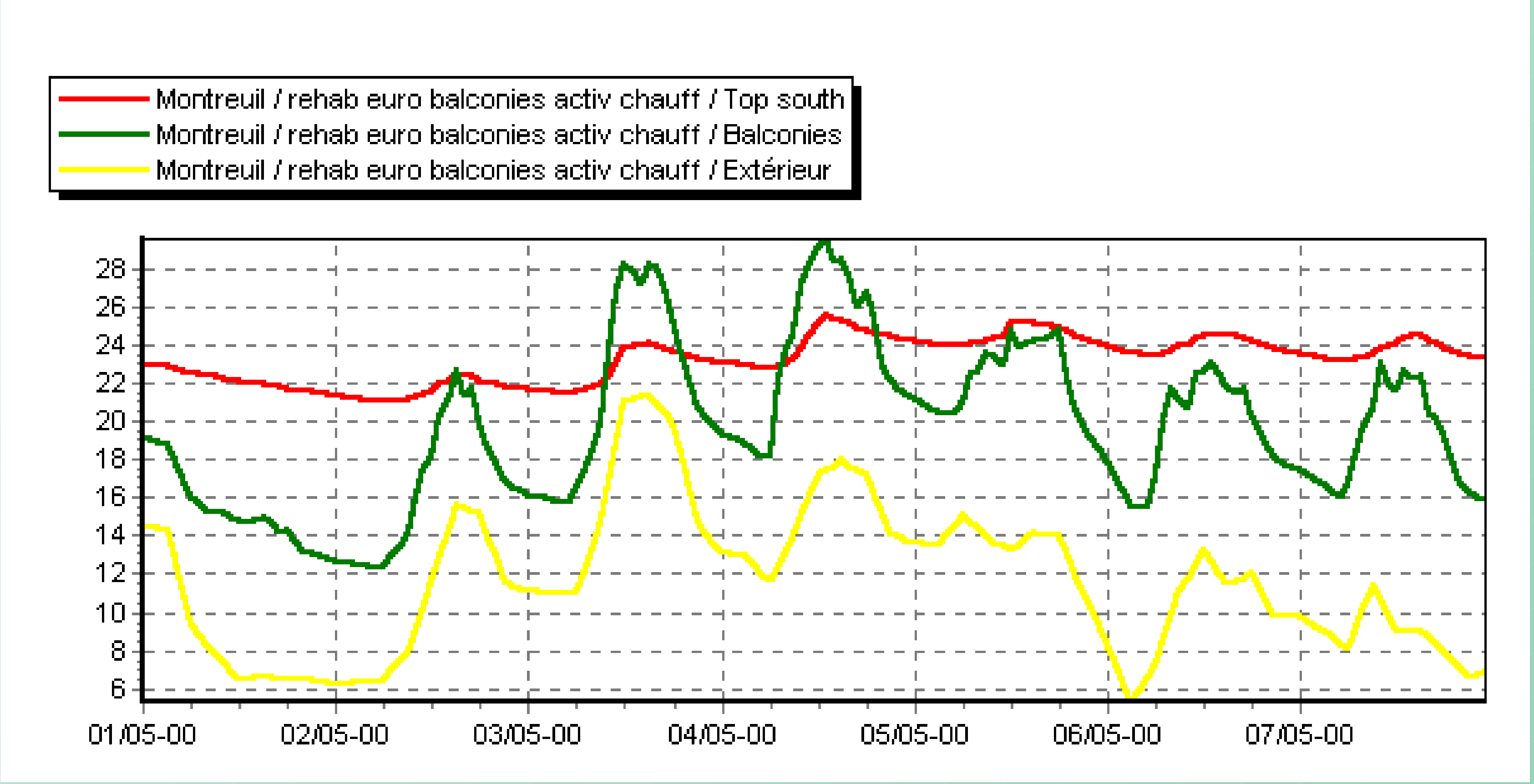
Temperature profiles with glazed balcony



Glazed balconies will have to be ventilated in hot periods

Temperatures remain acceptable in the dwelling

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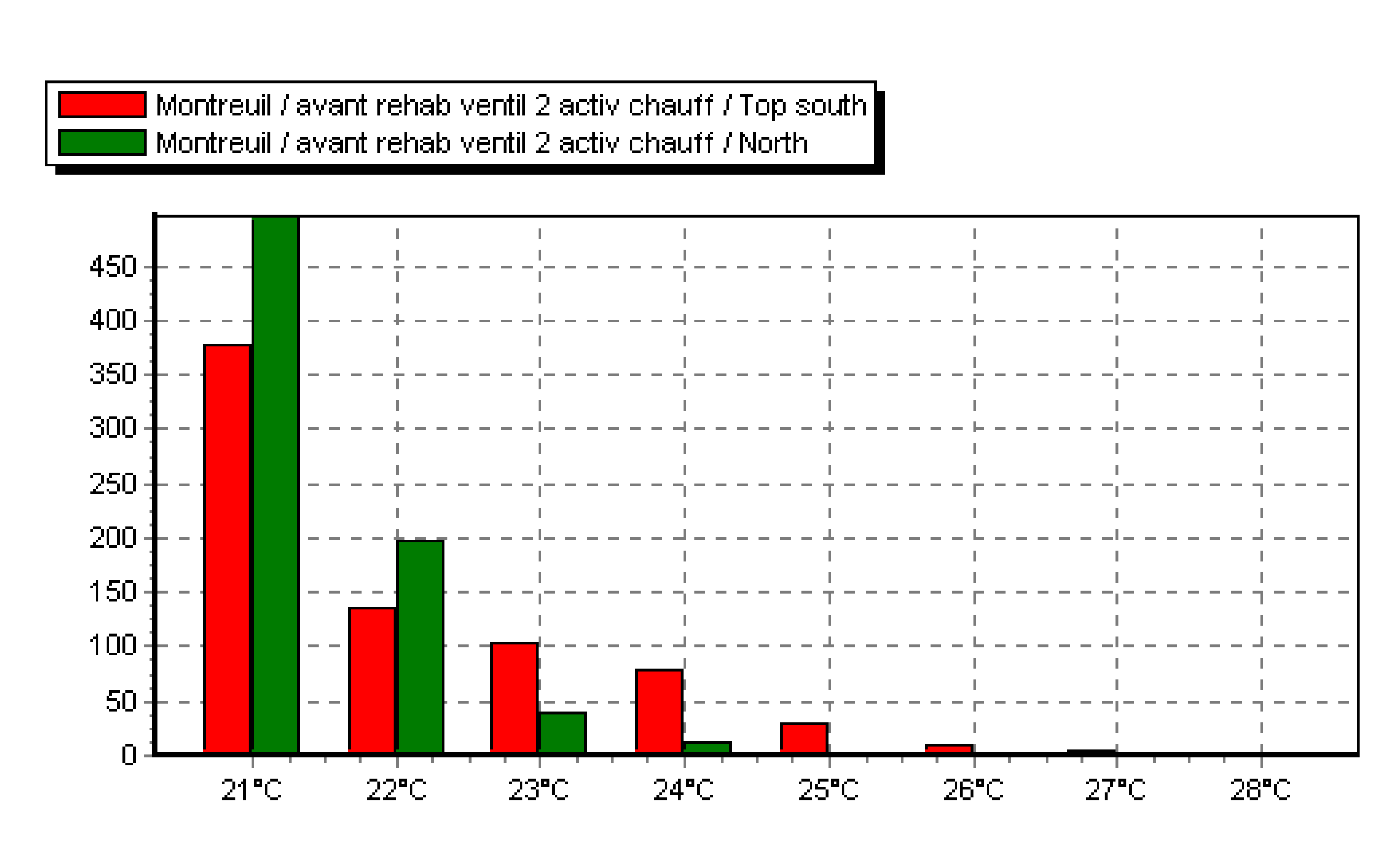
Temperature histograms



Example comparison between north and South oriented rooms

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Building site, balconies

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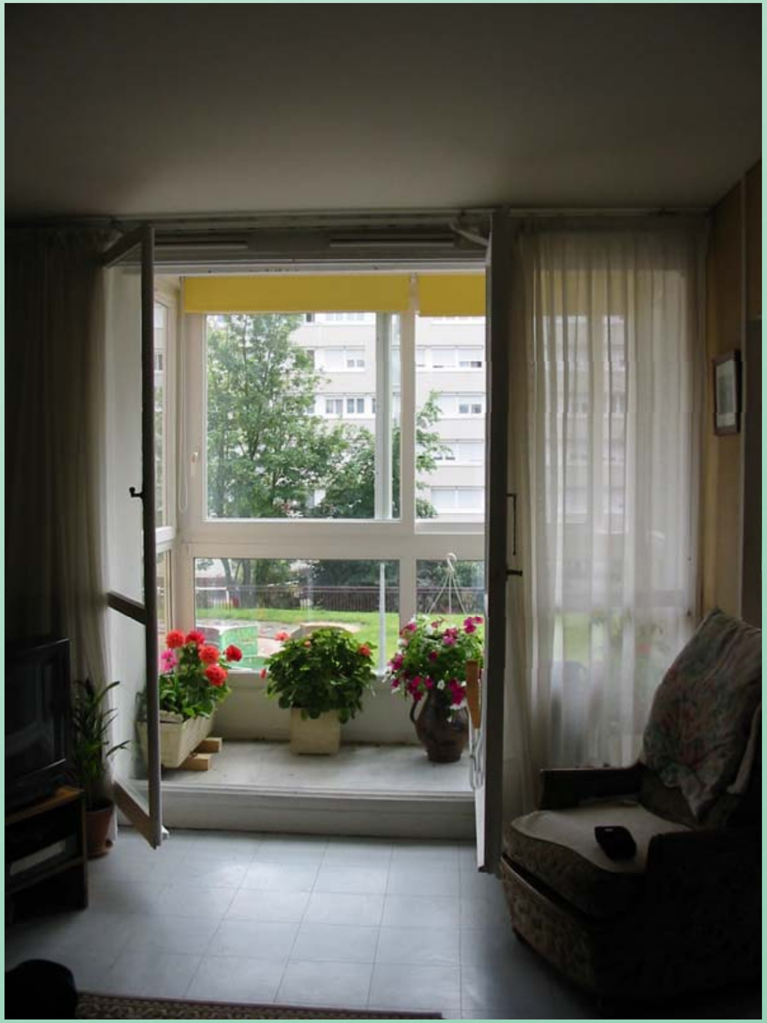
Glazed balconies



Cost of glazed balcony : 9,000 € per unit

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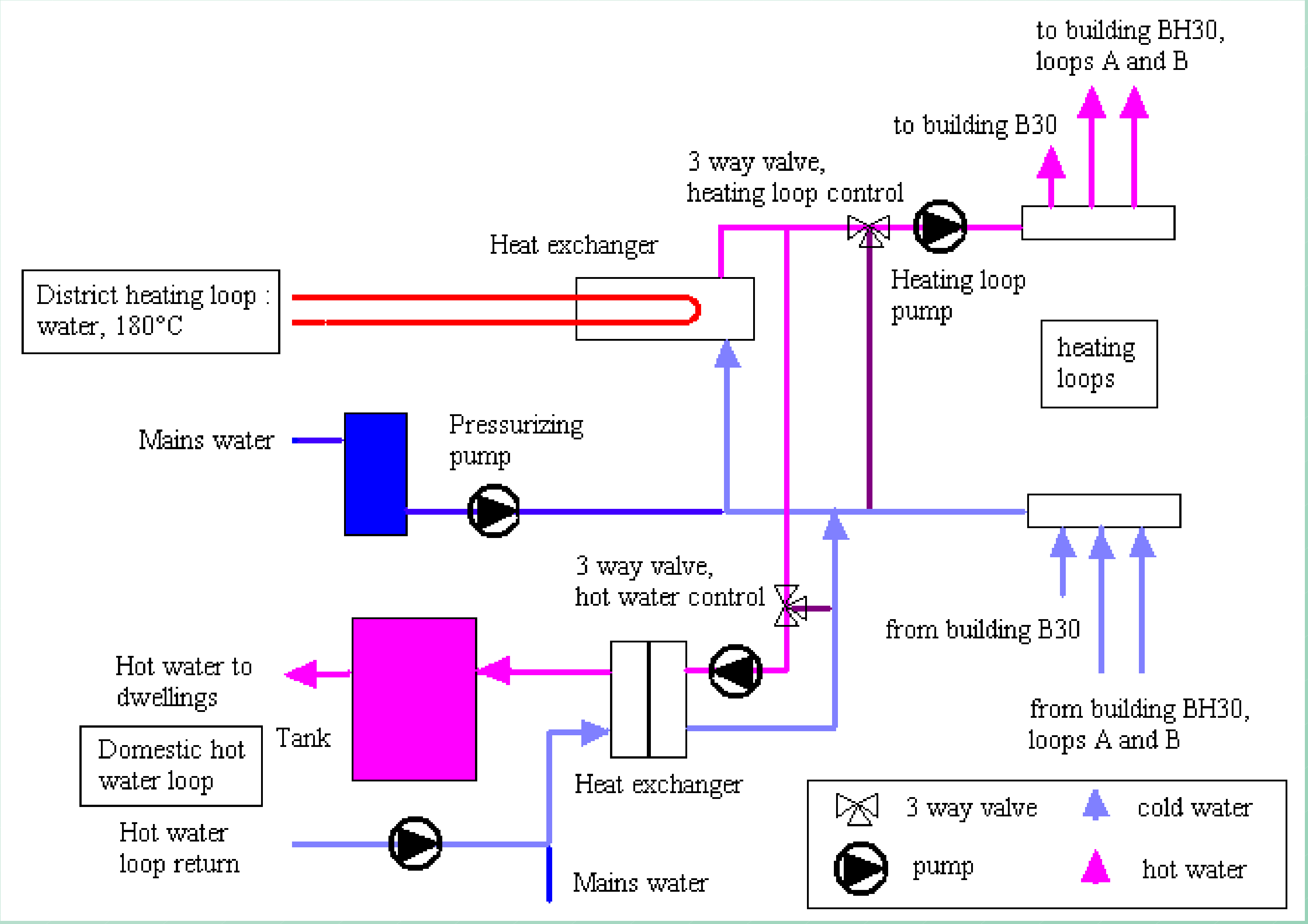
District heating, before renovation



Single heating loop for 2 buildings

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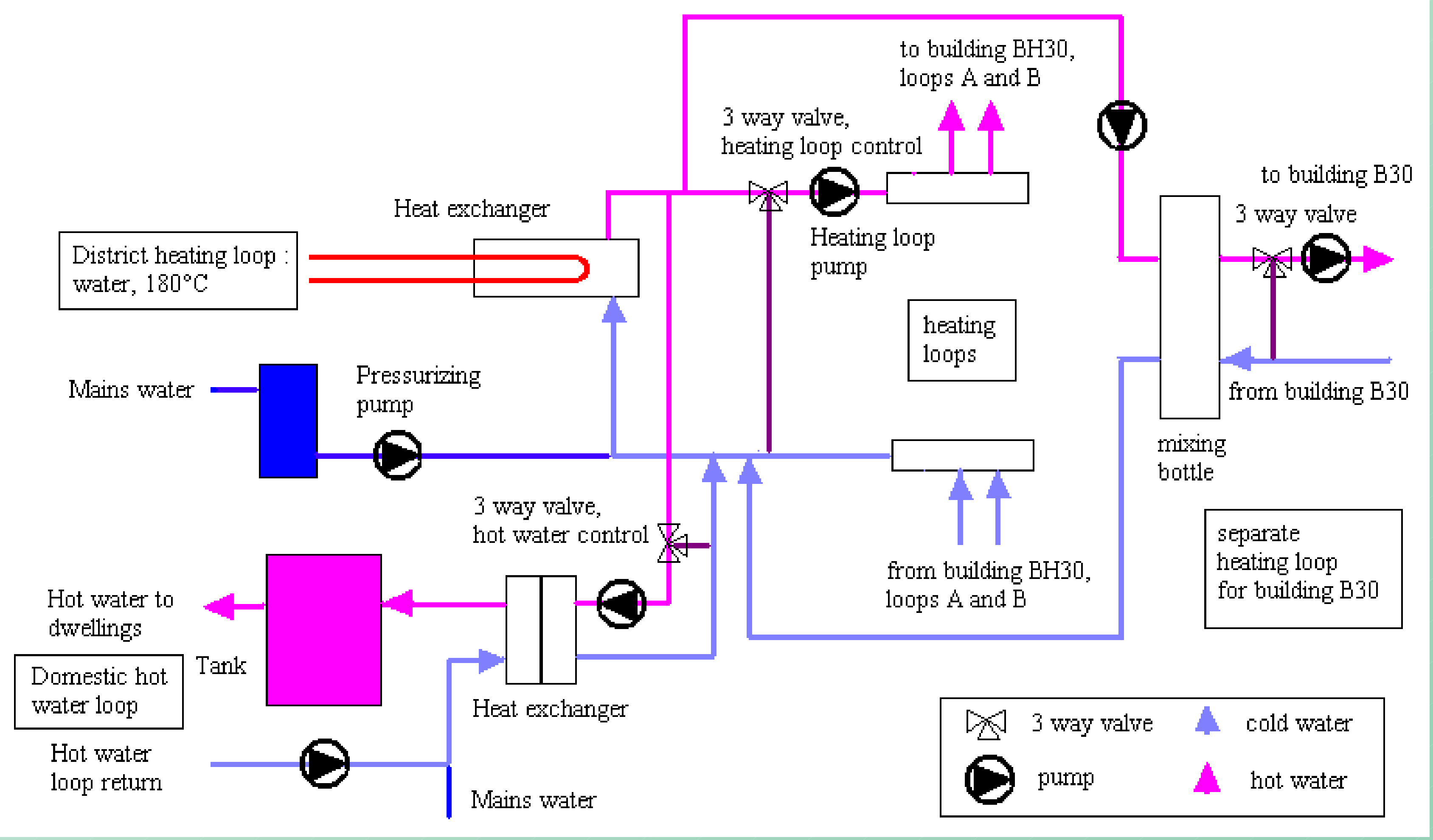
District heating, after renovation



Separated heating loop in each building

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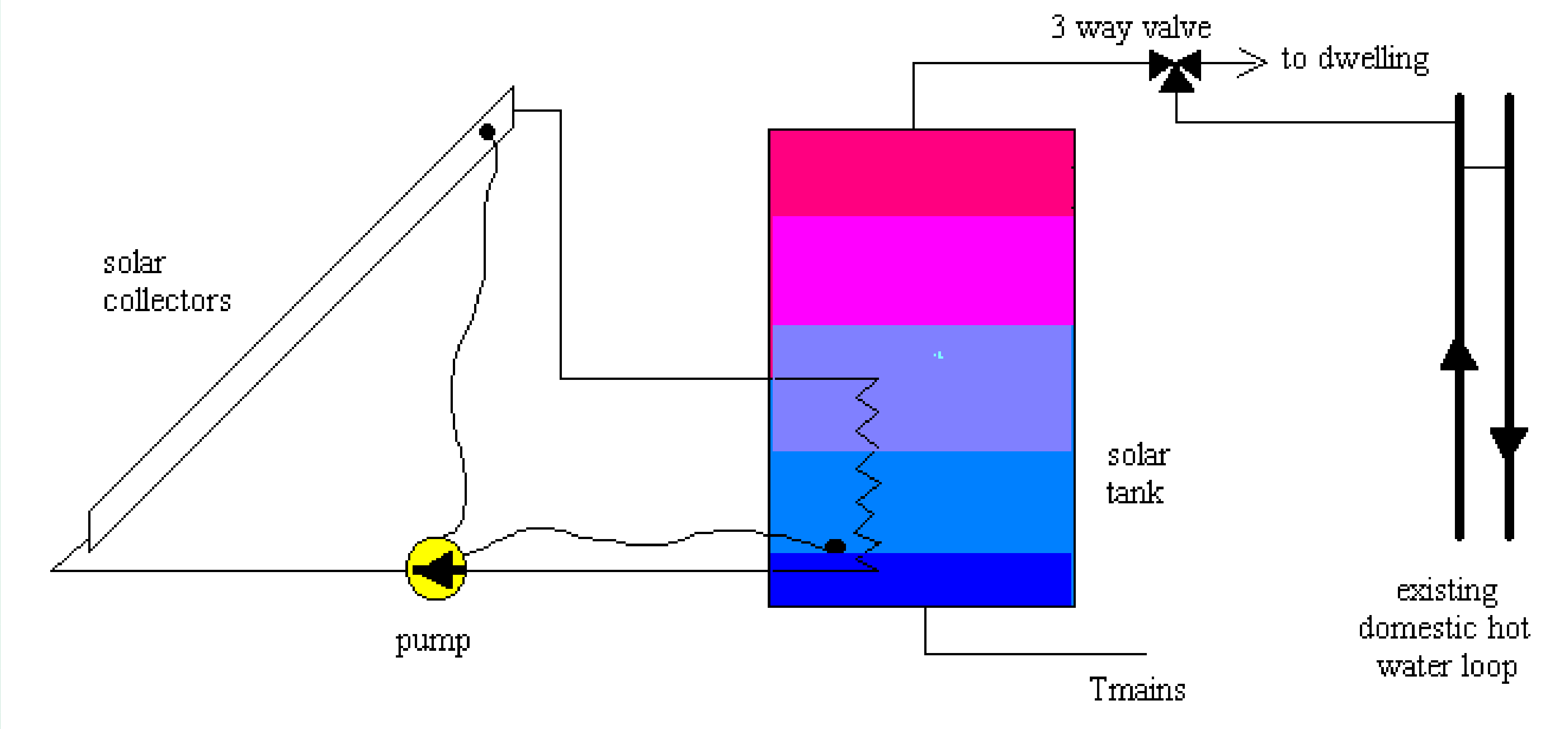
Solar water heater



No support from the region -> no sufficient investment for a collective system, individual system not relevant in this case (district heating)

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Low flow rate showers

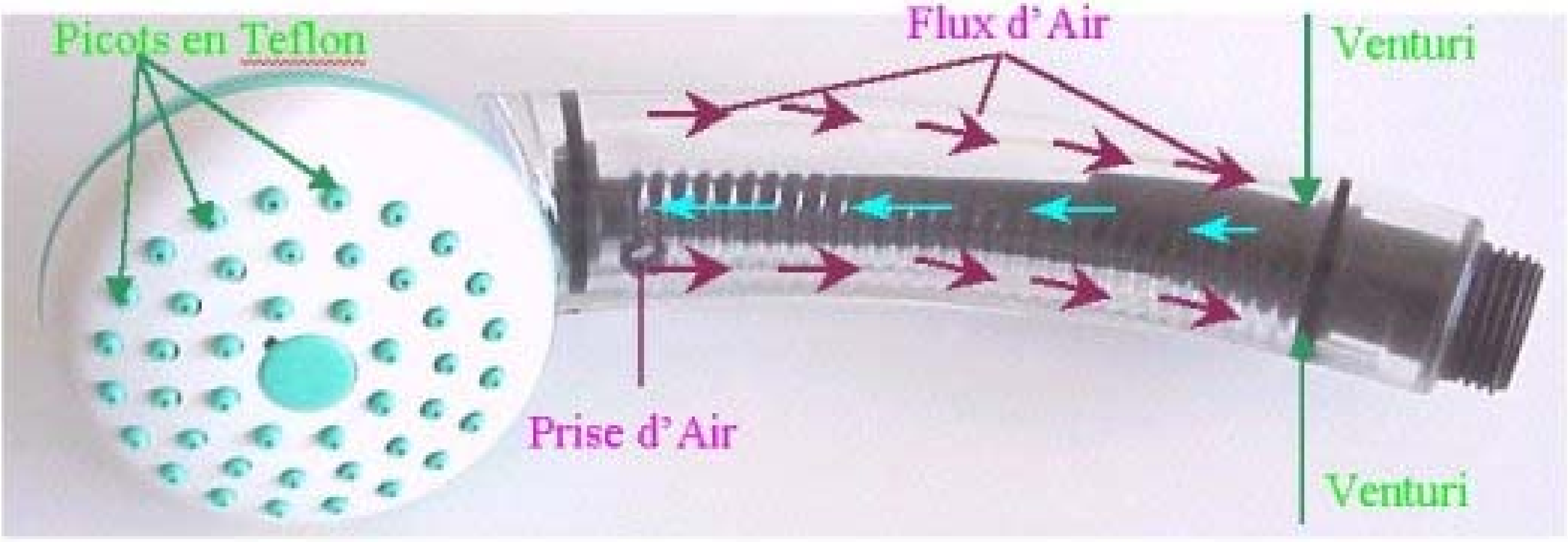
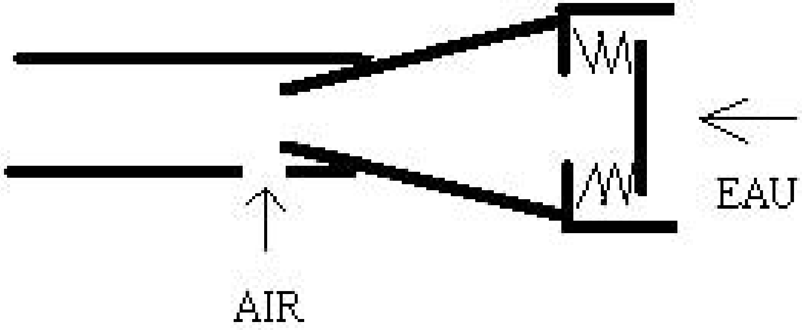


Photo : www.eco-techniques.fr



Venturi effect to increase the water speed, compensating a lower flow rate

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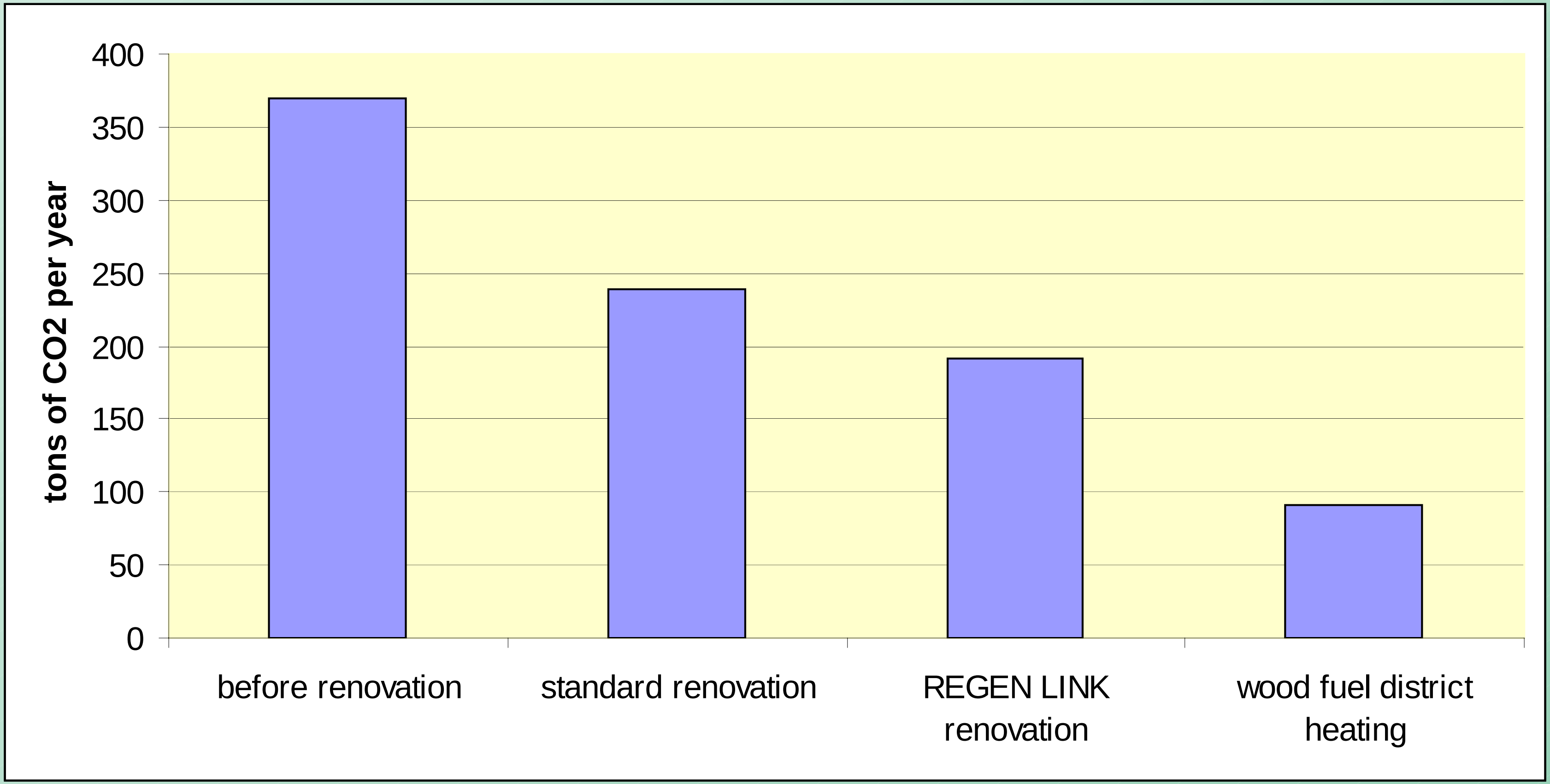
Results of life cycle assessment, EQUER



CO_2 emissions per year

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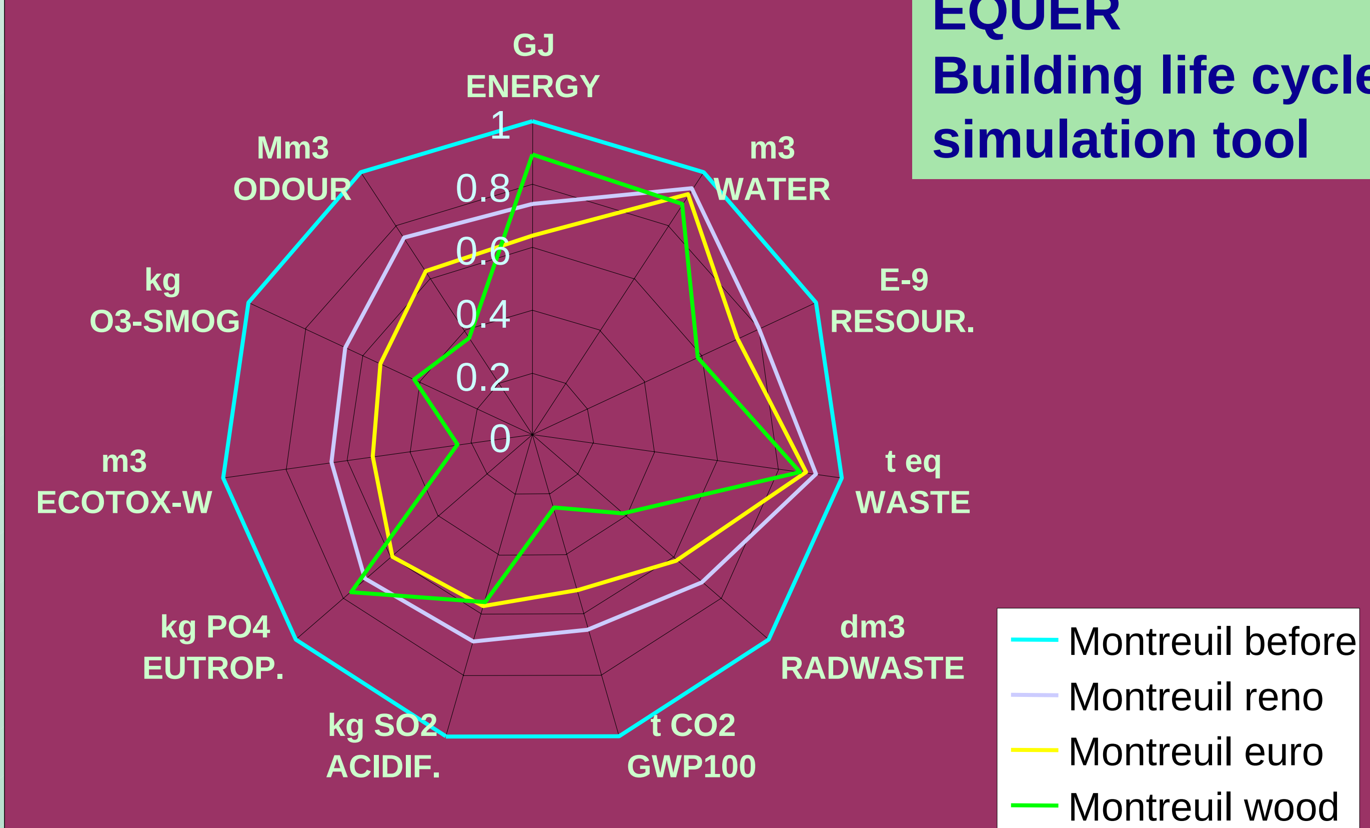
Results of life cycle assessment, EQUER



EQUER
Building life cycle simulation tool

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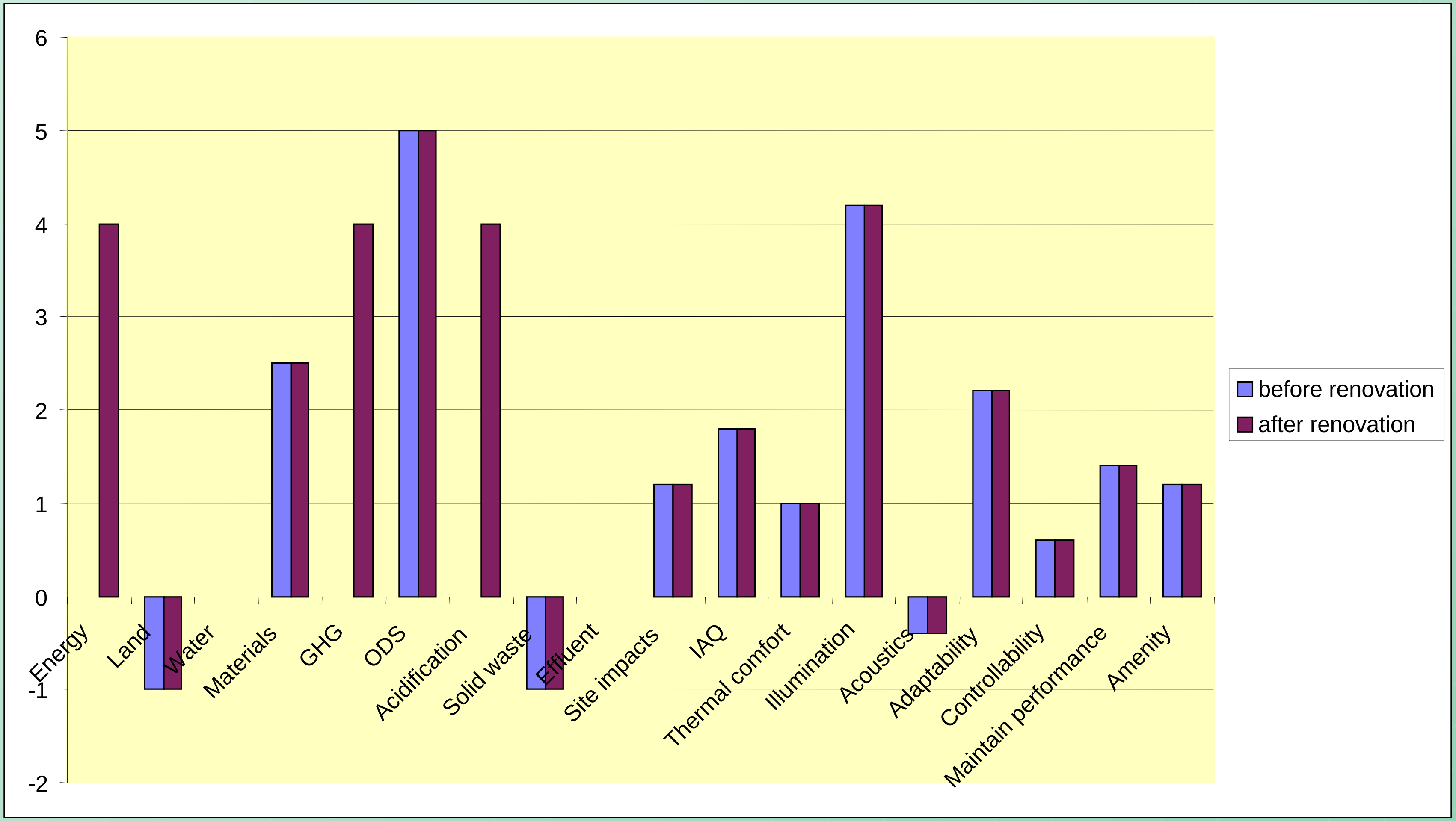
Use of GB Tool



Building after renovation

Heating load reduced by 32%, indoor temp. increased by 3°C

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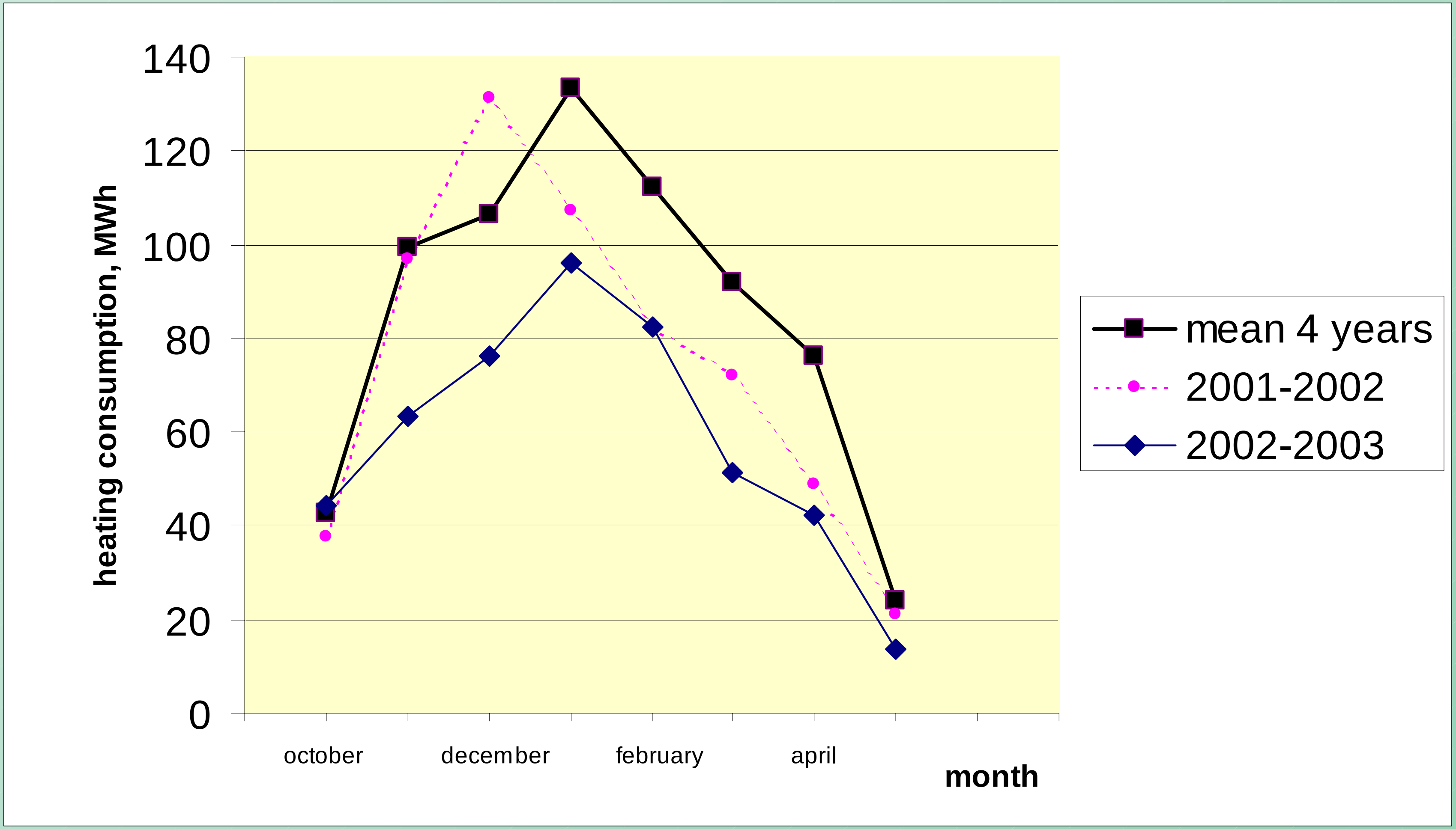
Energy consumption, space heating



Reduction = -32% instead of -50%

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Possible reasons / proposed corrective measures

- **temperature control (up to 23.5°C)**

Measure : progressive reduction (0.5°C every 6 months)

- **ground level partly heated according to occupancy**
- **users behaviour (opening windows)**

Measure : information of the tenants

- **thermal bridges (floor, windows, roof, balconies)**
- **ventilation flow rate (ach ?)**

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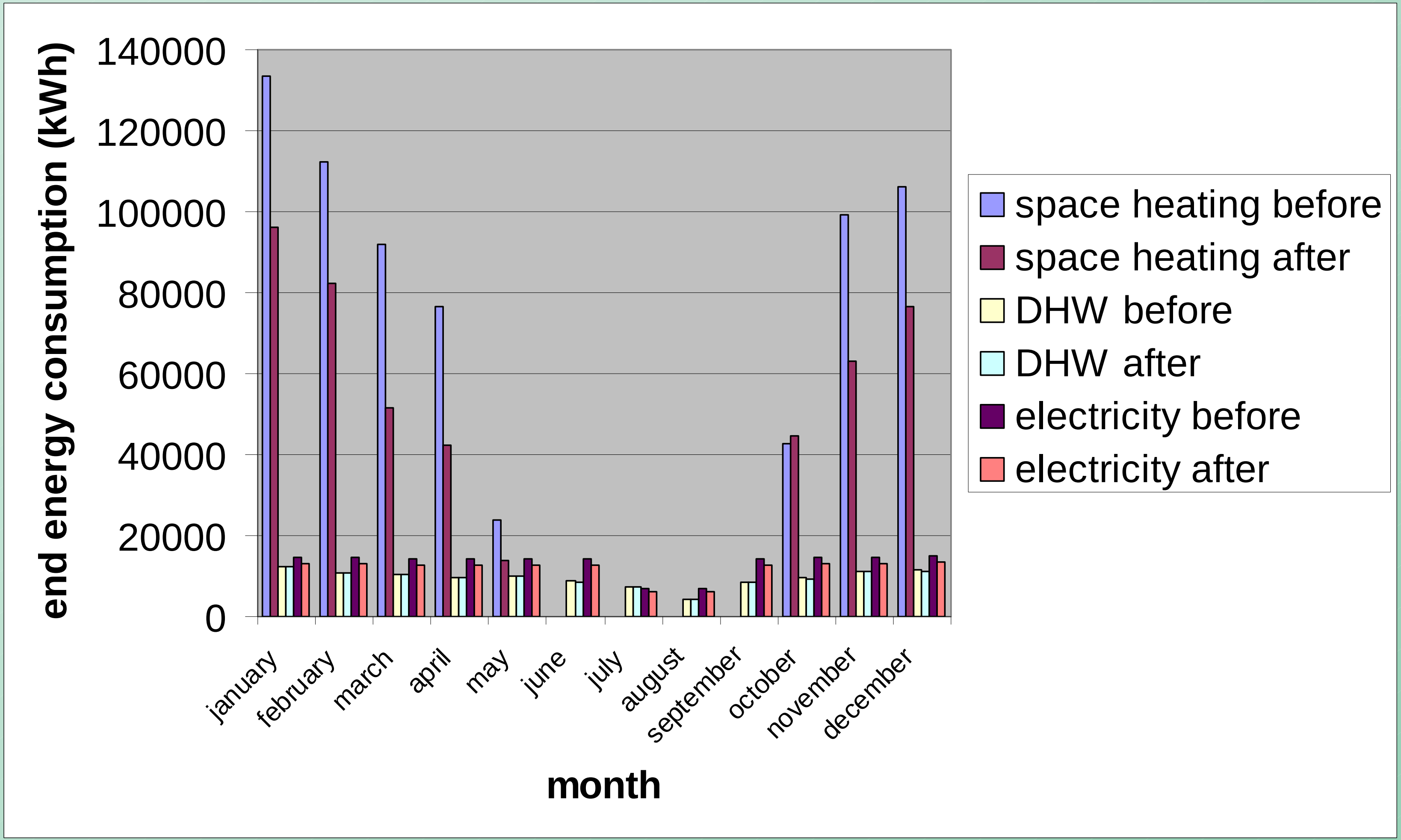
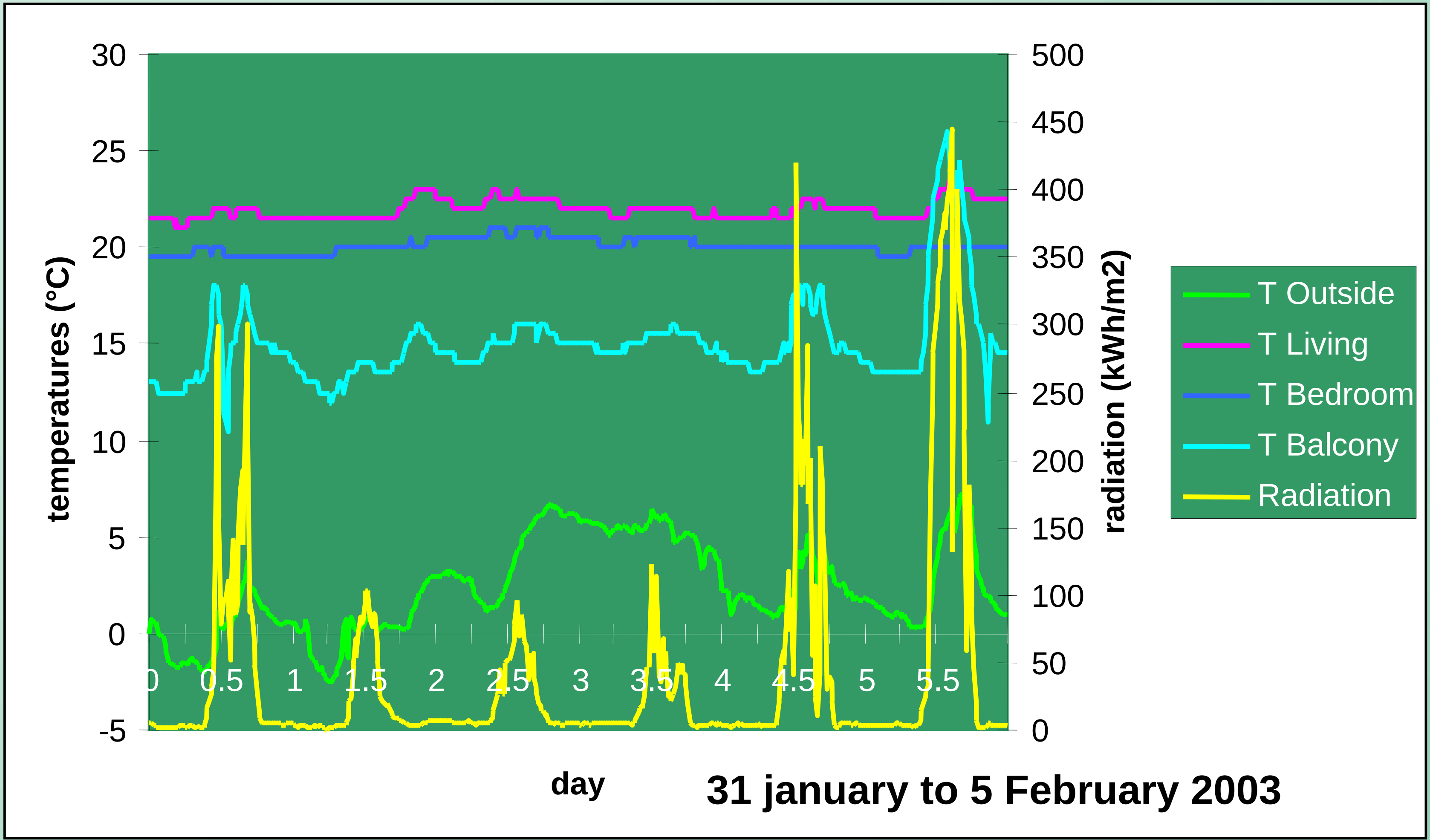
Measured energy consumption



Temperatures, with glazed balcony, winter period



The temperature is much milder in the glazed balcony than outside

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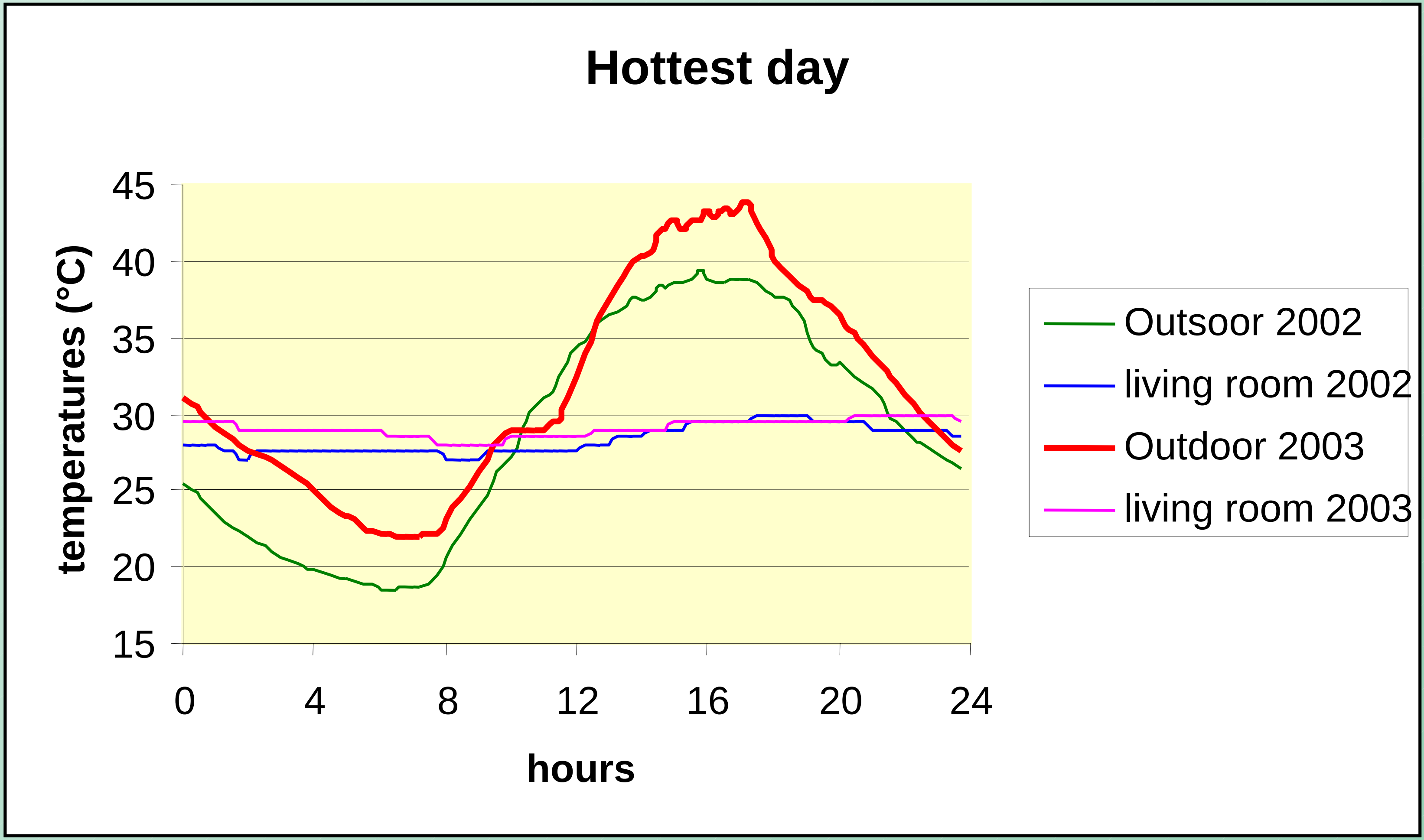
Comparison with and without glazed balcony



2002 : without glazed balcony
2003 : with glazed balcony

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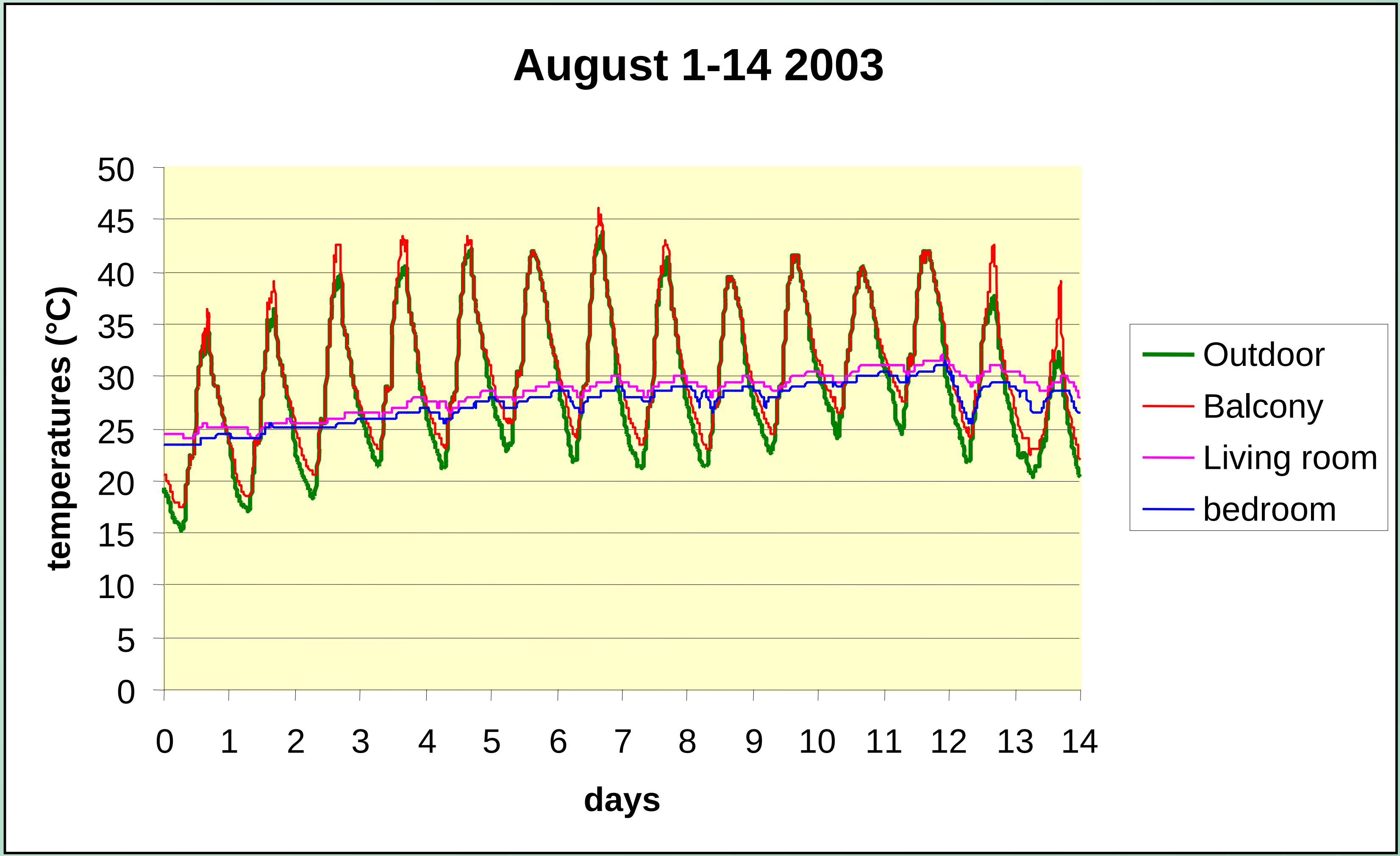
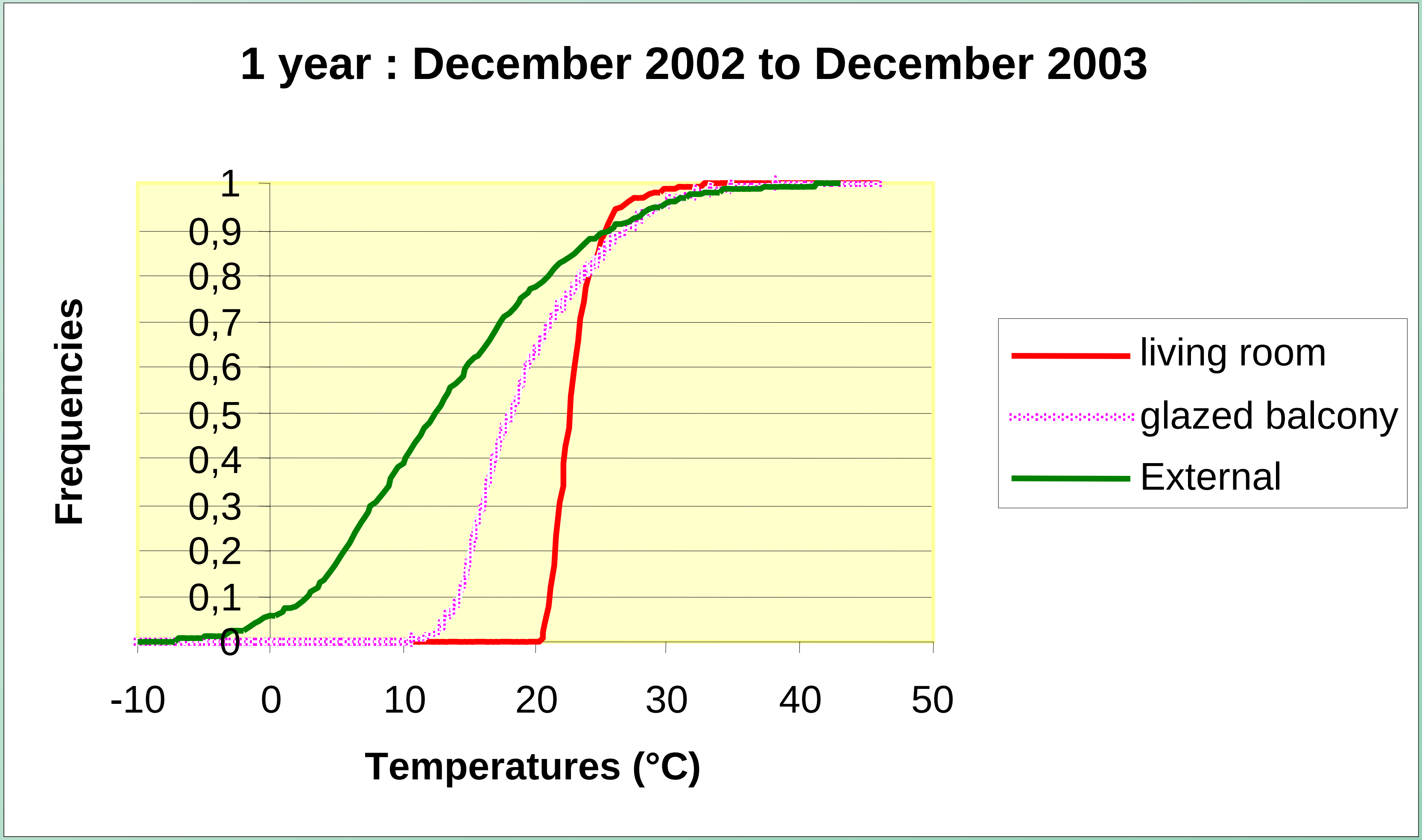
Summer 2003 (2 weeks unusual heat wave)



Maximum temperature
10°C cooler indoor than outdoor

Temperature frequency curves



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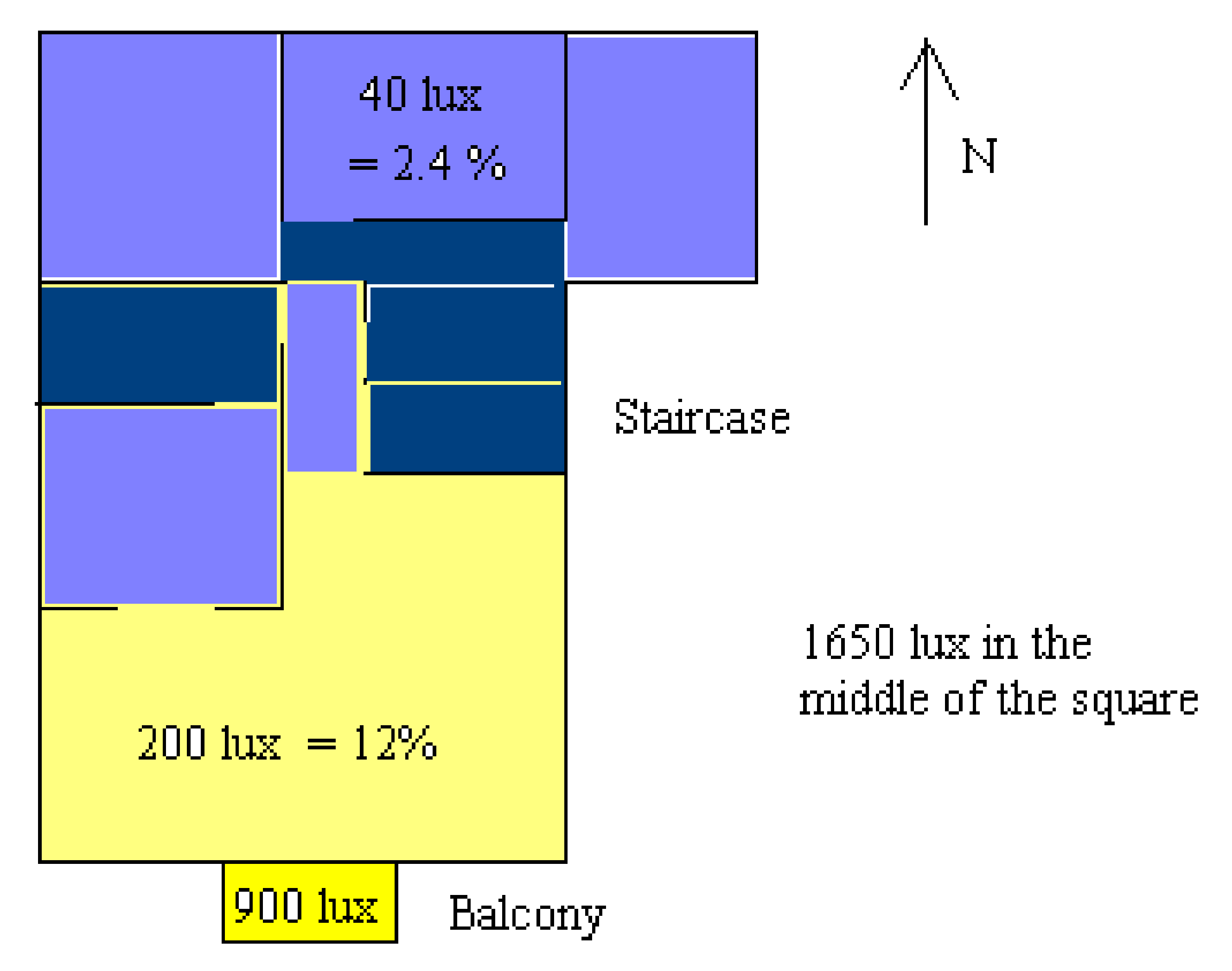
Daylighting



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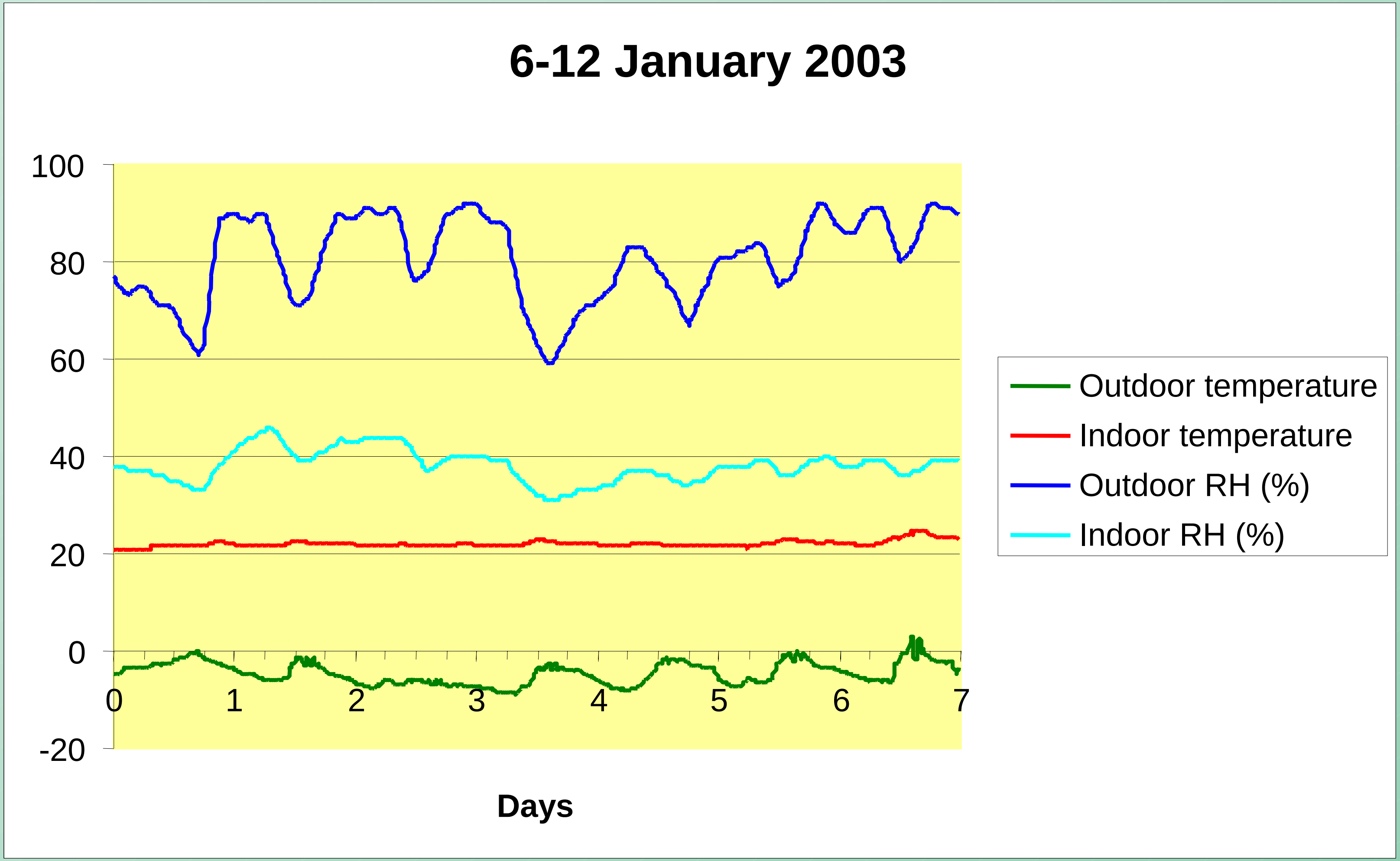
Indoor comfort, winter week



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Indoor humidity within comfort conditions (30 – 50%)

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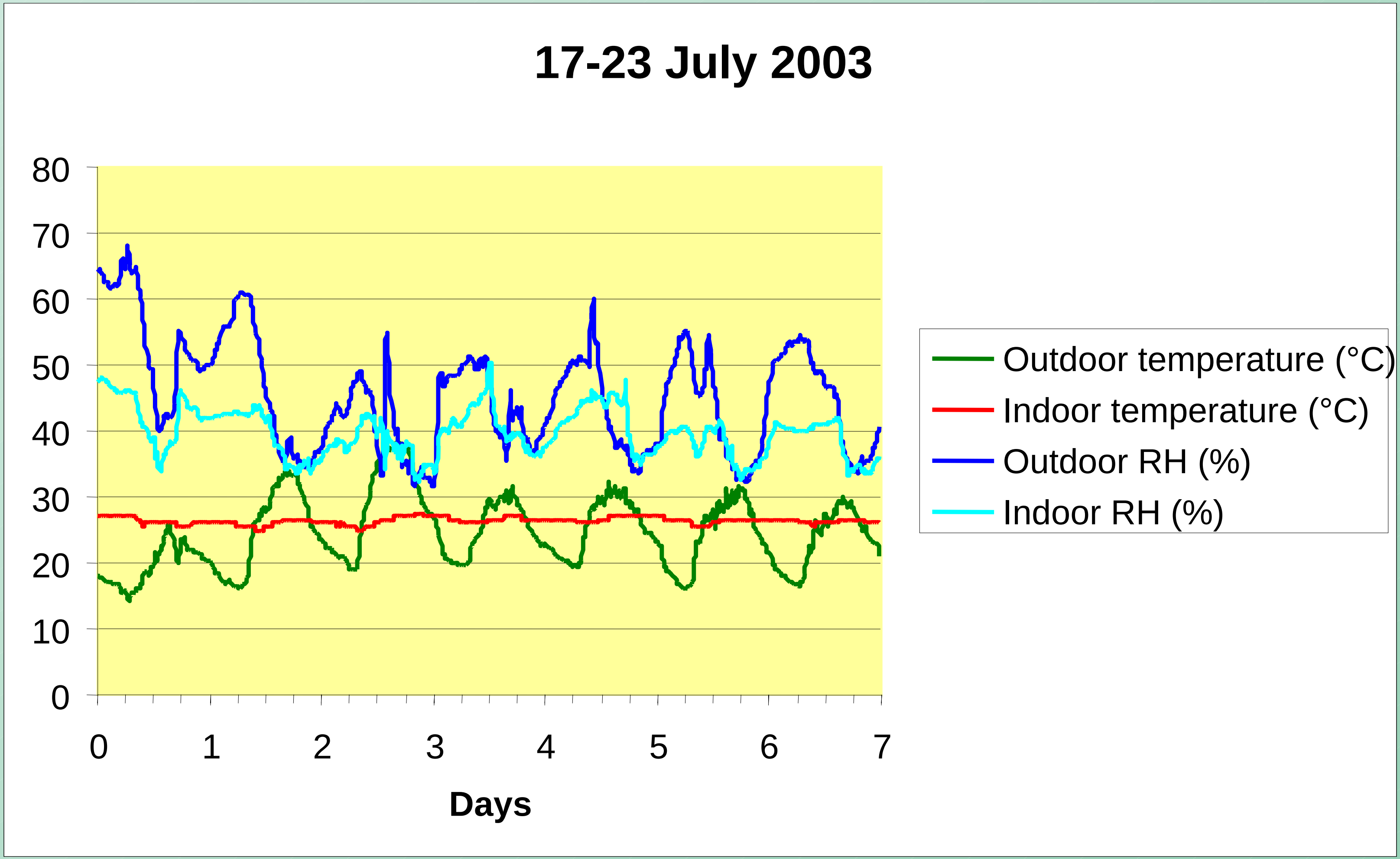
Indoor comfort, summer week



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Indoor humidity within comfort conditions (30 – 50%)

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Environmental issues

	Energy Sav [kWh/yea	Fuel typ [oil, coal o	CO_2 equivale [tons of CO_2/yea	TEP / year [Tonne Equivalen t
Heatin	217000	District hea	74,4	18,7
Electric	17000		1,5	4,4
Total	234000		75,9	23,0

- 76 tons CO_2 yearly = 26% reduction

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Economic balance

- **Renovation cost : 265 000 € + demonstration 185 000 €,**

5000 € + 3 500 € per dwelling unit

- **global pay back time : 16 years**
- **some technologies more cost effective than others :**
  - Low emissivity and argon filled glazing (+++ : 2 years)
  - Low flow rate showers (+++)
  - Moisture controlled ventilation (++)
  - Thicker insulation (20 years)
  - Glazed balconies
  - Solar domestic hot water (no regional support in 2002)

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Conclusions

- **Advanced glazing is very cost-effective, as well as low flow rate sanitary equipment**
- **More insulation is cost effective with a limit**
- **Ventilation control is in average cost effective but the actual performance depends on the occupancy**
- **Glazed balconies are not cost effective, but appreciated by the residents**
- **Integration of solar energy requires support**
- **Other projects in preparation including preheating of ventilation air**

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