N2

# Retrofitting of Borgen Secondary School, Norway

## 1 Photo

**Figure 1:** Artists impression of completed retrofit.

## 2 Project summary

Borgen secondary school was built in 1970. The school needs renovation and upgrade to be suitable for new working methods and tenants from the neighbourhood. The old building is to have a comprehensive retrofit, and 2000m2 of new construction will be the starting point for establishing a community centre. Good indoor climate, low energy and environment friendly solutions are key factors to the retrofit concept.

**Retrofit features**

- Enlarged windows with improved thermal insulation and solar shading.
- New roof to allow daylight inside.
- New ventilation system based on hybrid ventilation to obtain better indoor climate.
- Total change in plan layout to meet new working methods.
- Low energy concepts and environmentaly friendly solutions, supported by the national program *EcoBuild*.

## 3 Site

Borgen Secondary school is situated in Asker municipality, west of Oslo in the eastern part of Norway. Latitude: 60°N, Longitude: 11°E, Altitude: 100m, Mean annual temperature: 6°C, Mean winter temperature: –20°C, Climate description: Inland.

## 4 Building description /typology

### 4.1 Typology / Age

| Typology/Age | Pre 1910 | 1910–30 | 1930–50 | 1950–70 | 1970– |
|---|---|---|---|---|---|
| The open-plan school | | | | ● | |

Borgen secondary school was a typical secondary school from the 1970's with open plan; over the years divided into classrooms without corridors. The

students had to go outside from one room to another. The new layout will have space efficient solutions with home bases and special rooms that are adaptable to various working methods and social events.

### 4.2 General information

| | |
|---|---|
| *Year of construction:* | 1970 |
| *Year of renovation:* | 2002 - 2003 |
| *Total floor area ($m^2$):* | 6000 |
| *Number of pupils* | About 450 - 500 |
| *Typical classroom :* | Home bases groups of 15 or 45 pupils |

### 4.3 Architectural drawings

None available

**Figure 2:** Borgan School before retrofit.

### 4.4 Building construction Before Retrofit

The original building had a brick facade. The striking renovation to the building includes a new facade and roof. Due to new regulations on snow load, the roof had to be rebuilt. The old roof also resulted in minimum daylight inside. Original windows were small and did not meet today's standards for thermal insulation. The main construction of the old building also had to be strengthened.
The layout of the schools was inconvenient with no communication lines and needed to be totally changed.

## 5 Previous heating, ventilation, cooling and lighting systems

The ventilation in the old school was poor, as it was only by opening windows. Because of the small windows, wide roof and the layout, daylight levels inside the building were low.

## 6 Retrofit energy saving features

### 6.1 Energy saving concept

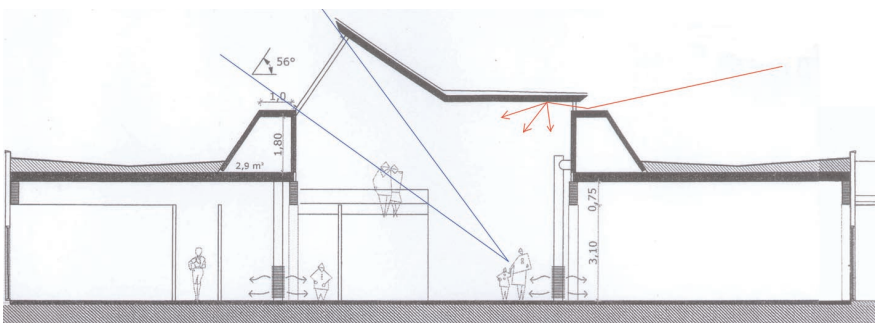
According to standard practice, the school should be space efficient and adaptable to various working methods and social events.
The building should have low purchased energy consumption with respect to ventilation, space heating and artificial lighting. Renewable energy should be utilized.
The school building and yard should be used as teaching arena to support Nature and Environment studies.

### 6.2 Building

*Daylight*

Getting daylight into the learning environment is important to the project. Studies on different solutions were made before the final design was selected. The old roof had to be removed so the new roof was designed to let daylight in to the middle of the building. Artificial light is automatically controlled.

**Figure 3:** Below: New roof under construction.
Right: Daylight entry to the common area in the centre of the building.



*Ventilation*
Hybrid ventilation is used for the building. The system is to give good indoor air quality and be energy efficient. The air is lead by a culvert from the air inlet tower to the classroom. Displacement is used as the ventilation principle. The air change rate is controlled by $CO_2$ sensors.

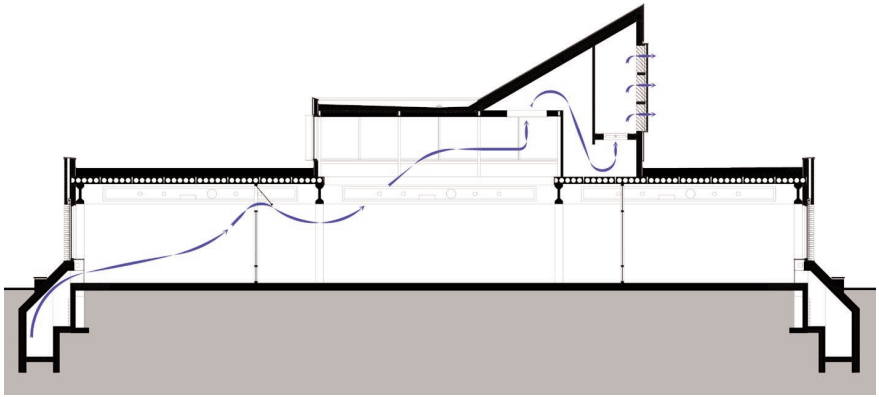


**Figure 4:** The hybrid ventilation system employs natural driving forces.

*Heating*
Installation of a geothermal heat pump (using heat from the ground) is utilised for space heating, preheating of ventilation air and domestic hot water.
Space efficiency and building flexibility are probably the factors that contribute the most to reducing the consumption for resources in a life cycle perspective. These factors are highly focused in this project.
The total energy consumption of the Borgen Community Centre is calculated to be about 50% of the total energy use of current new Norwegian school buildings.

*Electrical Energy*
The provision of daylight is a primary focus of the design. This will promote a healthy environment in which it is easier to concentrate. It will also produce eanergy savings as increasing the daylight reduces the need for artificial lighting and artificial lighting is automatically controlled by daylight sensors. Internal venetian blinds will be used to avoid thermal over-heating and the need for cooling. Electrictricity for ventilation fans is reduced by employing the natural driving forces; buoyancy forces and wind. Hybrid ventilation with demand control will be used with sensors for temperature levels, relative humidity and $CO_2$ levels to regulate the ventilation rate. Heat recovery will give further savings in electricity.

## 7 Resulting Energy Savings

| | Energy [kWh/m$^2$/year] | Power [W/m$^2$] |
|---|---|---|
| Space heating | 29 | 30 |
| Heating of ventilation air | 20 | 41 |
| Water heating | 13 | 10 |
| Fans and pumps | 15 | 6 |
| Lighting | 23 | 14 |
| Equipment | 11 | 8 |
| Cooling | 0 | 0 |
| **Total** | **111** | |

**Table 1:** Energy budget for Borgen Community Centre

**Figure 4:** Construction site in 2003.

## 8 User evaluation

Not available yet. The school is under construction and will be in use from autumn 2004.

## 9 Renovation costs

Borgen secondary school with integrated functions as a community centre has a budget set at 156,5 million NKR including work on fundations and infrastructure.
The project includes 4000m$^2$ retrofit and 2000m$^2$ new construction.
The community centre includes a secondary school, kindergarten, healthcare centre, dentist and church. It is also planned to use the facilities for sports clubs etc.

## 10 Experiences/Lessons learned

Not available yet. The school is under construction and will be in use from autumn 2004.
See also the home page of Borgen secondary school: www.borgen.gs.ah.no

## 11 General data

### 11.1 Address of project

Borgen ungdomsskole
Borgenveien
1388 Borgen
Asker
Norway

### 11.2 Date of report / revision no.

## 12 Acknowledgements


| | |
|---|---|
| *Builder:* | Municipality of Asker |
| *Architect:* | HUS arkitekter |
| *Building engineer:* | Seim Hultgreen |
| *HVAC engineer:* | Dagfinn H. Jørgensen |
| *Electrical engineer:* | Elconsultteam as |
| *Fire safety engineering:* | Norwegian Building Research Institute |
| *Research team:* | SINTEF and NTNU |


## 13 References


(1) Buvik, Karin:
"Miljøvennlige skoleanlegg"
5 skoler med tilkntning til programmet ØkoBygg.Rapport
Økobygg og Laringssenteret 2003, Norway

(2) Schild P.G; Mysen M.; Tjelflaat P.O.
"Bygningsintegrert ventilasjon - en veileder" Rapport
Økobygg 2003, Norway