Energy Project Villa – Follow up Report

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Preface

The purpose of this report is to follow up on the results from the Energy project Villa after one year of monitoring in the house after the retrofitting was carried out.

Previously three reports were made regarding the project: Energy Project Villa - Main report, EP Villa - report of appendices, and DTU-Byg (R-102) with modelling of energy consumption.

Once again the project participants would like to thank Anne & Niels Rasmussen, as well as Thomas Olsen and Lotte Rasmussen for making it possible to use the house in Køge for this demonstration project.

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1. Introduction

The Energy Project Villa demonstrated a large energy saving by retrofitting an existing typical master builder villa from before 1950.

The cost-saving effect of the retrofitting measures carried out was documented by first monitoring energy consumption and indoor climate, then renovating the parts of the building found to be most cost-effective, and finally by monitoring again. The renovation work on the house was carried out in November 2004.

The project focus has been to show the effect of the “easy-to-carry-out” measures, which do not interfere with the aesthetic appearance of the house and for which solution and products already exists.

The purpose of this report is to follow up on the results stated in Energy Project Villa – Main report after a full year of monitoring in the house after the energy renovation.

Due to the limited timeframe given for the project it was not possible to measure a full year of energy consumption before renovation activities started. The conclusions in this follow up report is therefore made on basis of a measuring period of two autumn months before renovation, scaled up to the heating season for a full year, and a full year of monitoring in the house after renovation.

Details of constructions and suggestions for energy renovating activities are displayed at the Rockwool Scandinavia web-site www.rockwool.dk under “Energirigtig renovering”, as inspiration to people searching for solutions to specific needs of their house.

2. Summary

The EP Villa project documented that it is possible to obtain large energy savings, compared to the necessary investment in a typical existing single family house built before 1950.

An investment of DKK 157,000 was made in retrofitting measures in November 2004. This follow-up report made after one year of monitoring has showed that the renovation has been considerably more beneficial than expected, mainly due to the high increase in energy prices.

The monitored energy consumption in the before situation was 53,400 kWh (332 kWh/m2) per year at an indoor temperature of 20 ºC and standard weather conditions. On basis of one year of monitoring in the house, after the energy renovation in the villa, the gross energy consumption has been 22,600 kWh (140 kWh/m2/year) at the same standard conditions. Thus the resulting energy saving found in the Villa is 30,800 kWh equalling 3050 litre of oil per year. This is 550 litres more than found at the time of publishing EP Villa – Main report.

The monitoring of the indoor environment with the variation during the year has shown that parameters have changed individually so does not point to an overall conclusion. The temperature levels are generally 1-2 ºC higher after the renovation, and the relative humidity are at the same level for comparable months and lower relative humidity is found in the after situation the rest of the year. The air change rate is after renovation decreased to 0.45 times per hour. The ventilation in the house is controlled by the occupants by opening of windows, and after the renovation also by having the opportunity to use mechanical exhaust ventilators in kitchen and bathroom to increase the ventilation in the house. Compared to recommendations, the relative humidity levels found in the villa in both the before and after situation are high, which indicates that the controlled air change rate with the people living there currently is too low.

In the follow-up period from December 2004 to December 2005 the price of energy has increased by 18 % to DKK 7.6 per litre (equals an increase of 16 % in fixed prices). In the same period the financing cost has been unchanged. This means a larger total saving the first year by carrying out the energy renovation than with the assumptions made in EP Villa- Main report.

The increase in energy prices during the year and a larger energy saving found after monitoring a full year after renovation, means that the value of the total savings has increased from DKK 16,000 to DKK 22,250, resulting in an net saving the first year of DKK13,750. Of this saving the occupants in the specific villa have chosen to convert 280 litres of oil equalling DKK 2050 into increased comfort.

If the scenario for future energy price is chosen conservatively with an assumption of 1.5 % increase in fixed prices a year, the total savings in NPV (net present value) will be DKK 622,400 seen over a 30-year period, which is DKK 225,000 more than found at the time of EP Villa - Main Report.

3. Measured Energy Consumption & Indoor environment

The following status of the energy consumption and the indoor environment in the villa AFTER renovation is based on a full year measurement data from 3/12 2004 – 3/12 2005.

Where relevant, the 12 month data AFTER renovation is compared with corresponding data from BEFORE renovation (data available from 9/9 2004-7/11 2004) and with corresponding data AFTER renovation from the EP Villa - Main Report (data available from 3/12 2004 – 3/1 2005). When comparing indoor environmental parameters during the heating season, the summer months AFTER renovation from 3/5-3/10 are not included.

This follow up report contains following information on energy and indoor environment:

- Temperature levels (during the heating season)
- Energy consumption
- Energy savings
- Evaluation of method used for extrapolation of energy consumption
- Air change rates
- Humidity levels

Compared to EP Villa - Main Report the following presentations of data, results, or discussions are new:

- Annual electricity consumption in the house
- Annual oil consumption and boiler efficiency
- Monthly variation of annual net energy consumption AFTER renovation
- Energy consumption for room heating outside the heating season AFTER renovation
- Annual energy consumption for Domestic Hot Water
- Evaluation of extrapolation method by comparison with result as of January 2005
- Result of additional measurement of air change rate in April 2005
- Presentation of coherent data on temperatures and relative humidity levels during the heating season AFTER renovation (data for the complete heating season are only available AFTER renovation)
- Critical humidity levels – including discussions on levels of absolute humidity

3.1 Indoor temperature levels during the heating season

In Table 1 average temperature levels during the heating season BEFORE and AFTER renovation is given. Three different periods AFTER renovation are compared:

1. Measurement period from 3/12-3/1 2004/05 (as of status in the official final report)
2. Measurement period from 3/12-3/5 + 3/10-3/12 (full year without summer period)
3. Measurement period from 9/9-7/11 2005 (same as before renovation)

Average Room air Temperatures [°C]	Before 9/9-7/11 2004	After 3/12-3/1 2004/05	After 3/12-3/5 + 3/10-3/12	After 9/9-7/11 2005
Living room	20	21	20	22
Dining room	22	23	23	24
Bed room	18	18	18	20
Children room – M	19	20	21	22
Children room – T	18	20	20	21
Kitchen	21	24	23	24
Bathroom	18	21	20	21
Entrance hall	18	20	20	21
Toilet	17	20	19	21
Entire house	**19**	**21**	**21**	**22**

Table 3.1: Comparison of average temperature levels during the heating season BEFORE and AFTER renovation.

As it appears from the table above, the level of room air temperatures is clearly higher after renovation compared to before renovation – regardless of the considered period of measurements after renovation. The room temperatures are typically 1-2 °C higher after renovation. This also applies for the overall (weighed average) room temperature of the entire house. When comparing the same periods of the year (9/9-7/11) before and after renovation the increase in temperature levels is even higher, namely from 2-4 °C and the overall (weighed average) room temperature of the entire house has increased by 2-3 °C.

3.2 Energy consumption BEFORE and AFTER renovation

In Figure 3.1 the measured monthly energy consumption for room heating and domestic hot water (DHW) is shown. The figure shows that the energy consumption for room heating outside the heating season is relatively small (< 200 kWh/month).

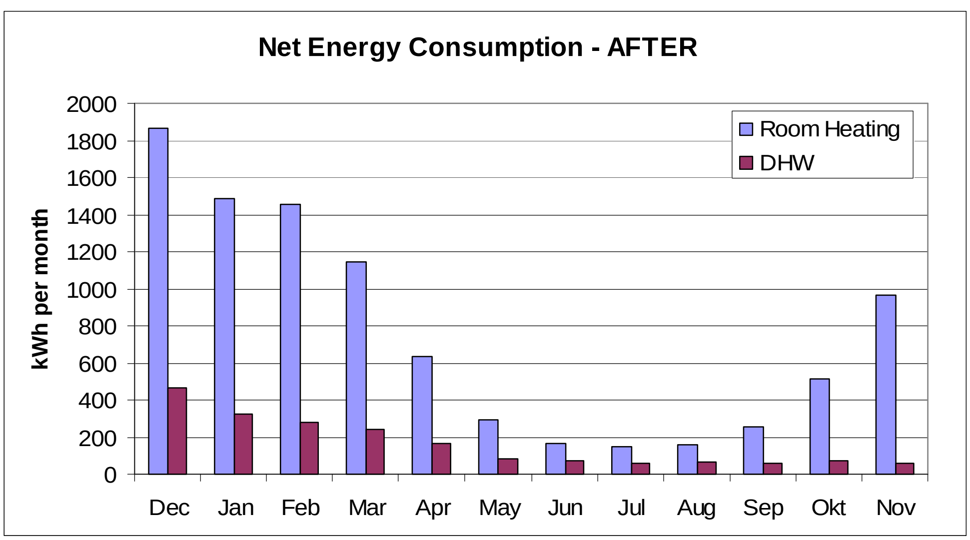

Figure 3.1: Measured Net Energy Consumption AFTER renovation.

As it appears from Figure 3.1, the energy consumption for room heating in May and September is only 200-300 kWh per month, i.e. close to the energy consumption for room heating outside the heating season. Thus, in the following, May and September will not be regarded as part of the heating season when calculating energy consumption and presenting and assessing indoor environment parameters during heating season.

3.2.1. Energy consumption for Domestic Hot Water (DHW)

The net energy consumption for Domestic Hot Water (i.e. energy going out from the boiler to the domestic hot water tank) from 3/12 2004 to 3/12 2005 has been: 1941 kWh ~1940 kWh

From December to March a missing non-return valve caused an increased flow in the Domestic Hot Water (DHW) loop, resulting in an increased heat loss from the DHW loop. The measured energy consumption for DHW from 3/12 2004 to 3/12 2005 thus includes an increased heat loss. As it appears from Figure 3.1, the energy consumption for DHW seems to be close to 70 kWh per month equalling less than 1000 kWh per year.

In the EP Villa –Main report the annual energy consumption for DHW was found to be 4350 kWh per year (based on an extrapolation of measurement data from BEFORE renovation). The high (extrapolated) energy consumption for DHW before renovation was caused by the system being buoyancy driven (and without any non-return valve), resulting in a constantly high heat loss from the DHW loop.

In the following, the measured energy consumption for DHW of 1940 kWh will be used AFTER renovation and the extrapolated 4350 kWh will be used BEFORE renovation.

3.2.2. Energy consumption for room heating and (DHW)

The net energy consumption for room heating in the Villa after energy renovation in the period of 3/12 2004 to 3/12 2005 is measured to:

Total heat production from boiler:	11032 kWh
- Part used for domestic hot water (DHW):	- 1941 kWh
Total energy consumption for room heating:	9091 kWh

Average indoor temperature in the period from 3/12-3/5 and 3/10-3/12 (i.e. indoor temperature during heating season) is: 20.5 °C resulting in a correction factor of: 0.95 (No temperature correction is made for the summer months). (For further detail on correction factors see Appendix B in EP villa - Appendix report)

Number of solar corrected degree-days in Køge (or nearest weather station) in the period from 3/12 – 3/12 2004/05 is 2364, corresponding to a degree-day index of: 2364/2622 = 90 compared to the reference year (DRY).

The gross energy consumption after renovation corrected to the standard reference year (DRY) weather conditions and corrected to a standardised indoor temperature of 20°C is:

$\mathbf{Q}_{\mathbf{yearly,\ after}}$ = (2622/2364·9091 kWh·0.95+1940 kWh)/0.738+7000 kWh ≈ **22,600 kWh/year**

This corresponds to 22600 kWh per year/10.08 kWh/l = 2242 l/year ≈ 2240 l/year

3.2.3. Oil consumption/Boiler efficiency

Precise information on the oil consumption in the Villa was not available for the EP Villa – Main Report. After a year of monitoring these data are available and therefore reported in the following.

From 15/12 2004 to 5/12 2005 the measured oil consumption has been: 2520 l
In the same period the boiler has delivered heat energy for domestic hot water and room heating equalling a total of: 10163 kWh/10.08 kWh/l = 1008 l

The boiler efficiency has thus been: 1008/2520·100% = 40 %

The difference between the corrected 2240 and the measured 2520 litres of oil can be explained by differences in indoor temperature and differences in used and realised boiler efficiency.

The actual temperature level in the house during the heating season has been 20.5 °C, whereas a correction of the oil consumption to an indoor temperature of 20 °C has been used in relation to the 2240 litres. There are fewer degree days at the actual location than in the standard reference year. On the other hand differences in outdoor weather conditions (at the location in Køge/Herfølge and in the standard reference year, DRY) and length of the period in question points in the other direction: The actual oil consumption of 2520 litres is measured for a shorter period than a full year (355 days) and there are fewer degree days at the actual location than in the standard reference year.

3.2.4. Electricity consumption

Precise information on the electricity consumption in the Villa was not available for the EP Villa – Main Report. After a year of monitoring these data are available and therefore reported in the following.

The electricity consumption has been constant around 3600-3800 kWh/year throughout the measurement period (see Table 3.1).

Period	Total [kWh]	Average [W]	Average [W/m²]
Oct 04-Oct 05	3850	440	2.7
Dec04-Dec05	3620	410	2.6

Table 3.1: Measured electricity consumption.

According to the occupants, they don't switch on the exhaust ventilators installed in kitchen and bathroom at the renovation. Only the exhaust ventilator in the bathroom which is humidity controlled has been in operation (however, probably less than 0.5 h/day corresponding to less than 18W · 0.5h/day · 365 days = 3.3 kWh/year). Electricity consumption for the installed measurement equipment has been constant throughout the measurement period.

3.3 Energy saving - Comparison with energy consumption BEFORE

Based on a full years measurement data the gross energy consumption **AFTER** renovation corrected to standard weather conditions (DRY) and corrected to a standardised indoor temperature of 20°C is:

$Q_{yearly,\,after}$ = (2622/2364·9091 kWh·0.95+1940 kWh)/0.738+7000 kWh ≈ **22,600 kWh/year**

For comparison, the extrapolated result from **BEFORE** energy renovation based on the available measurement data from 9/9 -7/11 2004 was:

$Q_{yearly,\,before}$ = (2622/228·2450 kWh·1.06 + 4350 kWh)/0.738+7000 kWh ≈ **53,400 kWh/year**

Conversion to litres of oil gives:
Corrected Energy consumption BEFORE renovation is 53,400 kWh/10.08 kWh/l = 5290 l
Corrected Energy consumption AFTER renovation is 22,600 kWh/10.08 kWh/l = 2240 l

The corrected energy savings in litres of oil has, thus, been: **3050 l**

3.3.1. Energy saving converted to improved comfort

In both EP Villa- Main report and this follow up report, conclusions are made based on comparison of energy consumption corrected to the same indoor temperature conditions, as they are the only comparable parameters.

It has been seen though, that after the energy renovation the occupants started having higher temperatures in the Villa, thus converting part of the potential saving into increased comfort/higher temperature. It has therefore been calculated how much of the savings that has been converted into comfort.

Without correction to a room temperature of 20°C, the energy consumption is:

Uncorrected energy consumption BEFORE renovation is 51,100 kWh/10.08 kWh/l = 5070 l
Uncorrected energy consumption AFTER renovation is 23,300 kWh/10.08 kWh/l = 2300 l

The resulting energy savings in litres of oil without correction to 20 °C is: 2770 l

Thus, the part of the energy savings chosen by the occupants to be converted into higher temperature levels, i.e. increased comfort, is 280 litres of oil.

3.4 Evaluation of extrapolation method – comparison with results as of January 2005

Based on a full year's data the gross energy consumption after renovation corrected to the standard reference year (DRY) weather conditions and corrected to a standardised indoor temperature of 20°C is:

$Q_{yearly,\,after}$ = (2622/2364·9091 kWh·0.95+1940 kWh)/0.738+7000 kWh ≈ **22,600 kWh/year**

Without temperature correction, the result is:
$\mathbf{Q}_{\mathbf{yearly,\ after}}$ = (2622/2364·9091 kWh + 1940 kWh)/0.738 + 7000 kWh ≈ **23,300 kWh/year**

In the original report the extrapolated and corrected energy consumption based on one month of measurement data from 3/12 2004-3/1 2005 was:

$\mathbf{Q}_{\mathbf{yearly,\ after\ jan}}$ = (2622/409·1862 kWh·0.94+4350 kWh)/0.738+7000 kWh ≈ **28,100 kWh/year**

Without temperature correction, the result was:
$\mathbf{Q}_{\mathbf{yearly,\ after\ jan}}$ = (2622/409·1862 kWh + 4350 kWh)/0.738 + 7000 kWh ≈ **29,100 kWh/year**

When comparing energy consumption for room heating only, the difference without temperature correction is:

(2622/2364·9091 kWh) – (2622/409·1862 kWh) = 10083 – 11937 kWh =1854 kWh per year

This corresponds to a change in annual energy consumption of 16% compared to the result based on one month of data from 3/12 2004-3/1 2005. On the basis of only one month of measurements it has, thus, been possible to extrapolate to a full year's net energy consumption for room heating with a reasonable accuracy.

When comparing the corrected gross energy consumption, the difference is:

28,100 - 22,600 kWh/year = 5490 kWh/year

This corresponds to a change in annual energy consumption of 24% compared to the result as of January 2005. The difference in extrapolated energy consumption for DHW is responsible for (4350-1940 kWh)/0.738 = 3266 kWh/year out of the 5490 kWh/year. The difference in corrected gross energy consumption for room heating is responsible for 5490-3266 kWh/year = 2224 kWh/year.

When comparing the extrapolated and corrected energy consumption in litres of oil with the realised energy consumption in litres of oil, the result is:

(28,100 kWh per year/10.08 kWh/l) – 2520 l/year = 268 l/year

This corresponds to a difference of only 10%.

3.5 Air change rates

For assessment of the infiltration rates through cracks and holes in the building envelope, blower door tests @ 50 Pa has been carried out before and after renovation. For assessment of the typical ventilation rates at the users/occupants normal use of the Villa 8-11 days of tracer gas (PFT) measurements have been carried out before and after the renovation.

3.5.1. Tracer gas measurements carried out

The aim of these tracer gas measurements has primarily been to assess the indoor air quality (i.e. air change rate) in living rooms and bedrooms during the heating season.

The tracer gas measurements have been carried out three times: 11 days from October 21 in 2004 (Before), 9 days from December 8th in 2004 (After I) and 8 days from April 21st in 2005 (After II). In the EP Villa – Main Report only data for (Before) and (After I) were available.

The external weather conditions during the three measurement periods are shown in Table 3.2:

	Period	wind speed [m/s]	External temperature [°C]
Zone 1+2 before	October 21- November 1, 2004	4.8	9.9
Zone 1+2 after	December 8-17, 2004 (After I)	3.4	4.1
Zone 1+2+3 after	April 21-29, 2005 (After II)	4.2	8.2
Heating season	October 1 – May 1	5.1	4.1

Table 3.2: Weather conditions in measurement periods and heating season in general

Table 3.2 show that the average wind speed in all three measurement periods has been close to but less than the average wind speed of the heating season. In all three measurement periods, the external temperature has been either equal to or higher than the average external temperature during the heating season. All together this means that the driving forces for the natural ventilation in the house in the measurement periods have been close to but a little less than the average of the heating season. This indicates that the average air change rate in the house during the heating season is equal to or higher than the measured air change rates.

In the first two periods a measurement set-up with two zones was used. In the third measurement a setup with three zones was used. The different set-up in the third measurement was used in order to be able to assess the overall air change rate in the house with higher precision than in the first two measurements. However, the more zones (i.e. number of different tracer gases) that are used the higher the uncertainty on the results becomes.

3.5.2. Measured air change rates

The overall results from the air change rate measurements are shown in Table 3.3:

Air change rates	**Before**	**After I**	**After II**
Blower Door @ 50 Pa	**19 h-1**	**9 h-1**	
Zone 1 **Living rooms**	0.32 h-1	0.21 h-1	0.09 h-1
Zone 2 **Bedrooms**	0.62 h-1	0.44 h-1	0.69 h-1
Zone 3 Entrance/hall			0.74 h-1
Zone 1 + 2	**0.41 h-1**	**0.28 h-1**	**0.27 h-1**
Zone 1 + 2 + 3			**0.40 h-1**

Table 3.3: Measured Air Change Rates Before and After renovation.

The uncontrolled infiltration rates are reduced with 50 % (according to the blower door test).

The total air change rate in the house is comprised by:

- Uncontrolled infiltration through cracks in the building envelope
- Infiltration through opening of entrance doors
- Intentional airing/ventilation through opening of windows or use of ventilators

Thus, the total air change rate in the house has not been reduced by 50%. As can be seen from the results in the table above:

- There are large deviations in the air change rates from zone to zone
- Air change rate in bedrooms first decreased then increased
- Overall ventilation rate in zone 1+2 has decreased after renovation

The measurement results show that the total air change rate in the house AFTER renovation is above 0.40 h^{-1} (probably around 0.45 h^{-1}), whereas BEFORE the renovation it has most likely been around 0.55 h^{-1}, i.e. a reduction of around 15-20%.

3.6 Humidity levels AFTER renovation and comparison with BEFORE

In order to asses the humidity conditions in the house during the heating season (i.e. the critical season of the year with regards to risk of mould growth) relative humidity levels have been measured in various rooms in the villa before and after renovation.

Due to variations in the outdoor climate, indoor humidity levels are best compared for equal periods of the year. Before renovation measurement data are only available from 9/9-7/11 2005. Comparison of humidity levels before and after renovation is thus carried out for this period of the year only.

Two sets of graphs are presented with different purposes:

1. Presentation of temperature and relative humidity variation during the year and average levels during the heating season AFTER renovation (i.e. 3/12-3/5+3/10-3/12 2005)
2. Comparison of temperatures and relative humidity levels from 9/9-7/11 2004 (BEFORE) and from 9/9-7/11 2005 (AFTER). Due to the variation during the year these are the only data relevant for comparison of levels of humidity BEFORE and AFTER renovation.
3.

Besides this an evaluation of the overall level of relative humidity in the house in the heating season of the year (before=after) is relevant, in order to asses if the values are critical from an indoor environmental point of view. This is done in section 3.7.

3.6.1. Humidity levels during the heating season AFTER renovation

Figure 3.2-Figure 3.4 show the temperature and indoor relative humidity variation in the before and after situation for the three rooms: Dining room, bedroom and bathroom. The aver-

age temperature and relative humidity level during the heating season after renovation (3/12-3/5+3/10-3/12 2004/2005) are showed with a red line on the same figures for the three rooms.

From the annual variation in humidity levels, the highest levels are clearly found to be at summer time and the lowest levels during the coldest winter time.

The dining room is generally the room with the highest temperature. It is also the driest room. The bedroom is the room, where they generally keep the lowest temperature. The bedroom and the bathroom are the rooms with the highest relative humidity levels. As it appears, the temperature levels during the heating season differ 0.4-1.6 °C for the three rooms. The room temperatures are 17.6-22.3 °C from 9/9-7/11 2004 whereas they are 18.1-22.7 °C from 3/12-3/5+3/10-3/12 2005.

The average indoor relative humidity during the heating season (i.e. from 3/12-3/5+3/10-3/12 2005) has been 34% for the dining room, 52% for the bedroom, and 55% for the bathroom.

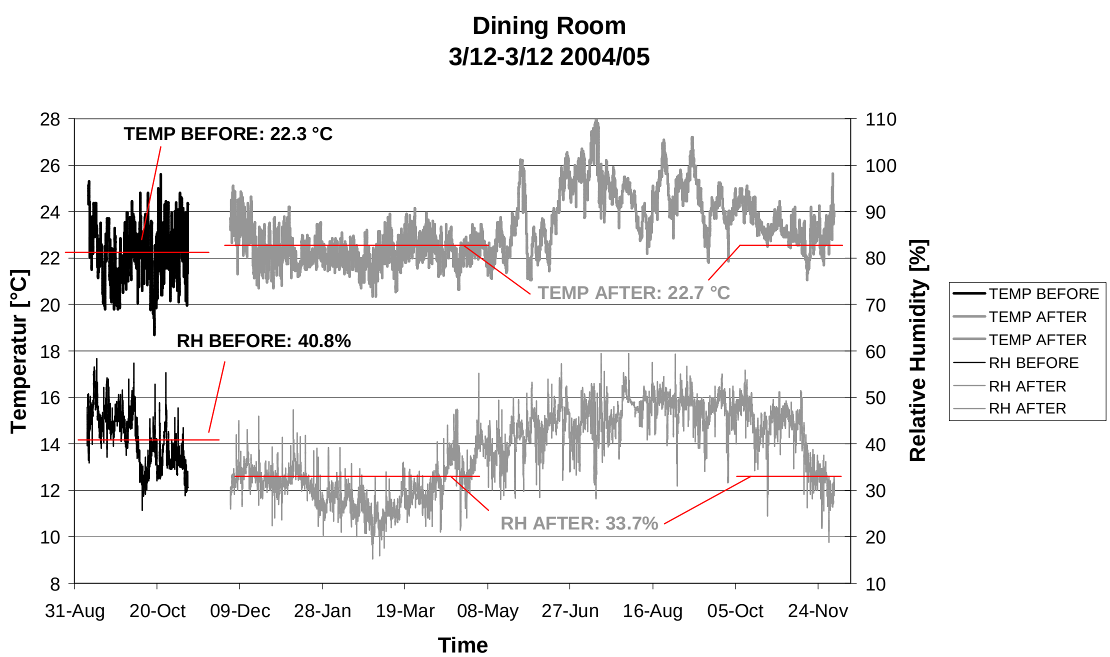

Figure 3.2: Dining room - Indoor temperature and relative humidity heating season 2004/2005.

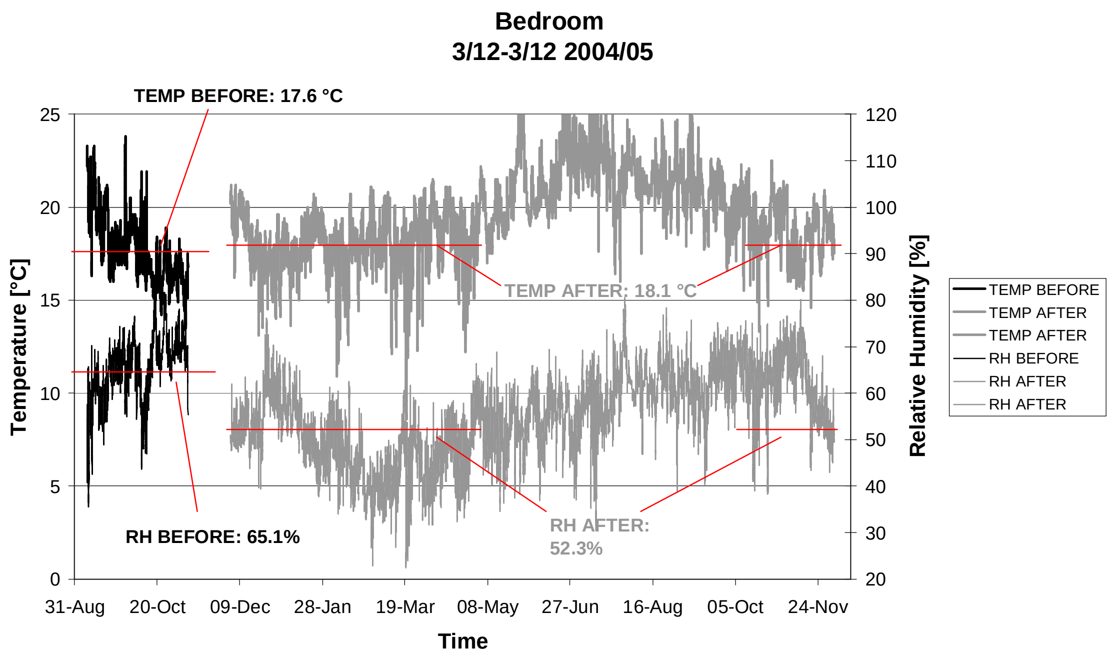

Figure 3.3: Bedroom - Indoor temperature and relative humidity heating season 2004/2005.

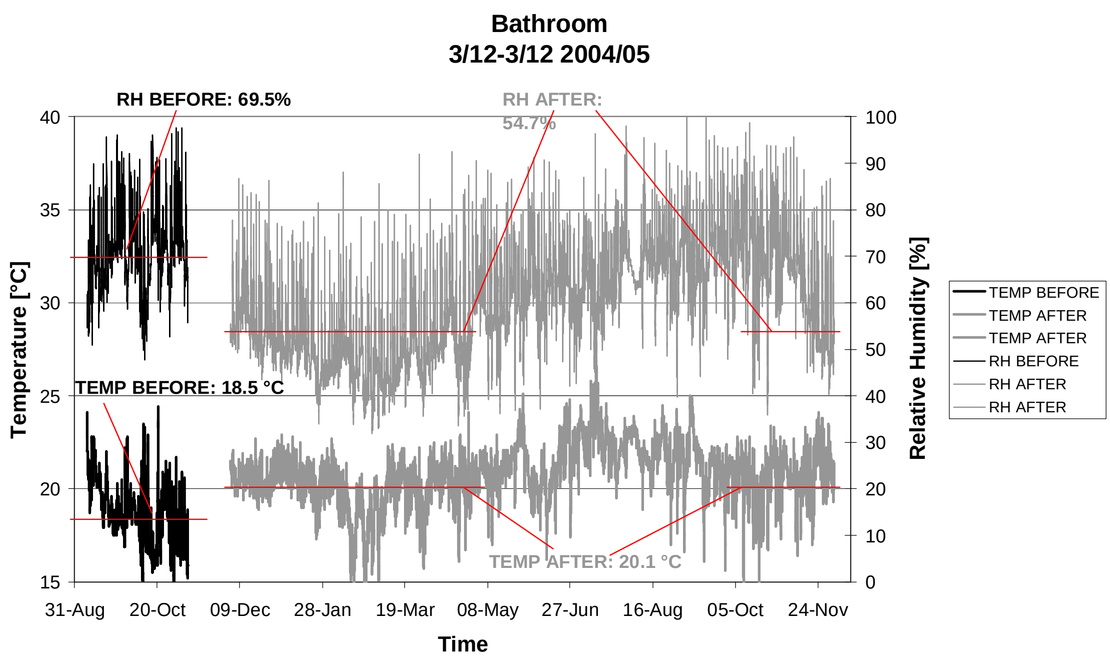

Figure 3.4: Bathroom - Indoor temperature and relative humidity heating season 2004/2005.

3.6.2. Comparison of humidity levels BEFORE and AFTER (autumn)

In Figure 3.5-Figure 3.7 temperature levels and levels of relative humidity are compared before and after renovation for the same period of the year (9/9-7/11 2004/2005) for the same three rooms as in paragraph 3.6.1.

The temperature levels are 0.8-1.5 °C higher after renovation (i.e. in September/October 2005 compared to September/October 2004). The relative humidity levels, however, are generally unchanged with the renovation. This implies that the air change rates have been reduced after renovation. Slightly higher outdoor humidity levels in 2005 compared to the same period 2004 can also explain part of the increase in indoor humidity level in 2005. See Appendix A. The average outdoor humidity before (6/9-7/11 2004) was 7.1 g/kg, whereas the average outdoor humidity after (5/9-6/11 2005) was 8.0 g/kg. For comparison, the average outdoor humidity during the heating season after renovation (3/12-3/5 + 3/10-3/12) was 5.2 g/kg.

In the bathroom a small humidity controlled extractor fan/ventilator has been installed during renovation. This was disconnected in September 2005 by the occupants to avoid the noise it creates and was therefore only running for shorter periods in September-November 2005 (< 10 days).

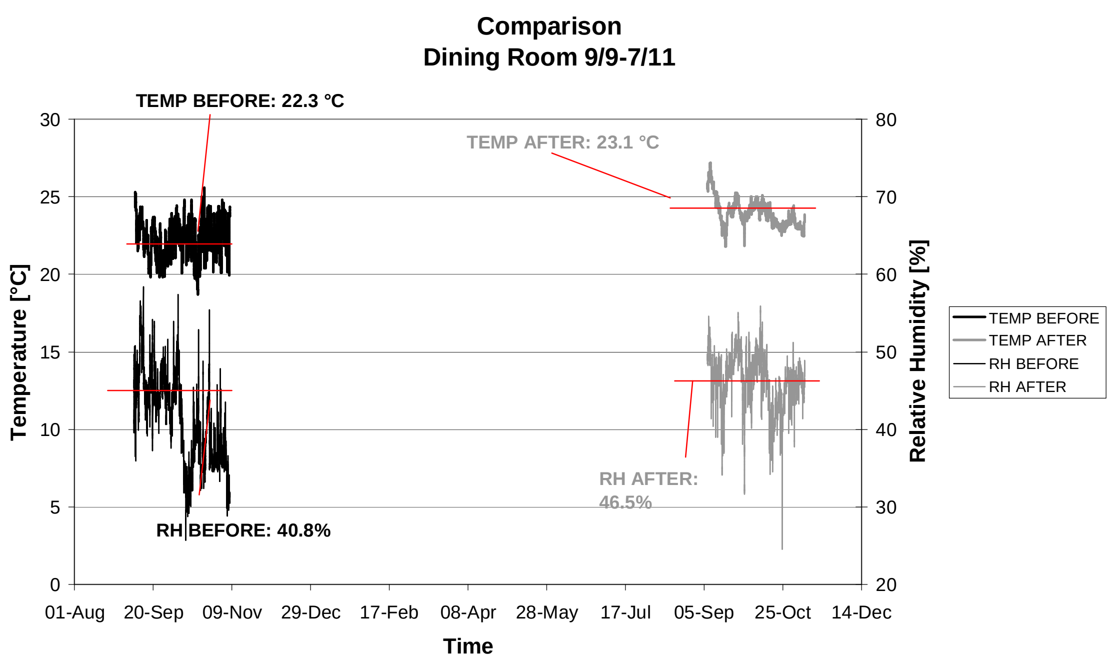

Figure 3.5: Dining room - Indoor temperature and relative humidity September/October 2004 and 2005.

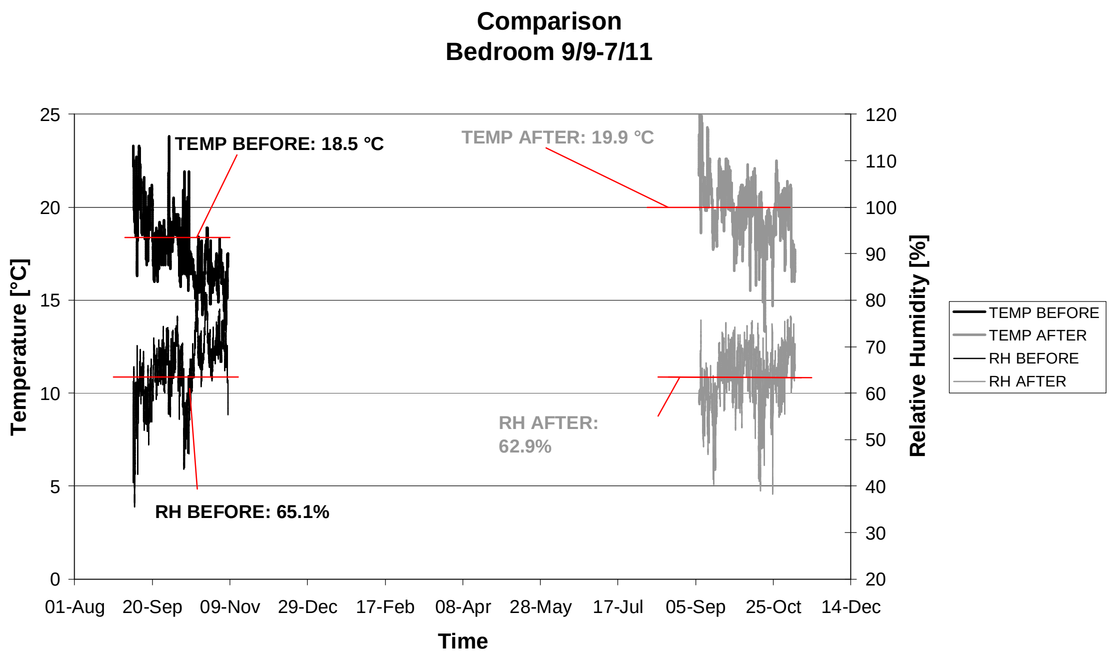

Figure 3.6: Bedroom - Indoor temperature and relative humidity September/October 2004/2005.

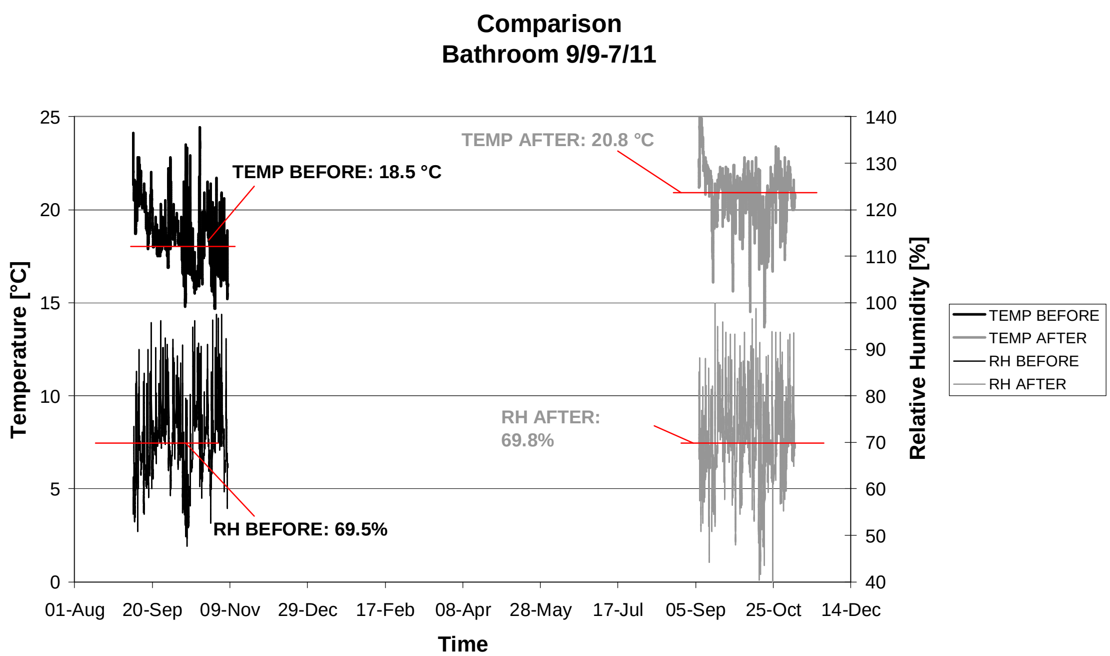

Figure 3.7: Bathroom - Indoor temperature and relative humidity September/October 2004/2005.

When comparing equal periods of the year (9/9-7/11), indoor room air temperatures have generally increased by 0.8-1.5 °C, whereas the relative humidity levels are generally unchanged, varying from 40-45% in the driest room (dining room) to 70% in the most humid room (bathroom). In the bedrooms the relative humidity level is unchanged around 60-62%.

Absolute humidity levels
When comparing the two autumn months the relative humidity levels are generally at the same level after as before renovation. Taking into account the increased temperature levels, this means that the absolute humidity level has increased after renovation. Part of this increase in absolute humidity can be explained by the increase in average outdoor humidity levels when comparing September-November 2004 with same period of the year in 2005. (See appendix A). However, taking into account the measured decrease in air change rates, the coherent measurements of indoor temperatures and humidity levels clearly indicate that there is an increased risk of mould growth at thermal bridges.

3.7 Discussion of humidity level

The relative humidity level in the villa is generally at the same level after as before renovation. For the autumn months 2004 and 2005 this level was 40-70 % RH depending on the room. During the heating season after renovation (i.e. from 3/12-3/5+3/10-3/12 2005) the average indoor relative humidity levels in the same rooms has been 34-55% depending on the room. In general, it is recommended to avoid longer periods with humidity levels of more than 40-45% during the heating season due to risk of mould growth and house dust mites (especially in the bedrooms). For the summer months it is recommended to keep the indoor humidity levels below 50-60%.

In order to assess what humidity levels in general are like in older Danish houses, existing literature and documented scientific measurement results in Denmark have been reviewed. There has not been found any surveys with coherent data of air change rates, indoor temperatures and relative humidity levels in older Danish houses to asses whether the data measured in the villa in Køge are the normal values found.

However, SBi have carried out two surveys for other types of dwellings:

1. A survey of newer, naturally ventilated single-family houses built after 1982. The average size of the houses is 115.6 m². The measurements were carried out during the heating season January-March 1992 and in October + November 1992, i.e. a combination of heating season and autumn months. The average air change rate was measured to 0.35 h^{-1}, with variations from 0.17-0.68 h^{-1}. The average indoor humidity was 45% in the living rooms (varying from 28-67%) and 53% in the bedrooms (varying from 37-69%). The survey revealed, that in houses with open vents for fresh air supply, the relative humidity was significantly lower than in houses without vents or with closed vents. This survey, thus, implies that in newer or airtight houses without vents it is normal to have relative humidity levels above the critical level of 40-45% - especially in the bedrooms.
2. A survey of flats in multi-family houses from before 1899 to 2000. The average size of the flats in the survey is 42.6 m², which is quite different from that of the villa in Køge (161 m²). The measurements were carried out from 1st of January 1999 to 8th of April 1999, i.e. a combination of winter and spring months. The method used for measuring air change rates does not take into account supply of "used" or re-circulated air from other flats. This means that the measured air change rates are not outdoor air, but total air – also re-circulated air from other flats. Other surveys have shown that the rate of re-circulated air from other flats can be quite high in multi-family houses,

> which makes it difficult to use the measured air change rates. The average total air change rate measured in the survey was 0.71 h^{-1}. However, in 25% of the flats the total air change rate was below 0.5 h^{-1}. In 13% of the flats significant growth of mould was found – primarily in kitchens and bathrooms. The measured average temperature in the flats was 18.8 °C and the measured average humidity level was 41.4 % with variations from 24-62%. Also in this survey many vents were closed or blocked.

Besides the two surveys carried out by SBi, a comparison can be made with measurement results from a typical single-family house from the 1970's (Retrofit project -Næstved). The results from Næstved show an almost equal level of indoor humidity in all rooms of around 50-53% at a room temperature of around 22.1 to 22.9°C in the autumn months (19/9 2005 – 30/10 2005). In comparison the months from 22/11 2005 to 18/12 2005 (in heating season) show measured average humidity levels varying from 37-40% and the room temperatures from 18.9-21.6 °C. The even temperatures around the house indicates that the occupants here have a different behaviour than what is seen in the Villa, and the average humidity level is during the heating season seen to be below the critical level of 40-45% with the current data.

3.8 Evaluation of indoor environment

The total air change rates in the house, constituting the fresh air ventilation in the house, has been reduced with around 15-20% from around 0.55 air changes per hour to around 0.45 air changes per hour. The ventilation in the house is controlled by the occupants by opening of windows, and after the renovation also by having the opportunity to use mechanical exhaust ventilators in kitchen and bathroom to increase the ventilation in the house. The required minimum air change rates in new houses built according to existing building regulations in DK is 0.5 air changes per hour. There has thus been an increased risk of insufficient ventilation. Insufficient ventilation might result in an increased risk of sensation of "heavy" indoor air and an increased risk of condensation and, thus, mould growth at thermal bridges.

The uncontrolled infiltration rates have been reduced with 50 % after renovation (according to the blower door test). Thus, the risk of discomfort due to cold draught through holes and cracks has been significantly reduced.
The average indoor relative humidity levels in the three rooms during the heating season (i.e. from 3/12-3/5+3/10-3/12 2005) has been 34% for the dining room, 52% for the bedroom, and 55% for the bathroom. In general, it is recommended to avoid longer periods with humidity levels of more than 40-45% due to risk of mould growth and house dust mites (especially in the bedrooms).

The relative humidity levels in the Villa are generally at the same levels after as before renovation. However, since higher temperatures have been registered after renovation, this implies that the air change rates have been reduced and the absolute humidity levels increased after renovation. Slightly higher outdoor humidity levels in 2005 compared to the same period 2004 can also explain part of the increase in indoor humidity level in 2005. See Appendix A. The average outdoor humidity before (6/9-7/11 2004) was 7.1 g/kg, whereas the average outdoor humidity after (5/9-6/11 2005) was 8.0 g/kg. For comparison, the average outdoor humidity during the heating season after renovation (3/12-3/5 + 3/10-3/12) was 5.2 g/kg.

In order to avoid an increased risk of mould growth at the thermal bridges it is recommended that the air change rate is increased through controlled ventilation. In this connection it is interesting to notice that after renovation the occupants in Køge were given the opportunity to use mechanical exhaust ventilators in kitchen and bathroom to help increasing the air change rate. The occupants, however, chose not to use the exhaust ventilators. In the bathroom the humidity controlled exhaust ventilator was deliberately disconnected in order to avoid discomfort caused by noise from the ventilator. The occupants have so to say chosen immediate comfort in preference to securing long term health.

A learning point from this project has thus been that there is a need for development or implementation of easy-to-use energy efficient local ventilation devices that doesn't cause problems of discomfort, for renovation of older single-family houses that are not suitable for a complete mechanical ventilation system.

4. Economy

The calculation of the economic result of the energy renovation of the villa, is based on the actual building cost as well as energy prices and financing expenses.

All of the retrofitting measures carried out on the Villa have an expected life of more than 30 years.

The work has been carried out by professional contractors, based on tenders submitted. Quotations were received from two contractors for each of the different measures, and the cheapest offer chosen.

The retrofitting work was carried out in November 2004, and the total cost was DKK 157,000 incl. VAT. Distribution of these costs can be found in accounting report in EP Villa - Main Report.

4.1 Energy prices

In the EP Villa - Main Report three scenarios are shown for the future increase of energy prices which can be used to extrapolate the development which can be representative for the Danish consumer, as well as current oil price.

	Yearly increase in fixed prices	Source	Scenario based on
Scenario 1	1.5 %	ECOFYS 3	Standard scenario for evaluation of energy savings in EU
Scenario 2	1.8 %	EIA 2004	USA- energy agency scenario of oil consumption increase until 2025
Scenario 3	2.34 %	DTU (Eurosun 2000 conference)	DTU sustainability scenario (doubled price over 30 years)

Table 4.1: Scenarios for development in energy prices

For the conclusion in EP Villa main report was used the conservative assumption Scenario 1, an increase of 1.5 % in fixed prices. The current day price then was DKK 6.4 per litre.

The current day price of oil is DKK 7.6 per litre.
The average price of oil in the monitoring period (December 2004 - December 2005) has been DKK 7.3 per litre. (See appendix P).

When looking at the actual development through 2005, we find that the price increase during the year has been more than 18 % from January to December. This equals an annual increase of 16 % in fixed prices.

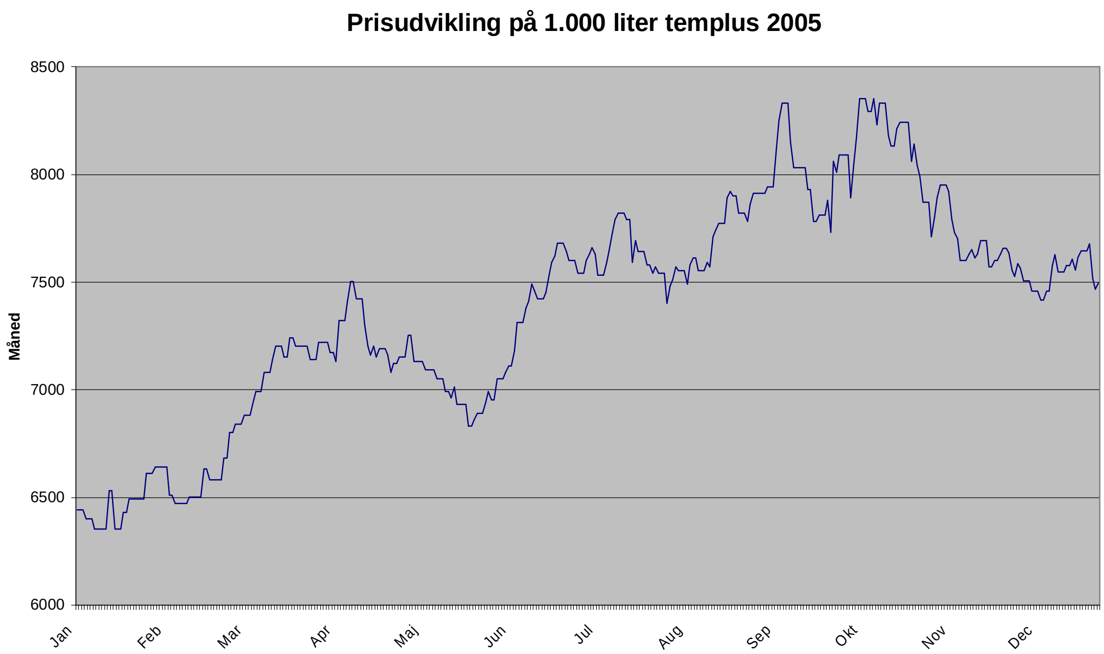

Table 4.2: Development in oil fuel prices 2005 (Source: Statoil)

Regarding predictions for the future prices of oil, there has for years been seen a steady increase and during the last two years it has been quite high. Since EP Villa- Main report was made in 2005 though, there has not been found any significant new inputs regarding the scenarios for price development the next 30 years. The Danish energy agency is expected to update their forecast during 2006 based on the recent changes from International Energy Agency (IEA).

4.2 Financing

The change in financial parameters during the year 2005 has been negligible, so if the loan was obtained as of December 2005 the monthly payment after tax would still be DKK 708 the first year. See appendix R for specification from Nykredit of "4 % obligationslån" obtained in January and December 2005.

Thus, in this follow-up report the same loan for financing is used as in EP Villa Main report, which is a "4 % obligationslån" obtained in January 2005, with a net value of DKK 157,000 and based on a 30 year period.

The yearly payment for this loan after tax deduction is DKK 8500. The NPV of the financing costs (30 years) are DKK 188,400. (See EP Villa - Main Report for details)

4.3 Money savings from day 1 as result of the energy renovation

The energy savings obtained by the energy renovation of the Villa found after one year of measuring in the after situation are 3050 litres of oil per year.
With an average oil price of DKK 7.3 per litre and financing with a "4 % obligationslån", the resulting NPV of the saving is shown below as functions of four scenarios for energy price development. For details from extrapolations in Net Present Value (NPV) see appendix S.

	Scenario 1	Scenario 2	Scenario 3	Sc. 4.2: No increase (dayprice 7,6 DKK/l)
Energy savings year 1	22,250	22,250	22,250	22,250
NPV Energy saving (30 years)	810,800	848,300	921,300	678,400
Yearly financing cost (30 years)	8,500	8,500	8,500	8,500
NPV Financing cost (30 years)	188,400	188,400	188,400	188,400
Resulting savings NPV	622,400	659,900	732,900	490,000

Table 4.3: Extrapolation of savings in DKK

With the energy savings the first year equalling DKK 22,250 and the financing cost for the building work of DKK 8,500, the resulting extra money available for the house owners to use for other purposes the first year is DKK 13,750.

If the energy prices scenario is still chosen in a "conservative" way, as an increase by 1.5 % (in fixed prices) in the financing period of 30 years, the total savings in NPV will be DKK 622,400 (810,800 minus 188,400).

For comparison the results found in EP Villa – Main report were: Resulting extra money for house owners the first year DKK 7,500 and NPV (scenario 1) DKK 396,000.

5. Conclusion

The EP Villa project has documented that it is possible to obtain large energy savings, compared to the necessary investment in a typical existing single family house built before 1950.

On basis of one year of monitoring in the house, after the energy renovation in the specific master builder villa from 1927, the gross energy consumption has been 22,600 kWh (140 kWh/m2/year) at an indoor temperature of 20 ºC and standard weather conditions.

The monitoring of the indoor environment has shown that parameters have changed individually, and therefore does not point to an overall conclusion. The temperature levels are generally 1-2 ºC higher after the renovation, and the relative humidity are at the same level for comparable months and lower relative humidity is found in the after situation the rest of the year. This means that the comfort for the occupants has improved. The air change rate is after renovation decreased to 0.45 times per hour. The ventilation in the house is controlled by the occupants by opening of windows, and after the renovation also by having the opportunity to use mechanical exhaust ventilators in kitchen and bathroom to increase the ventilation in the house. It should be noted though, that the relative humidity levels in both the before and after situation are high, which indicates that even though the air change rate is comparable with that of an average Danish house, the controlled air change rate with the people living there currently is too low.

The monitored energy consumption in the before situation was 53,400 kWh (332 kWh/m2) per year at an indoor temperature of 20 ºC and standard weather conditions. (It should be noted that the before situation is based on extrapolation from 2 months of monitoring).

Thus the resulting energy saving found in the Villa is 30,800 kWh equalling 3050 litre of oil per year.

In the follow-up period from December 2004 to December 2005 the price of energy has increased more that the conservative assumption made in the beginning of the year. The day price of fuel oil has increased by 18 % to DKK 7.6 per litre (equals an increase of 16 % in fixed prices). In the same period the financing cost has been unchanged. This means a larger total saving the first year by carrying out the energy renovation than with the assumptions made in EP Villa - Main Report.

The energy savings found by monitoring one year after carrying out the energy renovation, has a value of DKK 22,250 (€ 2980), resulting in an economic benefit after financing for the house owners of DKK13,750 (€ 1840) the first year.
This is an increase of DKK 6,250 per year (€ 840), compared to the result of EP Villa - Main Report, mainly due to the increase in energy prices during the year and a larger energy saving found after monitoring a full year. The occupants have chosen to convert DKK 2050 (€ 280) of these savings into increased comfort.

If the scenario for future energy price is chosen conservatively with an assumption of 1.5 % increase in fixed prices a year, the total savings in NPV will be DKK 622,400 (€ 83,300) seen over a 30-year period.

This follow up report shows that the money savings derived from the energy renovation was even higher after one year than expected when EP Villa – Main Report was made. Thus leading to the conclusion that the earlier people get an energy renovation done, the larger saving they obtain due to the current development in energy prices.

6. Dansk Resume

EP Villa projektet dokumenterede, at der kan opnås en væsentligt større besparelse på energiforbrug end de nødvendige investeringer i forbedringer, for en typisk villa bygget før 1950.

I november 2004 blev der investeret 157.000 kr i energi-renoveringstiltag. Opfølgningen beskrevet i denne rapport på baggrund af et års målinger i villaen viser, at renoveringen har været endnu mere lønsom end forventet – hovedsageligt på grund af den store stigning på energipriser.

I "før" situationen (inden energirenoveringen) blev der målt et energiforbrug på 53.400 kWh (332 kWh/m^2) pr. år ved en indendørs temperatur på 20 ºC og standard vejrforhold. Et års målinger i huset "efter" energirenoveringen har vist et brutto energiforbrug på 22.600 kWh (140 kWh/m^2) pr. år ved samme standard betingelser. Der er således opnået en energibesparelse i huset på 30.800 kWh svarende til 3050 l olie pr. år. Det svarer til 550 l olie mindre end hvad der var fundet da EP Villa hovedrapporten blev udgivet.

Målingerne af indeklimaet i huset med årets variationer har vist, at parametrene har ændret sig individuelt og der kan derfor ikke drages en samlet konklusion. Rumtemperaturen er generelt 1-2 ºC højere efter renoveringen og den relative fugtighed er uændret for sammenlignelige måneder, og har en gennemsnitlig lavere relativ fugtighed for resten af året efter renoveringen. Luftskiftet er reduceret til 0,45 gange i timen. Udluftningen i villaen sker ved at husets beboere åbner vinduerne og desuden er der ved renoveringen etableret mekanisk udsugning i køkken og badeværelse for at øge muligheden for udluftning i huset. I forhold til anbefalinger på området, er den relative fugtighed der er målt i huset høj både før og efter renoveringen, hvilket indikerer at den kontrollerede luftskifte med de nuværende beboere generelt er for lavt.

I løbet af opfølgningsperioden fra dec. 2004 til dec. 2005 er energipriserne steget med 18 % til 7,6 kr. pr. liter olie (svarende til en 16 % i faste priser). Finansieringsomkostningerne har i samme periode været uændrede. Derved bliver den samlede besparelse ved energirenoveringen det første år større end med de antagelser der blev lavet i EP Villa hovedrapporten.

De stigende energipriser i årets løb sammen med en større energibesparelse fundet efter et års målinger efter renoveringen betyder, at den samlede energibesparelse er steget fra 16.000 kr til 22.250 kr, hvilket giver en nettobesparelse det første år på 13.750 kr. Husets beboere har valgt at omsætte en del af denne besparelse til øget komfort, i alt 280 l olie, svarende til 2050 kr.

Vælges scenariet for udvikling af energipriser i fremtiden konservativt, med en forventet stigning på 1,5 % i faste priser om året, vil den samlede besparelse for en 30-årig periode i nutidsværdi være 622.400 kr. Dette er 225.000 kr mere end fundet på det tidspunkt EP Villa hovedrapporten blev lavet.

7. Literature

Literature	
”Energibesparelser i eksisterende og nye boliger”	Rapport BYG˙DTU R-080, 2004, ISBN 87-7877-143-9
”Vurdering af potentialet for varmebe-sparelser i eksisterende boliger”	By og Byg Dokumentation 057 Af Kim B. Wittchen, Statens Byggeforskningsin-stitut, 2004 ISBN 87-563-1202-4
“Mitigation of CO_2“ Emissions from the Building Stock	Report established by ECOFYS for EURIMA and EuroACE, 02/2004 e-mail: info@ecofys.de
“Byg boligerne bedre” Analyse af bygninger med gulvvarme og radiatorer	Af: Lars Olsen og Christian Holm Christiansen, Teknologisk Institut, Februar 2004, ISBN 87-7756-724-2
“Grundlæggende Klimateknik og bygningsfysik”	Af: M Steen-Thøde med flere, Aalborg Universi-tet, August 1995, ISSN 0902-8005 U9505
”Energirenovering af murermesterhus”	Af: Henrik Tommerup, Byg·DTU, R-102, 2004 ISSN 1601-2917 ISBN 87-7877-168-4
”Indeklimaet i boligen” SBI Anvisning 179	Af: Ole Valbjørn, Peter A. Nielsen Statens Byggeforkningsinstitut, SBI, 1993 ISBN: 87-563-0830-2
“Ventilationsforhold I nyere, naturligt ventilerede enfamiliehuse”	Af: Niels C. Bergsøe, SBI-Rapport 236, Statens Byggeforskningsinstitut 1994.
”Fugt, ventilation, skimmelsvampe og husstøvmider – en tværsnitsundersøgelse i lejligheder”	Af: Lars Gunnarsen, By og Byg Resultater 009, Statens Byggeforskningsinstitut, 2001.

Appendix O – Outdoor weather conditions in Sep & Oct 2004/2005

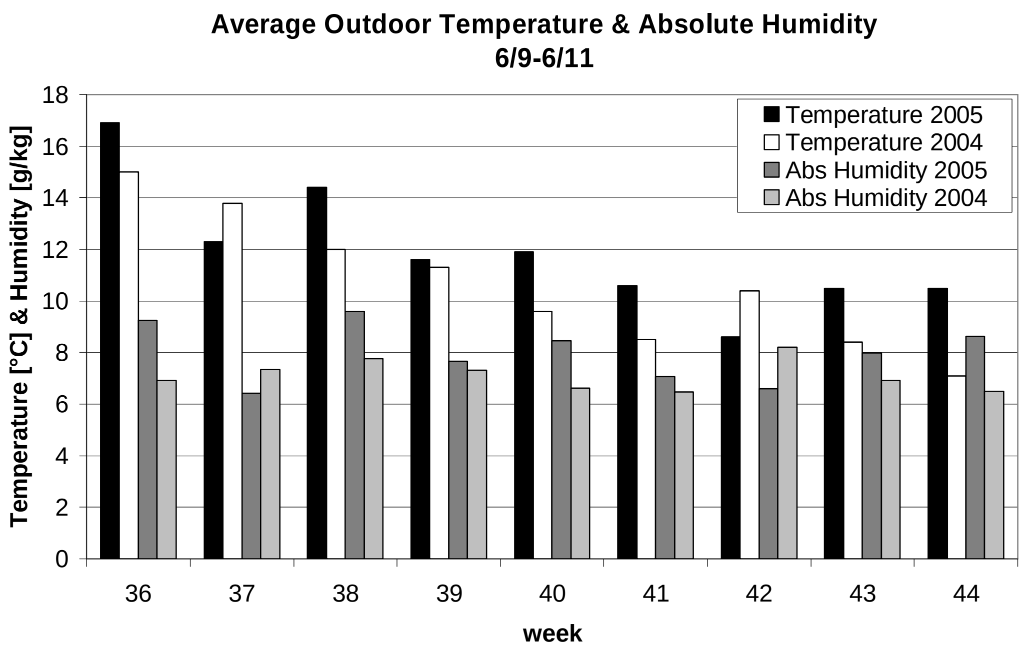

Figure 8: Comparison of weekly averages of Outdoor Temperature (°C) and Absolute Humidity (g/kg) from 6/9-6/11 2004/2005.

Average temperature **BEFORE** (6/9-7/11 2004):	10.7 °C
Average humidity **BEFORE** (6/9-7/11 2004):	7.1 g/kg
Average temperature **AFTER** (5/9-6/11 2005):	11.9 °C
Average humidity **AFTER** (5/9-6/11 2005):	8.0 g/kg
Average temperature **AFTER** (3/12-3/5 + 3/10-3/12):	4.1 °C
Average humidity **AFTER** (3/12-3/5 + 3/10-3/12):	5.2 g/kg

Appendix P

Statoil Prisinformation
Prisudviklingen - gennemsnitspriser

Historisk oversigt over udviklingen i gennemsnitsprisen på benzin, diesel/TruckDiesel og fyringsolie siden juni 2005.

Gennemsnitsprisen for h.h.v. benzin og diesel/TruckDiesel vises i kr. pr. liter incl. moms. Gennemsnitsprisen for fyringsolie vises i kr. pr. 1000 liter incl. moms.			
	Benzin*	Diesel/TruckDiesel	Fyringsolie**
2005			
2005 i snit	9,38	8,46	7.392
Gns. december	9,45	8,60	7.557
Gns. november	9,45	8,67	7.608
Gns. oktober	9,97	9,18	8.114
Gns. september	10,44	9,10	8.036
Gns. august	9,94	8,84	7.774
Gns. juli	9,74	8,69	7.618
Gns. juni	9,39	8,57	7.503
Gns. maj			6.991
Gns. april			7.241
Gns. marts			7.133
Gns. februar			6.610
Gns. januar			6.397
Gns. december 2004			6.632
Dec. 2004- dec. 2005			7.305

* Blyfri 95
** TemPlus

Appendix R

Nykredit

Nykredit A/S
Torvet 21
4600 Køge

22.12.2005

Vores ref.	Steen Normann Olsen
Ejendomsnr.	122694
Matr. nr.	1
Ejerlav	Køge Markjorder
Beliggenhed	Torvet 21

Vejledende beregning af lån

Lån Nyt 1: 4,0000 % Obligationslån, 30 år, Annuitet

	Nyt lån
1. års ydelse pr. måned i kr. før skat	930
1. års ydelse pr. måned i kr. efter skat	708
Det lånte beløb i kr.	175.000
Kursværdi i kr.	166.971
Effektiv rente p.a. inkl. omkostninger i procent før skat	5,60
Effektiv rente p.a. inkl. omkostninger i procent efter skat	3,90

Anslået beløb til udbetaling 157.046 kr.

De følgende sider indeholder:

Nykredit A/S · Torvet 21 · 4600 Køge · Tlf. 56640707 · Fax 56640700 · www.nykredit.dk
Cvr.nr.: 12 71 92 80 · København

Nykredit

Specifikation af ydelsesforløb

År	Rente og bidrag i kr. før skat	Afdrag i kr.	Ydelse i kr. før skat	Ydelse i kr. efter skat
2005	0	0	0	0
2006	8.269	3.166	11.435	8.706
2007	7.923	3.218	11.141	8.527
2008	7.772	3.349	11.120	8.556
2009	7.614	3.485	11.098	8.586
2010	7.449	3.626	11.076	8.617
2011	7.279	3.774	11.052	8.650
2012	7.101	3.927	11.027	8.684
2013	6.916	4.086	11.002	8.720
2014	6.723	4.252	10.975	8.756
2015	6.523	4.425	10.947	8.795
2016	6.314	4.604	10.918	8.835
2017	6.097	4.791	10.888	8.876
2018	5.871	4.986	10.857	8.920
2019	5.636	5.188	10.824	8.965
2020	5.392	5.399	10.791	9.011
2021	5.137	5.618	10.755	9.060
2022	4.872	5.846	10.719	9.111
2023	4.597	6.084	10.680	9.164
2024	4.310	6.331	10.641	9.218
2025	4.012	6.588	10.599	9.276
2026	3.701	6.855	10.556	9.335
2027	3.378	7.134	10.512	9.397
2028	3.042	7.423	10.465	9.461
2029	2.692	7.725	10.417	9.528
2030	2.328	8.038	10.366	9.598
2031	1.949	8.365	10.314	9.670
2032	1.555	8.704	10.259	9.746
2033	1.144	9.058	10.202	9.825
2034	717	9.426	10.143	9.906
2035	273	9.529	9.802	9.712

Nykredit

Oplysninger om lån

Hovedtal	Lån Nyt 1
Kreditor	Nykredit
Låntype	Obligationslån
Løbetid i år	30
Det lånte beløb i kr.	175.000
Kurs	95,4120
Kursværdi i kr.	166.971
Obligationsrente i % pr. år	4,0000
1. års ydelse pr. måned i kr. før skat	930
1. års ydelse pr. måned i kr. efter skat	708
Bidragssats i procent pr. år uden kernekunderabat	0,7148
Anslået bidragssats i procent pr. år med kernekunderabat	0,6432
Effektiv rente p.a. inkl. omkostninger i procent før skat	5,60
Effektiv rente p.a. inkl. omkostninger i procent efter skat	3,90
Afdragsform	Annuitet
Antal terminer pr. år	4

Nykredit

Forudsætninger for beregningen

Generelle beregningsforudsætninger

Beregningerne forudsætter, at lånet udbetales den 23. december 2005.

I beregningerne af det skattemæssige fradrag for renteudgifter er der forudsat følgende skattesatser:

Periode	Skatteprocent
2004	33,00
2005 -	33,00

Vi gør opmærksom på, at der i beregningerne ikke er taget højde for en eventuel skatterabat, såfremt Deres renteudgifter overstiger 20 % af Deres personlige indkomst.

Som Kernekunde i Nykredit opnår De en Kernekunderabat på bidraget på 10 % på lån ydet i ejerboliger, fritidshuse og landbrugsejendomme.

I beregningen er forudsat, at De er Kernekunde i Nykredit.

Nøgletallet 1. års ydelse pr. måned er udregnet som et gennemsnit af terminsbetalingerne indtil 22. december 2006.

Særlige forudsætninger om det nye lån

Lån 1 : Er et 4.00 % obligationslån, der afdrages efter annuitetsprincippet. Lånet er konverterbart og løbetiden er 30 år med 4 årlige debitorterminer.

Den anvendte kurs er foreløbig og 0,10 kurspoint under officiel kurs "Alle handler" kl. 17.00 på Københavns Fondsbørs den 21. december 2005.

Det lånte beløb fremskaffes ved salg af obligationer i:

- 4.00 % Nykredit serie 3 D årgang 2038 fondskode 0976164

Bidragssatsen for lånet er 0,6432 procent pr. år med kernekunderabat. Bidraget beregnes af lånets restgæld. Beregningsprincippet og størrelsen af bidraget kan ændres efter Nykredits beslutning.

I den effektive rente inkl. omkostninger før skat - også kaldet årlige omkostninger i procent - er indregnet kurstab/kursgevinst ved salg af obligationer, udgifter til kurtage, lånesagsgebyr, bidrag samt tinglysningsafgift til staten. De samme omkostninger indgår i beregningen af den effektive rente efter skat.

Afgivelse af lånetilbud

Et lånetilbud kan forudsætte vurdering af ejendommen. Endvidere forudsætter lånetilbud, at lånet kan bevilges i henhold til gældende regler.

Et eventuelt lånetilbud vil blive afgivet i henhold til de forhold og lovgivningsmæssige regler, som er gældende på tidspunktet for afgivelse af lånetilbudet. Dette kan medføre ændringer i forhold til disse beregninger.

Nykredit

Beregningerne er vejledende og er ikke udtryk for, at en låneoptagelse i alle tilfælde kan gennemføres på de vilkår, som beregningerne er baseret på.

Nykredit

Budget for låneoptagelsen

Kursværdi ved optagelse af lån

Lån Nyt 1: Obligationslån - 175.000 kr. til kurs 95,41			kr.	166.971

Omkostninger ved optagelse af lån

Lånesagsgebyr			kr.	3.000		
Kurtage			kr.	250		
Gebyr for tinglysningsekspedition	kr.	2.850				
- Kernekunderabat	kr.	450	kr.	2.400		
Tinglysningsafgift til staten (procentdel)			kr.	2.700		
Tinglysningsafgift til staten (fast del)			kr.	1.400		
Gebyr for tingbogsattest			kr.	175		
Omkostninger i alt					kr.	9.925
Anslået beløb til udbetaling					kr.	157.046

På grund af afrundinger kan summen af de enkelte beløb afvige fra den angivne total.

Specifikation af handelsomkostninger

Anslåede handelsomkostninger ved optagelse af realkreditlån:

Kursfradrag	kr.	175		
Kurtage	kr.	250		
Handelsomkostninger ved optagelse af lån i alt			kr.	425

Handelsomkostninger ved optagelse af lån i alt udgør 0,25% af summen af kursværdi og kursfradrag ved optagelse af lån.

Nykredit

Nykredit A/S
Torvet 21
4600 Køge

21.01.2005

Vores ref.	Steen Normann Olsen
Ejendomsnr.	122694
Matr. nr.	1
Ejerlav	Køge Markjorder
Beliggenhed	Torvet 21

Vejledende beregning af lån

Lån Nyt 1: 4 % Obligationslån, 30 år, Annuitet

	Nyt lån
1. års ydelse pr. måned i kr. før skat	930
1. års ydelse pr. måned i kr. efter skat	708
Ydelsens rentefølsomhed pr. måned i kr. efter skat	0
Det lånte beløb i kr.	175.000
Kursværdi i kr.	167.505
Effektiv rente p.a. inkl. omkostninger i procent før skat	5,6
Effektiv rente p.a. inkl. omkostninger i procent efter skat	3,9

Anslået beløb til udbetaling 157.579 kr.

De følgende sider indeholder:

Nykredit A/S · Torvet 21 · 4600 Køge · Tlf. 56640707 · Fax 56640700 · www.nykredit.dk
Cvr.nr.: 12 71 92 80 · København

Nykredit

Specifikation af ydelsesforløb

År	Rente og bidrag i kr. før skat	Afdrag i kr.	Ydelse i kr. før skat	Ydelse i kr. efter skat
2005	7.558	2.889	10.448	7.953
2006	7.934	3.207	11.141	8.523
2007	7.783	3.337	11.120	8.552
2008	7.626	3.473	11.099	8.582
2009	7.462	3.614	11.076	8.613
2010	7.292	3.760	11.052	8.646
2011	7.115	3.913	11.028	8.680
2012	6.931	4.072	11.002	8.715
2013	6.739	4.237	10.976	8.752
2014	6.539	4.409	10.948	8.790
2015	6.331	4.588	10.920	8.830
2016	6.115	4.775	10.890	8.872
2017	5.890	4.968	10.858	8.915
2018	5.656	5.170	10.826	8.960
2019	5.412	5.380	10.792	9.006
2020	5.159	5.599	10.757	9.055
2021	4.895	5.826	10.721	9.105
2022	4.620	6.062	10.683	9.158
2023	4.335	6.309	10.643	9.213
2024	4.037	6.565	10.602	9.270
2025	3.728	6.831	10.559	9.329
2026	3.406	7.109	10.515	9.391
2027	3.071	7.397	10.468	9.455
2028	2.723	7.698	10.420	9.522
2029	2.360	8.010	10.370	9.591
2030	1.982	8.336	10.318	9.664
2031	1.590	8.674	10.264	9.739
2032	1.181	9.026	10.207	9.817
2033	755	9.393	10.148	9.899
2034	313	9.774	10.087	9.984
2035	7	599	606	604

Nykredit

Oplysninger om lån

Hovedtal	Lån Nyt 1
Kreditor	Nykredit
Låntype	Obligationslån
Løbetid i år	30
Det lånte beløb i kr.	175.000
Kurs	95,72
Kursværdi i kr.	167.505
Obligationsrente i % pr. år	4,00
1. års ydelse pr. måned i kr. før skat	930
1. års ydelse pr. måned i kr. efter skat	708
Ydelsens rentefølsomhed pr. måned i kr. efter skat	0
Bidragssats i procent pr. år uden kernekunderabat	0,7136
Anslået bidragssats i procent pr. år med kernekunderabat	0,6424
Effektiv rente p.a. inkl. omkostninger i procent før skat	5,6
Effektiv rente p.a. inkl. omkostninger i procent efter skat	3,9
Afdragsform	Annuitet
Antal terminer pr. år	4

Nykredit

Forudsætninger for beregningen

Generelle beregningsforudsætninger

Beregningerne forudsætter, at lånet udbetales den 24. januar 2005.

I beregningerne af det skattemæssige fradrag for renteudgifter er der forudsat følgende skattesatser:

Periode	Skatteprocent
2004	33,00
2005 -	33,00

Vi gør opmærksom på, at der i beregningerne ikke er taget højde for en eventuel skatterabat, såfremt Deres renteudgifter overstiger 20 % af Deres personlige indkomst.

Som Kernekunde i Nykredit opnår De en Kernekunderabat på bidraget på 10 % på lån ydet i ejerboliger, fritidshuse og landbrugsejendomme.

I beregningen er forudsat, at De er Kernekunde i Nykredit.

Nøgletallet 1. års ydelse pr. måned er udregnet som et gennemsnit af terminsbetalingerne indtil 23. januar 2006.

Særlige forudsætninger om det nye lån

Lån 1 : Er et 4.00 % obligationslån, der afdrages efter annuitetsprincippet. Lånet er konverterbart og løbetiden er 30 år med 4 årlige debitorterminer.

Den anvendte kurs er foreløbig og 0,10 kurspoint under officiel kurs "Alle handler" kl. 17.00 på Københavns Fondsbørs den 20. januar 2005.

Det lånte beløb fremskaffes ved salg af obligationer i:

- 4.00 % Nykredit serie 3 D årgang 2035 fondskode 0975729

Bidragssatsen for lånet er 0,6424 procent pr. år med kernekunderabat. Bidraget beregnes af lånets restgæld. Beregningsprincippet og størrelsen af bidraget kan ændres efter Nykredits beslutning.

I den effektive rente inkl. omkostninger før skat - også kaldet årlige omkostninger i procent - er indregnet kurstab/kursgevinst ved salg af obligationer, udgifter til kurtage, lånesagsgebyr, bidrag samt tinglysningsafgift til staten. De samme omkostninger indgår i beregningen af den effektive rente efter skat.

Afgivelse af lånetilbud

Et lånetilbud kan forudsætte vurdering af ejendommen. Endvidere forudsætter lånetilbud, at lånet kan bevilges i henhold til gældende regler.

Et eventuelt lånetilbud vil blive afgivet i henhold til de forhold og lovgivningsmæssige regler, som er gældende på tidspunktet for afgivelse af lånetilbudet. Dette kan medføre ændringer i forhold til disse beregninger.

Nykredit

Beregningerne er vejledende og er ikke udtryk for, at en låneoptagelse i alle tilfælde kan gennemføres på de vilkår, som beregningerne er baseret på.

Nykredit

Budget for låneoptagelsen

Kursværdi ved optagelse af lån

Lån Nyt 1: Obligationslån - 175.000 kr. til kurs 95,72			kr.	167.505

Omkostninger ved optagelse af lån

Lånesagsgebyr			kr.	3.000	
Kurtage			kr.	251	
Gebyr for tinglysningsekspedition	kr.	2.850			
- Kernekunderabat	kr.	450	kr.	2.400	
Tinglysningsafgift til staten (procentdel)			kr.	2.700	
Tinglysningsafgift til staten (fast del)			kr.	1.400	
Gebyr for tingbogsattest			kr.	175	
Omkostninger i alt			kr.		9.926
Anslået beløb til udbetaling			kr.		157.579

På grund af afrundinger kan summen af de enkelte beløb afvige fra den angivne total.

Specifikation af handelsomkostninger

Anslåede handelsomkostninger ved optagelse af realkreditlån:

Kursfradrag	kr.	175	
Kurtage	kr.	251	
Handelsomkostninger ved optagelse af lån i alt	kr.		426

Handelsomkostninger ved optagelse af lån i alt udgør 0,25% af summen af kursværdi og kursfradrag ved optagelse af lån.

Appendix S

År	scenario 1 - 1.5% savings		Scenario 2 - 1.8% savings		Scenario 3 - 2.34% savings		Scenario 4.2 - dayprice/inflation savings	
N	30							
NPV		**810.841**		**848.331**		**921.347**	**NPV**	**678.439**
1	22.265	21.722	22.265	21.722	22.265	21.722	23.180	22.615
2	23.156	22.040	23.222	22.103	23.343	22.218	23.760	22.615
3	24.082	22.362	24.221	22.492	24.472	22.725	24.353	22.615
4	25.045	22.690	25.262	22.887	25.657	23.244	24.962	22.615
5	26.047	23.022	26.349	23.288	26.899	23.775	25.586	22.615
6	27.089	23.359	27.482	23.697	28.201	24.317	26.226	22.615
7	28.172	23.700	28.663	24.114	29.565	24.872	26.882	22.615
8	29.299	24.047	29.896	24.537	30.996	25.440	27.554	22.615
9	30.471	24.399	31.182	24.968	32.497	26.021	28.243	22.615
10	31.690	24.756	32.522	25.406	34.070	26.615	28.949	22.615
11	32.958	25.118	33.921	25.853	35.718	27.223	29.672	22.615
12	34.276	25.486	35.379	26.307	37.447	27.844	30.414	22.615
13	35.647	25.859	36.901	26.769	39.260	28.480	31.175	22.615
14	37.073	26.237	38.487	27.239	41.160	29.130	31.954	22.615
15	38.556	26.621	40.142	27.717	43.152	29.795	32.753	22.615
16	40.098	27.011	41.868	28.204	45.241	30.475	33.572	22.615
17	41.702	27.406	43.669	28.699	47.430	31.171	34.411	22.615
18	43.370	27.807	45.547	29.203	49.726	31.882	35.271	22.615
19	45.105	28.214	47.505	29.716	52.133	32.610	36.153	22.615
20	46.909	28.627	49.548	30.238	54.656	33.355	37.057	22.615
21	48.785	29.046	51.678	30.769	57.301	34.116	37.983	22.615
22	50.737	29.471	53.901	31.309	60.074	34.895	38.933	22.615
23	52.766	29.902	56.218	31.859	62.982	35.692	39.906	22.615
24	54.877	30.340	58.636	32.418	66.030	36.507	40.904	22.615
25	57.072	30.784	61.157	32.988	69.226	37.340	41.926	22.615
26	59.355	31.235	63.787	33.567	72.577	38.192	42.974	22.615
27	61.729	31.692	66.530	34.156	76.090	39.064	44.049	22.615
28	64.198	32.155	69.390	34.756	79.772	39.956	45.150	22.615
29	66.766	32.626	72.374	35.366	83.633	40.868	46.279	22.615
30	69.437	33.103	75.486	35.988	87.681	41.801	47.436	22.615

Årlig Inflationsrate	2,50%
Diskonteringsfaktor	2,50%