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# Energy efficiency in buildings through information – Swedish perspective

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**Abstract**

The studies presented here have shown that it is fully possible to influence energy consumption through information. An increase in the knowledge among consumers will motivate them to be more energy efficient. Since several interrelated factors are involved in this knowledge level, it is difficult to establish the individual influences but such factors as the electricity bills, electricity metering, discounting and even general information campaigns, have shown to give a positive results. Energy efficiency through investment leads to long lasting results, while the effects of behavioural change may diminish very rapidly. Various investigations have shown different results. Some of them showed decreasing effect after just a week whereas others led to significantly longer lasting results. There was, however, a tendency showing that the longer the duration of the trial or the larger the information quantity contributions were, the more prolonged were the effects. © 2000 Elsevier Science Ltd. All rights reserved.

*Keywords:* Behaviour; Information; Energy efficiency in buildings

## 1. Introduction

Efficiency improvements for electricity use can, in principle, be carried out in two different ways, either through more energy efficient technology or through changed consumer habits and behaviour. In both cases, knowledge on the effects of each available alternatives is required, which means that information, advice and education are important tools within energy efficiency measures.

However, it may be difficult to establish, how such information is to reach the consumer and how it should be designed. Similar information programmes can give very different results indeed, as was the case in the 'Stureplan-project' (SEAB, 1993), briefly described later, where the possibilities to reach power reductions through a simple energy efficiency information leaflet sent out to the households were investigated.

The initial task of this paper was to focus on Swedish research concerned with the influence of information on load demand, which has been carried out to this day, but since very few investigations of this type have been performed, the aim was broadened to incorporate general energy efficiency in residential and commercial buildings.

## 2. Different information strategies

When information programmes are carried out, it is very important to reflect upon what goal one wants to achieve with the information. Furthermore, there has to be a consideration of the difference in current knowledge between the members of the target group and what motives each member may have to engage in energy efficient behaviour. Efficiency through changed behaviour as well as investment measures, require different information strategies.

### 2.1. Energy efficiency through investment measures

As far as energy efficiency through investment in more efficient technology is concerned, a major obstacle is often the customer's lack of resources required, which is generally not only of the financial type. The problem can also be due to a lack of knowledge of one's possibilities, of where to turn with queries and of which products to buy. In order to make correct judgements before a purchase, the consumer must have access to the relevant

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information. Correct and complete information, on for example energy consumption and performance, is necessary for the customer to be able to evaluate a product and estimate the complete cost. Furthermore, it is important that the information is easily accessible. The customer is often unaware beforehand how an increased level of information may lead to energy savings, and if the electricity price constitutes a relatively small part of the total budget, it may not be obvious to the customers that they need to invest more time and resources into the acquisition of the necessary knowledge. The information given to the household, is thus a determining factor for whether an extensive energy efficiency lifestyle will be put into action.

### 2.2. Energy efficiency through changed behaviour

Other information strategies, may in part also be required, when it comes to energy efficiency through a change in people's habits and behaviour. Information strategies with the aim to influence people, so that it leads to long lasting changes, have to take into account several factors, which make up the basis of human behaviour. Human motivation and interest must be taken into consideration in order to change attitudes and patterns of action. This implies that the results which are aimed at information campaigns must be rooted in individual basic values, such as an interest for the environment or personal economy. The new knowledge must also be understood and arouse emotion, which in turn may motivate action.

Therefore, it must be possible to put the information to concrete actions and situations in every day life. At the same time, it is important that the consequences of action are perceived as close and direct as possible (Lindén, 1995).

## 3. Who informs?

How can information reach the public and who will inform them? In this chapter, several Swedish and European authorities, organisations and companies, which in different ways inform customers or the public about energy efficiency, are presented.

### 3.1. The Swedish National Energy Administration — Energimyndigheten

The Swedish National Energy Administration (STEM) was formed on January 1st 1998 and has taken over the part of the Swedish National Board for Industrial and Technical Development — NUTEK's operation, associated with energy and the electricity market (STEM, 1998a).

Energy efficiency is an important area at STEM, where they deal with tasks such as information distribution on energy efficiency, stimulation and acceleration of the development, as well as support of the introduction of energy efficient products and systems for homes, offices, industry and city transport. This can be carried out in a various ways, for instance through technology competitions, demonstrations, seminars, education, conferences, exhibitions, leaflets, reports and newsletters. STEM also engages in an active collaboration with property owners, producers, distributors, energy companies, consumer consulting and consultants in building, electricity, HVAC, Agenda 21-networks, etc. Furthermore, the STEM is responsible for the local energy planning.

### 3.2. STEM's technology competition

STEM administers support for the stimulation of development, competition and introduction of new energy efficient technology (SOU, 1995; STEM, 1998a,b). Through NUTEK, STEM has obtain a vast experience of technology competitions in several areas, for instance washing/drying, fridge/freezer, office equipment, ventilation and hot water boilers. The main thought behind the organisation is that an extensive energy efficiency program and care for the environment is possible if there is a possibility to choose efficient and environmentally friendly products, during purchasing of a particular product. This requires that the products are available in sufficient quantities, at a reasonable price, and that their characteristics are well known. Usually, information is not distributed directly to the public, instead energy companies, retailers and the mass media are used to spread the information to the buyers of energy efficient technology.

### 3.3. STEM's energy labelling

In 1993, the label "El Off Strömsnål" was promoted, in order to make it easier for consumers to find the best products from an energy point of view, and to contribute to product development, which took energy efficiency into consideration. The requirements incorporated by "El Off Strömsnål" were developed by NUTEK, and covered household appliances, windows, heat pumps and control systems. A compilation of different energy efficient products is published annually in collaboration with the Swedish Consumer Agency (Konsumentverket) and Swedish Electric Utilities R & D Company (Elforsk).

Since 1991, there have been European Union regulations concerning energy labelling of a couple of households products, helping the consumers to find out how much energy an appliance is using. However, there is a risk that the message will be confusing if the appliances are given many different labels, so extensive and

repetitive information campaigns are needed, if the use of "El Off Strömsnål" is to give a long lasting results.

### 3.4. STEM's local energy advice

As mentioned in the introduction, the lack of knowledge is often an obstacle for energy efficiency. The situation is complicated further by constant changes in the energy area. These changes are found, for instance, in the deregulation of the energy market, governmental energy grants, energy taxes, environmental policies and in the development of newer, more efficient products. These conditions may also change locally, as well as plans for district heating expansion. The amount of information is large, it may be difficult for the public to find solutions which suit their personal circumstances.

The purpose of the local energy advice is to "provide an objective, locally as well as regionally adapted information and consultation" (STEM, 1998a; STEM, 1998b). The information provided is aimed at households and smaller companies, which often lack knowledge and resources to make the right choices on their own. The local energy consultation service is used to co-ordinate and complement the consultation provided by the governmental authorities and commercial parties. There is also co-operation with several other groups, such as house owner associations, local nature-preservation authorities, and company associations.

Energy consulting for the public can be done in various ways, for example, through newspaper announcements, local exhibitions, demonstrations, directly via phone, direct information to households or through homepages on the Internet.

From January 1st 1998 there were governmental grants available for municipalities and rural districts which can be used to improve energy advice in the communities.

### 3.5. STEM's other activities

STEM publishes two newsletters, "The EFFect" and "More EFFicient Energy-use", which are aimed at those working with, or associated with energy-, technology- and environmental issues. They provide basic information on news and the development within energy efficiency. Both newsletters are available on the STEM's website: www.stem.se.

Furthermore, the website features newsletters from IAEEL, an international network for energy efficient lighting, and several other booklets and reports. Two notable reports on the site include "Halve the Energy Bill in the Single Family House!" and "Halve the Energy Bill in the Multi Family House!", which contain a vast number of concrete saving tips. There is also information on various projects within energy efficiency that the STEM takes part in (STEM, 1998a).

### 3.6. The Swedish Consumer Agency — Konsumentverket

The Swedish Consumer Agency (Konsumentverket) deals with energy issues concerned with support, stimulation, and education of consumers, industry representatives and policy makers on how to apply energy efficient measures. Konsumentverket distributes information to local consumer and energy consultants and to the public. Furthermore, it is responsible for the testing of domestic appliances such as washing machines and dishwashers. Konsumentverket has developed Swedish policies based on the European Union regulations on compulsory labelling of domestic appliances and it co-operates actively with the Swedish Institute for Standards (SIS) on issues of environmentally correct energy efficiency labelling (SIS is the nationally responsible organisation for "Swan-labelling"). Konsumentverket has a close co-operation with STEM on the technology competitions and participates in pilot studies, testing and evaluations. The results of these tests are published in the journal "Råd och Rön", which is distributed to approximately 600,000 readers (KOV, 1998).

### 3.7. The Swedish Council for Building Research — BFR

The aim of the Swedish Council for Building Research (BFR) is to improve and develop the built environment through the distribution of research grants to various universities, institutes, companies and individuals (BFR, 1998). They support research, development and experiments within the entire building process, i.e. physical planning, building design, building technology, methods of production, management and administration. Sustainable energy systems is one of the R&D fields granted by BFR. The research results are published in Swedish and English as scientific reports as well as leaflets written for the general public, approximately 50 books and documents each year. Furthermore, the magazines "Byggforskning" and "Swedish Building Research" are published.

### 3.8. CADDET

CADDET (Centre for the Analysis and Dissemination of Demonstrated Energy Technologies) is an information authority within the IEA International Energy Agency. The centre promotes the exchange of knowledge and information between the participating countries. Its purpose is to work towards improving energy efficiency and the better environment through faster distribution of technology and knowledge between the European countries. (BFR, 1998). The participating countries choose relevant projects which contain technology demonstrated within energy efficiency or renewable energy. Subsequently, decision makers, planners, architects, engineers, consultants and researchers, may study the

information through subscription to the CADDET information materials and then perform extensive technological and economical analyses on investigated technology within the energy field and attend seminars and conferences. CADDET in Sweden has its office within the Swedish Council for Building Research (BFR).

### 3.9. The Swedish Board of Housing, Building and Planning — Boverket

The Swedish Board of Housing, Building and Planning (Boverket) is a central authority which works with residential and environmental issues. Its main goal is to "operate toward the standardised and efficient applications of regulations and support systems within the following areas of operation: built environment, nature resources economy, physical planning, building and living" (BOV, 1998). The building department is responsible for the building requirements imposed by the community. These are primarily concerned with health, safety, accessibility and energy efficiency. The department follows the development in the field of building and co-ordinates the Swedish building policy with the European Union and acts towards a purposeful building construction and maintenance.

### 3.10. The Swedish Energy Advisors Association — Föreningen Sveriges Energirådgivare — FSE

Today, there are several types of energy advisors, including community energy advisors, the advisors within energy companies, installation engineers and consultants. The various advisors often target varying groups as they have differing specialist knowledge. A closer co-operation with an exchange of knowledge and experiences, may further increase the value of the energy counselling.

FSE, formed in 1982, is a non-profit association that is politically, professionally and commercially independent. The association consists of around 300 members. At the onset, all the members were local energy advisors, but nowadays the membership is equally devided between those within: 1. energy departments, 2. local energy advisors, property technicians and chimney sweeps, 3. consulting and contractor field, authorities and other organisations (NUTEK, 1996a,b; FSE, 1998; Eriksson, 1998).

The common goal for the future is to "act towards a more efficient energy use, influence and create conditions for environmentally correct energy solutions, which in turn make it natural for us to promote the use of renewable energy and work towards an ecologically stable society". One of the most important tasks of the association in the future is the educational issue and a promise of quality in future energy advisors. This work has already begun and during 1998 it became possible to obtain an energy advisor certificate and a letter of competence through the association.

Furthermore, the operation of the association includes tailored educational programmes for its members, an annual congress, a magazine for members containing the current debates as well as a several projects which aim to promote energy efficiency. The association also acts as a creator of opinion through participation in and stimulation of the energy debate as well as through acts of reference, influence and debate, for private customers, companies and authorities in the energy business.

### 3.11. The Swedish Society for Nature Conservation — Naturskyddsföreningen

The Swedish Society for Nature Conservation (SNF) is an independent non-profit association with approximately 176,000 members, which is Sweden's most influential environmental organisation (SNF, 1998). Their activities include the pressurising of politicians, tracking down of environmental villains, influencing regulation acts, providing information through published magazines, books and press material, and organising seminars, debates and conferences. The main goals, as far as energy work is concerned, is the transition to a sustainable energy system without nuclear power, considerably reduced carbon dioxide emissions, no new hydro-power expansion and preserved biological diversity.

From September 1997, the SNF has undertaken a national campaign called "Energy Smart", with the purpose of finding "the best energy alternative": The saved kilowatt hours. The campaign was initiated with a request from all the members of the association to save 10% of their electricity use within a year. During coming years SNF will arrange several different activities and happenings in order to decrease energy use and the annual Environmentally Friendly Week will continue to deal with energy from a consumer perspective.

### 3.12. European Union energy efficiency programmes

The energy commission runs several programmes which support energy efficiency activities. SAVE II (Specific Actions for Vigorous Energy Efficiency) is a follow-up of the SAVE programme which ended in 1995. SAVE II will be running until the end of year 2000 and acts to complement the energy efficiency work of the individual member countries. "The aim of SAVE II is to stimulate discussion and to show energy efficiency experiences on local and regional level. The purpose is to create an environment which stimulates energy efficiency investments and diversification of the energy efficient market" (SOU, 1995; STEM, 1998a,b). The programme provides support for pilot projects which in various ways deal with rational energy use, such as training of

different professional groups and small companies as well as information distribution through seminars.

Local authorities may apply for support when creating energy offices which are financed via SAVE II. These offices work with energy efficiency measures, introduction of alternative energy sources, as well as they act as a European Union contact for regional and local authorities for energy and environmental issues. Their intention is to provide technical assistance, consultation, training, competence and knowledge mediation as well as supervision, initiation and co-ordination of various national, regional and European Union projects. In order to obtain grants from the European Union, energy authorities are to be formed by the local authority or the county council and for each initiated Swedish energy authority an authority in a foreign country is to be created. Each application requires an experienced partner, i.e. an already existing energy authority. Furthermore, the authority is required to have its own budget and its own competent staff. In Sweden there are currently six energy authorities and another six counties applied to start an energy authority in 1998.

The SAVE-programme is non-technological and thus acts as a complement to a similar European Union-programme, Thermie, which also includes technological development for energy efficiency as well as research and demonstration. A network, the so-called OPET (Organisation for Protection of Energy Technology), has been created within Europe in order to spread information on results from the Thermie programme. This is done for example through co-operation with market parties, counselling, use of data bases containing information on energy technology as well as through promotion of the results from energy projects which target various parties on the energy market.

### 3.13. The energy utilities

For natural reasons, the energy utilities possess a lot of knowledge on energy use. The motives for sharing this knowledge with their customers may vary between utilities. Traditionally, the energy utilities have focussed on energy supply. The utility's profit is partly correlated to the amount of energy sold and therefore the incentives to decrease its customers energy use are not obvious. Active efforts to decrease the energy use of customers, or the removal from peak load, may be carried out in order to escape from the use of expensive peak load energy, or from the fact that there are overloaded sub-stations and expansion of the network would be too expensive or too difficult. Other reasons may be the fulfilment of more strict environmental requirements.

On the deregulated electricity market, the energy utilities have obtained new motives to influence the energy use of their customers. Since the customers are free to choose their electricity distributor, the energy utilities has to attract new customers as well as keep their old ones, through means other than just kilowatt hours, which any company is able to offer. Therefore, energy utilities often offer their customers a whole range of services such as consulting and energy inspections. In the longer run, energy utilities will probably become more service oriented and instead of offering their customers kWh of electricity or $m^3$ of oil, they will offer good indoor climate, lighting, guaranteed delivery, etc. If energy utilities sell for example an indoor temperature of 20°C, they may gain from reducing the energy use of their client in order to achieve this.

Utilities may use several means to reach the public they serve. The most frequent ways are advertising campaigns including announcements in the press, advertisements on bill boards and information leaflets sent out to consumers. The electricity bill is a natural information tool and several utilities have made attempts to expand it to an important source of information for the customer. Several utilities have opened "Energy Centres", where customers may obtain tips and advice. Furthermore, inspections, consulting and training are offered to those who take particular interest in energy issues, e.g. landlords.

### 3.14. Energy centres

Several energy utilities have today got centrally located "shops", usually called Energy Centres, which are open to the public. Here, customers may come to ask questions on their energy consumption and to obtain tips and advice on how to save energy (and money).

The Energy Centre presents energy efficient products, including kitchen and bathroom devices and is able to inform the customers about various available heating and ventilating systems. Furthermore, the Energy Centres arrange various lectures, meetings and exhibitions (HE, 1998).

## 4. General information campaigns

Several projects have been carried out with the purpose of decreasing energy use through information. By making the consumers aware of their energy use and by showing them the possibilities for a more efficient use of energy, several projects have found that despite varying results, there is a large potential to decrease energy use. Some examples are given below.

### 4.1. The Stureplan project

In February 1993, an information campaign was carried out in the Stureplan area in central Stockholm. This information campaign is particularly interesting, as it

was aimed mainly at decreasing the load demand. The campaign was a part of a larger project which focussed on the possibilities to reduce power and energy use in a couple of properties around Stureplan. The project was carried out by Stockholm Energy and a consultant, and was financially supported by NUTEK. The purpose of the campaign was to study whether electricity use could be influenced through distribution of simple information material, without strict guidelines. The results showed that it is fully possible to accomplish a change in customer behaviour in a positive direction, but that a single information occasion does not bring about any long lasting effects (SEAB, 1993).

The conclusions from this project were as follows:

- The measurements directly after the information campaign showed the lowest power demand in this area.
- The load in the sub-station was reduced by 40–70 kW (3–5% of normal load) during the three closest following days after the distribution of the information material, the largest load reductions occurred during the peak load periods.
- Most individual properties displayed the same pattern — the load reductions are the largest over the days following the campaign. However, it was also established that two of the eight properties had not been influenced by the campaign at all.
- Good results were obtained in those buildings which contained a majority of flats, which can probably be explained by the fact that energy use has a direct influence of personal economy in such cases.

### 4.2. *Vattenfall's Task 2000 — Uppdrag 2000*

Task 2000 — Vattenfall's project for more efficient energy use — was a market-oriented project with the aim to investigate various ways to save electricity. The goal of the project was the acquisition of the knowledge concerning the potential for energy saving in Sweden. The project's aim was to form the basis for future planning of new electricity production plants.

The result from Task 2000 represents a broad picture of different energy saving strategies. This summary, however, will only present strategies concerned with energy efficiency measures through information to private customers, a part of the project "From houses to habits" (Widegren-Dafgård, 1992).

The goal of the energy habit experiment was to investigate, through experiments in 350 households with direct resistive heating, whether it was possible to accomplish a 10% electricity reduction through changed habits. Furthermore, the experiment was expected to provide a better knowledge about how to influence the customers and which information procedures are the most efficient. In order to reach the goal, 10% of the households received adequate knowledge and incentives to be energy efficient with the possibility to control their own electricity use. The experiment was followed by both investigations on behaviour as well as interviews and measurements.

Three experimental groups were exposed for three different levels of influence (level 1 represented the least influence and level 3 maximum influence). Furthermore, there was a control group (level 0) which was not influenced in any way.

The energy habit experiment tested various types of market campaigns to influence human energy habits. The information, which was distributed to the households was divided into the various areas in which savings are possible, e.g. lighting, water heating, etc. The activities available were as follows:

- "Calendar", where it was possible to fill out and check the energy use each month.
- "Kick-off" lasting for two days at each location.
- The computer programme "The House", displaying what happens with the energy in a house and what can be done to save energy.
- All participating households received statistics containing energy facts, four times annually.
- All household received a magazine "The Energy Thought" containing all the news within the field of energy, four issues annually.
- The levels 2 and 3 households obtained energy audits carried out within their home. The level 1 households were offered a written energy balance calculation instead, together with the computer programme "The House".
- In the level 3 households, a remote display was connected to the house computers so it became possible to read the electricity use. The purpose was to test how the possibility of improved control would influence the interest in energy efficiency.
- A mobile exhibitions held at local retailer outlets.
- Moving exhibition "Theme Lighting", was presented in the residential areas.

The experimental starting-point was that the households were to save electrical energy without loss of comfort. Over 79% of the participating households managed to save energy. The households which decreased the electricity use due to the installation of more energy efficient supply systems such as heat pump or stove are not in this group. The total energy saving was on average 3.1% per household. For levels 0 (the control group) and 1, the calculations were based on monthly measurement data readings. For levels 2 and 3, data collected from the in-house computer was used.

54% of the participating households saved more than 500 kWh during the experiment. This group was named "the savers". Those who increased their energy use by more than 500 kWh were named "the spendthrifts". Only 17% of the households qualified for this latter group and they had on average increased their energy use

by 10%. Among the "savers", the 10% goal was almost accomplished.

Following conclusions can be drawn from this project:

- More than half of the households almost reached the goal of saving 10%.
- The households in level 3 had the best possibility to control their electricity use and this group contained the majority of "savers".
- Fewer households within levels 1 and 2 had been influenced to the same extent as level 3, but those who had been reached, had a higher average saving than level 3 households.
- The few households which increased their electricity use, increased it considerably.

### 4.3. The Eskilstuna project

The purpose with the project was to elicit energy efficiency through information distributed to the staff and parents at the Lagrådsgatan day care centre in the city of Eskilstuna, Sweden. The goal was to increase the consciousness about those factors which influence energy use and to establish energy efficient habits and routines. The project was carried out by Eskilstuna Energy Utility and Environment in collaboration with Svensk Energiutveckling (Swedish Energy Development).

The day care centre information campaign was initiated by a project presentation with the staff and parents. Subsequently, an energy inspection was carried out at the centre with the following results (CADDET, 1993):

- A high indoor temperature which was regulated through opening windows.
- The hot water was not hot enough, so the water was left running with the expectation that the temperature would increase.
- The kitchen fan was left "on" during the whole day due to a faulty timer.
- The cloth dryers were used inefficiently, for instance, a couple of mittens were dried on full effect for the maximum amount of time.
- The lighting discipline was unsatisfactory. The lighting was usually on all day.
- The management and maintenance routines were rather poor.

The energy training was given to the staff, landlords and parents on a number of occasions. The purpose of the information was to change habits and routines and to increase the motivation of the staff. Through the study of energy consumption concerning various appliances, more knowledge on energy use was collected. Advice, concerning simple energy efficiency methods was provided, such as how to regulate the indoor temperature, optimisation of the use of dryers and manual lighting control. The staff showed great interest in the project and were very positive to receiving monthly energy statistics from the energy supplier so that the control of the electricity use was made simpler. The children were engaged in the reading of the temperatures in their section. The "meter reading" became a fun activity and was carried out according to instructions. An inquiry was carried out in order to assess the influence of the information.

The Lagrådsgatan day care centre had an annual energy use of 550 MWh when the project was initiated. The energy consumption was supervised for two years. In total, 30 energy related measuring points at the centre gave a lot of information about heating and cooling equipment, hot water, the kitchen, hot- and cold water flows, general energy use per section and indoor and outdoor temperature.

The inquiry showed that there has been an increase interest among the staff and that the distributed information and knowledge was practised.

Follow-up measurements showed that almost all measured areas and devices had decreased in their energy use. For instance, the energy use for lighting, cloth dryers and kitchen equipment had been decreased by 43%, 58% and 31%, respectively. In total, there was an annual 10% decrease in energy use (CADDET, 1993).

### 4.4. Energy efficiency in schools

The Alliance to Save Energy, which has got its head office in the US, encourages methods of energy efficiency through various programmes. The Alliance supplies interested parties with training and technological know-how within various areas. Some work has been undertaken in schools, municipalities and rural districts in order to test the educational tools leading to a more efficient energy use. One of the on-going projects is the "Green Schools project". The project has got three primary purposes:

1. to educate students, teachers, landlords, caretakers and other school staff on energy efficiency measures,
2. to provide advice and training on which behavioural changes influence energy use
3. to offer a model of energy efficiency in schools which may be used both nationally and internationally (ASE, 1998).

The project aims to involve students in behaviour analyses, the development of strategies which may change the patterns of energy use within schools, the measurement of energy savings and the project evaluation. The thought is that the money saved through energy savings in the school will return to the school in order to increase the motivation for continued energy savings. The similar actions have been started in schools in Sweden.

## 5. The electricity bill as a source of information

The use of the electricity bill in electricity saving measures may seem obvious. It is the customers' receipt on how much energy they consume and is their direct contact with the electricity supplier. The electricity bill can also be used as a communication tool for saving arguments and saving tips, but in order for it to be an important electricity saving measure, the information must be easy to understand for those it is aimed at.

### *5.1. Pilot study on informative energy bills*

In 1988, the Nordic Council of Ministers commissioned a project, which focused on the evaluation of electricity bills in the Nordic countries and the development of recommendations to make them more informative. The project results are presented by Wilhite *et al.* (1988). The report establishes that the bills are difficult to understand and that there is no possibility for the consumers to evaluate how efficient their energy use is in the household. Furthermore, the report contains a presentation of results from behavioural studies which found that there is a large potential to decrease household energy use if energy bills are delivered frequently and if the information on energy consumption for previous periods is available so that a comparison can be made with other households.

The report provides several recommendations on how energy bills can be made more informative and these suggestions are based on, for example, experiences from the US, where most energy utilities use informative energy bills. These recommendations include:

- Increase the number of bills per year and base these on real energy use.
- The energy bills should contain information about the electricity use for previous periods and comparative information on the energy use in an equivalent household.
- The information on the bills should be decreased. If they contain too much information the consumers find it difficult to follow all calculations.
- The consumers should receive explanations of the information found on their bill.
- The energy bill should contain energy saving tips. The report argues that this type of information in combination with information on previous energy use and comparison with an equivalent household is particularly efficient as far as decreasing of energy use is concerned.

### *5.2. Informative energy bills in the Nordic countries*

Applying the pilot study mentioned above (Wilhite *et al.*, 1988), several experimental projects have been carried out in the Nordic countries. A compilation from these reports was made in 1996 in the NUTEK-report (1996c). The results have been mixed, from a 10% saving in Oslo (Norway) to no noticeable effect in the city of Helsingborg (Sweden). The reasons for the different results have been difficult to establish, but one reason may be that the trial period was too short in some cases. The households have simply not had the time to change their behaviour. Another reason may be that the statistical methods and the energy use statistics used as data have been different, why different results have been obtained. In each case, the results show that it is difficult to reach certain conclusions when human factors are the focus of research. Some of the mentioned experimental projects are presented and summarised in Table 1.

## 6. Household requirements on the electricity bill and other energy information

It seems rather obvious that information has the potential to influence people's energy use, but in order for the information to have the intended effect, it has to be designed in such a way that the customer absorbs it and is motivated to take the appropriate action. The NUTEK report "The households demands on the electricity bill and other energy information" (NUTEK, 1996a,b) presented a project where the households attitudes to energy savings and their views on the electricity bill and other energy information was investigated.

### *6.1. The project procedure*

The purpose of the study was to identify the households' needs for information on energy use and to formulate those demands onto the electricity bill as well as other energy information. This was carried out through three partial studies, a quantitative questionnaire study, where 270 households answered 60 questions; a qualitative interview study, where 20 households of varying composition were interviewed and also two group interviews.

### *6.2. Household attitudes and problems*

In order to evaluate the household consciousness and ambitions concerning electricity saving, the households were required to indicate whether they had taken any saving measures over the previous year and if they intended to take any measures in the future.

The results showed that nine out of 10 households had carried out some form of energy saving during the previous year. Most measures were behaviour related (i.e. more effective utilisation of household appliances) while the technological measures taken were often simpler such as new insulation strips. This may to some extent be

Table 1
Summary of informative energy bill projects in the Nordic countries, based on NUTEK (1996c)

| Project | Purpose | Sample | The bill improved through | Debit and reading | Energy-savings | Customer reactions |
|---|---|---|---|---|---|---|
| Oslo Norway (1989–92) | To establish the saving potential from improved electricity bills | 1400 | Bar-charts 2 years, energy saving tips. Six bills annually | Debit of real consumption. Reading by own staff | 10% | Increased energy consciousness, changed energy habits. Easier bill, more thorough reading |
| Helsinki Finland (1989–92) | To study the effects of improved energy bills | 700 | Electricity report with statistics and charts, saving tips. 10 bills annually. | Debit of real consumption. Reading by own staff. | 2% | Thorough reading of the information letter. Almost all customers satisfied and want to continue. |
| AKF-project Denmark (1989–91) | To evaluate the effects of various information efforts | 1500 | Electricity report each month with statistics and saving tips. | Preliminary debit. Self reading cards. | 2–4% | Increased information does not cause changed attitudes. Spendthrift people find it easier to save than others |
| MSE Denmark (1988–91) | To increase the consciousness of the energy consumption | 1000 | Simplified bill with 2 years' statistics and saving tips. Six bills annually | Debit of real consumption. Self-reading cards | 3% | The bill is made simpler and acts as a control tool. More conscious customers. |
| Tibro Sweden (1989–91) | To evaluate the effects of increased information | 1400 | Electricity reports as an appendix in the bill, compared with other customers | Preliminary debit. Self-reading cards | 2% | More energy conscious customers. The electricity bills work as an alarm-clock to take measures. |
| Helsingborg Sweden (1992–93) | To develop a system for improved bill information | 600 | Graphical information, comparison with equivalent house. 3, 6 or 12 bills annually | Debit of preliminary and real use. Self-reading. Answer phone | No energy-saving | Almost all the customers prefer the new bills. Easier to control the bill and obtain info on energy consumption. |
| Umeå Sweden (1989) | To offer an increased customer service | 50–1300 | Energy letter each month with consumption statistics and saving tips | Preliminary debit. Self-reading cards and answer phone | 12% | Changed habits due to the energy letters. |

explained in terms of the living situation, where technological measures are less interesting to carry out for a household which is renting their residence. The most common motive to make energy saving measures were private economical aspects, but also, national economical aspects (environment and economy) as well as an improved housing environment were given as motives.

Only every fifth households had plans for future measures which could lead to a decreased energy use, but the majority, 81%, did not have any plans at all. This may be related to the possibilities to decrease their energy use which the households estimated for themselves, as well as how keen they were to decrease their electricity use. 80% estimated that they had "very small possibilities" or "rather small possibilities" to reduce their electricity use while only 15% estimated that they had "rather big possibilities" or "very big possibilities". 46% of the households responded that it was "essential" or "very essential" to reduce the electricity use while 38% were neutral and 16% of the households thought it to be "unessential" or "totally unessential". A considerably greater number thought it to be essential to decrease energy use than had actually responded that they were capable of undertaking such energy savings.

In order to investigate which were the most significant problems that the households experienced with respect to information and energy savings, the households were asked to rank 14 different statements. The problems which obtained the highest ratings were as follows:

- Lack of knowledge on how to save efficiently.
- Lack of feedback in order to be able to control the effects of the measures taken.
- Lack of possibility to compare oneself with a reference object ('equivalent household')

Furthermore, the households were asked to estimate the influence of various measures on their future saving possibilities. The most influential measures were reported to be:

- More information such as saving and purchase tips.
- Purchase of energy-efficient domestic appliances.
- Display of effects of any saving measures on future electricity bills.

- Easy estimation of the most expensive activity (e.g. the electric heating, the dish-washing, or the washing of clothes)
- The knowledge that the saving efforts have a positive environmental effect.

### 6.3. Energy information and energy savings

In general, the households within the study consider themselves to have an acceptable energy use behaviour. They perceive themselves to be energy efficient, so that it is almost impossible to save more or behave differently than they currently do. Still, the households thought that increased knowledge through information would be an effective energy-saving method. The questionnaires revealed that 71% found it "very important" or "rather important" to receive information on how to save energy in the household. 67% thought that the electricity bill should contain this type of information, as the highest motivation to absorb saving tips and information occurred at its time of arrival. Part of the investigation was carried out as interviews in order to create a deeper understanding for how individual households handle their electricity bill as well as other information material, such as which type of information is the most interesting and how this information is read, interpreted and used.

### 6.4. The electricity bill

The questionnaire and interview evaluations, showed that the electricity bill serves two purposes, from the perspective of the households. First and foremost it is an invoice, but furthermore many people perceive it a control tool.

The households think that the electricity bill, as an invoice, should contain certain information, such as the total amount of energy use in kWh, the price per kWh as well as fixed charges, VAT and other taxes. The accuracy of the invoice should be easy to check and the households perceive themselves to have increased possibilities for doing so if there is access to, for instance, an electricity meter. Preliminary debiting is considered to reduce the intelligibility of the invoice and hinders the households' possibility to check the accuracy. Furthermore, the layout and content of the invoice may be an obstacle to its function, but may stimulate reading through an "easy to read" appearance. For comparisons, graphs are perceived as more comprehensible than tables and figures.

The households use the electricity bill as a control tool in order to control their own electricity use. This is achieved through comparisons with previous bills or with friends and neighbours and in some cases through personal usage statistics. The majority of the households considered it to be important to be able to compare their own use with the use of a "normal" or "equivalent" household, or to be able to make comparisons between the use during different periods. Bar charts, which described the annual use, month after month, were perceived as very positive and easier to understand and take in than numbers.

The role of the electricity bill as an incentive to save energy seems to rise when the households energy use increases in relation to the perceived individual "normal use". If the electricity bill contained information such as saving tips, its function as the "moderator of change" would possibly be fortified, especially if the saving tips were directly linked to the observed current trends of energy use increase.

### 6.5. Other energy information

The households evaluation of information material on energy shows that such material is usually too general and that there are too many booklets and fact leaflets. Furthermore, they can often be mistaken for advertisements. The households are often rather energy conscious but not energy knowledgeable. There is a consciousness as to the importance of low energy consumption, in the same way as not to pollute the environment, but the knowledge of the connection between energy use and behaviour is rather limited. The households think that the obtained information does not lead to understanding of what can be done in the individual household and what actions would lead to actual savings. In order for a breakthrough to occur, the information should be based on actual possible actions in the various forms of housing. Hence, the information should be less focused on base consumption calculations (e.g. hob, fridge running costs, etc) and more based on comparisons between various, concrete actions and behaviours. The consequences of different action patterns and activities have to be made clear, not only in kWh, but also in more apprehensible forms such as savings expressed in monetary terms.

## 7. Does the information give long-lasting effects?

The report by Gregory and Harrigan (1997) showed that education and information as a complement to other demand-side management (DSM) measures increases energy efficiency and that it is possible to obtain permanent effects for a longer period. The report describes a project which was carried out by the Niagara Mohawk Power Corporation Partnerships Pilot Program in 1990. The project idea was to offer customers in gas-heated houses assistance with insulating. The customers, which were all low-income earners, were divided into four groups. One group was a control group which was not offered any services, one group was only offered assistance with insulating, and two groups which also obtained energy training and thermostats. The training consisted of three

meetings in the customers' homes, which focused on providing the customers with an understanding of the consequences of alternative energy behaviour, making them motivated to participate in the programme and showing them the use of the thermostats. The meetings were followed up with letters together with the energy bill, where the customer was given feedback on the change in energy consumption. The project was run over one year and subsequently the energy company did not contact the customers.

After one year, the results showed that the groups which had received training had reduced their gas usage by 23.9% and the group without training by 13.8%. Three years later, the savings for the groups were 20.1% and 12.6% respectively, indicating little change over three years. As only energy savings on heating had been investigated, a surprising result was obtained. In the training group some households declined the assistance with insulation. Those who had accepted the offer, saved 30.2% during the first year, and 25.5% after three years. Among those who had declined the offer, the savings during the first year were 18.7%, but had increased to 24.6% after three years. It seems as if the training had been more effective in those households which had not been insulated. However, it should be added that the number of declining households were rather few, so the figures are somewhat unreliable.

## 8. Negative effects

When an energy efficiency programme is executed, result variations may be caused by consumer behaviour and various negative effects may arise. According to Goetschel *et al.* (1995), such effects include:

- Rebound effect. Participants in energy efficiency programmes tend to increase their use of electrical appliances as a reaction towards lower electricity expenses.
- Snap-back effect. Participants in energy efficiency programmes tend to buy more appliances as a reaction to saved money through lower electricity expenses.
- Free rider effect. Some of the participants would have become more energy efficient anyway, and it is therefore uneconomical to place resources on this particular group, as no more energy will be saved.

## 9. Discussion and conclusions

The projects presented here, show that it is fully possible to decrease energy consumption through information. However, they also show that it is difficult to establish beforehand exactly which effects an information campaign may obtain. The results from the projects vary from 10% savings to no noticeable effect and in some cases even an increased electricity use. This type of result insecurity may sometimes contribute to the underestimation of the information as a tool for creating energy efficiency. The effects of a concrete technological measure, such as the installation of energy efficient appliances, may last for as long as the appliance is running, while people may forget or loose the enthusiasm for behaviour based energy saving that they have acquired through information or education. Without evidence for how long savings last, it is difficult to estimate the cost efficiency of information measures; that's why other measures are sometimes given the priority.

It is always difficult to reach absolute results and find concrete evidence, when human factors play an important role. As far as energy efficiency information is concerned, human factors may be the major variable, which makes the data even more difficult to analyse. Various investigations reach different results, but there is a tendency that the longer the trial period, the longer lasting the effects. The Stureplan project showed that the effects started to diminish after only one week, while other efforts have led to substantially longer lasting effects. The education and information used as complements to DSM measures increase the total effect, and it is possible to obtain permanent effects over a longer period.

When the consumers are reminded constantly, the negative effects decrease. For every step, the knowledge among the participants will increase, which implies that the chances for the consumer to turn from possible actions to concrete actions will increase. The overall motive in society to increase energy efficiency is based on environmental thinking. However, the individual may find it difficult to see how a decrease of the personal energy consumption will directly influence the environment. The financial benefit is often a stronger motive. This can be noticed particularly when campaigns which try to attract people to buy energy efficient equipment using discount vouchers prove to be effective and popular. When various energy efficiency measures are carried out, it may also be important that the customers are given a clear confirmation, so that they continue to be motivated. This is why the electricity bill may play such an important part in the energy efficiency context, if it is designed in a way which makes it legible, apprehensible and comprehensive.

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