Section 3 Case studies
3.4 Montreuil, France

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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% CO2 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)

Heating load reduced by 32%, possible 50% reduction
If indoor temperature = 20°C
Cost: 5,000 € (standard Renovation) + 3,500 € per unit
- 76 tons CO₂ yearly (-26%)

Photos: B. PEUPORTIER
Contents

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

- Improve environmental quality in social housing renovation
- Reduce by 25% CO₂ 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)
Location

Montreuil

TREES
the building before renovation

Construction: 1969, not insulated, single glazing

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

Photos: B. PEUPORTIER
Energy needs before renovation

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

Glazed balconies

Glazing area,
Demand side management
Neighbourhood workshops
Site analysis, evaluation of solar exposure

Is this building suitable for solar retrofit?
Site analysis, evaluation of solar exposure

azimuth, 0° = south
90° = west

June
December

Height
0° = horiz.
90° = vert.

TREES
Shading from other buildings

Roof level

Ground level
Technologies

- Improved insulation
- advanced glazing
- humidity-controlled ventilation
- air preheating in glazed balconies
- Solar water heaters
- low flow rate sanitary equipment
Results of thermal simulation, COMFIE

The graph shows the heating load (kWh/m²/a) as a function of insulation thickness (cm). The heating load decreases as the insulation thickness increases. The graph compares different types of glazing and renovation strategies:

- Single glazing
- Double glazing
- Low emissivity glazing
- Glazed balcony with moisture controlled ventilation
- Standard renovation
- Before renovation
- REGEN LINK renovation

The graph indicates that the heating load is significantly reduced with increased insulation thickness and the use of more efficient glazing and renovation techniques.
Facade insulation

Life cycle assessment, example: CO₂ emissions
Optimum 20-40 cm (CO₂), 10 cm (cost)
External insulation

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

- Humidity controlled vent
- Glazed balcony
- Dwelling
- Wind controlled inlet
- Mechanical air extraction
Architect’s sketch
Design of the glazed balconies
Studying solar protection
Glazed balconies will have to be ventilated in hot periods. Temperatures remain acceptable in the dwelling.
Temperature histograms

Example comparison between north and South oriented rooms
Building site, balconies
Glazed balconies

Cost of glazed balcony: 9,000 € per unit
District heating, before renovation

Single heating loop for 2 buildings
District heating, after renovation

Separated heating loop in each building
Solar water heater

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

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

Photo: [www.eco-techniques.fr](http://www.eco-techniques.fr)
Results of life cycle assessment, EQUER

**CO₂ emissions per year**

- Before renovation: 400 tons of CO₂ per year
- Standard renovation: 250 tons of CO₂ per year
- REGEN LINK renovation: 150 tons of CO₂ per year
- Wood fuel district heating: 50 tons of CO₂ per year
Results of life cycle assessment, EQUER

EQUER
Building life cycle simulation tool

Montreuil before
Montreuil reno
Montreuil euro
Montreuil wood
Use of GB Tool
Building after renovation

Heating load reduced by 32%, indoor temp. increased by 3°C
Energy consumption, space heating

Reduction = -32% instead of -50%
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 ?)
Measured energy consumption

![Graph showing measured energy consumption over months](image)

- **Space heating before**
- **Space heating after**
- **DHW before**
- **DHW after**
- **Electricity before**
- **Electricity after**

**Month:**
- January
- February
- March
- April
- May
- June
- July
- August
- September
- October
- November
- December

**Energy Consumption (kWh):**
- 0
- 20000
- 40000
- 60000
- 80000
- 100000
- 120000
- 140000

**Note:** This graph illustrates the measured energy consumption for space heating, domestic hot water (DHW), and electricity before and after certain interventions. The data is presented monthly from January to December.
Temperatures, with glazed balcony, winter period

The temperature is much milder in the glazed balcony than outside

31 January to 5 February 2003
Comparison with and without glazed balcony

Hottest day

2002 : without glazed balcony
2003 : with glazed balcony
Summer 2003 (2 weeks unusual heat wave)

August 1-14 2003

Maximum temperature
10°C cooler indoor than outdoor
Temperature frequency curves

1 year: December 2002 to December 2003

Temperatures (°C)

Frequencies

-10 0 10 20 30 40 50

living room

glazed balcony

External
Daylighting

40 lux = 2.4%

200 lux = 12%

900 lux

Balcony

1650 lux in the middle of the square

Staircase

↑

N
Indoor comfort, winter week

Indoor humidity within comfort conditions (30 – 50%)
Indoor comfort, summer week

17-23 July 2003

Indoor humidity within comfort conditions (30 – 50%)
Environmental issues

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<td>Heating</td>
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<td>District heating</td>
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<td>Electric</td>
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<td>Total</td>
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- 76 tons CO2 yearly = 26% reduction
Economic balance

- Renovation cost: 265,000 € + demonstration 185,000 €, 5000 € + 3,500 € per dwelling unit
- Global payback 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)
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