Brogården, Alingsås

Project summary

Energy concept: Renovation using passive house technologies.

Background for the renovation – reasons

Intention for the renovation:

- Increase the accessibility
- Create a variation in apartment size
- Renovate because of wear and tear
- Improve on the poor thermal comfort
- Improve the poor energy efficiency by at least 50 %

Site:	**Alingsås, Sweden**
Altitude:	58 m
Heating degree days:	3724 (base temp. 17ºC)
Owner:	AB Alingsåshem
Architect:	Efem Arkitektkontor
Engineer:	Structural engineering: WSP HVAC: Andersson & Hultmark AB

Before renovation.

After renovation.

Contact Person:	Ing-Marie Odegren, CEO, Alingsåshem
Important dates:	Renovation of first 18 apartments finished in 2010
Date completed:	18th December 2013

Building description /typology

- Built 1971-73
- First 18 renovated apartments (of 300)
- Heated usable floor area (18 apartments) 1,274 m²
- Three storey buildings
- Poorly insulated building envelope and exhaust fan ventilation without heat recovery

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

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

Brogården consists of 300 apartments in three-four storey buildings built during the million homes' program. The first building to be renovated, which is described here, has 18 apartments. The apartments have good floor plans, with generous and easily furnished rooms. However, the buildings needed to be renovated due to wear and tear, to increase the accessibility, to create a variation in apartment size and to improve the energy efficiency.

Building envelope

The buildings are typical for the seventies with a concrete structure and in fill wall. Walls consisted of gypsum boards on non loadbearing wooden studs, 95 mm insulation and façade bricks. Basement: cast-in-situ concrete walls were without any insulation. There was 300 mm insulation on roof slab and wooden rafters with props on roof slab. The windows were single pane with supplementary aluminum sash and one additional pane.

The apartments were perceived as drafty and had a poor indoor thermal comfort due to leaky facades. The balconies constituted thermal bridges. The façade bricks were partly destroyed by moisture.

Architecturally the wish was to preserve the impression of the façade e.g. the yellow brick façade.

Heating, ventilation, cooling and lighting systems before retrofit

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

Domestic hot water is also heated by district heating. District heating is renewable to 98%.

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

The buildings needed a deep renovation.

Before renovation

Before renovation

Element	U-Value before renovation W/m²K	U-Value after renovation W/m²K
Exterior walls	0.30	0.11
Roof	0.22	0.13
Base plate	0.38	0.16
Windows average	2.00	0.85
Doors	2.70	0.75

Energy renovation features

Energy saving concept

The aim was to combine the necessary renovation with an upgrade to nearly passive house standard using passive house technologies.

Building

- Replacing the infill walls with well insulated new facades.
- Adding thermal insulation to the gables, the roof and the base plate.
- Improving the airtightness from 2 l/sm² to 0.2 l/sm² at 50 Pa.
- Replacing the windows with triple pane windows.
- Incorporating the balconies with the living rooms to eliminate thermal bridges and building new balconies supported by columns.
- Individual metering of household electricity.

Systems

Heating: Replacing the radiators with heating coils in the supply air of the ventilation system. Individual metering of domestic hot water.

Ventilation: Installation of decentralized balanced ventilation systems with heat recovery. The heat exchanger efficiency is 80 %.

Lighting: Low energy lighting for fixed lighting.

Element	After renovation
Exterior walls	Altogether 480 mm thermal insulation. Adding 430 mm of thermal insulation to the gables
Roof	Adding 400 mm of thermal insulation to the roof
Base plate	Adding 60 mm of EPS
Windows, average	Triple pane
Doors	New doors

Renewable energy systems

None, apart from district heating based on 98 % renewable energy .

Other environmental design elements

Added insulation to the foundation

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:		175 kWh/(m²·year)
after renovation:		74 kWh/(m²·year)
calculated savings:		101 kWh/(m²·year)

Actual energy consumption measured over a 12 months period:

before renovation:	normalized	175 kWh/(m²·year)
after renovation:	normalized	77 kWh/(m²·year)
actual savings:		98 kWh/(m²·year)

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

As 98 % of the district heating is renewable energy the reduction in CO_2 emissions is small.

During reconstruction the building was covered by a tent.

Calculated energy savings

Energy savings thanks to reduced transmission and ventilation losses are 129 MWh or 100 kWh/m²·year. Measured energy use is only slightly higher.

Craftsmen	17.7 mio SEK	14,000 SEK/m²
Total of which energy measures	25 mio SEK (2.8 mio Euro) 7.1 mio SEK (0.8 mio Euro)	19,800 SEK/m² (2,225 Euro/m²) 5,600 SEK/m² (625 Euro/m²)
NPV (sum of discounted energy savings – investments, assumptions: cost of capital 4.25 %, calculation period 50 years, energy price increase 4 %/year) The owner applies the profitability requirement of 5.5 %, district energy price increase of 3 % and electricity increase of 5 % above inflation.	0 mio SEK	0 mio SEK

Nice looking buildings with new balconies

Overall improvements, experiences and lessons learned

Energy

Annual savings 100 kWh/m²·

Indoor climate

- Improved thermal comfort
- Improved indoor air quality

Economics

The client divided the costs:

1) Energy saving measures, will be paid back in 17 years.

2) Improved standard of the apartments paid for by the tenants (5 m² larger living rooms, renovated bathrooms etc.) with a 35 % average rent increase.

3) The maintenance cost for the buildings, in any case needed.

Decision process – barriers that were overcome

The planning process took long time partly due to poor project management, which was overcome by improved project management.

The preservation of the area and accessibility questions in the project took much time late in the planning process. The energy issues were almost neglected at least in the beginning of the project. Someone has to be in charge of the energy issue.

Non-energy benefits

- New balconies and larger living rooms
- Better indoor climate
- Increased accessibility (ground floor)
- New water/ sewage system, electrical installations, bathrooms and kitchens, surface finish inside.

Prefabricated facade elements for the next phase of renovation.

Economic consequences for the tenants

Rent before: 734 SEK/m²/year íncl. space heating, DHW and household electricity

Rent after: 920-1120 SEK/m²/year incl. space heating

Rent increase: 186-386 SEK/m²/year

Energy savings: 127 MWh/year

Energy price (assumed): 1000 SEK/MWh

Energy savings: 100 SEK/m²/year

Users evaluation

The tenants were most satisfied with the new entrance, the entry phone and the fresh indoor air.

The tenants on the ground floor perceived occasionally the indoor temperature as low during the first winter and the users on the top floor perceived the indoor summer temperatures as high.

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 (60 %) in energy use, while keeping a similar architectural appearance. This was done using traditional building materials and with common contractors. The energy savings were estimated to be paid back in 17 years. The planning process was very long in this demonstration project. The energy aspect was for a long time not considered important. The conclusion is that comprehensive efficient project management is needed and that energy has to be included from the beginning. All necessary competence has to be involved from the very start of a renovation project.

Long side façade with balconies before (left and above) and after (below) renovation.

Experiences/lessons learned

The most important lesson is that passive house technology for renovation requires that all competence work together from the start. The project has shown that it is possible to renovate a million programs' home to a very low energy use using traditional materials and common contractors. Besides it is an advantage to use standard material in standard sizes.

Central ventilation heat recovery on ventilation should be used instead decentralized, to reduce maintenance work and work changing filters. The façade construction should be simplified from a four layer on-site construction to a two layer construction with insulation, to reduce investment costs and simplify the production. For the following buildings (150 apartments) prefabricated façade elements are used for renovation.

The tenants were satisfied with the renovation.

Another important conclusion is that the tenants have to be informed from the beginning. In this project they had to move out during the renovation.

References

[1] Janson, U., 2010, Passive houses in Sweden - From design to evaluation of four demonstration projects, Division of Energy and Building Design, Department of Architecture and Built Environment, Lund University, Faculty of Engineering LTH, Report EBD-T--10/12

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