ABSTRACT

UMEÅ ENERGY SAVING BLOCKS
QUALITY CONTROLLED PROGRAMS SAVE UP TO 40 PERCENT
ENERGY IN HOUSES BUILT IN THE 70´s

Erik Högberg & Christer Nordin
Meta Projektplanering AB, Sweden

The Umeå project is one of the Energy Saving Blocks initiated by The Swedish Building Research Council in 1981. The project started in Spring 1982 and aims at trying full-scale activities for saving energy in existing houses.

The following activities were included in this program:

* Completion of the thermostat valves and adjustment of the heating system

* Water Saving Fittings

* Individual electricity submetering

* Retrofit by means of heatpumps and heat exchangers

* Triple glazing

In one of the houses a combination of activities has been carried out. In this house the consumption has been reduced from original 15,700 kWh per flat to 9,600 kWh, or by about 40 percent. The remaining consumption, thus, is about 130 kWh per m2.

In the Umeå Saving Blocks we have proved that it is possible to save energy by employing suitably selected activities, but that it often results in increased total costs. Also the management of the project is crucial for success. Top management and staff must be highly motivated and supportive. Specified requirements must be assured in procurement and installation.

Pilot projects for testing before full scale operation are recommended. And the results should be followed up closely. A computerized energy statistics system has been required to keep energy consumption permanently at a low level.

UMEÅ ENERGY SAVING BLOCKS
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OBJECTIVE

The Umeå project is one of the Energy Saving Blocks initiated by BFR (The Swedish Building Research Council) in 1981. The project started in Spring 1982 and aims at trying all phases in programs for saving energy in existing houses.

The project has been carried out in a residential area from 1970 at Umeå. An important starting-point was the consideration that energy should be saved without making the housing costs (rents) increase. This implies (a) that the prevailing financing rules and the market situation influence the selection of activities, and (b) that the energy saving activities have been sought for within the fields of comparatively well-known techniques.

In order to secure energy saving in the long-term perspective in existing houses, various efforts are required - from a reliable diagnosis of the saving possibilities up to controlled implementation and follow-up. Therefore the following objectives have been specified for the project:

* To develop methods for the implementation of saving programs in practice
* To develop aids for more reliable "house diagnoses"
* To evaluate various energy saving programs in practice
* To follow up the influence on the economic result (the rent)

DESCRIPTION OF THE RESIDENTIAL AREA

The selected residential area is owned and managed by the "Bostaden" foundation in Umeå. It was built in the course of 1970 and 1971. In the two blocks there are a total of 31 houses with 476 flats in all.

Construction Technique

The selected houses have 2-4 storeys. The houses are of a comparatively "heavy" type with floor structure, end walls, and structural inner walls made of concrete. The side walls are of a lighter construction and mineral wool insulated. The facing of the houses is of brick. The k-value of the walls is 0.3-0.35 W/m2 degrees centigrade.

The attic floor structure is made of concrete and provided with insulation consisting of 400 mm of cutter shavings with a calculated k-value of 0.3.

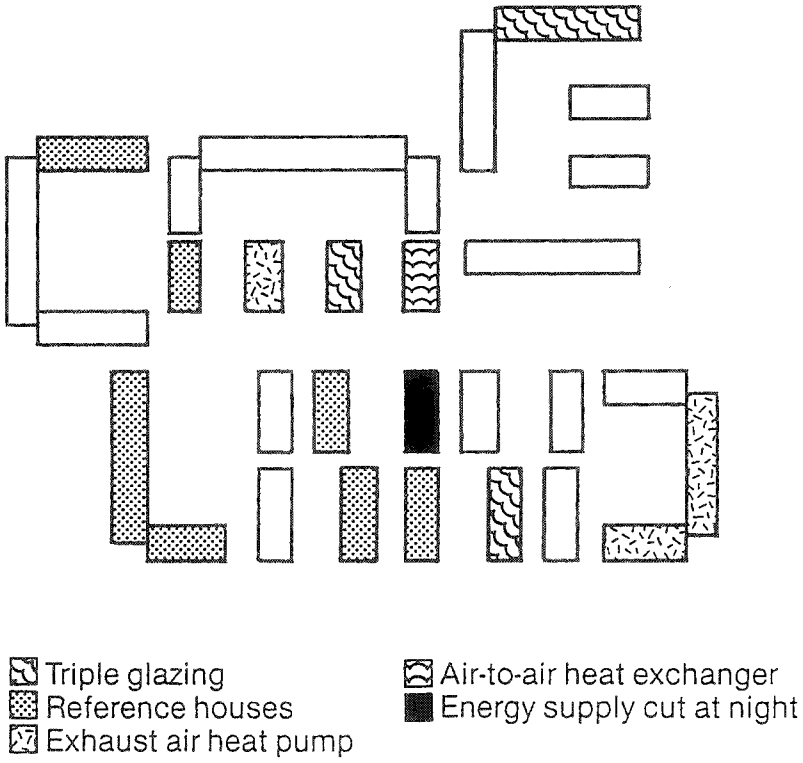

Figure 1. Conservation measures installed in Umeå Energy Blocks

Mechanical systems

The houses have balanced ventilation systems. The area is supplied with district heating via a central in each block of houses. Supply of hot water is arranged block-wise.

MEASUREMENT PROGRAM

An extensive measurement program was prepared, in order to facilitate the savings analysis of the implemented steps. Purposeful use of computerized aids for collection of data as well as ensuing analyses was chosen.

For the evaluation two main principles were utilized:

For all houses concerned the measurements were started well before the implementation of the program of activities, so that the consumption profile of the house could be assessed.

For each house subject to energy saving activities, a reference house was selected for current comparison with the measurement results. Thanks to the great number of available, comparable houses, this analysis principle proved able to supply reliable results.

Energy hot and cold water consumption and temperatures have been measured from the beginning of 1982 to the end of 1985. Energy was measured by energy meters both block-wise and in the program and reference houses.

The current evaluation was carried out weekly with computer analyses in the shape of diagrams and tables. The results were followed up regularly in discussions with the house caretaker(s) which implied a valuable check on meters function and ensured good continuity as far as the evaluation was concerned.

THE BASIC PROGRAM

When the program was started in 1982 some energy saving had already been achieved by lowering indoor temperature, tightening windows and time control of ventilation. In figure 2 total energy consumption (heat and hot water) is documented before and after the program on block level. Partial programs are deducted. Weather normalization on heat by using degree-days in computed.

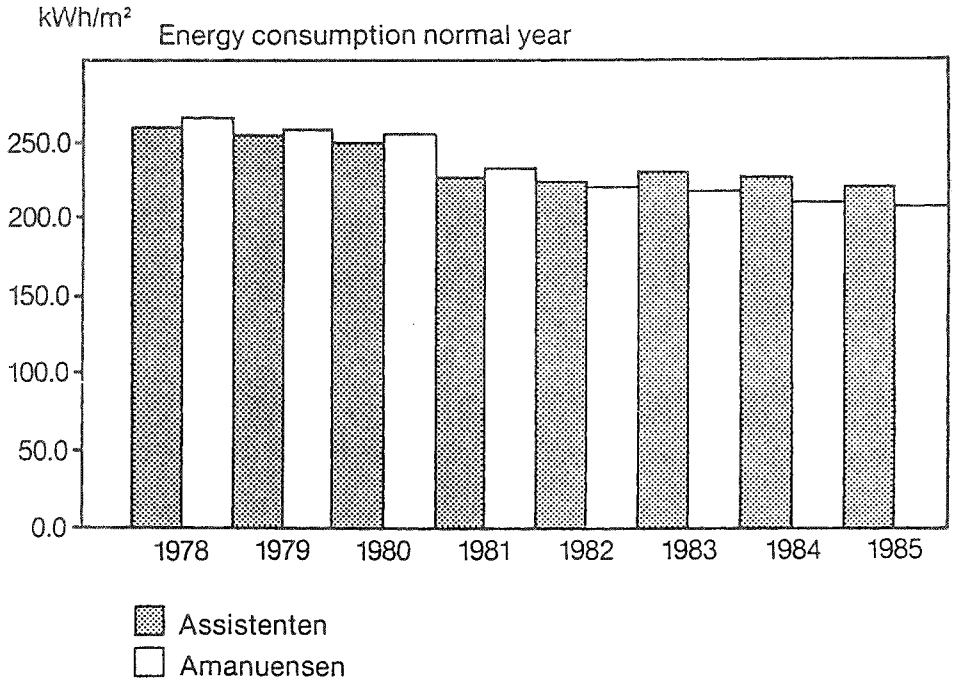

Figure 2. Energy consumption normal year
Blocks Assistenten och Amanuensen

This also includes energy saving from the basic program carried out in Autumn 1982 in all the houses.

The following activities were included in this program:

* Thermostatic valves on all possible radiators (from 70 to 90 %)

* Adjustment of the heating system on the radiator valves

OTHER ACTIVITIES

Other activities were implemented selectively in individual houses or blocks of houses. The energy balance was used for diagnosis and focussed the interest to ventilation and sewage losses.

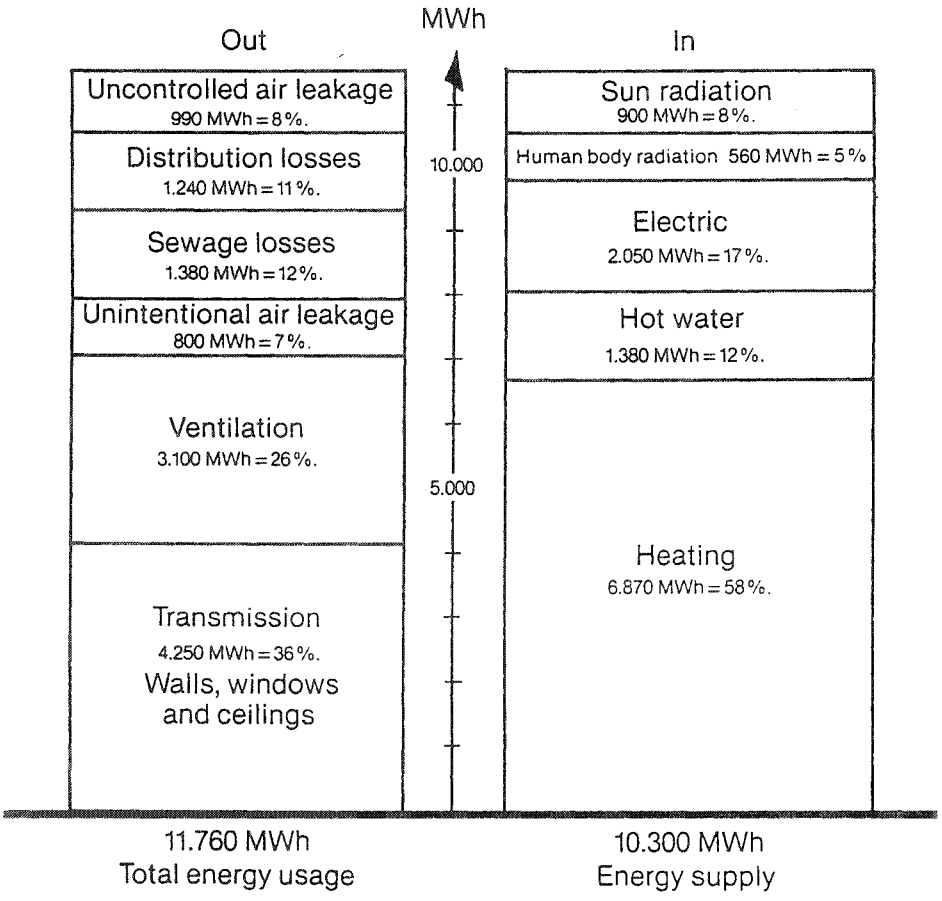

Figure 3. Energy balance both blocks measured and calculated before saving programs were selected

The activities finally chosen were as follows:

* Saving of water; replacement of all hot/cold water mixer taps in the "Amanuensen" block

* Individual electricity submetering

* Retrofit by means of heatpumps and heat exchangers

* Triple glazing

* Blocking of air intakes to change the system - from balanced to exhaust only air ventilation

ACHIEVED SAVINGS

Prior to the project start the total energy consumption at the block level was about 235 kWh/m2 (heat and hot water) of floorspace per annum, weather normalized.

The Basic Program

In the "Assistenten" block we were not able to observe any significant reduction of the energy consumption due to the basic program alone.

In the "Amanuensen" block where adjustment to a lower flow in radiators was carried out, a saving of about 12 kWh/m2 of floorspace/year was obtained, corresponding to 5 percent of the annual consumption at the block level. The remaining energy consumption after the implementation of the basic program is about 220 kWh/m2 and normal year.

Water-saving Activities

In the "Amanuensen" block all hot/cold water mixer taps were replaced with new ones of the one-handle-type. Showers and tubs were provided with thermostat controlled mixer taps. This resulted in an annual saving of cold water of 10 percent, +/- 4 percent. The hot water consumption was reduced by 13 percent, +/- 6 percent, corresponding to an energy saving of 3.5 kWh/m2 of floorspace/year. This was measured separately in the block central providing water for all houses.

Individual Electricity Sub metering

In both blocks a change to individual electricity submetering has been implemented. This has resulted in a saving of 10, +/- 4 kWh/m2 of floorspace/year from an annual consumption of 60 kWh/m2 of floorspace/year or about 4,400 kWh/flat/year. The saving of electricity therefore can be stated as 17 +/- 8 percent of the total consumption of electricity.

Heat Exchanger

A double plate air to air heat exchanger was installed in the ventilation system in a house with 12 flats and a total floorspace of 878 m2. The saving for a normal year has been measured and proved to be 21.7 MWh/year for this house, corresponding to 25 kWh/m2 of floorspace/year. Out of the total energy consumption including hot water and distribution losses, this constitutes about 12 percent. The possible saving is reduced by the fact that the exchanger freezes when the outdoor temperature goes below -10 degrees centigrade.

Heatpump in house with 12 flats

In this house the heat pump is connected with the evaporator directly in the exhaust air duct. It produces domestic hot water and supplies also a certain amount of base heat by means of radiators connected to the hot water circulation (HWC) and preheats the intake air. The heat pump covers about 30 percent of total energy for the house.

The actual achieved saving for the house is 52.4 MWh, corresponding to 54 kWh/m2 of floorspace and normal year, or 25 percent of the total energy consumption. The installed heat pump is oversized and has an average system coefficient of performance (COP) of 2.1. This will be discussed in detail in another paper on the conference.

Heatpump in house with 39 flats

This installation is of the indirect type, and has a water/glycol mixture. The heat pump in this case smaller, reduces energy by 50 kWh/m2 and normal year, i.e. about 23 percent, but due to the longer operation times and the considerably higher system COP (3.4) much more favourable total economy is obtained.

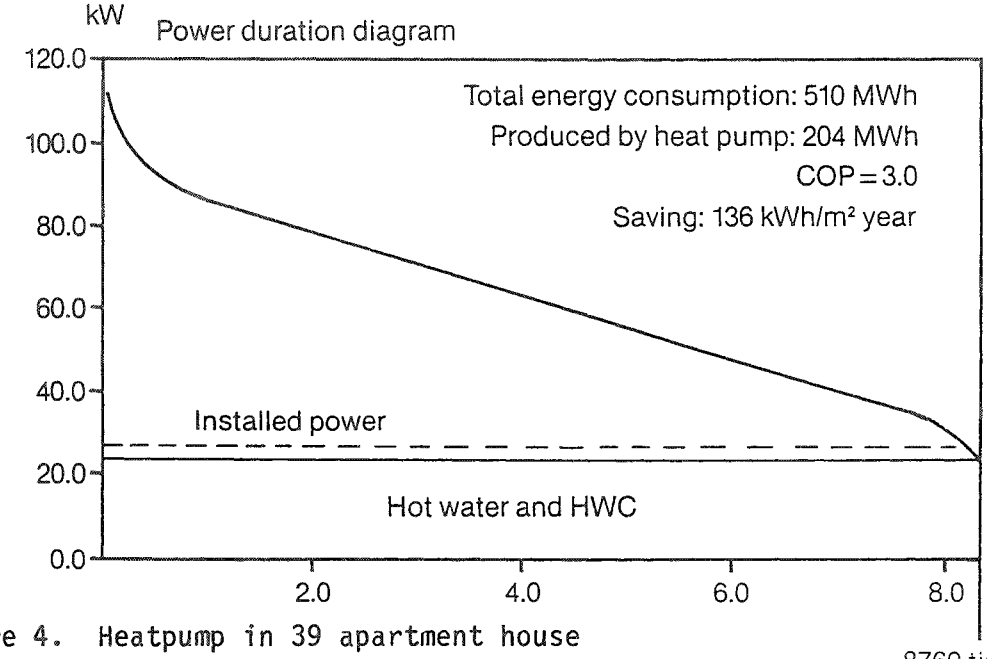

Figure 4. Heatpump in 39 apartment house

Triple Glazing

Triple glazing has been carried out in three houses. The resulting actual saving has been measured and found to be 8 kWh/m2 of floor-space/year as an average value for the three houses. This corresponds to 4 +/- 2 percent of the total energy consumption at the block level.

EVALUATION OF THE ENERGY SAVINGS

We have described what energy savings results the individual activities have given. We have achieved and been able to measure the planned savings for the activities carried out. The Basic Program which resulted in a lowering of the temperature down to 20 degrees centigrade in the flats has caused many tenants in our follow-up inquiry to complain about too low indoor temperatures. This has been amplified by the closing of the intake air so that the draught through the external walls has increased. However, the complaints also increased in the block in which no changes in the indoor climate had been introduced. It seems as if the requirements in respect of a good indoor climate have increased in the course of the years when the project was carried out (1982-1985).

In one of the houses a combination of activities has been carried out (basic program, water saving, heat pump, and triple glazing). In this house the greatest total saving has been obtained. The consumption has been reduced from the original 15,700 kWh per flat to 9,600 kWh, or by about 40 percent. The remaining consumption, thus, is about 130 kWh per m2. But, nota bene, there is some uncertainty in respect of the combinatorial effects of various activities.

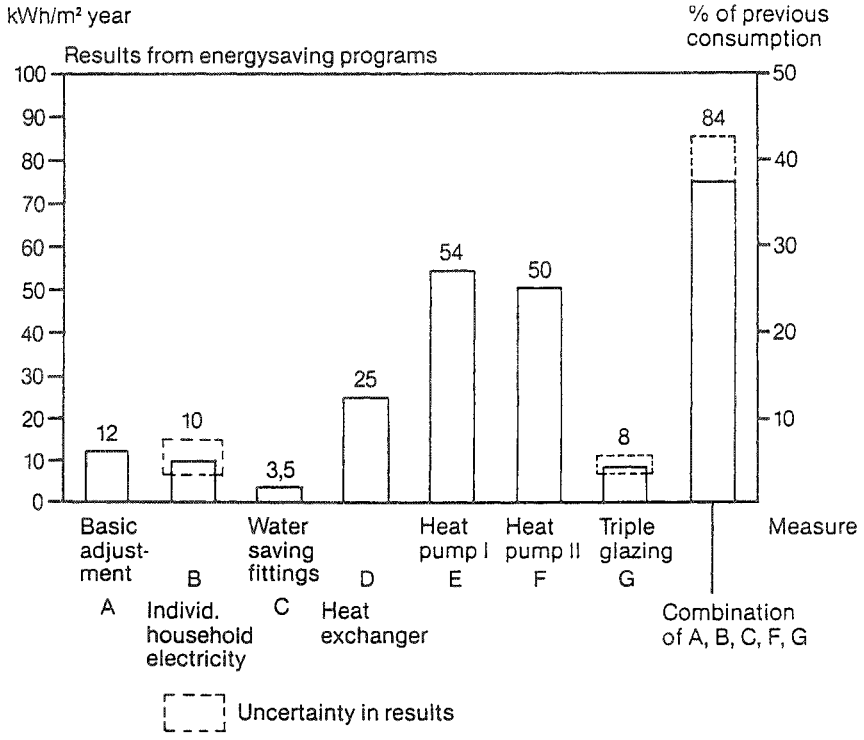

Figure 5. Energy Blocks Umeå
Energy saving all programs

ECONOMIC RESULTS OF ENERGY SAVING PROGRAM

When the energy saving program was started, everybody expected the energy price to continue increasing about 2 percent higher than the inflation, at the time about 8 percent. In fact, inflation as well as energy price increases have been kept down, and they are not expected to be on the same high level in the future. Moreover, the energy tarifs in Umeå have been adjusted to the energy production and contain today fixed charges of about 30 %. This implies that the house owner cannot immediately benefit from the savings.

The financing conditions have drastically deteriorated during the course of the project. For most of the implemented activities, government energy loans were obtained at an interest of 3 percent, slowly increasing by 0.25 percent/year. At present interest subsidies are obtained, the first year resulting in an interest of 6 percent, i.e. double compared with before, and in addition at a faster increase rate. A total elimination of these subsidies for installation activities is being discussed, which would cause another doubling of the interest cost to the ordinary market interest, today 12-13 percent.

The activities tried in the "total house" were such as were considered profitable from the house management point of view in 1982. For these reasons we have performed sensitivity analyses of what consequences various energy prices and financing conditions give rise to for the various activities.

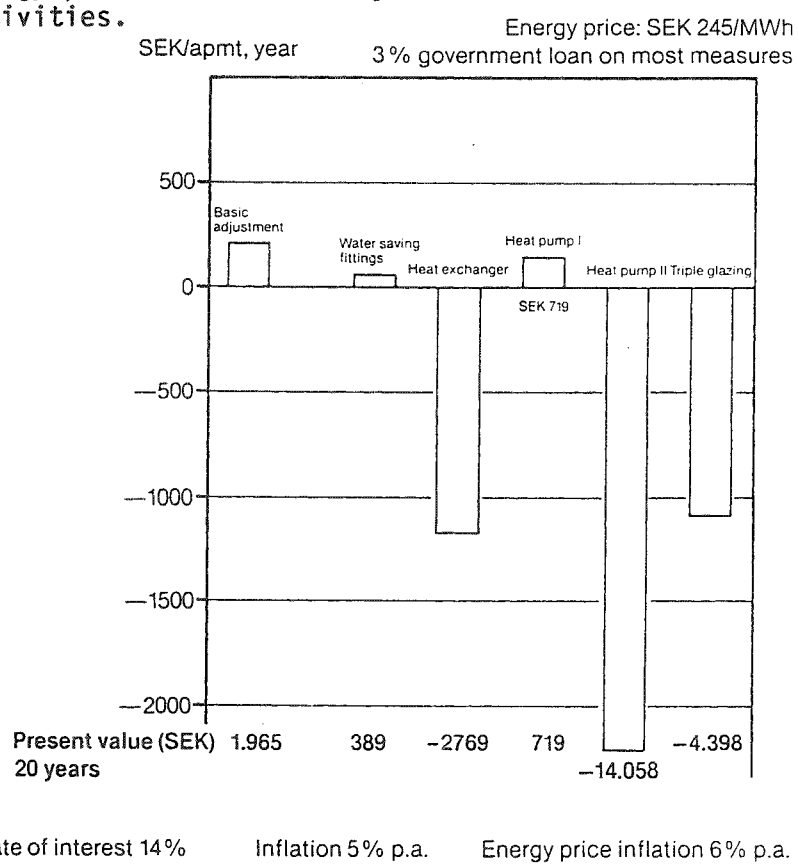

Figure 6. Energy Blocks Umeå. Changes in profits due to energy saving programs

Summarized, these analyses show that only the Basic Program gives a house management profit, if the interest subsidies are completely abolished. With the original financing conditions and an energy price of about 245 SEK per MWh, even the optimum-sized heat pump and introduction of individual electricity sub metering were profitable. Other activities have given the planned energy savings. However, the investments have become so high that they would not have been implemented owing to their negative effect on the economic result.

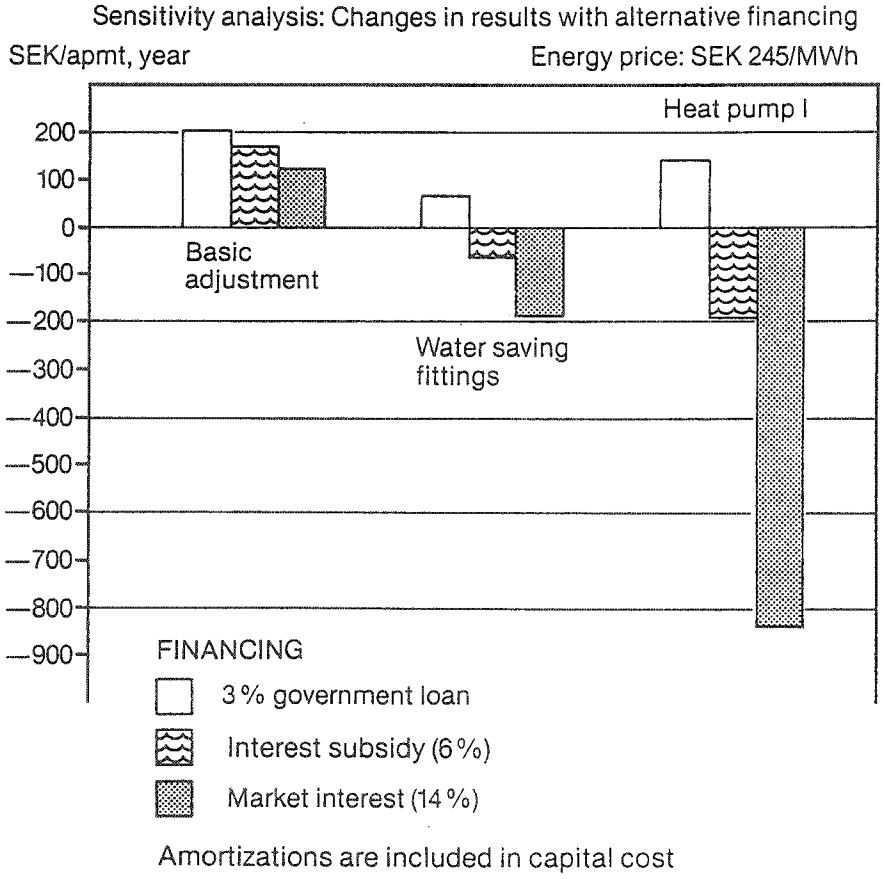

Figure 7. Energy Blocks Umeå
Economic results Year 1 SEK/apartment

SAVING ENERGY - NOT ONLY A QUESTION OF TECHNIQUE

In the Umeå Energy Saving Blocks we have proved that it is possible to save energy by employing suitably selected activities, but that it often results in increased total costs. A few concluding experiences are compiled below:

- The management and the staff have all the time been positive and motivated for the project. This is particularly essential for rendering the results lasting. E.g. complaints on temperatures easily lead to an increase of radiator temperatures.

- Heavy investments must be matched to the object in question and be calculated already in the program stage. It is easy to make bad decisions.

- Specified program requirements must be assured in procurement and installation. In this project so-called functional procurement (package deal) has been applied.

- Consultants and entrepreneurs must focus on the specific prerequisites of the object in question. Standard dimensioning clichés give bad performance data. Standards and thumb rules often lead to oversizing in respect of real power needs.

- The price of capital is the determining factor as far as heavy investments are concerned. Deteriorations, having been implemented since the project was started, render most major investments, for example for heat recovery, non-profitable.

- The development of the energy price and the shape of the tarifs is critical. Today we consider it less profitable to save energy than only a few years ago. Therefore, in selecting activities, fast pay back investments should be preferred, and sensitivity analyses should be carried out for heavier investments.

- As was the case in this project, saving programs should be tested on a smaller scale - pilot projects - prior to implementation in the intended part of the house property concerned. The additional costs for implementation in stages is more than well balanced by the better basis for decisions for all parties in respect of technical details, economic results as well as organizational and other problems in connection with implementation and operation.

- The results should be followed up and evaluated continually. An elaborate monthly energy statistics system with weather normalization is required, in order to keep the consumption permanently at a low level. Such a system was installed in the company at the beginning of 1985 and has resulted in even more significant reduction of energy consumption.