Sems Have, Roskilde

Project summary

Energy concept: Insulation, ventilation, PV system, heating system

Background for the renovation and main measures

Renovation and conversion of a dormitory/day-care centre into 30 low energy apartments:

- Conversion as the buildings could no longer be let out for the original purpose
- Improved thermal envelope – walls, roof and windows
- Balanced mechanical ventilation with heat recovery
- New (district) heating system
- PV system for reaching nearly-zero energy (Danish Building Class 2020)
- Improved architecture

Site:	**Parkvej 3-5, DK-4000 Roskilde**
Altitude:	35 m
Heating degree days:	2906 (base temp. 17°C)
Cooling degree days:	0
Owner:	Housing Association Zealand
Architect:	Kullegaard Arkitekter
Engineer:	Terkel Pedersen
Contractor	Daurehøj Erhvervsbyg A/S

Contact Person:	**Charlotte Szøts Housing Association Zealand**

Important dates:	Renovation start: October 1, 2012 End of renovation: December 31, 2013
Date completed:	August 31, 2014

Building description / typology

- 2 blocks
- Built: 1973 – new windows and additional insulation in 1995
- General information: Energy label C before renovation
- Gross heated floor area: 3,626 m² after renovation

The two blocks of Sems Have before the renovation (to the left) and after the renovation (to the right).

Building envelope, heating and ventilation system before the energy renovation

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

Sems Have originally consisted of:

- block A containing a day-care centre at the ground floor and a dormitory at 1st to 3rd floor.
- block B containing a day-care centre at the ground floor and a hall for e.g. music at the 1st floor.

The buildings were rented by the municipality, however, when the municipality terminated the lease, the housing association was left with buildings which could not be rented out.

Energy demand before the renovation

Before the renovation, the buildings were rated at energy class C buildings. So the energy demand was not the reason for the renovation. The buildings were renovated since they could not be rented out due to their layout and because they were worn down.

Building envelope

Both blocks had a loadbearing internal concrete construction with panel walls containing 125 mm mineral wool + in 1995 extra 100 mm mineral wool was added.

The windows were double glazed with a U-value of 2.8 W/m^{2}K.

The roof of block A was insulated with 200 mm mineral wool. The horizontal part of the roof of block B was insulated with 150 mm mineral wool while the mansard part of the roof was insulated with 125 mm mineral wool.

Basement: walls against soil had no insulation, the rest had 50 mm mineral wool. Floor slap in basement consisted of 200 mm expanded clay aggregate below the 100 mm concrete slap.

Heating and ventilation systems before retrofit

The buildings were heated by district heating with an indirect two-line radiator circuit. Domestic hot water via a 2,500 litre tank insulated with 100 mm mineral wool.

The day-care centre and the halls (in block B) were ventilated by balanced mechanical ventilation with heat recovery below 60 %. The dormitory and the basements were naturally ventilated.

Block A before renovation

Block B before renovation.

Element	Area after retrofit m^2	U-Value before retrofit W/m^{2}K	U-Value after retrofit W/m^{2}K
Panel walls	1,497	0.2	0.2
Gable walls	224	0.3	0.3
Windows, doors	568	2.8	1.0
Roof	1,043	0.2-0.32	0.09
Floor over basement	970	2.3	1.1

Energy renovation features

Energy saving concept

The building had to be renovated since they could not be let out due to their layout and because they were worn down:

- Conversion from day-care centre and small dormitory flats to 30 up-to-date and affordable apartments of 67-145 m^2.
- Nearly-zero buildings (Danish Building Class 2020).
- Large PV system.

Building

- Everything except for the internal concrete construction and the roof insulation of block A was removed.
- The mansard part of the roof of the 1st floor (hall) of block B was re-placed with vertical walls identical to the other walls of the buildings.
- New pitched roofs in order to allow for 400 mm insulation.
- The hall at the 1st floor of block B was divided into 7 apartments with an extra floor in part of the apartments. The living rooms are of double height.

Systems

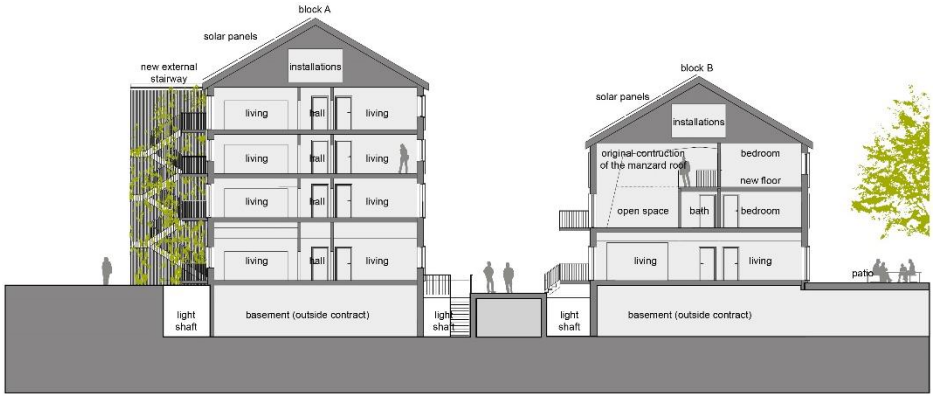
Heating: New district heating system, radiator circuit, two new domestic hot water tanks of each 1,000 litre with a heat loss coefficient of 3.7 W/m^2K.

Ventilation: The flats are ventilated by balanced mechanical ventilation with heat recovery. SFP factor: 2 kJ/m^3 and efficiency of heat recovery: 84.

Lighting: New lighting – LED and low energy fluorescent tubes - in the staircases.

Element	After renovation
Exterior walls	Prefabricated elements: Internal: 2x12.5 mm gypsum plates 240 mm mineral wool 9 mm fibre cement board External: 63 mm air gap behind slate tiles
Windows, doors	Triple glazed low-energy windows with 2 layers of low-E coating and Argon between the glasses.
Roof	Block A: originally 200 mm mineral wool + added 200 mm extra insulation: total 400 mm Block B: new insulation: 400 mm

Renewable energy systems



Cross section of block A (to the left) and block B (to the right) after the renovation.

Achieved Energy Savings and Costs

Energy consumption for space heating and hot water before and after renovation:

District heating consumption for both buildings incl. basement:

before renovation - measured:	508 MWh/year
after renovation - calculated:	179 MWh/year
Energy savings – district heating:	329 MWh/year = 65 %

Energy consumption after renovation – calculated using the Danish calculation tool Be10:

Net mean space heating demand :	9.4 kWh/m²gross area *
Net mean domestic hot water demand:	13.7 kWh/m²gross area
Building related electricity demand:	6.0 kWh/m²gross area
Electricity production from PV panels:	3.6 kWh/m²gross area
Primary energy demand minus PV production:	16.2 kWh/m²gross area
Danish Building Class 2020 (nearly-zero energy) is	20 kWh/m²gross area

* not including heat loss to the basement. With the basement included both blocks are still approx. nearly-zero buildings.

Calculated energy savings and PV production

Annual saving of district heating: 329 MWh/year = 214,000 DKK/year.

Before the renovation the electricity demand for ventilation was 57 MWh/year. This demand is after the renovation calculated to 20 MWh/year. Savings: 37 MWh/year = 81,000 DKK/year

PV electricity production:

13 MWh/year = 29,000 DKK/year.

Estimated total annual savings valued to be:

89 DKK/m² = 12 EUR/m².

The two buildings after renovation.

Renovation Costs

Expence	million DKK / million EUR	kDKK/m² / kEUR/m²
Craftsmen	44.31 / 5.91	12.2 / 1.63
Consultants	5.19 / 0.69	1.43 / 0.19
Various building project costs *	22.89 / 3.05	6.3 / 0.84
From 2015 to 2020	0.23 / 0.03	0.06 / 0.01
Total	72.62 / 9.68	20 / 2.67

New balconies

* Repayment of old loans, building owner fee, municipality and state charges and fees, stamp duty for a new mortgage etc.

Overall improvements including non-energy benefits

Energy

Savings: heating 329 MWh/year
electricity 37 MWh/year
PV production: 13 MWh/year

Indoor climate technical improvements

The indoor climate was improved due to:

- Balanced mechanical ventilation with heat recovery
- Less heat loss and draught through windows and doors

Economics

The buildings had to be severely renovated or demolished as they could no longer be used for the original purpose.

The Housing Association wanted at first to renovate (not including the basement) according to Low Energy Class 2015 (30.5 kWh/m^2). However, as Building Class 2020 (20 kWh/m^2) would only cost 232.000 DKK (31,000 EUR) or 0.3 % extra - for the PV systems, better windows and extra 60 mm insulation on the roof - it was chosen to go for the Building Class 2020 instead.

Decision making process – barriers that were overcome

- Difficult to get the approval from the municipality to change the status of the buildings from dormitory/day-care centre to residential.
- Difficult to comply with modern acoustic requirements.
- Removal of PCB, asbestos and paint containing lead.

Economic consequences for the tenants

Due to the change in the status of the building there is no point in comparing the rent before and after the renovation.

Rent after: 897 DKK/m^2/year
= 120 EUR/m^2/year (excl. energy)

The rent is comparable with the rent of other apartments of similar quality in Roskilde. But the annual expenses for energy use is lower than in similar buildings.

Non-energy benefits

The renovation has resulted in:

- Up-to-date affordable apartments which can be rented out
- Improved architecture
- Improved indoor climate
- New sewer system, new- cold and hot-water system and new electrical system
- New lighting in the staircases
- New kitchens and bathrooms
- Balconies for some apartments
- Elevator to apartments in block A
- Improved surroundings
- Saved CO_2 due to the conservation of the concrete structure
- Prestige: nominated to a renovation award

User evaluation

The users are very content with:

- The quality and layout of the apartments
- The indoor climate
- The improved architecture and surroundings

However, the best indicator of the users opinion of the new apartments is that there is a waiting list to get an apartment.

One of the gables.

Summary and experiences/lessons learned

Summary of project

Two buildings containing a dormitory, day-care centre and a hall were successfully transformed to up-to-date nearly-zero energy residential apartments.

Only the concrete structure and the insulation of the roof (the latter in one building) were preserved. The preservation saved money and CO_2.

The renovation was financed like new social housing (not subsidized). The rent of the apartments is comparable with other apartments of the same quality in the area. The new apartments are very popular.

New internal walls and inserted deck at the first floor of block B.

Experiences/lessons learned

The experience of Housing Association Zealand is that it is a good idea when performing deep energy renovation to strip the building down to the loadbearing constructions and add a new thermal envelope instead of trying to improve the original thermal envelope.

It is a challenge to upgrade existing buildings to contemporary and future-proof apartments especially if the new design uses other module lines etc. than the original design.

The concrete structures (including decks) were maintained, however, this made it difficult to comply with modern requirements regarding acoustics.

PCB, asbestos and paint containing lead had to be removed from the building and safely deposited.

The Housing Association experienced difficulties in obtaining approval from the municipality to change the status of the buildings from dormitory/day-care centre to residential.

The new improved apartments and architecture has been well received by the tenants. There is at the moment a waiting list for persons who would like to rent an apartment in the buildings.

Sems Have has been nominated to the renovation award Renover 2014.

References

[1] Family homes – in the Youth House (in Danish). Kullegaard Arkitekter, Moe & Bødsgaard og Daurehøj Erhvervsbyg A/S

[2] Family homes in the Youth House – Energy calculations (in Danish). Terkel Pedersen Rådgivende Ingeniører Aps.

[3] Energy certificate (in Danish). September 3, 2009. Danakon A/S

[4] http://renover.dk/project/sems-have/ (in Danish)