Sustainable renovation

Per Eneborg, 2011-01-17

Introduction

In 2008, 23% of all energy consumed in Sweden was related to residential real estate and service establishments.
That year it added up to 141 TWh[1].
This is a considerable amount of energy that, of course, generates equally considerable costs in the real estate business.

In 2009 the cooperation began between NCC construction and Akelius to find a way of making a substantial renovation of two buildings in Helsingborg profitable. We are used to calculating rent-increasing measures, but this time the challenge was to find measures to reduce energy consumption and maintenance costs.

A sustainable renovation.
The question I would like to answer is:
What can be done to reduce energy consumption in existing buildings?

In this rapport I will show which solutions were suggested and why in order to lower energy consumption in the properties Örnen 23 and 24 in the following areas:

- Window replacement and sealing measures
- Heating
- Water consumption
- Electricity

[1] Facts and figures - Energy in Sweden 2009. Energimyndigheten. www.energimyndigheten.se

Örnen 23 & 24

The properties Örnen 23 and 24 in Helsingborg are undergoing an extensive renovation. The buildings were built in 1955 and 1949 with most of the main structures in original condition. Together the two properties consist of 59 apartments and a heated area of 4,924 m2. The initial purpose was to rebuild kitchens and bathrooms in every apartment and replace all pipe-work and electricity to prevent future problems, but there were other areas that also needed attention.
In Örnen 24 the heating system was out of date, the roofs on both buildings were showing signs of wear and tear, most of the windows were original and the cellar and stairwells were in need of refurbishment.
To finance this project the rent-increasing actions would not be sufficient so an investigation into energy-reducing and cost-efficient measures was launched.

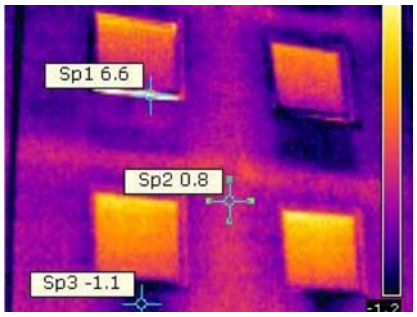
Analysis of energy-reducing measures

In order to analyze what affect any measure would have, the buildings energy-consumption must be established.
Data was collected from actual costs and estimated values and the conclusion was:

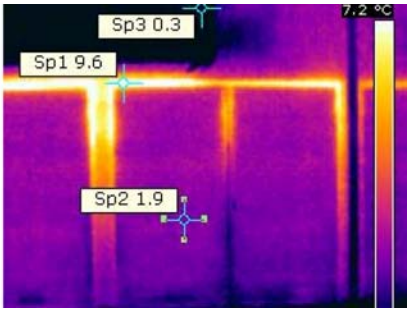
	KWh/year	KWh/m2
Heating	392 238	80
Losses in heating system	66 132	13
Hot water	158 984	32
Addition for airing	49 240	10
Electricity common spaces	39 415	8
Total	**706 009**	**143**

The buildings outer shell

To find out why the energy consumption is as high as it is, a density test and thermal scan with an IR-camera was made.
The purpose of these tests was to assess the amount of air-leakage and where the leakage was located.

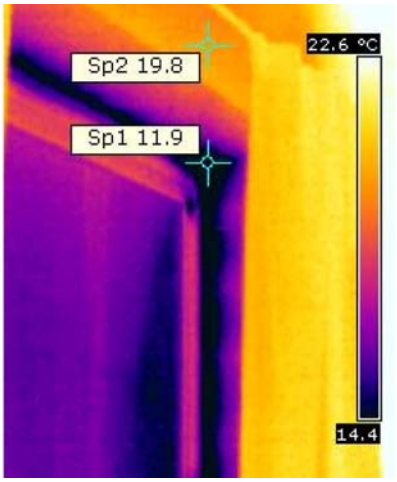


The bright fields indicate higher temperature. The marks show surface temperature.



The upper picture shows the normal heat-conduction from where joists and inner-walls meet the outer-wall. In the same picture we see the affect of a window not quite shut.
The lower picture shows the heat-leakage from the garage doors.

Two apartments were subjected to the density test.
The apartments were at 50 Pa pressure-differences compared to outside air-pressure and the air-leakage was measured to 1.3 and 1.0 l/s and m2.



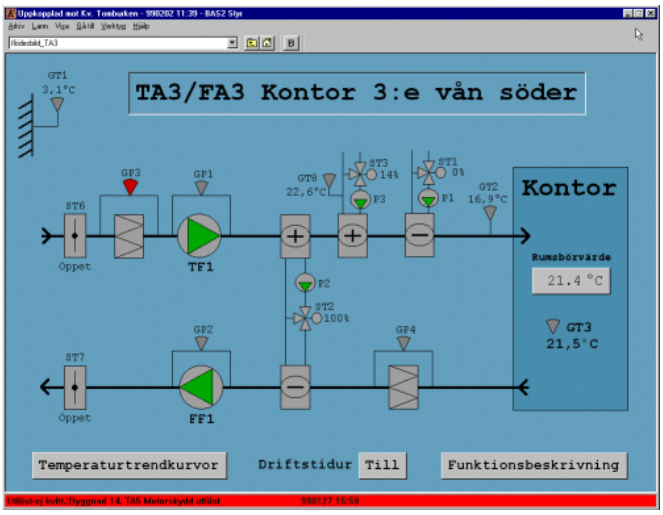
The air-leakage is mostly due to poor sealing's in and around windows and balcony-doors.

Replacing the windows and improving the sealing's around them is one way to dramatically reduce energy consumed in the buildings. The air-leakage was assessed to be reduced to an average of 0.6 l/s and m2.

Heating

Both heating systems in Örnen 23 and 24 are waterborne with a central heating source, district heating. Different varieties of pumps and throttle valves adjust the flow through the system and evenly distribute the heat.
Radiators of different sizes and executions emit heat in desired areas and the cooled water circles back to the heating source for reheating.

The main objective is to have the installation running as efficiently as possible. Installing a modern automatic control system to the heating plant enables easier monitoring, regulating and fine-tuning the system. The system suggested has a feature, forecast control, which automatically downloads local weather-forecasts and adjusts its settings to operate in sync with the weather.



http://www.bastec.se/

This software from BASTEC enables you to monitor and change the settings to optimize the installation from your PC.

In addition to the system above an adjustment of the balancing-valves throughout the entire heating system was recommended; furthermore, making sure that the proportions of heat exchangers, pumps, valves and even the pipes are correct for the particular system. Altogether making it run as accurately as possible.
The savings these measures bring about can be surprisingly great. A decrease of the indoor temperature by one degree saves 5% of the heating costs.

Water consumption

The hot water consumed in the buildings is heated in the same way as the water heating the buildings, i.e. by district heat. Because of the fact that the heating of tap water is integrated in the heating-installation of the building the costs are accounted jointly.
It is possible to install meters to get a précis figure but in this case it can only be estimated.
Therefore the energy-consumption mentioned before is an estimated figure based on actual cold water consumption and the assumption that 44% of the total water-consumption is hot.

Since the bathrooms and kitchens are being renovated, the most logical and efficient way of reducing water consumption is by installing water-saving fixtures. In consultation between NCC and Akelius, the choice of using fixtures from Gustavsberg AB was made. Their product has an adjustable comfort-zone that regulates the flow and amount of hot-water used. In order to get a stronger flow or warmer water the lever needs to be held in wanted position. When letting the lever go, it automatically

springs back to the pre-adjusted position within the comfort-zone.

http://www.gustavsberg.se/44114.asp

Compared to the best selling faucet of ten years ago this fixture, combined with water-saving nozzle, can save up to 40% of energy cost and water consumption.
As of 2007 these features were integrated into Gustavsbergs standard assortment.

Electricity

The electricity consumed in the buildings is a fairly small portion of the total energy used. It powers the lighting in basements, stairwells and outside fixtures and the machinery in the laundry-room. In many buildings built around the same time as these, lighting-fixtures consist of conventional light bulb fixtures.
In those cases, installing low-energy fixtures is an obvious investment that reduces every light source's energy-use from, for example, 40W to 9W making the savings over 80%.
In Örnen 23 and 24 this was already done, with some exceptions.
The suggestion put forward to reduce consumption of electricity was to install fixtures with somewhat lower consumption and built in presence detectors. Presence detectors react to changes in thermal radiation that occur when someone stays in a room – if the room is empty, the light turns off automatically. They have high sensitivity and can detect small movements even in large rooms.

Savings

In the energy-report made by NCC the calculation of savings were divided in three measures.

1. Window replacement, sealing and water-saving fixtures.
2. Adjusting heating and valves and installing forecast control.
3. Presence detecting lighting fixtures

The savings were calculated to show the result each alternative produced after the previous alternative already was effective.

Alternative 1 resulted as below.

	KWh/year	KWh/m2
Heating	276 919	56
Losses in heating system	46 125	9
Hot water	127 187	26
Addition for airing	49 240	10
Electricity common spaces	39 415	8
Total	**538 886**	**109**

Alternative 2, when alternative 1 was in effect.

	KWh/year	KWh/m2
Heating	245 652	50
Losses in heating system	24 565	5
Hot water	127 187	26
Addition for airing	19 696	4
Electricity common spaces	39 415	8
Forecast control, saving	-27 021	-5
Total	**429 494**	**87**

Alternative 3, when alternative 1 and 2 were in effect.

	KWh/year	KWh/m2
Heating	245 652	50
Losses in heating system	24 565	5
Hot water	127 187	26
Addition for airing	19 696	4
Electricity common spaces	31 129	6
Forecast control, saving	-27 021	-5
Total	**429 494**	**85**

All of the alternatives are to be executed within the project.

The total consumption is calculated to be reduced by 40.34% or 284,801 KWh.
When calculating what these savings will render in money saved, actual costs from late 2009 were used.
Electricity – 1.15 SEK / KWh
District heating – 0.61 SEK / KWh
The total saving adds up to 178,203 SEK a year.

This renovation is expected to be finished in May 2011. Hopefully the post audit of the energy-consumption of these properties will correspond with this forecast.

All aspects of energy part 2 – group work

Per Eneborg, 2011-01-17

Questions

Introduction question 1

In the report “Sustainable renovation” three alternative measures are mentioned.

1. Window replacement, sealings and water-saving fixtures.
2. Adjusting heating and regulation valves, and installing forecast control mechanisms.
3. Presence detecting lighting fixtures.

The consumption of energy before any measures were taken was as below.

	KWh/year	KWh/m2
Heating	392,238	80
Losses in heating system	66,132	13
Hot water	158,984	32
Addition for airing	49,240	10
Electricity common spaces	39,415	8
Total	**706,009**	**143**

The cost of each investment is:

1. 1,800,000 SEK
2. 500,000 SEK
3. 150,000 SEK

Question 1:
Which alternative is the most profitable investment on its own?
Use the tables on page 7 and 8 to calculate the savings.
Use the pricing on energy used in the report, estimate the lifetime expectancy, inflation is 2% and the discount rate is 7%.

Introduction question 2

In an article in ERA, the largest electricity market newspaper in Sweden and Scandinavia, Harry Frank, professor of innovation-technology, was interviewed. In his research he concludes that Swedish electricity production, on average, generates 10 g of co2/KWh and district heating 94 g of co2/KWh.

Question 2
Using the figures above, what is the effect on the environment of each of the three energy-saving measures?

All aspects of energy part 2 – group work

Per Eneborg, 2011-01-17

Answers

Question 1

Estimation of lifetime expectancy:
Alternative 1: 35 years
Alternative 2: 20 years
Alternative 3: 20 years

NPV:
Alternative 1: 6,983 SEK
Alternative 2: 322,107 SEK
Alternative 3: - 32,603 SEK

Alternative 2 is, on it own, the best investment.

Question 2

In theory the measures reduce emissions of carbon dioxide by roughly 26 tons a year.

Alternative 1: 15,709,562 g
Alternative 2: 10,282,848 g
Alternative 3: 82,860 g

In total: 26,075,270 g (26 tons).