

Property name: Segevångsskola
Property owner: Malmö Stad
Consultants: CIT Energy Management AB

Total Concept method

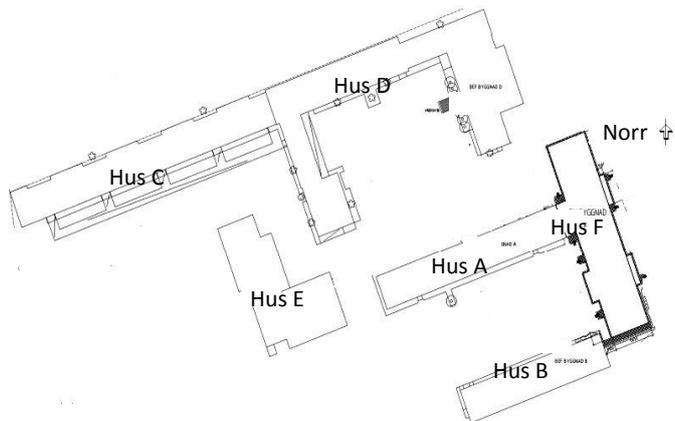
Step 1. Creating the action package

Building and its use

Year built: 1960-ies and 2006
Area: 5 386 m² heated area
Type of building: Elementary school

Segevångsskola is an elementary school locating in Malmö. The property consists of six buildings: Building A, B, C, D, E and F. Most of the buildings (buildings A- E) were built in the 1960-ies. One of the buildings was built in 2006 (building F). During the same year building E was also expanded and renovated. Total heated area of the whole property is 5386 m², divided between the buildings as follows: Building A 530 m², Building B 415m², Building C 731 m², Building D 2 443 m², Building E 619 m² and Building F 648 m².

The buildings incorporate classes from grade 0 up to grade 6. There are about 260 students in total in the school and ca 40 employees. Buildings A and F are used by pre-school classes. Buildings C and D have class rooms for grade 1 to grade 6, a laboratory, handicraft rooms, office areas and a gymnastic hall. Building B is used for leisure activities during afternoons and evenings and in building E there is a canteen and leisure rooms.



Indoor climate

Indoor temperature requirements are set for 21 degrees for all rooms, except the gymnastics hall, where the room temperature requirement is 17 degrees. According to the requirements the supply air temperature must be ca 2 degrees lower than the room set temperature. Other indoor climate requirements (air quality, lighting, noise levels) correspond to the national requirements for school facilities. For example, according to the National Work Environment Authority, the carbon dioxide concentration in the room air should not routinely exceed 1000 ppm.

Room temperature measurements carried out during autumn period 2014 showed that room temperatures in several classrooms were sometimes too low while on some sunny days they exceeded +30 °C. According to personnel working in these premises summer temperatures are often experienced to be too warm and winter temperatures rather cold. Indoor air quality measurements showed that airflow rates in classrooms in building D were too low to keep the air quality requirements 1000 ppm CO₂. According to the staff the door to the corridor and windows must usually be kept open for ventilation. Carbon dioxide concentration in the classrooms in Building C did not exceed recommended levels during the measurements.

The status of the building and its technical systems before measures

Building envelope

Buildings A and B have wood-frame façade construction with ca 45 mm insulation and wood cladding (U-value ca 0,6 W/m²K) and mono-pitched roof with ca 100 mm insulation and roofing felt (U-value ca 0,4 W/m²K). The buildings have 2-glaze windows with varying U-values. Some windows are original from 1960-ies and some have been replaced during the last ten years. Proportion of older coupled windows is estimated to be about 30%. The two buildings (A and B) are most probably going to be demolished in the future.

Buildings C to E have wood-frame construction with ca 70 mm insulation and brick veneer cladding (U-value ca 0,35 W/m²K) and mono-pitched roofs (U-value ca 0,4 W/m²K). Most of the windows are 3-glaze windows (Building C and D) or 2-glaze modern windows (Building E). Building F has brick facade and modern 2-glass windows. Buildings A, C and D have manually controlled external solar shadings on south façade.

Heating

The property is heated by district heating system, distributed via two substations: one locating in Building B, supporting buildings A and B and one locating in Building E, supporting Buildings C, D E and F. The heating systems are in operation when the outdoor temperature is below 17 degrees.

Ventilation

Building A has two FTX units with rotary heat exchangers and electric heating batteries. The units are controlled via time channel, but there is also possibility for forced ventilation in classrooms for 2 to 4 hours, which is manually controlled.

Building B is ventilated with mechanical supply and exhaust air ventilation via a supply air ventilation unit and an exhaust air fan. There is no heat recovery in the system. According to the mandatory ventilation inspection the supply airflow rate of the system is 0,4 m³/s. However, the information about the exhaust air fan is not available. According to the design drawings supply and exhaust airflow rates should be 0.7 m³/s. The buildings C and D have mainly exhaust air ventilation with a number of exhaust fans. In Building C the exhaust fans are controlled with occupancy sensors and in Building D with time channels. There is no heat recovery in the systems. The gymnastics hall and wood work classroom in Building D have separate FTX units as well as the laboratory room in Building C. Buildings E and F are ventilated with modern FTX- units, operated during the school occupancy hours.

Lighting

There are different types of luminaries installed in the buildings. Most of the classrooms and bi-areas in Building A, B and D (except offices) have FTL lighting fixtures with T8 tubes and are controlled manually. Building C, the office areas in Building D, classrooms and bi-areas in Building F and E have modern FTL lighting fixtures with T-5 tubes. Occupancy control of luminaries is available only in some rooms in Building D and in the toilets and other bi-areas in buildings E and F.

Equipment

Building E has a canteen with a kitchen that is used for lighter cooking and preparation of food. The kitchen has typical restaurant kitchen equipment (frying plates, ovens, blenders, etc). About 250 portions of food is prepared for lunch every workday.

Control and monitoring system(s)

Buildings E and F are connected to a central control and monitoring system. The remaining buildings are controlled on site.

Energy and resource use before measures

Total specific energy use before measures (baseline) 167 kWh/m²,yr

Whereas,

Heat energy (district heating) 128 kWh/m²,yr

Electricity for building operation 14 kWh/m²,yr

Electricity for tenants 25 kWh/m²,yr

Energy supplied to the Segevångsskolan consists of electricity and district heating. Measured total energy use of the building in 2011-2014 was in an average about 186 kWh/m² yr incl. tenants (corrected to normal year) and 161 kWh/m² yr excl. tenants. Measurement of district heating is carried out in the two substations. Electricity for building operation and electricity for tenants is measured together.

According to the energy audit, it can be difficult to meet the indoor climate requirements set for the school premises with the current system solutions in Buildings B, C and D. Therefore, upgrading of ventilation systems is recommended as "Measure 0" and energy savings potential of the identified energy saving measures has been assessed based on the new baseline for energy use. According to calculations, the heat energy use of the property will decrease by about 15 % due to energy recovery in the most simple system option, while the electricity use will increase by about 12 % after "Measure 0". The new baseline will be ca 167 kWh/m² yr incl. tenants and ca 142 kWh/m² yr excl. tenants, as shown above. "Measure 0" also leads to increased quality of the premises and the property.

Identified energy saving measures

23 energy saving measures have been identified during the auditing. Eleven measures are included to the proposed action package. Some of the measures, e.g. replacement of thermostats and hydronic balancing will also be carried out as part of the property maintenance plan, therefore only part of the investment cost is included to the costs for energy efficiency improvement. The same applies also for measures in lighting systems. Installation of demand controlled ventilation in Buildings B, C and D provides good energy saving potential. However, in the cost calculations it is assumed that demand controlled ventilation will be installed at the same time as systems are upgraded for improving indoor climate, meaning that only additional costs for demand control has been included in the calculation. Measures in the building envelope can provide considerable energy saving potential, but are too costly to be part of the profitable action package.

Summary of the action package

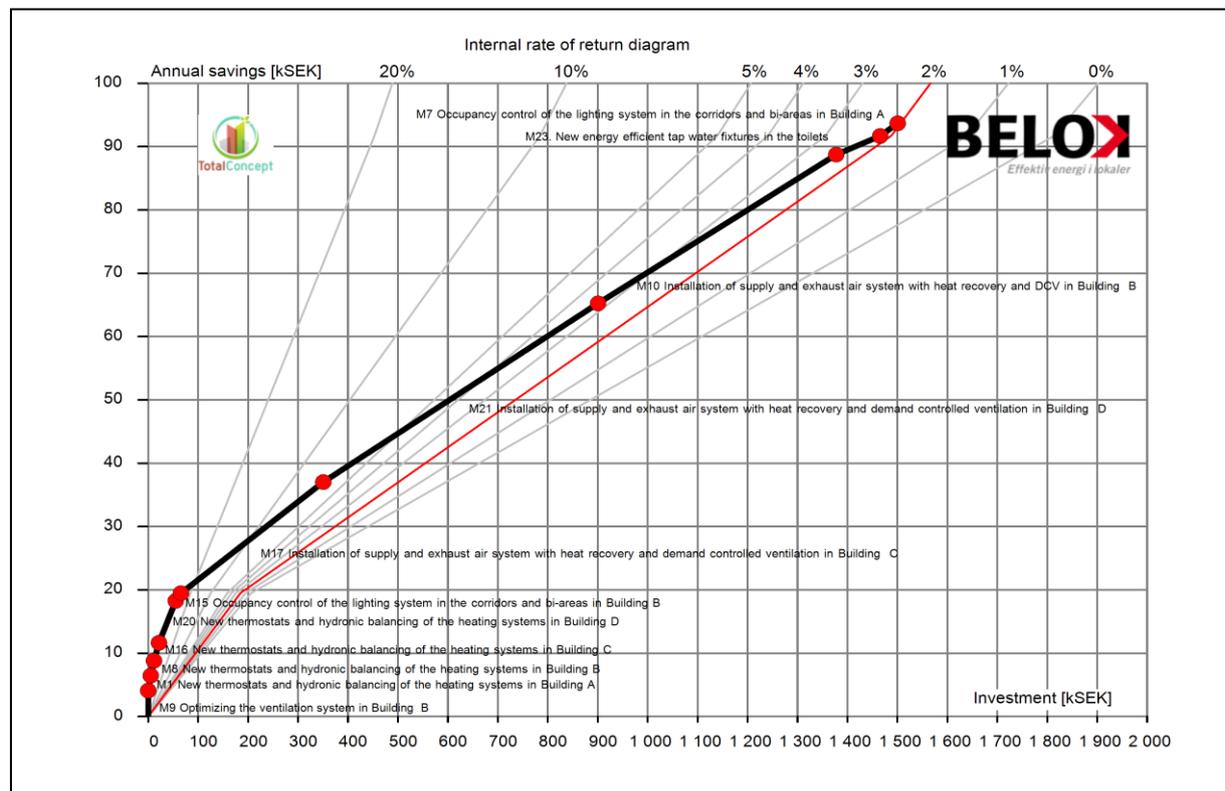
Results

The total energy saving potential with the proposed action package is approximately 12 % compared to the new baseline. Annual district heating use of the property can be reduced by ca 12 % and electricity use by ca 13 %. In Building A the energy saving potential with the action package is about 6 %, in Building B about 34 %, in Building C about 18 % and in Building D about 12 %.

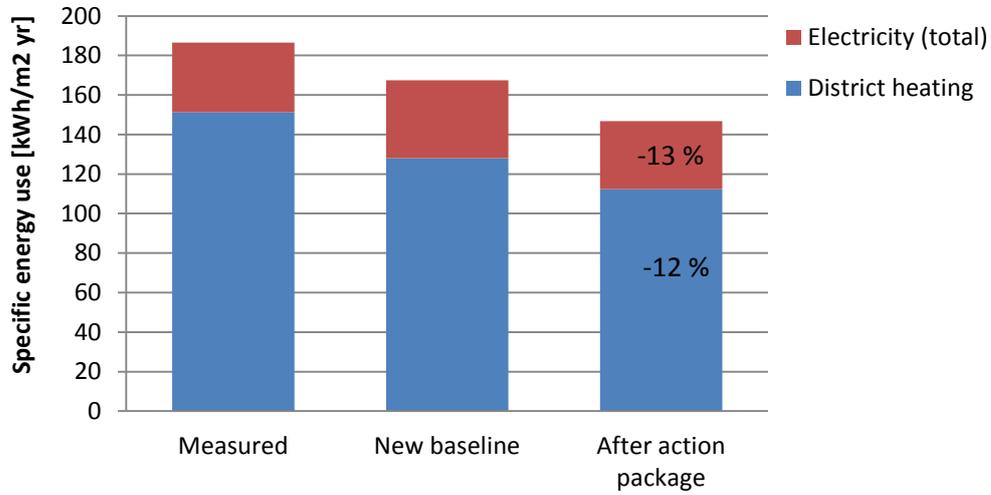
The total annual energy use of the property will be about 122 kWh/m² yr excl. tenants and ca 147 kWh/m² yr incl. tenants. Total annual costs savings will be about 94 kSEK/yr. Energy investment cost for the proposed action package is ca 1 501 kSEK. The internal rate of return of the proposed action package is 2 %. The property owner's profitability demand is 2% and relative energy price increase above inflation is estimated to be ca 1%.

The total energy savings potential with all investigated measures is about 21%, compared to the new baseline, whereas in Buildings A, B, C and D the energy use can be reduced by about 27% in total. Building A has energy saving potential about 38%, Building B about 59%, Building C about 29% and Building D about 14% compared to the new baseline.

Measure	Investment cost kSEK	Cost saving kSEK/yr	Total energy saving MWh/yr
1 M9 Optimizing the ventilation system in Building B	0	4	8
2 M1 New thermostats and hydronic balancing of the heating systems in Building A	5	2	4
3 M8 New thermostats and hydronic balancing of the heating systems in Building B	6	2	4
4 M16 New thermostats and hydronic balancing of the heating systems in Building C	10	3	5
5 M20 New thermostats and hydronic balancing of the heating systems in Building D	33	7	12
6 M15 Occupancy control of the lighting system in the corridors and bi-areas in Building B	10	1	1
7 M17 Installation of supply and exhaust air system with heat recovery and demand controlled ventilation in Building C	285	18	18
8 M21 Installation of supply and exhaust air system with heat recovery and demand controlled ventilation in Building D	550	28	30
9 M10 Installation of supply and exhaust air system with heat recovery and demand controlled ventilation in Building B	477	23	24
10 M23. New energy efficient tap water fixtures in the toilets	88	3	3
11 M7 Occupancy control of the lighting system in the corridors and bi-areas in Building A	35	2	2
- Sum	1501	94	112



Total energy use of the Segevångsskolan property



Energy use per building before and after measures

