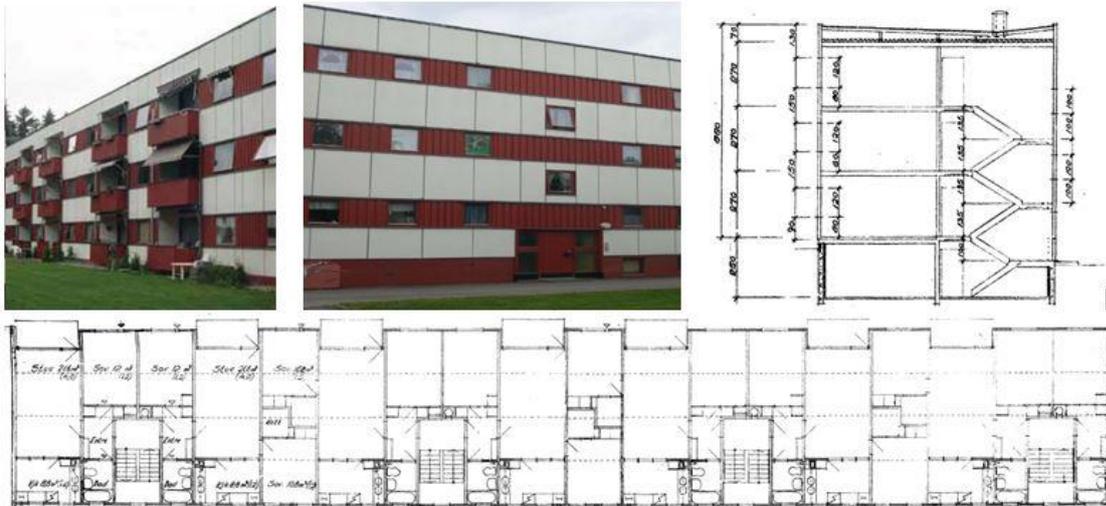


Norway: Myhrerenga Borettslag

Summary of the project

Mixed ownership *housing cooperatives (borettslag)* account for 14% of Norway's building stock, and Myhrerenga Borettslag – a case study for energy efficient retrofitting – is one of these condominiums. The borettslag was built in 1967 and is located 15 km north of Oslo along main road E6. It consists of seven identical multi-unit buildings, has 24 apartments divided in eight units per floor, plus a basement.



Top left and centre: the West and East façades of the Myhrerenga Borettslag before renovation. Top right: the original drawing of the cross section of one the apartment buildings. Bottom: the original drawing of the plan of one of the apartment buildings.

Nine out of ten borettslag were built after 1946, which is consistent with the European trend of the massive growth of housing cooperatives after the Second World War. Energy efficient intervention was necessary due to the very poor thermal performance of the seven buildings, and their very costly heating energy consumption.

The building structure is composed of an array of parallel reinforced concrete walls which delimit each apartment and constitute, with the concrete floors, the building's load bearing structure. The external walls on the East and West sides mainly consist of a timber frame system covered with wood cladding, which is still commonly used in Norway. The windows, located on the East and West façades only, were replaced in the 1980s, and had wooden frames with double glass panes with a heat transfer coefficient of approximately $2.6 \text{ W/m}^2\text{K}$. The roof construction and the basement also had a wooden frame, both were poorly insulated, and thermal bridging was a major issue occurring at every structural connection. The existing inefficient energy supply system also was in dire need of renovation; on top of which, heating could not be regulated in the individual apartments.

Actors and organisation

The intervention can be considered top-down. Norwegian housing cooperatives are represented by the Cooperative Housing Federation of Norway (NBBL), which embraces 47 housing cooperative associations, 10,000 affiliated housing cooperatives, and counts for up to 450,000 housing units and 925,000 members. **Myhrerenga Borettslag is represented by USBL**, which is the biggest Norwegian housing cooperative association. **It was USBL's technical director who proposed the idea of a complex, energy efficient renovation project** to the board of Myhrerenga Borettslag.

It is important to note that USBL was externally involved in the EKSBO project (2006-2009), which was a research project funded by the Norwegian Research Council and aimed at increasing the energy

efficiency and use of renewable energy in the existing housing stock. Among the partners of the EKSBO were SINTEF Byggforsk (Building and Infrastructure), a public institution that promotes social housing and energy-efficient housing by, among other activities, providing low-interest loans; as well as Husbanken (Norwegian State Housing Bank). **Husbanken contacted USBL for collaborating on a pilot project on the energy retrofitting of a borettslag**, with a possibility to bringing it to passive house standard; after which USBL contacted the Myhrerenga board. The residential community of Myhrerenga had been discussing on proceeding for a renovation of the buildings in several assembly meetings since 2007; and upon their agreement with USBL, the renovation process was initiated in 2009.

Shareholders of a borettslag may be natural persons or legal persons (public authorities, public institutions, public companies, and private companies that have special agreements with public authorities). Natural persons can only own one share, while legal persons can own shares for up to 10% of the shares of the housing cooperative, and each share corresponds to a unique dwelling. Shares can be transferred for a limited time or indefinitely (sold). By buying apartments in a housing cooperative, the buyer automatically becomes a member of the cooperative by means of the owned shares. Each share gives the right to cast one vote during the housing cooperative meetings, for the election of the housing cooperative board members, or for the approval of decisions concerning the procurement or maintenance of the building. The decisions are approved when a consensus of at least two thirds of the votes is reached.

Most Myhrerenga Borettslag residents were young couples or old persons, and they were relatively easy to convince to go for the energy retrofitting for three main reasons:

- (1) many of the inhabitants were newcomers, and wanted to improve their living conditions; notably, they wanted higher indoor comfort level as the existing apartments were draughty and humid;
- (2) they hoped to save on their energy bills;
- (3) they wanted to increase the value of their properties as a result of the renovation process.

As a further component to the project's success, the borettslag's board members were also familiar with energy efficient standards and renovations, and had an active role in convincing the residents to opt for complex and exhaustive energy efficient retrofitting; and accordingly, they managed to obtain more than two thirds of the shareholder votes to launch the pilot project.

Implementation and financing

The USBL managed the renovation process between 2009 and 2011 in eight stages:

1. USBL considered the building's condition and made an overall assessment;
2. Residents of the housing cooperative were gathered during general assemblies to vote on the rehabilitation proposal;
3. USBL contacted professionals with expertise in passive house low-energy retrofitting (SINTEF Byggforsk and the architectural firm Arkitektskap);
4. Three renovation options were proposed to the residents. After one year decision of retrofitting to passive house level was accepted.
5. Based on the project description USBL contacted contractors and defined a tender;
6. USBL had clarification meetings with contractors, where economics, performance and progress were discussed;
7. USBL controlled the progress and follow-up of the project in relation to the main contractor;
8. Finally, USBL inspected the project on its completion.

The project was co-funded using ENOVA and Husbanken preferential loans. ENOVA, a Norwegian National Energy Agency owned by the Royal Norwegian Ministry of Petroleum and Energy (MPE), together with Husbanken, provided subsidized loans for the high energy efficiency retrofitting low energy class residential buildings. This gave additional incentive to the borettslag to choose go beyond basic energy efficient interventions, and undertake a complex renovation including thicker-than-usual insulation, low-U-value windows, heating recovery, high-efficiency heat pump, and solar collectors. ENOVA granted a funding of approximately 6.4 Mil NOK, and Husbanken provided a renovation loan at an interest rate of 4.7%, which was lower than the usual bank loans (5.7%). The total cost of renovation was 74.5 million NOK, which includes the external funding of approximately 10% covered by ENOVA (6.4 million NOK). The USBL Cooperative Building and Housing Association, of which the CSO is part, took a 30-years through the subsidized Norwegian Housing Bank (interest rate 4.7%) and partially through private banks (5.7% interest rate). As a result the monthly common costs increased by 20%; but thanks to the subsidized loans for the thorough EE renovation, it was in fact lower than the raise that would have been required for a standard renovation. It was estimated that the value of a 2-bedroom apartment increased by 40% after the renovation.

The physical implementation of the renovation began in February 2010. All of the seven apartment buildings were renovated. The key interventions included

- The replacement of the existing windows with triple-glazed windows with argon internal insulation, with a U-value of 0.8 W/m²K;
- The concrete slabs of the balconies were substituted with steel frame balconies to reduce the thermal bridges;
- 200 mm extra mineral wool insulation was added on the outside the existing facades, which achieved a U-value of 0.12 W/m²K;
- The roof was insulated with 350 mm of blown-in insulation;
- The ceilings of the basement were insulated with 100 mm of EPS;
- A mechanical ventilation system was installed by placing the ducts in the existing shafts of the centralized vacuum cleaning system. A heat recovery system with an efficiency ratio of 0.80 was installed with the ventilation unit;
- The existing oil boilers were substituted with three air-to-water heat pumps, which are working in cascade. This means that depending on the heating demand all the three heat pumps are activated sequentially;
- The heat pumps are connected to solar thermal panels installed on the roof.

The new heating system is based on an air-to-water heat pump linked to roof-installed solar collectors; this way the already installed radiators could be used and unnecessary additional costs were avoided. From the energy simulation it was claimed that the saving of energy cost for heating was 560 000 NOK/year, which is equivalent to 860 000 kWh/year.

Constraints and challenges

Critical factors seem to have played a very limited role in this particular project. The institutional, financial and subsidy environment equally buttressed a retrofitting of very high level energy efficiency, and the end-users – the majority of shareholders of the borettslag – agreed with the thorough renovation at the suggestion of the board. Lower income shareholders were satisfactorily compensated reduced energy costs: the loan repayment is lower than the savings, as the net savings per apartments result to be between 300 and 400 NOK per month. The success of this project led the USBL to propose to the various housing cooperatives that it represents a counselling service for low-energy retrofitting, based on the experience acquired during the energy retrofitting of the Myhrerenga Borettslag.