Property name: Högsbo 20:22 office
Property owner: Harry Sjögren
Consultants: CIT Energy Management

Total Concept method

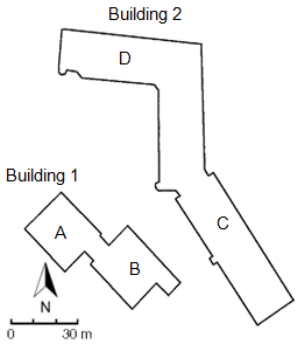
Step 1. Creating the action package

Building and its use

Year built: 1982 (A, B, C): 1986 (D)
Area: 14543 m² Heated area
Type of building: Office building

The Högsbo 20:22 property is locating in Gothenburg and consists of two office buildings divided into four building sections: A, B, C and D. Sections A and B are part of Building1 and Sections C and D are part of Building 2. All of the building sections have four floors and incorporate mainly office rooms, but there are also some storage rooms on the ground floor. There is a lunch restaurant (ca 325 m2) in Section B, open from 11:00-13:30 during working days and has ca 190 places in total. Section D has an underground garage.

About 60 % out of the total heated area (A_{temp}) of the property was rented out in year 2013 and about 70 % in year 2014. In average there are approx 170 persons present in the buildings during normal occupancy hours, from 8:00 to 18:00 from Monday to Friday. The Högsbo 20:22 buildings have rather low occupancy density per used area, about 45 m^2/person. The aim is to decrease the vacancy level to 15%, which has been used as baseline for calculations.



Indoor climate

Indoor climate requirements set for the office premises are the same as commonly set for the office environment in Sweden: minimum room temperature winter time +21°C and summer time +23°C; minimum airflow rates 7 l/s per person + 0,35 l/s m2. The requirements for lighting and maximum noise levels are in accordance with national requirements set for the work premises.

The indoor climate requirements are generally met. Some office areas are experienced to be too cold winter time and in some zones even summer temperatures. The measurements on site showed the indoor temperatures vary in between +22°C and +23°C during the August- September.

The status of the building and its technical systems before measures

Building envelope

The building envelope is in a rather good condition. Both of the buildings are similar in construction: the frame is set on concrete pillars and the floor frames are made of concrete structure. The ground floor facade consists of concrete, insulation and brick wall outside. Estimated total U-value is ca 0,26 W/m2K. The upper facades are made of light construction with the metal sheet outside and have estimated total U-value is ca 0,24 W/m2K. The buildings have flat roofs made of concrete structure (insulation ca 250 mm). Majority of the windows are

triple pane wooden windows (U-value is ca 2.0 W/m2K). All windows are original, from 80ies, except for part of the lunch restaurant section.

Heating

The buildings have district heating, distributed via two substations: one locating in Section A, supporting sections A, B and C and one locating in Section D, supporting only Section D. The rooms are heated via 1-pipe radiator system. Distribution pumps are from 80ies as well as most of the radiator thermostats. The radiators are functioning poorly, especially in Section D and are step-by-step replaced with new ones when premises are renovated for the new tenants. The primary side of the heating systems was balanced in 2012, no hydronic balancing has been made in the radiator circuits. The garage has air heaters with recirculation air, operating only during the extreme cold weather.

Ventilation

There are totally 8 air handling units installed. The units for the office areas operate from 6:40 to 18:00 M-F and the unit for the lunch restaurant from 6:40 to 14:00 M-F. Majority of the units are from the 80-ies and show signs of wear. All ventilation units have heat recovery, whereas four units have regenerative heat exchangers (temperature efficiency varying 63 % - 75 %) and other units use return air for heat recovery (temperature efficiency 63 % - 75 %). All office systems are equipped with after heating and/or after cooling coils on the main ducts. The supply air temperatures are varying in between +19.5 °C to +20.5 °C at outdoor temperatures of +20 °C to -20°C. The ventilation systems have quite high SFP values, for some systems up to 4.0 kW/(m^3/s). All offices premises are ventilated with constant air volume flow (CAV). Total airflow rate is about 1,6 l/s m2 for Sections A&B, about 0,8 l/s m2 for Section C and about 1,8 l/s m2 for section D. The airflows in Section C needs to be increased to adapt to the new tenants.

Cooling

About 75 % of the office premises have hydronic comfort cooling system with chilled beams. Chilled water is produced with two chillers locating on the roofs of Section A and D. The chillers are from 1995, estimated COP value 2.5. The chiller for Sections C and D has problems with compressors, which need to be replaced. Cooling system in Section D and C is in operation all year around, due some server rooms that are connected to the central cooling system.

Lighting

FTL lighting fixtures with T5 and T8 tubes are installed in the buildings. Most of the office areas have modern lighting, installed during recent years. In the common areas low energy light bulbs are installed. All lighting is manually controlled, except in the garage (occupancy sensors) and outdoor lighting (astronomical clock).

Equipment

There is standard office equipment used in the premises. Each tenant has a separate kitchenette. Lunch restaurant has typical restaurant kitchen equipment (frying plates, ovens, blenders, etc) for preparing food on site.

Control and monitoring system(s)

All of the technical systems are connected to the central building management system from KTC, installed in 2007.

Other systems

Domestic hot water is produced by district heating via separate heat exchangers.

Energy and resource use before measures

Total specific energy use before measures (baseline)	128 kWh/m2,Year
Whereas,	
Heat energy	58 kWh/m2,Year
Electricity for building operation	34 kWh/m2,Year
Electricity for tenants	36 kWh/m2,Year

Based on measured data in 2013 the total specific energy use for the Högsbo 20:22 property was 88 kWh/m² yr excl. tenants (corrected to normal year) and 120 kWh/m² yr incl. tenants. This is rather low energy use compared to other similar office buildings in Sweden and can be explained by the relatively high vacancy level in the buildings and low occupancy rate in the used premises. Since a number of tenant adjustments are planned for the upcoming years a new baseline for the property's energy consumption was calculated by using the calibrated energy simulation model. The annual energy use of the property will decrease by about 8 %, up to ca 128 kWh/m² yr incl. tenants. These values are shown above.

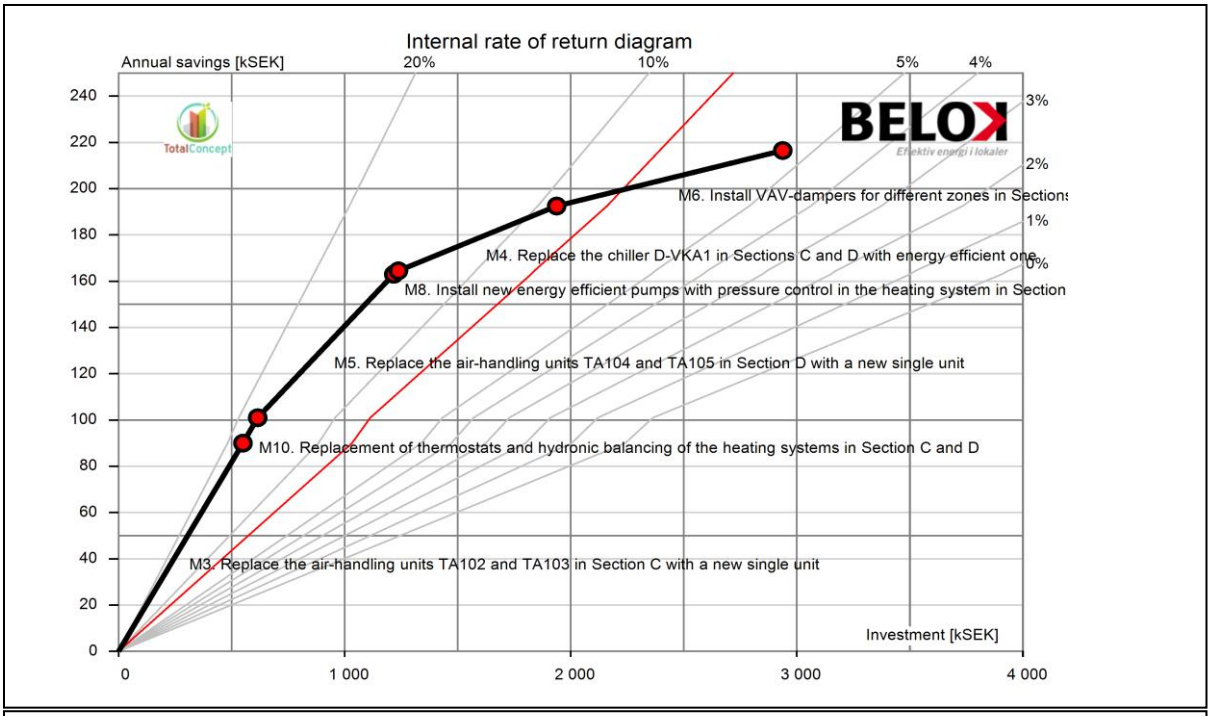
Identified energy saving measures

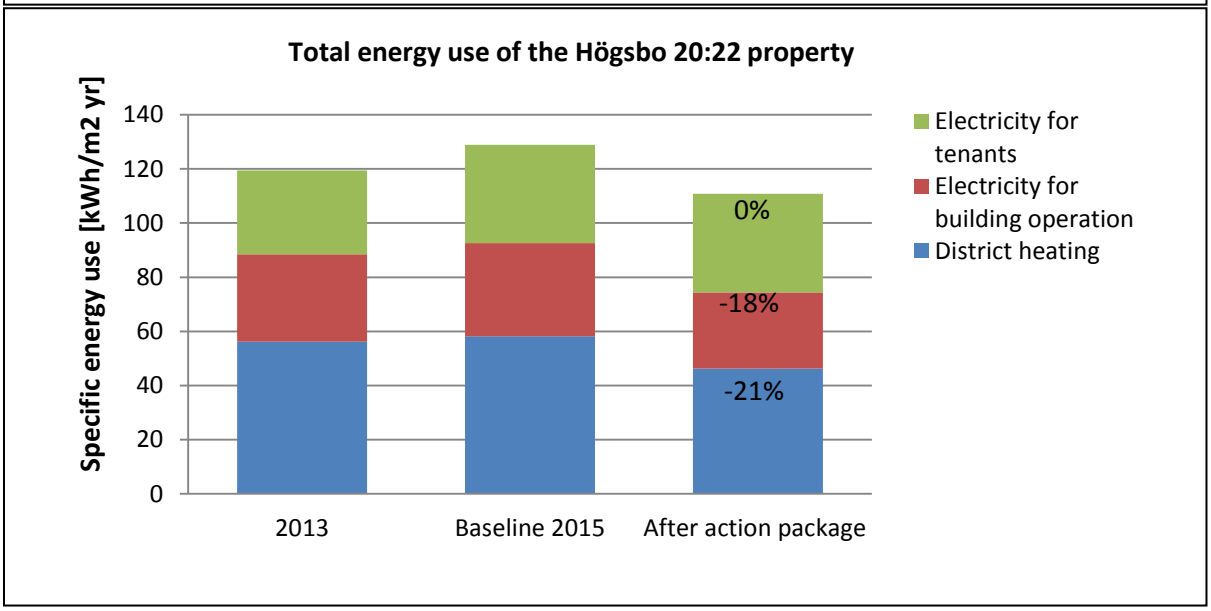
Since the Högsbo 20:22 property already has rather low energy use, more extensive measures will be required to decrease the energy use even more. Twelve energy saving measures were identified during the auditing. Six measures are included to the proposed action package. The proposed action package includes measures for Sections C and D. According to the property owner a number of proposed measures will be carried out as part of the upcoming renovation for the tenant adjustments in these building sections and therefore will be prioritized first. In the calculations it has also be taken into account that since majority of the measures will be carried out as part of the upcoming tenant adjustments as well as for property maintenance then only part of the investment cost is included to the costs for energy efficiency improvement. Several proposed measures contribute also to reduction in power demand and reduced power costs.

It is proposed to replace the existing air-handling units with more energy efficient ones. Also, installing VAV-dampers on the main ducts connecting the different zones in Sections C and D is suggested to minimize the airflow rates in unoccupied spaces. Additionally, replacement of chillers and optimizing the pump operation in the cooling system is proposed. In the heating systems new thermostats on the radiators and hydronic balancing of the entire system is recommended as well as installation of energy efficient pumps with pressure control.

Summary of the measures in the action package

	Measure	Invesment cost kSEK	Cost saving kSEK/year	Total energy saving MWh/year
1	M3. Replace the air-handling units TA102 and TA103 in Section C with a new single unit	550	90	115
2	M10. Replacement of thermostats and hydronic balancing of the heating systems in Sections C and D	65	11	21
3	M5. Replace the air-handling units TA104 and TA105 in Section D with a new single unit	602	62	70
4	M8. Install new energy efficient pumps with pressure control in the heating system in Section D	21	1	2
5	M4. Replace the chiller D-VKA1 in Sections C and D with energy efficient one	700	28	30
6	M6. Install VAV-dampers for different zones in Sections C and D	1000	24	26
-	Sum	2938	217	264





Results

The total energy saving potential with the proposed action package, with measures for sections C and D, is approximately 14% compared to the new baseline. The total annual energy use of the property will be about 74 kWh/m² yr excl. tenants and ca 111 kWh/m² yr incl. tenants. Annual district heating use can be reduced by about 21% and electricity use by about 18%. Total annual costs savings will be about 217 kSEK/yr.

The internal rate of return of the proposed action package is 5.5 %, which is somewhat lower than the property owner's profitability demand 8%. This is due to the fact that the last measure in the action package (M6) is exceeding the profitability line, but is included to the package as it is planned to be carried out by the property owner anyway. The estimated relative energy price increase 2% has also been taken into account in the calculations. Investment cost change ±20 % (due to uncertainty of cost for measure 3) leads to the internal rate of the return to be in a range of 5.0%- 6.0%.

The total energy savings potential with all investigated measures is about 37%, compared to the new baseline.