Backa röd, Gothenburg, Sweden

Project summary

Energy concept: To achieve a substantial reduction of the energy losses

Background for the renovation – reasons

The technical status of the building was poor due to wear and tear and the energy use was high before the renovation. The intentions were to:

- Take care of the deteriorated façade
- Improve all technical systems, which were in bad condition
- Renew the kitchens and bathrooms, which were in bad condition (original condition)
- Renew the surface finish in the apartments, as it was needed
- Improve the energy efficiency

Site:	**Gothenburg**
Altitude:	35 m
Heating degree days:	3307 (base temp 17ºC)
Owner:	Bostads AB Poseidon
Architect:	Pyramiden Arkitekter
Engineer	Structural engineering: Byggtekniska Byrån i Göteborg HVAC: Andersson & Hultmark

Contact Person:	Cathrine Gerle, project leader, Bostads AB Poseidon
Important dates:	The first energy renovation was finished in 2009
Date completed:	9th September 2014

Building description /typology

- First 16 energy renovated apartments (of 1,564)
- Heated usable floor area 1,357 m²
- Built: 1971
- Prefabricated concrete elements and balanced ventilation without heat recovery

Before renovation.

After renovation.

Building envelope, heating, ventilation, cooling and lighting systems before the energy renovation

Description of building (building situation, building system, renovation needs and renovation options).

Backa röd consists of 1,574 apartments in high-rise buildings, low-rise buildings and low tower blocks built during the million homes' program. The first building to be energy renovated, which is described here, is a low tower block with 16 apartments and 4 floors. The apartments have good floor plans, with generous and easily furnished rooms. However, the buildings needed to be renovated due to wear and tear.

Building envelope

The buildings are typical for the seventies with a prefabricated concrete structure of sandwich facades panels. The facades were damaged by carbonation and were in need of renovation.

The building was leaky, through the façade and between the apartments. Draught occurred from the in fill walls at the balcony and cold floor was caused by the thermal bridges from the balconies.

Heating, ventilation, cooling and lighting systems before retrofit

The buildings are heated by district heating. In each apartment there were radiators under the windows.

Domestic hot water is also heated by district heating. District heating is renewable to 81%.

The apartments were ventilated by mechanical exhaust and supply ventilation without heat recovery.

The intention of the renovation was upgrade the standard of the building.

Before renovation

Element	U-Value before renovation W/m²K	U-Value after renovation W/m²K
Exterior walls	0.31	0.12
Roof	0.14	0.10
Ground floor	0.40	0.10
Windows (average)	2.40	0.90

Energy renovation features

Energy saving concept

The aim was to combine the necessary maintenance renovation with a 65 % reduction in energy use. The overall intention was therefore to:

- Renovate the building
- Reduce the energy use
- Improve the indoor climate

Building

- Additional insulation, loft and crawl space
- Exterior additional insulation and sealing of the façades and new windows
- The joints between the apartments were rendered impermeable to air movement with floating putty on the floor
- New draught-proofed curtain wall on the balcony side
- New balconies on freestanding supports to minimise thermal bridges
- Individual metering of and invoicing for hot water

Systems

Heating: New radiator system with thermostat valves. Temperature sensors in the apartments. Individual metering of domestic hot water.

Ventilation: Change from exhaust and supply system for ventilation to an exhaust and supply system with heat recovery (rotary heat exchanger), with an efficiency of 85%. Cooker hood with separate fan and no heat recovery.

Lighting: Low energy lighting for fixed lighting.

Element	After renovation
Exterior walls	Adding 200 mm of thermal insulation
Roof	Total of 500 mm of thermal insulation
Crawl space	Additional insulation with 500 mm Leca and heat supply by supply air
Windows	Triple-glazed low energy windows

Renewable energy systems

None, apart from district heating produced to 81 % from renewable energy and the electricity is green electricity.

Other environmental design elements

Extended eaves and balcony after renovation

Achieved Energy Savings, CO2 reductions and Life Cycle Costs

Energy consumption for heating, hot water and facility electricity before and after renovation

Calculated energy consumption:

before renovation:	178 kWh/(m²·year)
after renovation:	60 kWh/(m²·year)
calculated savings:	118 kWh/(m²·year)

Actual energy consumption measured over a 12 months period:

before renovation:	normalized	178 kWh/(m²·year)
after renovation:	normalized	63 kWh/(m²·year)
actual savings:		115 kWh/(m²·year)

BBR2012 (building code requirement for new construction) 90 kWh/(m²·year)

As 81 % of the district heating is renewable energy and the use of electricity only increased somewhat the reduction in CO_2 emissions is small.

Calculated:
Energy savings thanks to reduced energy losses are calculated to be 147 MWh or 118 kWh/m². The measured energy reduction is 157 MWh or 115 kWh/m².

Renovation Cost and LCC (NPV)		
Total (price level of 2009)	18.05 mio SEK (2 mio Euro) of which 3.75 mio SEK (0.42 mio Euro) energy measures	14,500 SEK/m² (1,625 Euro/m²) of which 3,000 SEK/m² (335 Euro/m²) energy measures
NPV (sum of discounted energy savings – investments, assumptions: cost of capital 4.25 %, calculation period 50 years, energy price increase 4 %/year). The owner has the tougher profitability requirement of 6.25 % and assumes that the energy price follows the inflation.	3.75 mio SEK (0.42 mio Euro)	3,000 SEK/m² (335 Euro/m²)

Overall improvements, experiences and lessons learned

Energy

Annual savings 147 MWh

Indoor climate

- Improved thermal comfort and indoor air quality

Economics

The costs have been divided into refurbishment 14.3 mio SEK and energy efficiency measures 3.75 mio SEK (total cost of 18.1 mio SEK).

The investments consist of standard-raising measures 6.0 mio SEK, operating cost reducing measures 1.8 mio SEK, neglected maintenance 8.3 mio SEK and unprofitable energy measures 1.95 mio SEK.

The payback time of the energy savings is estimated to be 25 years. However the owner only considers their yield (profitability) requirements.

Decision process – barriers that were overcome

The alternative of demolishing the buildings and building a new one was considered, but was not considered politically realistic as there is a severe lack of apartments in Göteborg. Besides it was a pilot project for energy renovation, to gain experience for future renovations.

Non-energy benefits

- Water and sewage systems replaced, hot water circulation installed
- New electrical installation
- New bathrooms and kitchens
- Change to parquet floor in living rooms and bedrooms
- New surface finish in the apartments
- Safety doors for the apartments
- New extended balconies, which also reduce the thermal bridges
- Façade repaired

Economic consequences for the tenants

Rent before: 694 SEK/m²/year íncl. space heating and dhw

Rent after: 938 SEK/m²/year incl. space heating

Rent increase: 244 SEK/m²/year

Energy savings: 160 MWh/year

Energy price (assumed): 1000 SEK/MWh

Savings: 160 x 1000=160,000 SEK = 118 SEK/m²/year

Users evaluation

The tenants perceive that

- Draughts from external walls and windows, and cold floors have been completely eliminated
- The room temperature is more comfortable, although it gets warm indoors in the summer.
- Unpleasant odors and noise levels have lessened

General data

Summary of project

The renovation was necessary due to wear and tear. The results were substantial improvements in the standard of the building and at the same a substantial reduction in energy use, 65 %, while keeping a similar exterior architectural appearance, however a completely different color. The energy saving measures had low profitability in this demonstration project. The standard improvements meant new installations, new bathrooms and kitchens, and new surface finish. The energy saving measures included added thermal insulation to the building envelope, low energy windows and installation of ventilation heat recovery.

The tenants have appreciated the improvements in thermal comfort, indoor air quality and noise climate.

References

[1] Byman, K., Jernelius, S., 2012, Economy for reconstructions with energy investments, Energy center of environmental administration of Stockholm city.

[2] Östlund, M., 2013, Katjas Gata – Classic million program house became low energy building (in Swedish) http://www.byggtjanst.se/For-alla/Hallbar-upprustning-av-miljonprogrammet/Katjas-Gata---klassiskt-miljonprogramshus/

[3] Mjörnell, K., et.al. 2011, Milparena – Million homes program arena Innovative action proposals for renovation of the building envelope and installations (in Swedish), SP Rapport 2011:39, Technical research institute of Sweden

Experiences/lessons learned

According to the owner the energy efficiency measures have not been profitable. Given the rather stringent yield requirements of the owner (profitability requirement of 6.25 %, energy price increase according to the inflation) only half of the energy investment will pay for itself.

If energy efficiency measures which result in improvements of indoor climate could be considered as standard-raising and allow a rent increase the profitability would be reasonable even with the stringent yield requirements. Major energy renovations only make sense in buildings which need a major traditional renovation. The profitability of renovations increases for bigger multi-family buildings and if many buildings can be renovated at the same time here.

The owner has therefore continued with similar energy renovations of five tower blocks of the same type in the same area. An additional feature is adding two floors on the roof. This way the profitability requirement of the owner will be met.

After renovation with new facade and balconies etc.