The language of energy efficiency – industry vs energy freaks. Experiences from case studies

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Abstract

Many countries in the EU try to decrease the energy end use in industry with a wide range of energy efficiency programmes. Very often the industries themselves show little interest in these programmes, because the programmes have been created by "energy freaks" and they only focus on the energy side. This should be seen in the perspective that in Denmark as an example the electricity cost for an industry, that is not very energy intensive, is often only 3-5% of the production cost. To ensure a higher interest for energy savings and thereby realize the efficiency potential in the industrial sector it is necessary to speak the language of the industry, and that means phrases like reduced maintenance cost, reduced number of unplanned production stops, better working environment, reliability, better quality and education of the employees, and other things that add value to the value chain in the industry.

This paper presents three successful energy-efficiency campaign case studies carried out in Denmark and an outlook towards some other Scandinavian energy-efficiency programmes directly or indirectly addressing the language barrier in industrial sector. Although these studies and programmes were successful, they most probably would have been even more successful should they to a higher degree have emphasised on the language of the receiver of the information (i.e. industry).

Background

In Denmark as in many other EU countries nearly 70% of the electricity consumption in industries is used in electrical motors for production machinery, pumps, compressors, cooling plants, ventilators and fans. Many programmes in EU have focused on the issue introducing high efficient motors (HEM) in industries. Often an energy consultant can have a hard time convincing the energy manager that he should show interest in HEMs because the energy saving is very little if one only looks at one motor. This paper deals with energy efficiency in industry from several aspects. One aspect is experiences from three information campaigns in Denmark focusing on reducing the losses in motors and motor driven systems. The main idea was of course reducing the electricity consumption, but the campaigns also focused on the maintenance side, education of the employees etc. The campaigns were directed towards the working man and the workers' manager. Secondly, the paper deals with experiences from some industrial energy-efficiency activities carried out in Sweden and Norway, addressing (directly or indirectly) energy-efficiency language barriers. The paper ends up concluding on the importance of establishing a long lasting energy policy platform and the importance of focusing on the spin off effects "carrying" the energy savings when the energy freaks try to "sell" energy efficiency.

Danish DSM experiences

Demand Side Management (DSM) has been on the agenda in Denmark since the mid 1980s. At this time DSM was in its childhood, there were very few experiences and it all started with consultancy services. The activities were formed by the Danish electric utilities, on which the Danish

government imposed the implementation of energy savings for funds collected through the electricity bill as a levy (approximately 0.006 DKK/kWh corresponding to approximately 0.0001 Euro/kWh).

The electric utilities started to train energy consultants who became specialised in industrial energy audits and giving advice on energy consumption, primarily focusing on auxiliary systems like lighting, compressed air, ventilation and heating (electric).

The typical experience of these auditors was identifying savings in the range of 20% of the consumption that was mapped, while 10% of the savings were realised[1]. This was achievable since until then there had been very little focus on the energy bill due to the fact that the cost of energy was only a minor fraction of an industry's total costs.

The energy consultants gradually became well known, and the industry learned that money could be earned if they focused on the energy-consuming systems. It also started to become obvious to the industry that energy efficiency is not only about repairing existing plants, but also about being energy aware when equipment is purchased.

It is a well-known fact among energy consultants that the largest financial gain, when talking about energy-efficiency, is present when new equipment is purchased. Many examples in Denmark and elsewhere show that it is worthwhile to energy-scrutinize projects. It is furthermore a fact that not only the price, but also the energy consumption of the product during its entire lifetime is important when buying new equipment[2]. As an example, for a compressed air installation, the investment cost is 20%, the maintenance cost is 10% and the energy cost is 70% if looked in the perspective of a 15-year life cycle cost analysis. However, this knowledge is not obvious among industry people.

The utilities in Denmark played a major role when implementing and realizing the Danish government's energy policy directed towards the industry, and the initial "tools" in this work were the utilities' consultants working with energy audits and awareness campaigns. Experiences from the consultants' energy audits distinctly pointed out a major lack of knowledge of energy-efficient equipment among industrial staff. Both when replacing and purchasing new equipment they bought what they used to buy instead of looking for new more efficient products. One example of this was the motor area, where several surveys carried out before and during the campaign period of the Danish High Efficiency Motor (Sparemotor) campaign[3] showed that the degree of knowledge about High Efficiency Motors was very low. As nearly 70% of the electricity consumption in the Danish industry is used in connection with motors and motor driven systems, the Danish Utilities' Organisation, ELFOR, decided to launch a campaign aiming at this area in the industry. It was also decided that this campaign should be the starting point of a sustainable campaign strategy directed towards industry.

Danish energy-efficiency campaigns

Several energy-efficiency and awareness campaigns have been run in Denmark. Three of these campaigns are described in this paper. These are the High Efficiency Motor (HEM) campaign[4], the campaign for Optimization of Belt-Driven Motor Systems[5], and the Energy-Efficient Fans campaign[6].

THE HIGH EFFICIENCY MOTOR CAMPAIGN

The High Efficiency Motor campaign ("Elselskabernes Sparemotorkampagne") was launched in September 1996 in conjunction with an industrial exhibition. The timing of the launching event was chosen to ensure attention to the campaign from media. A mere 28% of the target group had heard of HEMs before the campaign. The campaign period was set to a three-year period.

It was also decided that the Danish Electric Utilities and their consultants should play an important role in the campaign to ensure synergy effects between campaign and the utilities' other energy saving activities. The idea was that the utilities' organisation ELFOR should co-ordinate the campaign on national level, and that the utilities and their energy consultants should promote the campaign on local level.

Campaign Target Groups

When initiating a campaign it is important to consider the roles of all the different actors, from equipment producer to end-user. Already when planning the campaign the suppliers and producers of motors were contacted. They have an important role to play, since their influence on the Original Equipment Manufacturers (OEM) group and the end-user is of major proportions. Consulting engineers who often are involved in designing industrial plants and other projects is another very important group. OEM producers who supply motor-driven products (ventilation, cooling towers, pumps etc.) is yet another important group. One might even say the most important group, since very often when a new cooling tower is purchased the buyer thinks "I have paid 50 000 Euro for this cooling tower, such an expensive investment has to be efficiently equipped", while the manufacturers on their hand most often merely look at the investment cost of the equipment components and not the life-cycle cost of the equipment.

After analysing the current market situation, the following campaign strategy was decided:

- A public support scheme should make it more popular to purchase HEMs.
- Motor producers should be provided incentives to produce and promote HEMs.
- OEM manufacturers should be motivated to equip their products with HEMs.
- End users should be stimulated to demand HEMs.

Campaign Tools

But what is the definition of a HEM? To clarify this ELFOR published a "positive list". This list turned out to be a very strong tool, and the role of the "positive list" was enforced to be even stronger when the Danish Energy Agency decided to support the motors on the "positive list" through offering HEM purchasers a direct subsidy. The "positive list" was published on the campaign web site, www.sparemotor.dk. The requirements for admittance to the "positive

list" were jointly set up by the Danish Energy Agency and the motor producers and suppliers.

Lessons learned from previous campaigns led the Danish Energy Agency to implement a subsidy, which was very straightforward, easy to calculate and apply for. The subsidy design was simply DKK 100 (14 Euro) per kW motor power (shaft power) if the motor was published on the "positive list". This subsidy strategy was very successful.

ELFOR designed the awareness campaign in co-operation with a public relation company. The message of the awareness campaign was simple, and the awareness campaign was very successful. A recurrent theme built on humoristic drawings by a well-known Danish cartoonist and author was chosen for this awareness campaign.

The day the campaign was launched, the first edition of the "positive list" was published and sent by direct mail to the 4 000 largest Danish industrial enterprises. Several full-page advertisements were inserted in national newspapers. Also a press conference was held where the homepage of the campaign was introduced. During the almost three years in which the campaign ran, the "positive list" was updated five times and sent by direct mail to the Danish industry.

In the months following the campaign start several meetings and seminars on energy-efficient motors were held by the electric utilities and others. Articles were submitted in the daily press and trade magazines. Articles with case studies from industrial enterprises having chosen High Efficiency Motors were regularly printed, primarily in trade magazines. Local utilities also reported on their own case studies, from experiences on local level.

HEM campaign objective

The HEM campaign objective was to increase the market share of energy-efficient motors from virtually zero to at least 25 000 motors out of approximately 150 000 motors sold annually should be energy efficient. The campaign goal was more than well met! In the three-year campaign period roughly 75 000 High Efficiency Motors were sold, thus making the campaign three times as successful as expected.

An independent evaluation consultant assessed the impact of each major mail and advertising element of the campaign. Should the activities not have shown satisfactory results, the campaign steering committee was prepared to discuss and alter or re-arrange the campaign after each campaign element. The campaign steering committee was exchanging experiences with HEM professionals from United Kingdom, to learn how they have dealt with the challenge of teaching and convincing the industry to use HEMs.

Assessments of the target group awareness and attitudes made during the campaign period gave in short the following results:

- Prior to the campaign merely 28 percent had heard about High Efficiency Motors. After the campaign 77 percent could mention a producer or supplier of high efficient motors without hesitation.
- Prior to the campaign 18 percent believed that High Efficiency Motors were too expensive. Today only 10 percent share this opinion.

Figure 1: *Example of illustration used in the Danish High Efficiency Motor Campaign.*

- Prior to the campaign 18 percent believed that conversion efficiency is important. Today 26 percent shares this perception.
- Prior to the campaign only 17 percent found it crucial to purchase High Efficiency Motors. Today 59 percent share this opinion.

Moreover, we know from interviews with several large Danish industrial enterprises that several of them now have chosen to include High Efficiency Motors in their procurement policy.

Interest in campaign and actions taken from motor producers and suppliers

Several motor producers are now producing High Efficiency Motors. One major Danish motor producer has early during the campaign even chosen to change the entire production exclusively to High Efficiency Motors.

Especially in the beginning of the campaign many of the motor suppliers were sceptical. Their scepticism was primarily aimed at the suppliers themselves. There were accusations of exaggerations of the conversion efficiency in order to ensure a place on the "positive list". However, this self-regulation naturally also had a positive effect.

At the beginning of the campaign the stage was not set for control of the motors' conversion efficiency. When early in the campaign a standardised test certificate was demanded from the motor manufacturer, some producers chose to withdraw their entries from the list.

Producers not initially accepted on the list spent a lot of energy trying to find campaign faults and irregularities. However, with the increased demand for High Efficiency Motors the criticism faded away, and instead these producers tried to improve their own motors in order to be accepted on the list.

HEM campaign cost and cost efficienc

As mentioned, the Danish industry purchased 75 000 High Efficiency Motors during the campaign period. These motors contribute to the estimated annual electricity saving of at least 20 GWh. The total electricity consumption of motors in the Danish industry is estimated to 6.5 TWh. Based on present annual electricity production in Denmark the electricity savings achieved through the HEM campaign equal to a reduction in CO_2 emissions of 15 000 tons per year.

The total HEM campaign cost was approximately DKK 7 million (approximately 1 million Euro). This means that the HEM campaign by far is among the most cost efficient measures undertaken in Denmark when comparing the achieved energy savings to the project investment.

THE CAMPAIGN FOR OPTIMIZATION OF BELT-DRIVEN MOTOR SYSTEMS

The Optimization of Belt-Driven Motor Systems campaign[7] was operated by two Danish companies, Louis Poulsen & Co and TRE-FOR, and financed by the Danish Energy Agency.

The Danish HEM campaign served as a platform for this new campaign. Questions like "What are we going to do, now that the High Efficiency Motors are running 10% faster than the old motors?" often led to discussions about belt-driven systems, how to design them and maintain them. It became apparent that there was a great lack of knowledge about the design and maintenance of belt-driven systems. The immense proportion of industrial electricity end used in connection with motors and motor-driven systems (more than two thirds) and a report from the Danish Utilities Research and Development Institute (DEFU)[8] showing that the losses in electric motors due to over-dimensioning, and motors suffering from poor system efficiency, is bigger than 25%, underpinned the need for this new campaign.

When this campaign was started the Danish industry was not aware of the electric losses from switchboard to workload, especially not the losses in the belt-driven systems most commonly used in Denmark. The most commonly used system covers nearly 75% of all transmissions, thus by far being the most interesting link in this connection.

Pilot projects

Experiences from pilot projects had shown that it was possible to achieve savings in the magnitude of 10% of the system energy consumption. The savings were mainly obtained through more careful dimensioning and implementation of better maintenance program. The pilot projects also showed that a lot of rumours and disinformation about the selection of belt types were commonly spread. In some industries the common view was that one type of belt was the best solution for all cases. Unfortunately the belt world is not that simple, and inevitably such a view will lead to many disadvantages.

Simple rules – big changes

The concept with the Optimization of Belt-Driven Motor Systems project was to show that simple rules of thumb, the use of traditional belt systems, and focus on the dimensioning of the system as a whole could lead to both significant savings and reduced production cost. The main element of the project was decided to be a folder that could be used for dimensioning, re-dimensioning and, if one wanted to energy-scrutinize, a belt system.

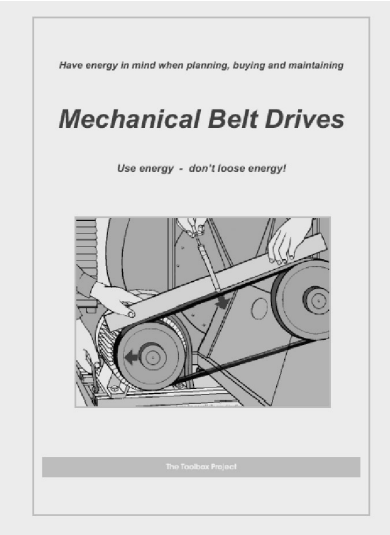

Figure 2: *The Optimization of Belt-Driven Motor Systems Campaign brochure.*

Campaign target group

The target group for the Optimization of Belt-Driven Motor Systems campaign was energy responsible staff in the industrial sector, the public sector and service and trade, consultants, equipment producers (OEM), installation businesses, and energy service businesses.

Campaign tools

The Optimization of Belt-Driven Motor Systems project resulted in a new tool to use when dimensioning, re-dimensioning, purchasing and providing machine service. Also a better understanding for the energy saving possibilities on the above-mentioned components was achieved. Furthermore increased understanding of the importance of service and planned maintenance was obtained through the project.

The information folder developed for this project included short but accurate descriptions of the following kind:

- Load types; ventilation, pumping, cooling, compressed air and miscellaneous.
- Correct motor choice; standard motors or HEMs (and focus on the type of torque needed).
- Starting methods; star/delta, soft starter, electronic soft starting.
- Belt transmissions; Description of the 8 most common types and how to choose the one best matching the transmission task and the climate for the transmission (cool, hot, greasy or dust).
- Energy wise selection and dimensioning of the system (motor – starting methods- pulleys- belts).

- Mounting; here necessary tools are described, and the campaign was followed up through marketing of a toolbox with all tools necessary to do a proper work.

The Optimization of Belt-Driven Motor Systems campaign was followed up by courses for the maintenance staff giving both theory and practical training at a test facility built by TRE-FOR, see picture in Figure 3. The courses gave experience with using the tools. Furthermore the courses provided possibilities to see the differences in RPM if the belt tension for instance was wrong, to learn in practice differences in working with a good quality motor sledge as opposite to a poor one, to see what poor alignment of the pulleys do to belt life, and to see the differences in using different belt types and pulleys, etc. The program also included a presentation of a maintenance program for belt systems: it is still a common misperception among maintenance staff that when the belt is running, you can forget all about it. The courses concluded with four reported examples on projects were the campaign staff had optimized the motor-driven systems.

Figure 3: *The Optimization of Belt-Driven Motor Systems campaign test facility built by TRE-FOR.*

Campaign elements

The main campaign element was training of industrial maintenance staff conducted by the utilities' energy consultants. Training seminars were held to disseminate the campaign message, how to optimize motor systems with belt transmissions. When addressing the industry people, the focus was not only on energy savings but more on maintenance, product lifetime, LCC, unplanned stops etc. In this part of the project the sales technique and market knowledge from Louis Poulsen's[9] sales department really showed the "Energy Freaks" how to speak the industry language. A folder printed in 40 000 copies was addressed towards the target group through direct mail, the folder has since been reprinted in 20 000 copies. Newsletters and articles in technical magazines read by the target group also accompanied the training. Since the campaign was supported by the Danish Energy Agency the campaign was coordinated with other energy saving activities carried out by the agency.

Cost and cost efficiency of the Optimization of Belt-Driven Motor Systems campaign

The campaign budget was 1 million DKK (approximately 150 000 Euro), the major part of the campaign costs were covered by the Danish Energy Agency.

Since campaign budget did not include resources for evaluation the campaign has not been independently evaluated. However, records of results from the campaign have been kept by TRE-FOR. The campaign included 30 seminars with a total of 800 participants and one 3-day course giving 25 participants in-depth insight and knowledge of belt transmissions. More than 50 000 folders have been handed or mailed out. There is also a general awareness of the campaign among the suppliers of transmission equipment, evident e.g. through the willingness of the major suppliers of transmission systems in Denmark to co-operate with the campaign organisation.

One example of spin off effects of the project is the test facility that could handle loads up to 100 kW, where belt systems could be tested under different loads and climate, developed by DEFU and the Danish Technological Institute.

THE ENERGY-EFFICIENT FAN CAMPAIGN

More than 15% of the industrial electricity end use relates to ventilation. Most fans require huge amounts of energy, thus there are millions for industry to save by changing to energy-efficient fans ("Spareventilators")[10]. This was the starting point for a campaign undertaken by the Danish utilities to raise the industrial awareness of how energy-efficient fans are able to reduce electric power consumption to the benefit of company finances as well as the environment. The idea was also to benefit from the growing awareness of energy efficiency achieved by the High Efficiency Motor campaign and the Optimization of Belt-Driven Motor Systems campaign.

Campaign elements

The campaign began in autumn 1999, and was carried out during a three-year period ending in the autumn of 2002. The campaign elements were a homepage at www.spareventilator.dk, a "positive list" of energy-efficient fans (Spareventilator list), direct mail to end-users and consultants, and a public awareness campaign consisting of advertisements in daily newspapers and trade journals. Again the advertisements focused on simple messages on energy-efficiency measures.

Campaign target groups

The energy-efficient fan campaign had several target groups. These were the 4 000 most energy consuming Danish industries, consultants working towards industry, utility energy consultants, manufacturers of fans, and other trades and industries.

Campaign targets

The primary campaign target was to increase the market share of energy-efficient fans. This was quantified to sale of 9 000 energy-efficient fans during the three year campaign period, thus reducing total energy consumption for ventilation in Denmark by approximately 160 GWh. However, the campaign also embraced targets of influencing fan manufacturers to develop energy-efficient fans, and of creating

Table 1: Efficiency Rate Requirements in the Danish energy-efficient fans campaign.

Shaft power	From 0 to 0.5 kW	From 0.5 to 1 kW	From 1 to 3 kW	From 3 to 10 kW	From 10 to 20 kW	From 20 to 50 kW	From 50 to 100 kW	Larger than 100 kW
Minimum parameters for maximum efficiency rates	76%	78%	79%	80%	81%	82%	83%	84%

awareness and motivating consultants and energy consultants to actively promote energy-efficient fans.

The Spareventilator® definition

To be included in the Spareventilator®list two conditions had to be fulfilled. The first condition was a minimum efficiency requirement, and the second condition was that a fan must have a reasonable range based on volume flow. All data, including the criteria and the minimum measuring point defined had to be made available and be described in the measurement report for each fan. Documentation for fan pressure and air volume performance was required to be in accordance with ISO 5801. The required efficiency rate should be or exceed the efficiency of Tolerance Class 2 in accordance with DIN 24166.

Fans could be registered as Spareventilators only once.

Cost and cost efficiency of the Energy-Efficient Fans campaign

The budget for the energy-efficient fans campaign was 10 million DKK (corresponding to 1.4 million Euro). Since the campaign just recently has been finished the evaluation of the campaign has not yet taken place.

The preliminary campaign results indicate that 30 000 energy-efficient fans have been sold during the campaign. Should these figures be confirmed, the energy-efficient fans campaign, just like the Danish High Efficiency Motor Campaign, has been more than three times as successful as expected! Also 12 seminars where 300 participants have been educated concerning energy-efficient fans have been held.

Scandinavian outlook

Denmark is of course not the only country where industrial end use has been on the agenda during the last two decades. National and regional energy-saving and energy-efficiency measures have been undertaken in many other countries, and reasons for a Scandinavian outlook are rather obvious when studying the Danish efforts and the results of these efforts.

SWEDISH EXAMPLES OF INDUSTRIAL ENERGY-EFFICIENCY PROGRAMMES

Numerous actions on industrial energy-efficiency programmes and actions have been undertaken by the Swedish energy authorities since the late 1970s. Early in the "energy saving era" the predecessors of the Swedish Energy Agency (STEM) carried out major information programmes on industrial energy end-use, often specifically directed towards different trade branches. These programmes included general awareness campaigns, trade specific handbooks on energy-efficiency and checklists. In the 1980s the Swedish National Energy Agency also subsidised industrial energy audits, subsidies primarily directed towards small and medium sized enterprises.

Swedish national programmes and projects focusing on industrial energy end-use carried out in recent years aiming at addressing the language barrier are for instance the EKO-Energy project, establishment of "programme requirements", and an effect-chain analysis of industrial knowledge and awareness of energy-efficient motors.

Swedish effect-chain analysis of industrial knowledge and awareness of energy-efficient motors

A survey among Swedish industries regarding knowledge of the energy-classification system of electrical motors[11, 12] was carried out in 2002. This survey also included an effect-chain analysis on attitudes and behaviour concerning life cycle cost calculations in conjunction with electrical motors and motor driven systems. The study included three industrial branches, pulp and paper industry, chemical base industry, respectively iron and steel industry. The analysis was based on interviews with representatives from 200 plants with 50 or more employees, which corresponds to 80% of the total number of plants in Sweden within these three branches.

The study showed that the knowledge of the motor energy classification system is very low in general within the three studied industrial branches. Only 15% of the 200 interviewees could mention the European definition of an energy-efficient motor (Eff1) when asked. Furthermore the study shows that the knowledge of the European motor database EuroDEEM is virtually non-existing.

Another interesting part of the study was the answers given by the interviewees when asked which factors the think are of most importance when purchasing motors. The 200 industrial representatives were given eight fixed alternatives to grade between "very important" and "of no importance". They were also asked to add other factors of importance. The eight fixed alternatives were:

- Low operation cost compared to a standard motor,
- Short pay off time,
- LCC (Life Cycle Cost),
- Technical life time of the motor,
- Low maintenance cost,
- Replacing same model,
- Recommendation from motor manufacturer,
- Purchasing cost.

If we isolate the answer "very important" only two factors were of major significance to the industrial representatives in the study. These were motor lifetime and low maintenance cost, with 70% or just below that fully agreeing. Replacing the same model is very important to 45% of the interviewees, and the other five factors rank between 28% and 37%, with low operating cost as the least important. Factors of importance mentioned by the interviewees apart from the given eight were short delivery time, standards, service and repair availability. Also spare part systems, operating quality and noise level were mentioned as answers to this question.

One dominating reason for low operating cost and LCC being factors of least importance is probably the split responsibilities between separate company departments for investment and operation budget (with very low interaction between them) that often industries live with. Another important reason is lack of information, awareness and knowledge. Another reason for not purchasing energy efficient motors mentioned in the survey is lack of experience from efficient motors. The effect-chain analysis performed in the study clearly show that interviewees having received information and a raised level of knowledge find low operating cost and LCC being more important than the average result of the study.

The study clearly shows the importance of the "energy freaks" speaking the language of industry when aiming at realising the often large energy-efficiency potential in the industrial sector.

The EKO-Energy project

The Swedish EKO-Energy Project[13] was a project on industrial energy efficiency run between 1991 and 2001. The project goal was supporting industries to implement energy management systems and identify and implement energy-efficiency measures. The project also included an award where the most successful business in sustainable energy end-use was appointed annually. Apart from the award the project tools were subsidised energy audits, help to implement or develop energy, quality and environmental management systems and an information network among energy managers within the companies participating in the project.

The project participants often mentioned three key success elements of the project. The first is the project visibility provided through the award, the participating companies were given a lot of attention in national and local press and trade magazines in conjunction with the annual award ceremony. The second is the importance of the support when implementing energy, quality and environmental management systems provided through the project. Finally, the third success factor mentioned by the project participants was the auditing consultants ability to focus on what was important for the participating companies, and not only talking about energy savings in kWh. All these success factors are very similar to the success factors being highest ranked by industrial representatives having taken part in the Danish campaigns described earlier in this paper.

Guidance through "programme requirements"

The Swedish National Energy Agency has also produced "programme requirements" in several areas to provide energy-efficiency guidance for the industry when purchasing new equipment such as fans, cooling systems and compressors. These "programme requirement" guides illustrates energy costs and life cycle cost calculations taking industry interests such as reliability in production and low maintenance cost in consideration. Three of these guidelines are Cooling Compressors – Guidelines and specifications, Industrial Fans – Guidelines and Specifications, and Compressed air - Guidelines and specifications.

Also the Swedish Indoor Climate Institute has published a series of guidelines for the industry. This series consist of classified guidelines, developed for use under Scandinavian conditions, for indoor climate and ventilation systems intended to meet present-day requirements, and include the R1 Guidelines 'Classified Indoor Climate Systems – Guidelines and Specifications' and R2 Classified Air Distribution Systems – Guidelines and Specifications[14]. The R2 Guidelines contain voluntarily applicable performance specifications, expressed as function requirements, for airborne distribution systems. The specifications relate to electrical efficiency, measurement and adjustability, ease of cleaning and certain additional factors. Some of these areas are divided into class categories.

The guidelines mentioned here all aim at addressing energy efficiency in a language used in industry.

NORWEGIAN EXAMPLES OF INDUSTRIAL ENERGY-EFFICIENCY PROGRAMMES

In Norway, just like in Denmark and Sweden, more than two thirds of the industrial electricity consumption relates to motors and motor-driven systems. Several Norwegian projects on industrial energy-efficiency projects have been carried out to raise the industrial awareness on energy-efficiency and to stimulate energy saving measures since the beginning of the 1980s. One example of these activities is the subsidised industrial energy audits carried out by the Norwegian regional energy centres. Hundreds of audits have been carried out covering all industrial trades[15, 16]. Another Norwegian model of great interest when it comes to industrial energy-efficiency is the national trade network focusing on issues like sustainable energy end-use, information campaigns and seminars. This network was started in 1989, and is financed by ENOVA, with the Norwegian Institute for Energy Technology acting as operating agent. The network focuses on making high interest industrial matters like production and reliability "carry" the message of energy efficiency.

Lessons learned

From the case studies (campaigns and projects) described above three important lessons can be learned when aiming at more efficient energy use in industry. These three lessons are the case studies' key success factors.

The first and foremost of these lessons is that matching and fine-tuning the language of the transmitter to fit the receiver is crucial for the result. The transmitter (here the "energy freaks") often speaks about saving energy to save money. Very often these possible savings are described at an aggregated level or vaguely described as estimates, sometimes not even quantified in monetary terms but instead in

kWh. The receiver, the industry representatives that is, commonly want to hear about low maintenance costs, high quality, EMAS, more efficient production, and other things they perceive as added values in their commercial operation. And they definitely say no to any kind of energy-efficiency measures if there is as much as a tiny risk for an unplanned stop in their production line. Thus it is an absolute necessity to teach campaign advisers or project consultants the interests of and language of industrial representatives to achieve successful project and campaign results.

The second lesson of major importance is to keep the message simple. Simple messages raise and create the customers interest in what the next step might be. One example of the simple-messages lesson is that written information should not be too heavy. Another thing is that a campaign information text should help the reader answer some of the customer's questions or solve one or few of the customer's problems. But probably not all of them at the same time, since the information then risk being too long and too complicated.

The third lesson of major importance we would like to convey is to make sure at the beginning of the project to define and clarify the roles of all different actors involved. Having clarified this from the start has several advantages. It facilitates smooth co-operation among actors, saves time and project or campaign costs, makes assessment of project or campaign elements and necessary changes of initial plans easier during the project running time, and of course simplifies the assessment as a whole after its termination.

New initiative for common Scandinavian energy-efficiency activities

Industry in the Scandinavian countries has many similarities due to practice and regulations. The energy-efficiency potential is large. However, incentives (or the perceived incentives) and awareness of potential savings within the industry is not satisfactory. A new Scandinavian initiative on energy efficiency in industry has been taken by the Swedish National Energy Agency, the Danish National Energy Agency, the Danish Utilities' Organisation, and the Norwegian Institute for Energy Technology. This initiative aims at providing opportunities and better incentives for an industrial sustainable energy consumption to a high degree based on lessons on language barriers learned in projects described in this paper. Through joint efforts the volume and demand of energy-efficient motors and motor-driven systems will be more significant, and thereby the market impact will be higher.

This new Scandinavian network is investigating the possibilities to jointly carry out new campaigns and other information activities on for instance energy-efficient pumps, energy management "light" for small and medium sized enterprises (SMEs), bench marking, and common websites and conferences on sustainable energy end-use in industry.

Summary and conclusions

This paper has reported on a number of energy-efficiency actions seeking to address energy-efficiency language barriers in industry in the three Scandinavian countries Denmark, Sweden, and Norway. Awareness of energy efficiency is generally low in the industrial sector. However, an active energy policy including awareness-raising measures and well planned "language courses" brings about a more positive attitude towards energy efficiency in the industrial sector.

In the actions described in this paper some key success factors have been identified. These are:

- Identify, enforce, encourage and use energy-efficiency driving forces. One such driving force is definitely environmental requirements. Experiences from Denmark as well as Sweden show that environmental good reputation is important and that industry sub-suppliers feel obliged to observe requirements on sustainable environmental measures (among which energy-efficiency often is seen of major importance).
- Facilitate visibility of good examples of industrial energy efficiency. Awards, press releases, articles in newspapers and trade magazines are excellent ways of creating added values to support measures for sustainable industrial energy consumption.
- Bring simple messages. Simple messages raise and create the customers interest in what the next step might be. One example of the simple-messages lesson is that written information should not be too heavy. Another thing is that a campaign information text should help the reader answer many of the customer's questions or solve some of the customer's problems. But probably not all of them since the information then risk being too long and too complicated.
- Make sure in the beginning of a project to define and clarify the roles of all different actors involved. Having this clarified from the start has several advantages. It facilitates smooth co-operation among actors, saves time and project costs, makes assessment of project elements and necessary changes of initial project plans easier during the running time, and of course simplifies the assessment of the project as a whole after its termination.
- The mind of an "energy freak" is not directly compatible with the mind of an industrial energy manager. Should a significant part of the energy-efficiency potential existing in the industrial sector be realized, the "energy freak" has to learn to speak the language of the industrial energy managers. The industry representatives want to hear about NO risk of un-planned stops, low maintenance costs, high quality, EMAS, more efficient production, and other things they perceive as added values in their commercial operation. The "energy freaks" must stop speaking merely about saving energy to save money. It also means that the "energy freaks" must learn to be more market oriented, the consequences of this being that energy consultants must learn to focus on how to sell a message. Thus it will be as common that energy consultants participate in sales courses and other communication courses as they do in technical courses, should the industry in the future have success with respect to energy savings.

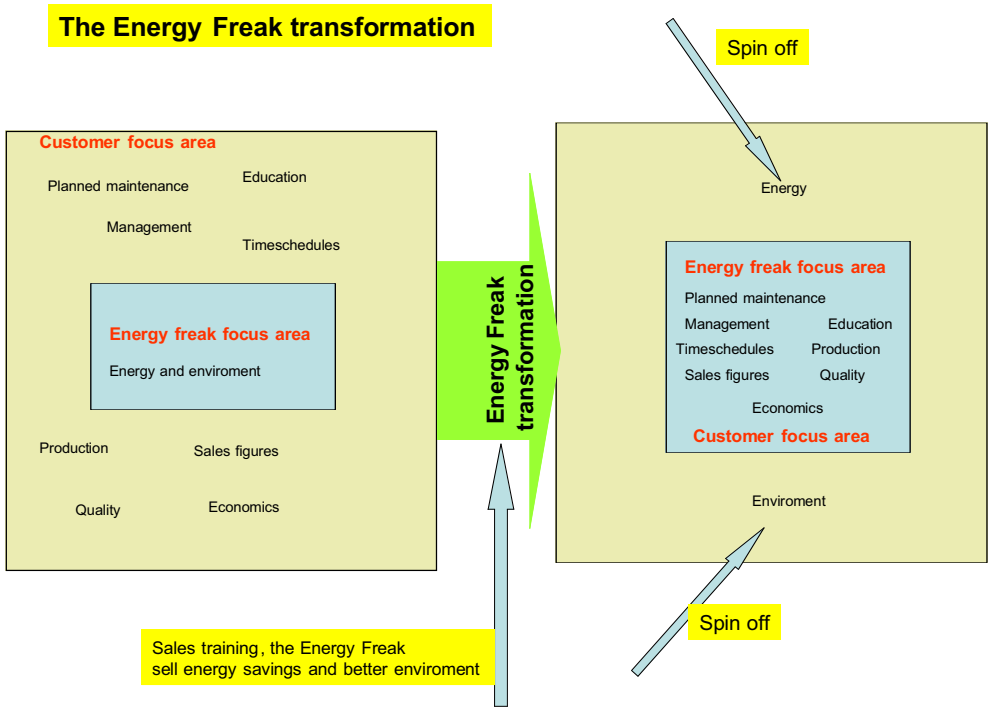

Figure 4: *An attempt to illustrate "the Energy Freak Transformation". The mind of an "energy freak" is not directly compatible with the mind of an industrial energy manager. Should a significant part of the energy-efficiency potential existing in the industrial sector be realized, the "energy freak" has to learn to speak the language of the industrial energy end-users.*

In figure 4 we have made an attempt to illustrate the barrier between a traditional energy consultant (an "Energy Freak") and the industrial energy end-user. "The Energy Freak" focuses on energy and environment, while the customer focus on planned maintenance, management, reliability in production and so forth. Here is a language barrier. Therefore it is of outmost importance that the "Energy Freak" is trained in what could be called the language of the end-user or "sales techniques" in a manner that gives him or her the skills to expose what really is the issue or the focus area for the current customer. If the customer's focus area is planned maintenance, then planned maintenance should be used as the carrier of energy savings, thus making planned maintenance lead to energy savings. This is what we see as the "Energy Freak" transformation. However, language barriers exist in all other links of the energy chain too. Hence it is important that for instance people running campaigns and write information articles remember this fact too. "Energy Freaks" (like us) always have to keep in mind that if our message was so interesting, no energy-consulting work would be needed, everybody would find their way to energy savings on there own. So when developing a campaign or other energy-efficiency programme specially language-trained "Energy Freaks" have to be involved to ascertain successful results (benefiting from real life experiences just like the Danish optimizing belt transmissions campaign did from Louis Poulsen's experiences). Furthermore we "Energy Freaks" have another important task to fulfil, namely translating the policy makers' messages of CO_2 reductions and Kyoto protocol etc. to the language of the industrial energy end-user.

Abbreviations

DEFU	Danish Utilities Research and Development Institute
DSM	Demand Side Management
EMAS	Eco-Management and Audit Scheme
HEM	High Efficiency Motor
LCC	Life Cycle Cost
OEM	Original Equipment Manufacturers
RPM	Rotations per minute
SME	Small and Medium Sized Enterprises

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