Property name: Drivhuset
Property owner: Vasakronan
Consultants: CIT Energy Management AB

Total Concept method

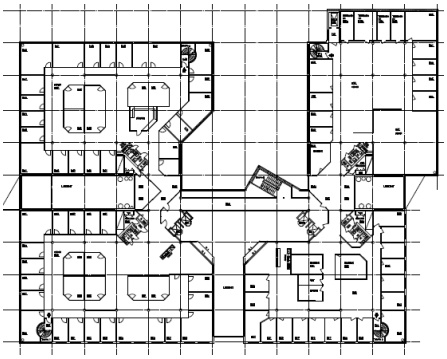
Step 1. Creating the action package

Building and its use

Year built: 1989
Area: 16 238 m² Heated area
Type of building: Office building

Drivhuset is an office building locating in Gothenburg and is divided into four quadrants: Yellow, Red, Green and Blue. The quadrants are connected together with a large glass covered atrium. The building's eight floors houses nine tenants with a number of different activities. Floors 3-7 incorporate mostly office premises, while on the 8th floor there is a gym, conference rooms and technical facilities. Floors 1 and 2 consists of a garage, technical rooms, and archives. Approximately 93% of the building was rented out in 2014. In average there are about 200 people working in the building during normal working hours from 7:30 to 6:00 p.m. One of the tenants has also working hours outside traditional office hours.

A total renovation will be carried out in this building in order to improve the function of the building and to adjust for new tenants. The aim of the Total Concept project has been to incorporate energy efficiency measures to the total renovation of the building and to achieve energy savings of more than 50 %.



Indoor climate

Indoor climate requirements set for the office premises are: room temperature during winter + 22 °C (min +20°C); room temperature during summer +23-24 °C. The requirements for hygienic air flow rates, lighting and maximum noise levels are according to the national requirements.

According to interviews with tenants and operational personnel the thermal climate in some office premises are experienced to be somewhat cold during wintertime and too warm during summer time. Quite a few tenants, therefore, use their own electric heaters (ca 2 kW) to keep room temperatures at a comfortable level. Some tenants pointed out also problems with air quality in some of the meeting rooms, where the air gets stuffy in a short time after the room is occupied. Long-term measurements of room temperatures were carried out in a number of office rooms during the auditing. According to the measurements the air temperatures were between +19-20 °C in the mornings and gradually increased by about one degree for about an hour.

The status of the building and its technical systems before measures

Building envelope

The building envelope is in a rather good condition. The exterior walls consists 'of brick, insulation and drywall. The roof is made of insulated light construction with the metal sheet outside. The façades have large percentage of windows and glazed area. Also the roof area of the atrium is fully glazed. There are five different types of windows, with the U-value in between 1.9 and 2.7 W/m^{2}K, depending on the window type. The windows on the south, west and east side have exterior automatic-controlled solar shadings. Majority of the vertical glazed area in the atrium, windows on the 7th floor and in all corner floors will be replaced during the renovation. It is also planned that a winter garden is built adjacent to the glass façade in the north.

Heating

The building is connected to the district heating network. Most of the premises are heated via radiator system. Only the atrium area and the garage is heated with supply air, whereas the garage area is heated with the return air from the atrium area. Due to somewhat lower room temperatures in some of the office rooms some tenants have their own local electrical heaters in these rooms (with ca 1-2 kW electrical power).

Room temperatures are in many rooms controlled with the same room temperature regulators for comfort cooling and heating (room and zone regulators). These temperature regulators are original, from 1989. Therefore the function of these regulators should be checked. The pumps in the heating system are pressure controlled, with pump stop at +14- +15 ºC outdoor temperature. There is also a snow melting system at the entrance area, which is connected to district heating.

Ventilation

There are six air-handling systems installed in the building. LS1-LS4 are supply and exhaust air systems and LS5 and LS6 are recirculation systems. LS1 and LS2 support the atrium area, floor 8 and technical areas and garage on floors 1 to 3. The systems have no heat recovery during the day time operation. At night time the systems operate with 100 % recirculation air to maintain the required room temperature in the atrium area. LS1 and LS2 have rather high SFP-values: ca 3.2 kW/(m^3/s) for LS1 and 3.7 kW/(m^3/s) for LS2. LS3 and LS4 support the office areas on floors 3 to 7 and are equipped with regenerative heat exchangers. However, the temperature efficiency of the heat recovery systems is rather low, about 44% for LS3 and 58% for LS4. Both systems operate with CAV flow rate. LS3 and LS4 have also quite high SFP values: 4.3 kW/(m^3/s) LS3 and 3.2 kW/(m^3/s) for LS4. There are also have a number of circulation fans on floors 4 to 7 connected to these systems that transport the air from the office areas to the atrium area, where the air is centrally extracted.

Cooling

The building is connected to the district cooling network since 2011. The office premises have hydronic comfort cooling system with chilled beams, but there are also a number of fan coils installed in the office areas on floor 4, in the elevator rooms and in TV room. The cooling system is in operation all year round due to these fan coils in these areas. Some server rooms and two laboratories have their own process cooling with DX cooling units.

Lighting

The premises have a variety of different types lighting fixtures and control. Most of the office premises have modern FTL lighting fixtures with T5 tubes. Only some premises have older type of FTL fixtures with T8 tubes. In most of the corridors and side rooms there are lighting fixtures with low energy light bulbs installed. In the common areas (kitchen/dining, atrium) there are halogen spot lights. All the common lighting in the office areas is controlled manually via key opening at the entrance doors to each tenant. All rooms have also possibility for manual control. The garage area has older type of FTL lighting fixtures (T8) that is switched on around the clock.

Equipment

There is standard office equipment used in the premises. Several tenants have also their own server room. Each tenant also has its own kitchenette with kitchen equipment such as coffee machines, microwaves (s), fridge (s), dishwasher (s), etc. There are also two laboratories with various appliances. In the building there are 5 elevators.

Control and monitoring system(s)

All the technical systems are connected to a central control and monitoring system (BMS) from Siemens.

Energy and resource use before measures

	Measured before (2014)	*Baseline*
Total specific energy use before measures	231 kWh/m^2,yr	272 kWh/m^2,yr
Whereas,		
District heating (corrected to normal year)	83 kWh/m^2,yr	119 kWh/m^2,yr
District cooling	55 kWh/m^2,yr	53 kWh/m^2,yr
Electricity for building operation	32 kWh/m^2,yr	36 kWh/m^2,yr
Electricity for tenants	60 kWh/m^2,yr	64 kWh/m^2,yr

The property has a rather high energy use compared to other similar existing office buildings in Sweden. Based on measured data in 2014 the total specific energy use for the Drivhuset office building was approx. 171 kWh/m² yr excluding tenants and 231 kWh/m² yr including the tenants (heat energy use corrected to normal year).

The indoor climate investigations on site revealed that a number of rooms do not fulfil the room temperature requirements. Additionally a number of tenant adjustments are planned for the building. Therefore a new baseline for the property's energy use was calculated by using a calibrated energy simulation model made with IDA ICE simulation tool. According to the new baseline the total specific energy use will be approx. 208 kWh/m²yr excluding tenants energy (based on “normal year”) and approx. 272 kWh/m²yr including tenants energy.

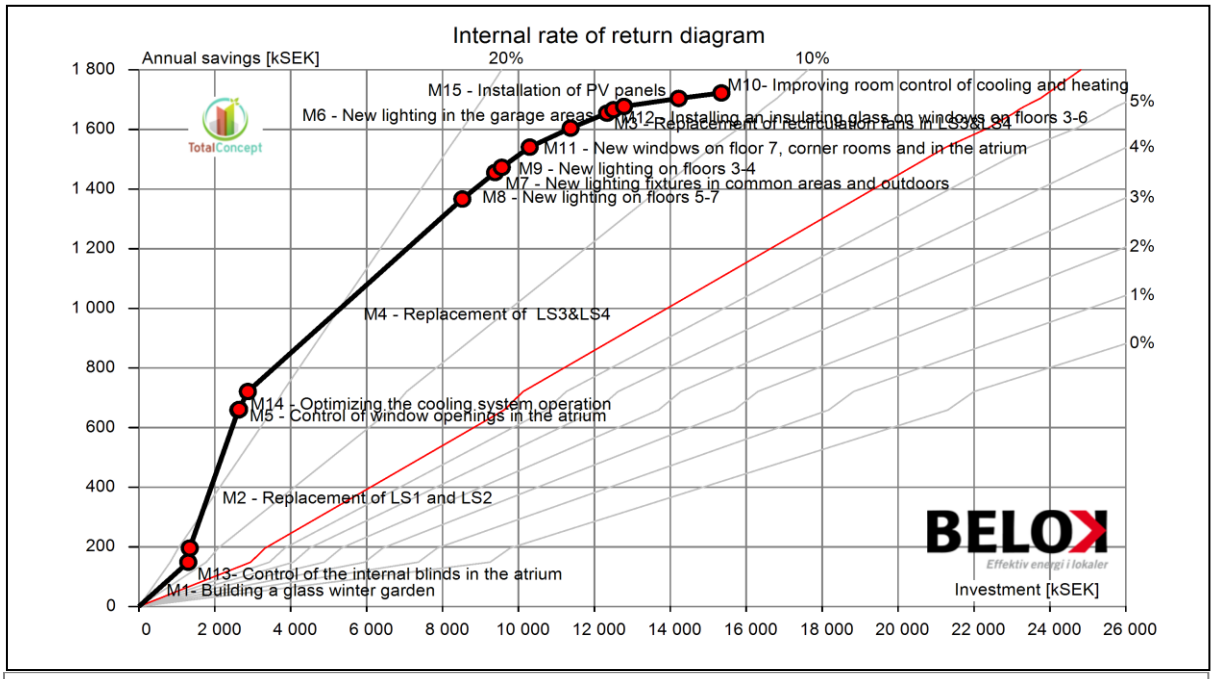
Identified energy saving measures

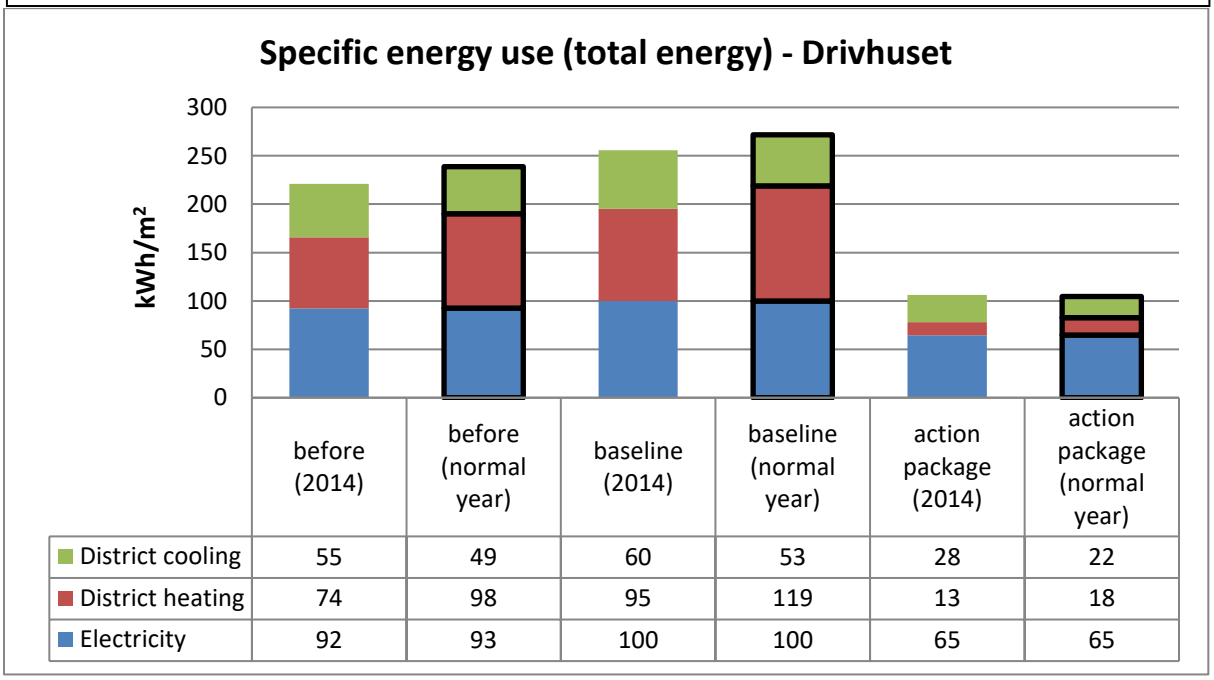
Fifteen energy saving measures were identified during the auditing and are included to the action package. The biggest saving potential is in the ventilation systems. According to the proposed measures the air-handling systems LS1 and LS2 will be replaces with a number of smaller and more efficient systems with central heat recovery. Also the units LS3 and LS4 supporting the office premises will be replaced with more energy efficient ones. Additional savings will be achieved with optimizing the performance of the cooling and heating systems.

A number of proposed measures in the action package will be carried out as part of the upcoming renovation for the tenant adjustments or for building maintenance. Therefore 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.

Summary of the measures in the action package

Measure		Invesment cost kSEK	Annual cost saving kSEK/year	Annual energy saving MWh/year
1	M1- Building a glass winter garden	1300	149	247
2	M13- Control of the internal blinds in the atrium	40	47	19
3	M2 - Replacement of LS1 and LS2	1280	463	568
4	M5 - Control of window openings in the atrium	20	2	4
5	M14 - Optimizing the cooling system operation	230	60	223
6	M4 - Replacement of LS3&LS4	5651	646	743
7	M8 - New lighting on floors 5-7	862	89	174
8	M7 - New lighting fixtures in common areas and outdoors	177	18	24
9	M9 - New lighting on floors 3-4	735	67	133
10	M11 - New windows on floor 7, corner rooms and in the atrium	1077	64	137
11	M6 - New lighting in the garage areas	960	50	78
12	M12 - Installing an insulating glass on windows on floors 3-6	168	11	12
13	M3 - Replacement of recirculation fans in LS3&LS4	280	11	18
14	M15 - Installation of PV panels	1440	27	55
15	M10- Improving room control of cooling and heating	1125	18	29
-	Sum	15345	1722	2462





	before (2014)	before (normal year)	baseline (2014)	baseline (normal year)	action package (2014)	action package (normal year)
District cooling	55	49	60	53	28	22
District heating	74	98	95	119	13	18
Electricity	92	93	100	100	65	65

Results

The total energy saving potential with the proposed action package is approximately 60 % compared to the new baseline and approximately 55 % compared to the year 2014 energy statistics (corrected to normal year). The total annual energy use of the property will be about 55 kWh/m² yr excl. tenants and about 105 kWh/m² yr incl. tenants. Annual district heating use can be reduced by about 85 %, annual district cooling by about 55 % and total electricity use by about 35 % compared to baseline. Estimated total annual costs savings will be about 1720 kSEK/yr. Energy investment cost for the action package is about 15.4 milj. SEK. The internal rate of return of the proposed action package is 11 %, which is above property owner's profitability demand.