Experience with Implementing Energy Management through Networking in Norway

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ABSTRACT

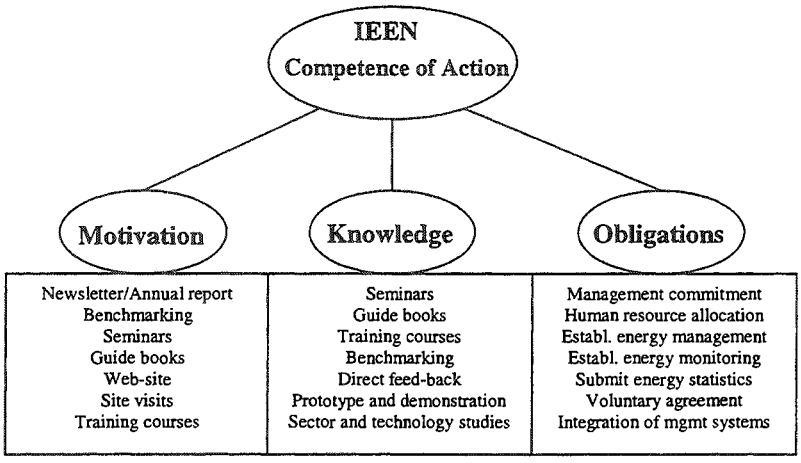
This paper describes experiences from implementation of energy management in Norwegian industry, it provides an overview of Norwegian framework conditions and emphasizes the fact that governmental energy efficiency measures are generally restricted to "soft measures". This is important in order to avoid influence on the deregulated electricity market by introducing "hard measures" such as grant schemes.

"Soft measures", and in particular "*enhanced Competence of Action*" can give successful results by implementing energy management, however one needs appropriate methods to measure the impact. Focus is put on measuring the qualitative results of implementation of energy management in industry.

The paper introduces the Competence of Action model and the "Self performance evaluation" tool, which can be used to measure the impact of the key elements in the model which are in fact also the key elements in energy management. Furthermore the activities and results in the Norwegian governmental programme, the Industrial Energy Efficiency Network - IEEN is described.

In the discussion, IEEN activities are put into the Competence of Action model, thus showing the relations between the activities in the IEEN and the model.

The results measured by self performance evaluation show that proper implementation of the model contributes to enhance companies' performance with regard to Motivation, Training, Monitoring, Policy and Organizational issues, thus fulfilling the objectives of enhancing Competence of Action. Furthermore, the results show that the IEEN is a viable catalyst for achieving the governmental objectives, however with a fair potential of continuous improvements in the future.



Introduction

The intention behind this paper is to show the effectiveness of implementing energy management in industry through networking, given the framework conditions of the liberalized energy market in Norway and the current governmental energy efficiency policies.

Figure 1 below describes the overall method according to which this paper has been written. Each of the levels and boxes will be further detailed in the paper.

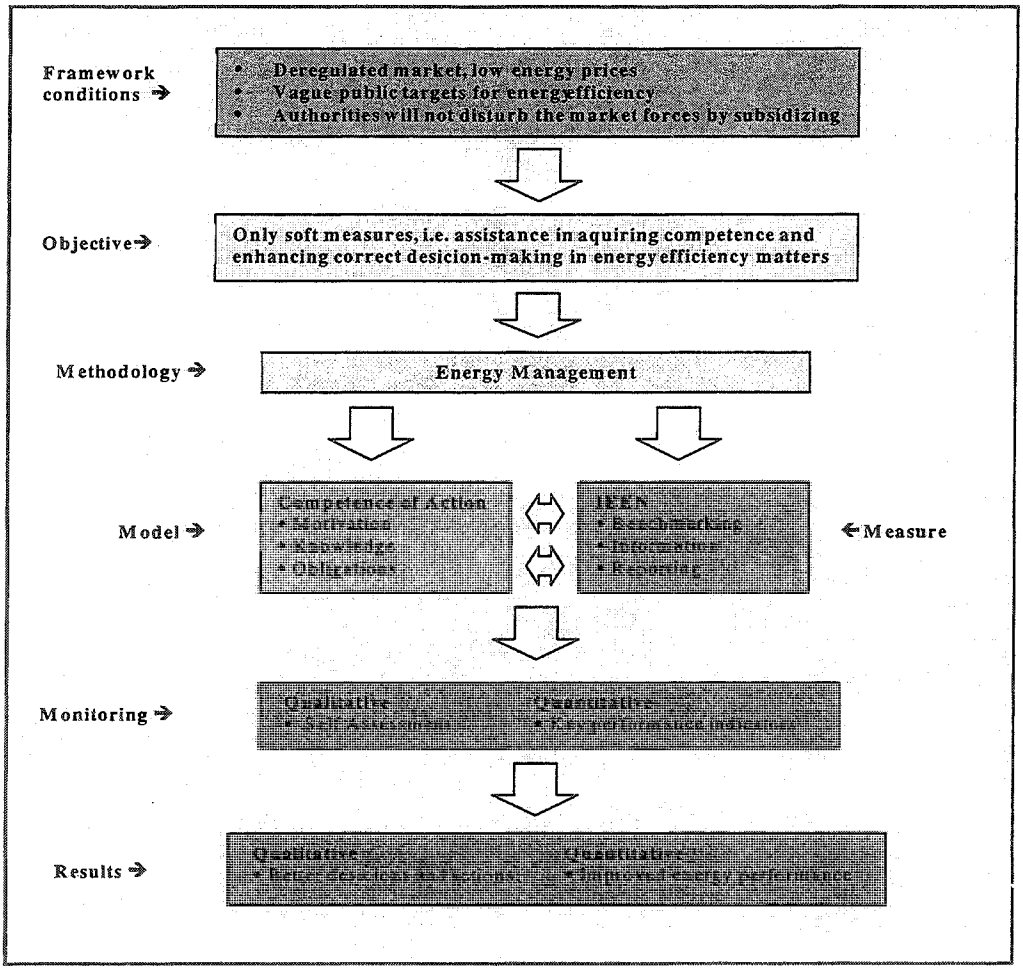


Figure 1 Overall paper method

Framework conditions

Energy in Norway

Almost all (99.5%) of Norwegian on-shore electricity is produced from hydro power plants. Installed capacity in 1997 was 27.3 MW, capable of producing 112.9 TWh as an average for a mean hydrological year. From 1986 to 1996 total final consumption of energy grew by on average 1.0% per year. The electricity share has been almost constant at approximately 48% of final energy, while solids and gas have increased at the expense of oil. The evolution of final energy consumption is shown in figure 2.

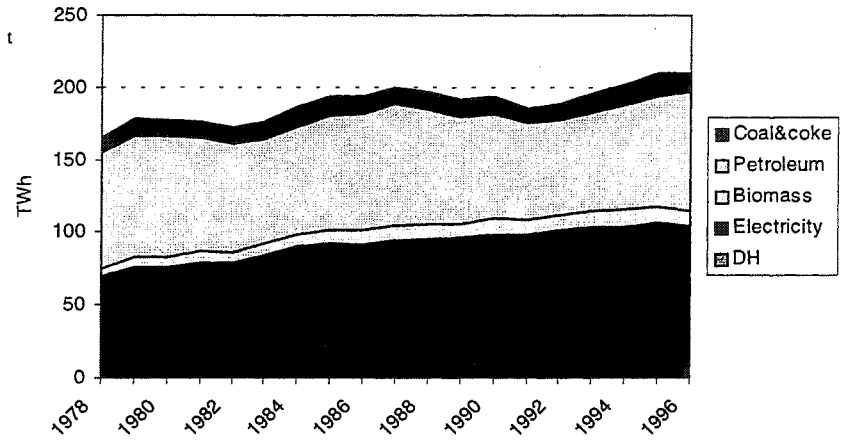


Figure 2 Final Energy Consumption by fuel in 1996.

Presently (1999), there is a fast increasing shortage of domestic hydropower production in a mean year. Net electricity imports in 1997 and 1998 were 4.0 and 3.6 TWh respectively (Alm, Krogh and Mydske, 1998).

Deregulated electricity market

The Norwegian power market has been formally open to competition since 1991, but real market access for all the end user groups was not established until 1995. Both the practical implementation and market impact have been good on the whole.

The market is now regarded as being sufficiently open in order to realize an efficient market over time. The table below sums up the development of market access since 1991.

Table 1 Annual changes in the market access regulations for end users

1991	Introduction of the Energy Act Local supplier has a significant market advantage NOK 5000 per year per customer stipulated as maximum fee for using a supplier other than the local supplier
1994	Maximum fee reduced to NOK 4000 per year per customer.
1995	Hourly metering requirement for change of supplier eliminated. NOK 246 stipulated as maximum fee for changing suppliers.
1996	Hourly metering for electricity consumption in excess of 500 MWh per year.
1997	Fees are eliminated.
1998	All end users can change suppliers on a weekly basis.
1999	Hourly metering for all installations over 400 MWh.
2000	Reading of all end users at the end of the year.

1 NOK = 0,133 US$

Free trading in electricity is dependent on the establishment of a system for the metering and calculation of how much electricity is bought and sold at all times. Power consumption will change continuously according to the end users' demand for power for heating, lighting, etc. Due to the continuous fluctuations in production and consumption, the value of the power will also change frequently.

As with many other goods, the power price is set before delivery. The price will be dependent on the supply and demand of power for future delivery periods. (NVE 1998)

Constraints on governmental influence

The previously described electricity market is very complex, and Norwegian authorities are therefore reluctant to introduce public measures that can influence the good functionality of this market, such as direct or indirect subsidies. In turn this implies that the other energy markets, the heat market etc will receive little or no subsidies to enhance the introduction of biomass, heat pumps etc.

The solution to date has been to organize the public measures in a way that leave all decisions to be made by the end-users, and focus the public effort on assisting them in their decision-making process. This means that the majority of public energy efficiency measures are what we call "soft-measures", that is measures that aim at enhancing the end-user's competence to decide and act according to what they find being best for themselves, their business and/or of course society at large. However, there is no exact definition of what is best for any of these user groups, and assessments of the quality of these decisions and actions are very difficult to make.

The following section describes the type of energy efficiency measures that have been introduced to the different user groups in Norway.

Energy efficiency measures

Energy efficiency has been part of Norway's energy policy since the oil crises in the mid-1970s. The degree to which attention has been focused on energy efficiency, and the funds allocated to energy efficiency measures, have varied. The amounts allocated were particularly high in 1990-1993, when a temporary grants scheme was in operation for energy efficiency measures in private households, the service sector and the industrial sector. In addition to the grant scheme, the state has continuously financed other measures, mainly general information and training activities.

The objective of energy efficiency measures and activities in Norway has always been to ensure rational use of energy resources. Furthermore, in order not to disturb the energy market forces, the use of subsidies to favour certain energy sources or technologies is currently not good policy. The governmental objective is presently to assist end-users in acquiring sufficient knowledge and competence so that they can make correct decisions and act accordingly in matters regarding energy efficiency.

In the following section we will illustrate how the governmental energy efficiency measures and activities are organized in Norway to achieve the above mentioned objectives.

Institutions and organization

Figure 3 shows how official energy efficiency work in Norway is organized. The role of the Ministry of Petroleum and Energy is to ensure that state funds are allocated rationally, draw up a long-term strategy for energy efficiency, and evaluate changes in the use of energy-efficiency instruments.

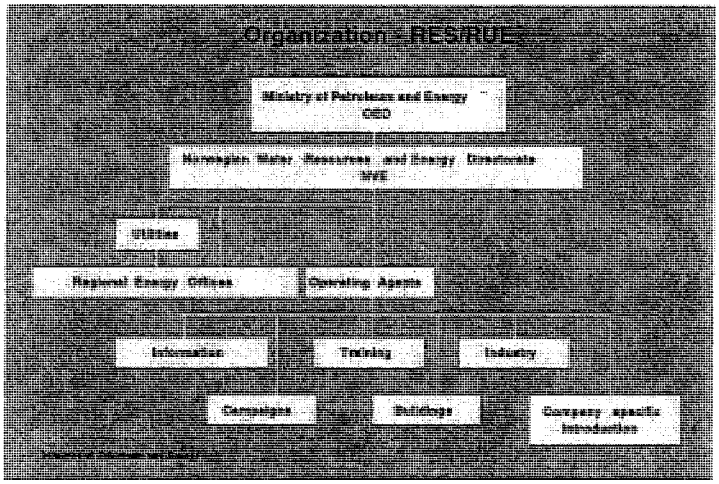


Figure 3 Energy Efficiency in Norway, Organization

Experience shows that one important barrier to greater activity in this field in Norway is lack of knowledge. Information and training, together with the introduction of new technologies, are therefore the most important instruments available to the authorities.

Operating agents: The Norwegian Water Resources and Energy Directorate (NVE) is responsible for administration of governmental efforts in this field. It has chosen to delegate responsibility for practical implementation of the various measures to operating agents outside the central government administration, and these were appointed in the course of 1995. The sectors and activities covered are:

- Industry
- Buildings
- Information and training
- Campaigns
- Introduction of innovative energy technologies

Regional Energy Offices: Pursuant to the Energy Act of 1991, energy utilities which hold local area licences are required to implement certain energy efficiency measures vis-à-vis users in the area. The authorities are encouraging the establishment of regional centres to organize such activities. The first centre opened in August 1994 in Sør-Trøndelag County. By the end of 1997, centres had been established in all 19 counties. The regional energy efficiency centres are responsible for local information and training activities. They cooperate with the Information Centre for Energy Efficiency in arranging courses and meetings. The centres can also provide customers with basic advice on energy efficiency. The centres' activities are based on the statutory duties of the energy utilities, which include the provision of information and advice on energy efficiency. These activities may be financed by a supplementary charge of up to NOK 0,003 per kWh included in the transmission tariff at the lowest grid levels. The centres are to be open to other participants than the energy utilities, such as oil companies.

Budget

The Governmental energy efficiency budget in 1996 was 100 MNOK (13 MUS$). The budget increased to 148 MNOK (20 MUS$) in 1997, 173 MNOK (23 MUS$) for 1998 and the proposed budget for 1999 is 270 MNOK (36 MUS$).

Methodology - Energy Management

As described in the above, governmental energy efficiency objectives will be achieved by the implementation of "soft measures". Energy management is seen as a strategic approach in this sense and furthermore a prerequisite for achieving energy efficiency improvements.

Experiences with successful implementation of energy efficiency in the industrial sector indicate that energy efficiency is not exclusively determined by economic decisions but depends to a large extent on the existing company culture, and on the engagement of firm internal key actors and their interaction within the organization (DGXII 1998). To secure the company energy supply in terms of amount, quality and price, energy management has to be an integral part of everyday practice through an ongoing process of gaining lasting motivation and efficiency knowledge.
Following the methodology of traditional "Business Excellence", the company's long term objectives can only be reached through continuous improvements of all factors affecting the defined Critical Success Factors (CSFs). This methodology can also be applied to energy management, and we may call this *Energy Management Excellence* or *Competence of Action.* This approach will, by way of both qualitative and quantitative improvements in energy performance, in time also give measurable energy efficiency results. In this paper we will not focus much on the *quantitative* or technical energy efficiency results, which are normally measured by different monitoring, benchmarking and statistical methods. However, we will focus on the monitoring of the qualitative progress of energy management for which a simple model has been developed. The model will be described in the following, and is based on the most significant CSFs in energy management (IEA 1995).

Competence of Action - model

The key elements in the Competance of Action model are described below.

Motivation

Energy cost often represent a small part of total costs, energy prices are still relatively low and stable, and energy is treated as an overhead rather than as a raw material cost. Due to the above, energy is given low priority in terms of management attention in many industrial organizations. Thus managers are not directly accountable for its use and as a result energy is being wasted.

In our model we have defined information and rewards (or penalty) to be critical success factors for increased motivation. Effective use of external (case studies and benchmarking) and internal (energy monitoring) information will stimulate people to act. General management procedures should provide appropriate information with regard to energy, to the right people at the right time. Another important issue to motivate the staff to save energy is to give rewards to people that contribute to reduce the energy use.

Knowledge

It is not enough to be motivated if you don't know how to act or make the right decision. Knowledge is essential to everyone in the organization with some influence on

the energy bill. Key people need special competence, and targeted and energy related training schemes should be part of the company's career development programmes.

Monitoring energy use gives valuable knowledge about the energy use, new opportunities for saving as well as maintaining savings from any existing efficiency investments. Key performance indicators are of great value for internal monitoring, but also for benchmarking with other competitors.

Obligations

To succeed, energy management needs full support of senior management. One success criterion is to include and state this clearly in the company policy. This constitutes a clear commitment for the company, with regard to both internal and external expectations. The policy has to be followed up with targets, action plans, monitoring and evaluation. This also requires a good organization with well-established routines and clear delegation of responsibilities.

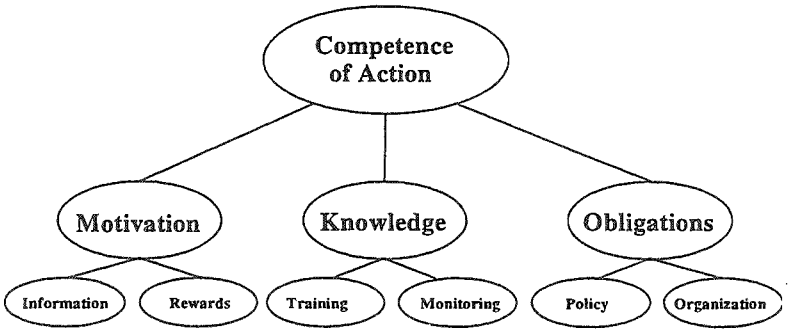


Figure 4 Competence of Action - Model

Evaluating Energy Management

It is difficult to monitor qualitative indicators like energy management. However, some relevant methodologies exist and the IEEN has adopted one based on a model described by CADDET (IEA, 1995). In our case the model has been slightly modified, and the "IEEN-version" is described in Table 2. The model has a three-level score for assessing the development of energy management and is done by self-assessment within the company.

Table 2 Model for energy management evaluation

Level	Motivation	Training	Monitoring	Policy	Organization
3	Information is used actively to motivate all employees	Targeted and energy related training of management and employees	Regular registration, processing and follow-up of energy data	Energy policy is established, for instance as part of the environmental policy, and is known to all employees	Energy management is fully integrated in business management with well established routines and clear delegation of responsibilities
2	Informal, ad-hock information to selected groups in the company	Key-personnel attend training courses on own initiative	Regular registration of energy data, but no further use of the material	Energy policy is established, but only rarely known within the company	Partly established energy management, however, with vague routines and responsibility areas.
1	No, or hardly any information to the employees	No, or hardly any energy related training activities	No, or hardly any internal energy monitoring	No energy policy is established	No energy mgmt. routines have been established

Industrial Energy Efficiency Network

The main objective for the Industrial Energy Efficiency Network programme (IEEN) is to focus on energy efficiency in SMEs, and to improve the ability of individual companies to make correct decisions in matters regarding energy and environment. (Competence of Action) The IEEN 570 members' accounts for about 40% of the energy use in industry. The network, with a total budget of 1.5 mill US$ in 1997, is financed by the Norwegian Water Resources and Energy Directorate (NVE) and is governed by an executive committee of industrial representatives, as illustrated in figure 5. The operating agent for industry, Institute for Energy Technology (IFE) is responsible for the secretariat and daily administration of the network and its activities.

General agreements are made with industrial sectors through their trade associations, and individual companies may then voluntarily join the IEEN. At present the only requirement for membership is the provision of an annual statement of energy consumption and production volume.

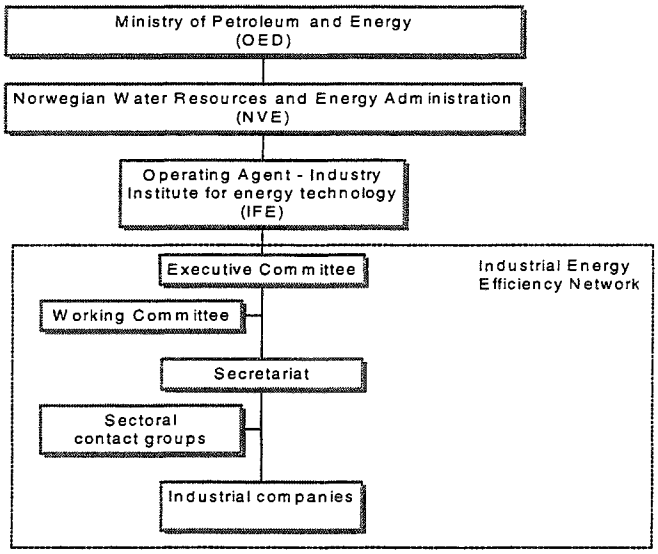


Figure 5 Organization of the IEEN

The executive committee of industrial representatives is authorized to establish strategy and a programme of work within the overall external budgetary framework. The industry also has a high degree of influence through the sectorial contact groups, which develop priority lists and action plans for annual activities in their sector. In practice this implies that each sector may adapt IEEN core activities, tailor-made for specific needs.

In each member company there is a contact person in charge of interaction with the secretariat. In addition the IEEN acts as a communication link between the industry, energy consultants, suppliers of products and services and the authorities, with the aim of reducing existing information barriers between them.

As mentioned, the main objective of the IEEN is to improve industrial companies' in-house ability to make optimal decisions regarding energy and the environment. (Competence of Action) The current IEEN strategy is based on the elements described in the following.

Information and motivation

The main information and motivation activities are based on publications and tailor-made, sectorial seminars and workshops. Two regular publications are issued to provide relevant information to the IEEN members;

1. The quarterly newsletter "Enøk Forum" is issued by the Operating Agent for Information and covers energy efficiency and renewable energy in general. However it includes editorials, news flashes and comments relevant to the industrial sector specifically.
2. The IEEN Annual report (IFE 1998) is issued annually, and is the main site for the presentation and discussion of the benchmarking data supplied by the IEEN members.

The recently established web-site, (www.enoknorge.no) will also be important to update the industry on ongoing activities. Furthermore, guide books, site visits, training courses, tailor-made seminars and targeted information such as descriptions of successful EU-projects and IEA CADDET material are other instruments to stimulate the industry.

Benchmarking on specific energy consumption

A key IEEN activity is the benchmarking of specific energy consumption in different sectors. This benchmarking is based on annually submitted company reports on energy consumption and production output. These reports are quality controlled and processed to obtain average company specific and sectorial benchmarks of specific energy consumption. In general, if there are large differences in energy consumption of different manufactured products, statistical methods, such as multi-variable regression analysis, are used to obtain sectorial specific energy consumption figures. The IEEN annual report presents company specific energy data in an anonymous manner and thus actively used to motivate companies to improve their energy efficiency.

Prototype and demonstration projects

A decisive factor for industry to invest in more energy efficient technologies is to demonstrate its economic profitability. The IEEN does this by identifying best practice examples of energy efficiency projects, monitoring them and producing project reports for distribution to target groups. The IEEN may finance part of the investment in such demonstration projects, limited to 50 % of the total costs.

Sector and technology studies

Sector and technology studies are important tools to investigate energy efficiency potentials within sectors. These studies may be regarded as sectorial energy audits, and are also performed for new sectors prior to joining the IEEN. In case of market introduction of a new technology that may be applicable to several sectors, there are normally incomplete assessments available on the energy efficiency potential of this particular technology in the different sectors. Targeted studies may then be funded and undertaken within the IEEN to assess such potentials.

Energy management and analysis support

A new and important service to IEEN members is energy management and analysis support, and about 50% of the IEEN annual budget is currently allocated to this purpose. As a member of IEEN, a company, plant or site is offered experienced energy consultant assistance in designing and implementing an energy management system, more or less free of charge. A group of 30 consultants which are pre-qualified by IEEN, offer assistance to the companies in implementing energy management. Energy management is not a goal in itself, but it helps the company to secure the energy supply in terms of amount, quality and price. Being a tool for obtaining continuous improvements with regard to energy efficiency and choice of energy sources, energy management does not differ significantly from other management systems. In most cases energy management can therefore be successfully integrated into the company's existing routines and administrative systems. The IEEN can be seen as being a catalyst in this process.

During the last three years more than 120 companies within the Industrial Energy Efficiency Network have taken benefit from the Network's Analyses Support Scheme to establish energy management or carry out an energy audit.

Results

Criteria for successful energy efficiency activities can be measured by quantitative indicators (reduction of energy consumption) and qualitative indicators (Competence of Action). Figure 6 shows the average results from self-performance evaluations carried out in 120 IEEN companies, after having implemented energy management. The evaluation methodology is described in detail in Table 2.

Provided that it is an unrealized energy efficiency potential that is economically profitable, increased Competence of Action will also result in action. Based on the reported energy data, IEEN provides key performance indicators which can be used to monitor the development of specific energy consumption.

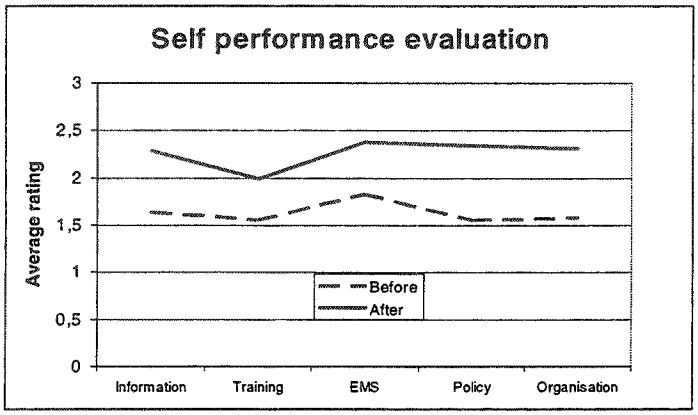


Figure 6 Improvement in Competence of Action after implementing Energy Management

A majority of the members can refer to positive results in terms of increased production and reduced specific energy consumption (kWh/produced unit). Although the results are sensitive due to the choice of reference year and changes in production

(different products, different quantities), yet it gives an indication on the development with regard to energy efficiency in Norwegian industry. Figure 7 shows the change in specific energy consumption in % from 1995 to 1997 for 12 sub-sectors (IFE 1998). The energy savings represent 290 GWh or about 1% of the total energy use in the member companies.

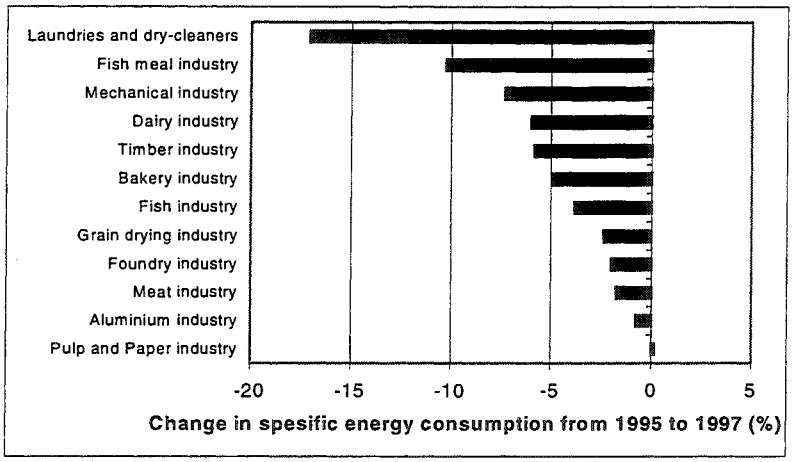


Figure 7 Change in specific energy consumption from 1995 to 1997 within IEEN companies

The results are supported by a separate market survey (MMI 1998) that shows that 60% of the companies have carried out energy efficiency activities during the last two years. Furthermore, 79% of those state that these actions have been highly or quite profitable, and 90% of the companies in IEEN fully or partly agree that the membership is important to promote energy efficiency in industry.

Discussion

Based on the original model, with the description of the different IEEN activities built in, figure 8 hows the resulting IEEN Competence of Action model. This resulting model is a tool for further and continuous improvements of the IEEN.

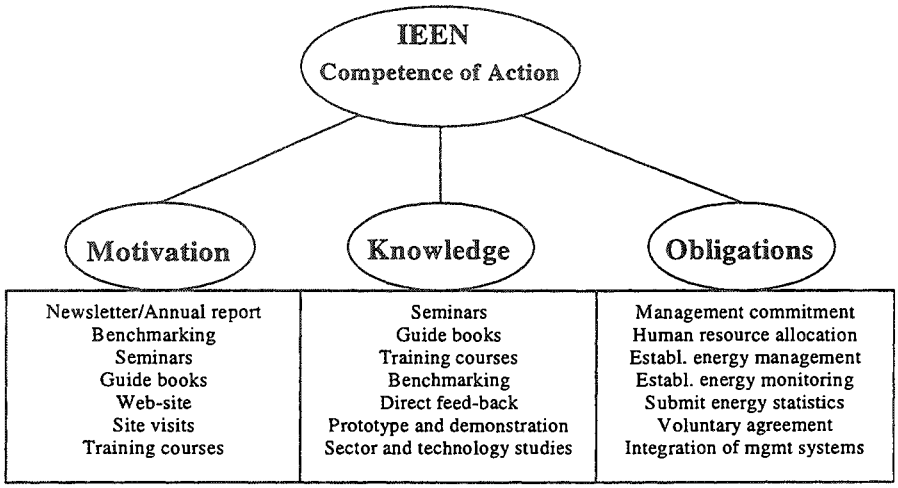


Figure 8 IEEN-Competence of Action

From the model, one can immediately see a number of missing elements in the IEEN activities, which according to the original model must be fulfilled in order to make the picture complete, and thus secure Competence of Action. One example of such missing elements could for instance be that there are no activities on *rewards* within the network. A natural consequence of this will then be to see whether such activities could be included in the future, thus contributing to a continuous improvement of the network.

The reference group from which the input to this paper has its origin, are exclusively members of the IEEN. This fact limits our possibility to draw clear conclusions with regard to the impact the network approach has on industrial companies in general. It is clear, however, that the IEEN member's Competence of Action has increased by implementing energy management, ref. figure 6. A natural activity in the near future would be to establish a reference group of companies outside the IEEN in order to benchmark the IEEN-members with the non-IEEN members with regard to improvement in Competence of Action.

Conclusions

Introducing energy management based on the Competence of Action model has proven efficient, and supports the idea of using the Industrial Energy Efficiency Network with all its elements of Motivation, Knowledge and Obligation as a basis for implementing energy management in industry.

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