RESULTS FROM OSLO ELECTRICITY WORKS' ENERGY CONSERVATION PROGRAM

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ABSTRACT

Oslo Energy Conservation Program has the target: 15% saving in energy consumption relative to 1980, that is to say 1500 GWh by the year 2000. To reach this target we provide grants and loans for subscribers who are effecting special energy conservation measures. Calculations show that overall the conservation program is profitable, costing far less than new firm power.

We recently started to use a new data base management system called FICS and now it is our most important source of data for evaluating energy conservation.

Our most important aim now is to try to arouse the interest of those who would have most to gain from energy conservation measures. When we started work on this task we quickly realized that there were two important main areas about which we lacked information:

1. Subscribers' decision-making processes in respect of investments in energy conservation.

2. What discrepancy is there between the anticipated and real saving - and what are the reason for any such discrepancy.

On improving subscribers' decision-making processes we found Harold Wilhite's report: "Improving the energy-conservation consultant's interaction with residential clients", so interesting that we asked him to prepare a specific program we could follow. The findings from this work were surprising in their consistency with finding from California. We have created two seminars on the topics of interview technique and decision making, the centerpiece was two video programs.

Our first post-implementation analysis in 1985 covered 50 buildings, the 1986 investigation 200. The result showed a clear trend indicating that with present methods of calculation we usually achieve the anticipated conservation gain. However, there are wide variations. Those who achieved a major saving were well aware that greater comfort was part of the benefit.

The results of the current evaluations performed have led to many major and minor changes in the rules for Oslo's Energy Conservation Program, making it easier for subscribers to understand what we can offer them and facilitating the decision-making process. The result have also led to better understanding of and greater interest in energy conservation within Oslo Electricity Works. We intend to make annual performance analysis (PIPA) and it is estimated that these will cover about 10% of new projects.

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INTRODUCTION

Oslo Electricity Works is an energy works that supplies electricity and district heating for the City of Oslo, and is also responsible for the city's energy conservation program. Oslo is the capital of Norway. It has 450,000 inhabitants, while the country as a whole has a population of about 4 million.

In 1985 Oslo Electricity Works supplied roughly 7 TWh in electricity and 500 GWh in district heating. Electricity totalling about 100 TWh was generated in Norway during the year, all at hydro-electric power stations.

1. BRIEF DESCRIPTION OF OSLO'S ENERGY CONSERVATION PROGRAM

Oslo Electricity Works provides grants and loans for subscribers who are effecting special energy conservation measures. The conservation program commenced in 1982 and up to April 1986 we received 4,900 applications. 3,300 of these were granted and 2,000 energy conservation measures have been completed.

The procedure followed is that the subscribers contact an energy conservation consultant who is approved by Oslo Electricity Works. This consultant makes an energy audit of the building and draws up the grant application, cooperating with the building owner. Such surveys are made free of charge, the consultants' fees are paid by the Electricity Works. Conservation measures are grouped in three categories:

1. A types of measure: Pay-back in less than two years.

2. B types of measure: Capital investment cost less than for new firm power.

2. C types of measure: Support for combined measures (B types) up to a given maximum cost, that is to say new firm power.

As a general rule no aid will be granted for type A measures. Measures of type B will receive aid equalling the cost of the measure, provided that all known type A measures have been effected. In the case of type C measures, the subscriber must bear the major part of the cost. Financing terms such as interest and repayments are adjusted so that the saving in energy costs will always be more than the annual outlay on interest and repayments.

Although the number of applications far exceeded our expectations, we managed to give grants and loans according to our budget.

2. WHY IT IS NECESSARY TO EVALUATE THE OSLO ENERGY CONSERVATION PROGRAM

Before the program was started in 1982, a plan was drawn up setting the following target: 15% saving in energy consumption relative to 1980, that is to say 1,500 GWh by the year 2000. This targe was set without it being reviewed in the general energy planning context.

The energy conservation program was taken into consideration in Oslo's Energy Plan for 1983 - 2000, but made only very limited impact on the plan. Its target, i.e. a saving of 1,500 GWh, was divided into annual protions up to the year 2000 and then deducted from the energy demand forecast. Predictions were so uncertain that the effects and importance of energy conservation measures did not play a very prominent role.

Energy conservation was treated differently in the last energy plan for 1985, which also analyzes developments up to the year 2000. Apart from taking energy conservation measures into consideration when preparing forecasts, it also allowed for the fact that such measures must be treated as an alternative means of satisfying the demand for energy, being similar to new projects for developing firm supplies of power.

This means that more attention must be focused on the returns and long-term effects to be gained from energy conservation measures. A new need for measuring the effects really achieved by our energy conservation program has thus arisen and systematic evaluation has become important to us.

At present we are working on the following issue:
What would be the optimal energy-saving input in Oslo Electricity Works' energy planning efforts?

We are the only company in Norway that employs this manner of determining the reasons and input for energy conservation measures.

3. MAIN RESULTS OF OSLO'S ENERGY ECONOMY PROGRAM

Table I. Approved cost per kWh saved. (Oslo Electricity Works' investments in energy conservation measures.)
Firm 1985 prices in NOK (Norwegian kroner)

Sector	1981	1984	1985
Housing	1.64	1.56	1.22
Commercial buildings	0.51	1.40	1.01
Municipal buildings	0.32	0.51	0.53
Average (weighted)	0.97	0.93	0.87

These figures can be compared with the cost of new firm power, which is NOK 3.50 - 3.75 per kWh. (1$ = 7,60 NOK)

1981 is the reference for the target figure that was set before the Oslo Energy Conservation Program started work and is the reference applied in energy planning.

Calculations show that overall the conservation program is profitable, costing far less than new firm power. However there are wide variations. Investment costs are lower for commercial buildings than for private houses. Municipal buildings often show extremely good results.

4. UNDERLYING DATA FOR EVALUATION

Computers are used extensively in our work and it was natural to extend the computer system to include a data base for energy conservation. This data base is now completed and each grant or loan application we received is recorded in tha data base before work on it commences. We recently started to use a new data base management system (DBMS) called 'FICS' and now it is our most important source of data for evaluating energy conservation.

5. RESULTS OF EVALUATION BY MEANS OF FICS

To determine the energy conservation measures (ECM) and types of housing which gave the best returns, the following tables were prepared by means of FICS:

Table II. Approved cost (NOK) per kWh saved. (Measures of type A and B)

Measure	Total	Housing	Commercial buildings
Insulating walls	1.63	1.71	1.17
Insulating floors	1.42	1.50	1.17
Insulating roof	1.97	1.69	2.17
Windows	1.63	1.74	1.37
Sanitation	0.46	0.30	0.48
Heating systems	0.70	1.02	0.59
Vent., cooling	0.77	0.75	0.77
Other measures	0.46	0.50	0.46

This clearly shows that insulating is not as profitable as the conventional ventilating, heating and sanitation measures. Insulating walls is more profitable in commercial buildings than in private houses, but roof insulation is cheaper in houses than in commercial building.

Ventilation, heating and sanitation measures show good returns in both private houses and commercial buildings. Improving heating systems gives especially good returns in commercial buildings.

Table III. Approved cost (NOK) per kWh saved in the housing sector. (Measures of type A and B)

Measures	Apartment houses	Private houses
Insulating walls	1.83	1.58
Insulating floors	1.40	1.68
Insulating roof	1.86	1.52
Windows	1.73	1.75
Sanitation	0.30	0.34
Heating systems	1.02	1.25
Vent., cooling	0.75	0.26
Other measures	0.46	1.01

Here we see that there is no substantial difference in the profitableness of the various measures for apartment houses and private houses. A great many of the apartment houses are cooperatives or condominiums, so that one application may be equivalent to 100 - 500 applications for private houses. Concentrating on such cooperatives would mean that conservation measures were effected for a very great number of dwelling units, compared with the number that would be represented by the same number of decision-makers in the private-house sector.

Table IV. Approved cost in millions of NOK. (A and B types of measure)

Measure	Commercial buildings	Housing
Insulating walls	2.70	22.54
Insulating floors	3.84	16.42
Insulating roof	10.65	6.03
Windows	0.87	2.72
Sanitation	6.45	0.43
Heating systems	21.12	12.16
Vent., cooling	45.24	2.21
Other measures	8.70	1.01
Total	99.57	63.52

Here we see a very uneaual distribution between the different measures and the amounts spent on commercial buildings and on housing. In commercial buildings only 18% was spent on insulating, while the remaining 82% was spent on ventilating, heating or sanitation.

The oppisite is found in the housing sector, where 75% is spent on insulating and only 25% on ventilating, heating and sanitation.

The change in the degree of profitableness over time that is seen in Table I can be explained by the fact that insulating, ventilating etc. were used in unequal proportions. The improved returns in the housing sector are due to the increasing number of cooperatives that are included in the figures. Cooperatives usually use measures that involve ventilating etc.

The improved returns for commercial buildings are also due to more systematic conservation in respect of ventilating, heating and sanitation, particularly improving heating systems and profitable ventilating measures.

From the point of view of the energy conservation program, it is desirable to give priority to the measures that give the best returns.

However, it being only fair to act on the principle that applications should be dealt with in the order in which they are received, we have little opportunity of giving priority to the projects that offer the most gains.

Instead we must try to arouse the interest of those who would have most to gain from energy conservation measures.

Factors which we stress as important are: Greater interest in energy conservation should be encouraged in commercial buildings, giving particular attention to ventilating etc. In the housing sector, apartment houses should especially be urged to display greater interest in energy conservation. Private houses that have their own heating and ventilating systems should be urged on to greater effort. In houses that do not have their own systems, i.e. those that are heated by electricity direct, without any ventilation system, we must try to influence the owners so that they have the houses insulated, first carrying out the measures that give the lowest investment cost per kWh saved. At present we find that this group over-invests in new windows (C projects) as compared with insulating the walls and roof.

6. EVALUATION - WAYS AND MEANS OF HANDLING AREAS GIVEN PRIORITY

When we started work on this task, we quickly realized that there were two important areas about which we lacked information:

1. Subscribers' decision-making processes in respect of investments in energy conservation.

2. What discrepancy, if any, is there between the anticipated saving and the real saving - and what are the reasons for any such discrepancy?

Two studies have already been made within the above areas and have given encouraging results.

The energy conservation department has carried out a trial project for post-implementation performance analysis (PIPA).

With regard to understanding the subscriber's dicision-making processes, we started by studying a number of interview investigations, but this study produced little specific information. We chose a different plan for the further work, however.

7. IMPROVING SUBSCRIBERS' DECISION-MAKING PROCESSES

H. Wilhite (Reference 5) had prepared a report for Oslo Electricity Works entitled: Improving the energy-conservation consultant's interaction with residential clients. We found this report so interesting that we asked H. Wilhite to prepare a specific program that we could follow.

The two focal points were:

(1) Family And Collective Decision Making

What motivates families to get interested in the possibility of an energy retrofit for their dwellings; which strategies will be effective in encouraging them to follow through and make an energy improvement? In the case of cooperatives, who are the principal actors in the decision process and how can the auditor have the most positive impact on that process?

(2) Interview Style And Technique

How does one conduct an interview with a family in such a way that the family gives honest and open information about themselves and their energy problems and needs.

The research program included extensive interviews with the auditors themselves, attending audits in both single-unit dwellings and cooperatives, and in-depth, open-ended interviews with samples of home-owning families and of principal actors in the cooperative decision environment, including cooperative chairman, steering committee members and individual families.

The findings from the single family interviews were surprising in their consistency with findings from California. Just to name a couple of interesting results, reducing monthly energy costs is not a strong motivator that starts middle and upper middle class Norwegian families thinking about a retrofit for their house. The most powerful factor is an on-going drive, in some cases an obsession, to continuously improve the house, where aesthetics and appearance play a central role. Family members are constantly evaluating and working out priorities and strategies for 'improving the nest'. For those families who have decided to make an energy retrofit, it is often the case that for one or another reason, the retrofit became cognitively defined by the family as a home improvement, and was therefore inserted on their priority list of things to do to the house.

Understanding the family scenario of home improvement is extremely important for auditors. Emphasizing the ways that retrofits improve the house, its structure, its energy-efficiency, ist comfort and especially its appearance, is a strategy that should enrich the traditional single-dimensional approach of hammering home reduced energy costs.

In the case of the collective dwellings, the research showed that there were a number of ways that consultants could improve their presentation of retrofit alternatives, and again, that some fundamenttal knowledge about how decisions are made in these collective situations was indispensable.

Based on the research findings, we wrote a chapter in the auditors handbook on both the single-family and cooperative decision environments and how the auditors could improve their approaches to both. We were not satisfied with this written formulation as a means of conveying such new and difficult material to auditors. We decided to create two seminars on the topics of interview technique and decision making, the centerpiece of which would be two video programs that would be developed on the basis of the research results and experience with interview methodology.

The first video is composed of straight takes of interviews that H. Wilhite did with families about their energy attitudes, behaviour and decision making. The programme was made to demonstrate interview technique and to act as a medium for bringing the consultants into the homes of three typical families. We used the interviews as a mechanism for showing how to formulate appropriate questions, and how to use the family responses to formulate presentations of retrofit alternatives.

The video, and the seminar generally, received an overwhelmingly positive response from auditors, and partly based on that response we went on to make a second video programme on the collective dwelling decision environment, which is also centered on interviews with residents. That programme has just recently been concluded, and was also received with enthusiasm, not only by auditors, but by those in the energy conservation department at Oslo Electricity Works who administer the audit program.

We were impressed by the impact of these interview-based videos. They seem to convey an insight into the importance of 'people factors', and to stimulate those not used to dealing with them to begin thinking of ways to account for them in their approaches. We have decided to make the videos and accompanying seminars a permanent part of the training program for new auditors.

8. POST-IMPLEMENTATION ANALYSIS, OSLO ENERGY CONSERVATION PROGRAM

Results are at hand from a trial analysis involving 50 cases. A major project covering 200 cases should be finished in summer 1986.

The objective was to find a method that will reveal any differences between the anticipated saving and the real saving. We were also interested in finding the reasons for any differences that might form a basis for improving the loan scheme. The following procedure was employed:

1. We first wrote to the owners of all the buildings, furnishing general information concerning the project.

2. To obtain as many details as possible relating to each particular case, a careful study was made of the files concerning the cases.

3. The required basic data were transferred to separate report forms.

4. True electricity consumption figures were obtained from the Electricity Works' subscriber information system.

5. We contacted the building owner by phone, to obtain information about any other forms of energy used (oil, kerosene, wood). We also asked about any alterations in the building, the number of persons, changes in habitual uses, indoor temperature etc. Often more than one phone call was necessary before data of the desired quality were obtained.

6. All energy consumption figures were adjusted for temperature by Oslo Electricity Works.

7. In some cases a site inspection was necessary.

The chief results are given below:

Table V. Post implementation analysis

Type of building	Private houses	Apartment houses	Commercial buildings
Estimated saving	35%	19%	11%
Saving achieved	29%	25%	17%

(Calculated on the basis of the group's total consumption in kWh per year per square meter.)

The figures show a clear trend indicating that with present methods of calculation we usually achieve the anticipated conservation gain.

Fig. 1 shows a comparison between the anticipated post-conservation consumption (consultant's calculations) and the recorded post-conservation consumption. When these quantities are equal, the curve will be a straight line through zero variation (see Fig. 1). The rise in the curves indicates the extent to which we managed to estimate post-conservation consumption accurately - the steeper the better.

Further Details Concerning The Results For Private Houses

Fig. 2 shows the savings and the frequency of the savings that were achieved.

In about 7% of the cases no saving was achieved, or there was an up to 10% increase in energy consumption; about 2/3 saved more than 20%, and just over 20% achieved a saving of more than 40%.

Most building owners were well satisfied with the results, but naturally those who did not gain any saving were disappointed.

All of those who had a saving of up to 20% realized that a substantial part of the gain takes the form of greater comfort. This greater comfort means that the indoor temperature is higher, and is often combined with more of the house being in daily use.

All of those who achieved a saving of over 20% were extremely pleased with the energy conservation measures effected. They too were well aware that greater comfort was part of the benefit. They all said that the house was better to live in - warmer, with less draft and noise. There was no mention of any negative aesthetic factors resulting from the energy conservation measures.

In the case of saving judged by energy sources, the saving is clearly related to the price of the energy. Private houses firstly save kerosene, which is the most expensive, and secondly oil - the second most expensive, and finally electricity, which is the cheapest.

Further Details Concerning The Results Of Energy Conservation In Apartment Houses

In apartment houses we encountered difficulty in determining the real saving. These difficulties consisted in determining a figure for the previous consumption that could realistically be compared with the subsequent consumption. Many of these apartment houses were very old and of an extremely poor standard before the conservation measures were effected. About half of the buildings were undergoing complete rehabilitation combined with energy conservation measures.

The electrical installations in apartment buildings of this kind are usually under-dimensioned so that they were unable to use the desired amount of electricity in extremely cold periods, for example. Because of the poor standard, not all of the appartment houses were fully occupied.

Rehabilitation involves building bathrooms and WCs and a modern kitchen. One offect of this improved standard is that different tenants move in after rehabilitation, many of them younger people whose way of life involves a higher energy consumption.

Pre-conservation consumption is largely calculated on the basis of empirical figures. The information provided concerning electricity consumption is checked with the Electricity Works' figures. It is not easy to determine the quality of the data available regarding pre-conservation consumption. Often oil, kerosene, coke and wood constitute a large portion of the energy used by these groups for which data are usually lacking. The savings recorded as percentages show great variations. Subsequent consumption increased in the case of about 20% of the apartment houses, all of them in buildings that involved the problems described above. We are testing out various computer-based energy models to find one that enables us to estimate the pre-conservation consumption more realistically in buildings of this type.

If the apartment houses where energy consumption increased are excluded, the anticipated saving was 18% while the saving achieved was 30%. This figures illustrate the difficulty of determining the effects of energy conservation measures.

A general pattern in apartment houses is that the energy conservation gain principally derives from oil consumption, which is often reduced substantially, 20 - 50% is not unusual, while electricity consumption often increases 5 - 30%; here I would refer to my previous remarks concerning the electrical installations in old buildings.

The great majority of the apartment buildings report a substantial improvement in the indoor climate. Noise insulation is greatly improved in buildings on roads with heavy traffic, and some occupants say that dust problems are greatly reduced. Fitting new windows is the engergy conservation measure most frequently used in these buildings, which explains these improved environmental conditions. Relative to the measures effected, the saving gained is rather high. One reason for this may be that the old windows were more draftly than was usually assumed. A great many apartments changed from single to treble glazing.

9. HOW EVALUATION RESULTS ARE USED

The results of the current evaluations performed have led to many major and minor changes in the rules for Oslo's Energy Conservation program, making it easier for subscribers to understand what we can offer them and facilitating the decision-making process.

The status energy conservation now has in engergy planning has led to planning work being more comprehensive than was possible only a few years ago. Moreover the energy conservation results have led to better understanding of and greater interest in energy conservation within Oslo Electricity Works.

Energy conservation consultants have great possibilities of influencing the building owners' energy conservation decisions. As the energy conservation department is responsible for their training and for management of the consultant scheme, the consultants should quickly be informed of the evaluation results. Our work on the energy conservation videos has resulted in the consultant course swinging more strongly over from technical perfectionism and towards better understanding of decision-making processes in energy conservation.

The results from the videos also show that many people are interested in printed matter showing specific examples of good, successful energy conservation measures to help them with their decision-making. At present material presented at a press conference is being improved and rewritten in a more popular form. It will be used in a brochure on the results of energy conservaton measures which is being prepared by an advertising agency and H. Wilhite.

At present we are planning a campaign to spread this result-oriented information to all who contemplate performing energy conservation measures. As previously mentioned, we intend to make annual performance analysis (PIPA) and it is estimated that these will cover about 10% of the new projects. We aim to rationalize the work substantially by using standardized questionnaires and data processing models.

References:

1. Energyplan for Oslo 1983 - 2000

2. Energyplan for Oslo 1985 - 2000

3. Energy conservation plan for Oslo

4. Improving the ENØK-consultants

5. Interaction with residential clients
by Harold Wilhite, Resource Policy Group, Oslo, Norway

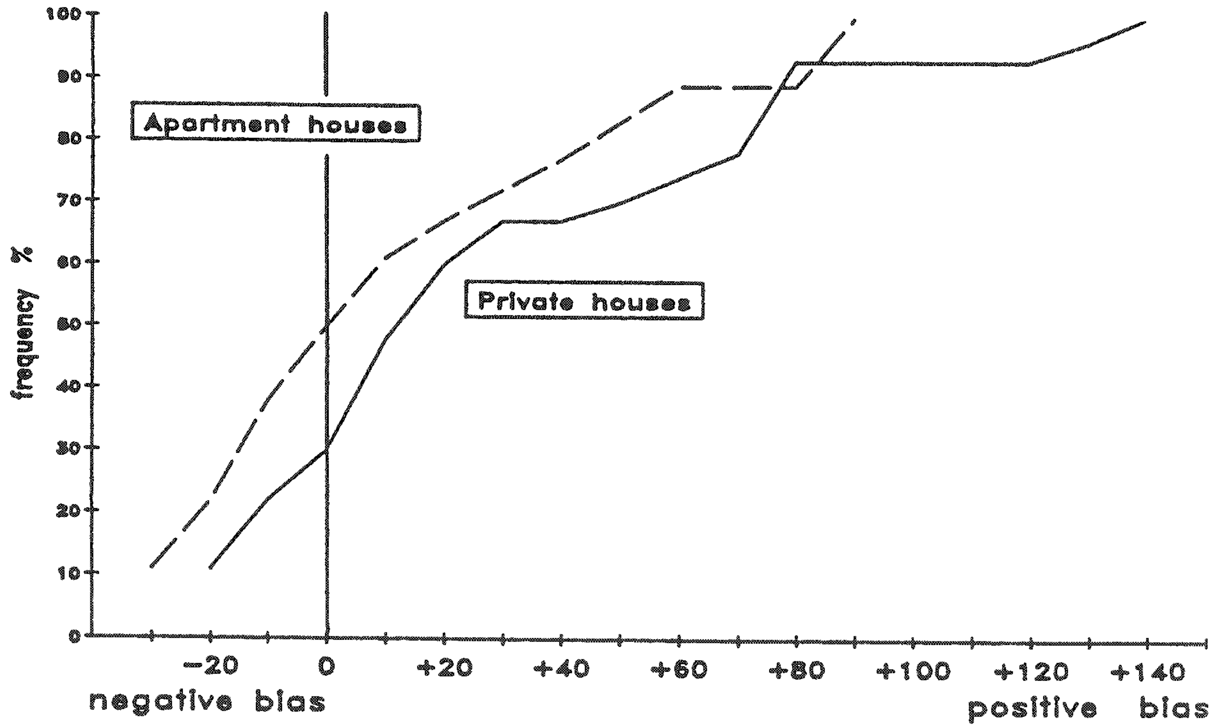

Figure 1. Comparison.
Anticipated post-conservation consumption.
Recorded post-conservation consumption.

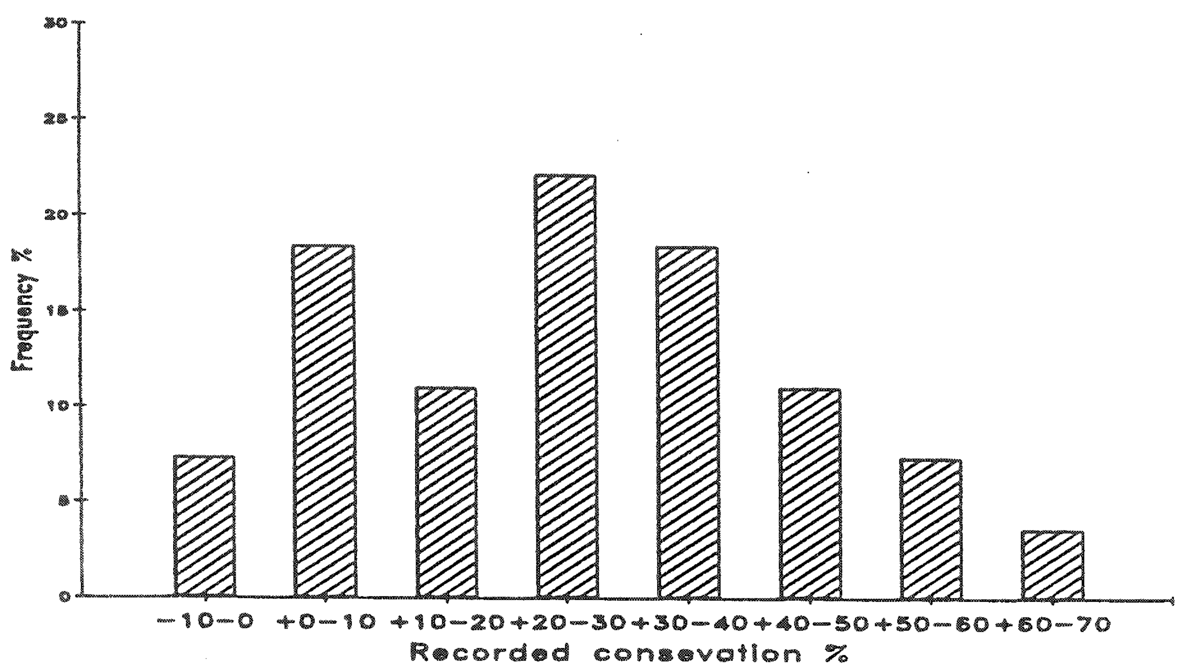

Figure 2. Private houses.
Recorded energy conservation.