Evaluation of the swedish programme for energy efficiency - successful examples of market transformation through technology procurement

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Synopsis

NUTEK runs one of the major energy efficiency programmes in the world based on technology procurement. Recent evaluation of this programme reveals promising results.

Abstract

The Swedish National Board for Industry and Technology (NUTEK) runs a major energy conservation in Sweden. The programme spans from 1991 to 1998 with an overall budget of ca 950 million kr ($150 million). NUTEK's programme is quite unique in that most of its activities are concentrated on technology procurement compared to the usual more static measures typical for national activities elsewhere.

A major evaluation of the NUTEK's energy efficiency programme was performed in 1996 to find the achieved and future effects of the measures with emphasis on energy effects. Five representative technology procurement projects out of some 30 initiated were chosen for more detailed analyses. These areas represent an energy use of 40 TWh/yr in Sweden and the estimated market potential is 13 TWh/yr.

The major result of the evaluation is that after 5 years of work NUTEK's programme on energy efficiency has accomplished a series of major achievements: in average the procured technologies are 30% more energy efficient than prevailing products, the sales volumes are increasing and some learning effects have already been captured, the unit-costs of some technologies are decreasing, etc. The projects have been economically justified. The major factor for success lies in understanding the market.

The five procurement projects have captured about 1% of their market potential which corresponds quite well to the penetration rate of industrial products in general. By the end of the 90's this may increase to around 10%.

1. Introduction

The Swedish National Board for Industry and Technology (NUTEK) runs a major energy conservation programme to realize the economically and technically justified energy efficiency potential in Sweden. The programme spans from 1991 to 1998 with an overall budget of ca 950 million kr ($150 million). Being not only one of the major energy efficiency programmes in the world, the NUTEK's programme is quite unique in that most of its activities are concentrated on technology procurement (TP). Technology procurement can be characterized as a dynamic measure, or dynamic process, to introduce new energy-efficient technology on the market compared to the usual measures (e.g. subsidies, technology development) which are more static in nature and typical for most national activities elsewhere. Simplifying, TP is a kind of public competition in which different type of actors are brought together to define a technology goal which is reached through a competition including market incentives.

During the summer 1996, a major evaluation (Lund 1996) of the NUTEK's energy efficiency programme was performed in order to analyse both the achieved and expected effects of the programme and to give more specifically answers to the following basic relevant questions:

- what has been achieved by the programme so far and why,
- what effects could be expected in the future,
- what has been the influence of external factors on the outcome, i.e. to what extent would these effects have been achieved without NUTEK's efforts,
- does the programme fulfil its goals.

The methodological approach was quite sophisticated and interdisciplinary. We employed in the evaluation e.g. different effect and economic analyses, studies on changes in social behaviour, penetration analysis with diffusion models, and made an international comparison. The principle of the working method is shown in Figure 1-1.

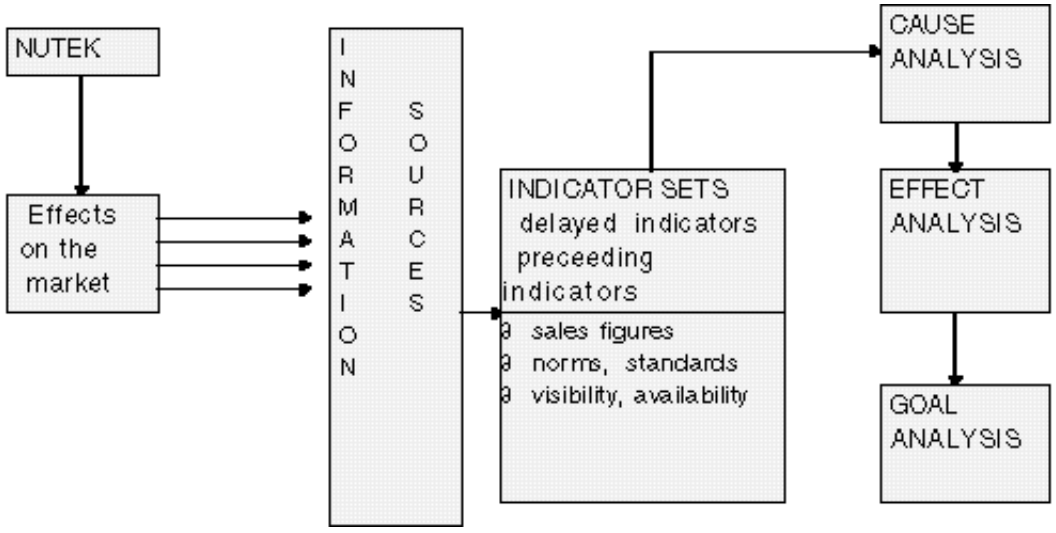

Figure 1-1. The principle method employed in the evaluation.

NUTEK has so far initiated some 30 technology procurements with more than 1,500 projects and in-depth analysis of each of them were outside the scope of the evaluation. Also, some of these were at this stage clearly irrelevant due to their short existence on the market and too scarce data available. To make a reliable evaluation on the effects, a long enough duration is required on the market (not only as a project) to get the necessary statistics. Therefore, five representative technology procurement projects were chosen for more detailed analyses. These included:

- energy efficient refrigerators,
- HF-ballasts for lighting systems,
- energy efficient (super) windows,
- energy efficient monitors,
- small heat pumps for residential houses.

The above areas represent an energy use of 40 TWh/yr in Sweden and the estimated total market potential of the five technologies is some 13 TWh/yr. The direct technology procurement related project costs for the five technologies were 27 million kr.

2. General Findings

The major result of the evaluation is that after 5 years of work (the analyzed TPs were in average 3 years old) NUTEK's programme on energy efficiency has accomplished a series of major achievements: in average the pro-

cured technologies are 30% more energy efficient than prevailing products, the sales volumes are increasing and some learning effects are already been captured, the unit-costs of some technologies are decreasing, etc. Moreover, the implementation has been both from the private and national economy point of view advantageous. Also, an indication on first changes in the spontaneous organizational behaviour initiated by NUTEK has been found. This means that there has been not only success with the first associated groups, but a wider dissemination has started.

An important observation was that the improvements in energy efficiency of the procured products well exceeded the efficiency trends of competing technologies. TP thus represents a kind of technology jump in energy efficiency which would have not been achieved through natural development until say after 10 years, or, in the worst case energy efficiency would have not appeared in the product at all.

The direct energy savings from the five analyzed TP-projects was in late 1995 70-130 GWh/yr and indirect, e.g. catalyzed by the programme, 35-85 GWh/yr. This would mean that the projects have captured about 1% of their market potential which corresponds quite well to the penetration rate of industrial products or innovations in general during an equal time period. By the end of 90's, the energy effect could increase to 1-1.6 TWh/yr. Also, most important, it is very evident that the development would not have happened without NUTEK's initiative and consequently NUTEK seems to have speeded up the development by several years. The programme measures seem to have succeeded well.

There are differences among the procured technologies, but as a general observation, we may put forward following important factors that effect the success:

- understanding the actual, hidden and future market needs,
- timing of the introduction of the product on the market,
- the size of the first market created to the existing market size; perceived market size,
- the strategic importance of the product to the participating companies and industries,
- the investment cost of the procured product,
- integration of functional characteristics (mostly non-energy) into the product,
- involvement and commitment of key actors, e.g. consumer groups, equipment producers.

The HF (high frequency) device lighting system can be mentioned as an example of a very successful TP project in which a strong market penetration has been achieved. Figure 2-1 shows the effects from NUTEK - the procurement was realized in 1991-92. The market for HF in late 80's was about 5,000 per year and the first market created through TP was 26,000. The energy savings from a HF is ca 19-20 kWh/yr. By late 1995 or 3 years later , the yearly sales of HF is had increased to some 600,000/yr and was dominating the market of new installations. The success can directly be related to the factors mentioned in the list above.

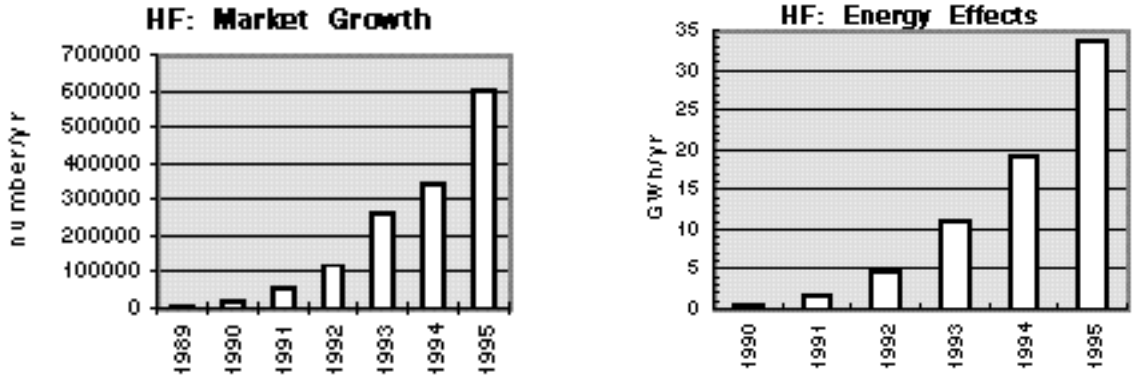

Figure 2-1. Market growth and energy effects of HF as a result of NUTEKÕs TP project.

The future effects of HF, as the penetration is almost a classical case example, can well be estimated by a diffusion model (e.g. Bass's models) in which the model parameters are derived by curve fitting from the existing data. The results of that exercise is shown in Figure 2-2. By now, HF has captured slightly over 10% of the total stock of all ballasts installed and the model shows that the whole market potential for HF would be reached by year 2005. The corresponding energy saving is 400 GWh/yr. If adding other lighting system improvements that often are associated with HF, the total effect anticipated may come up to 1,200 GWh/yr.

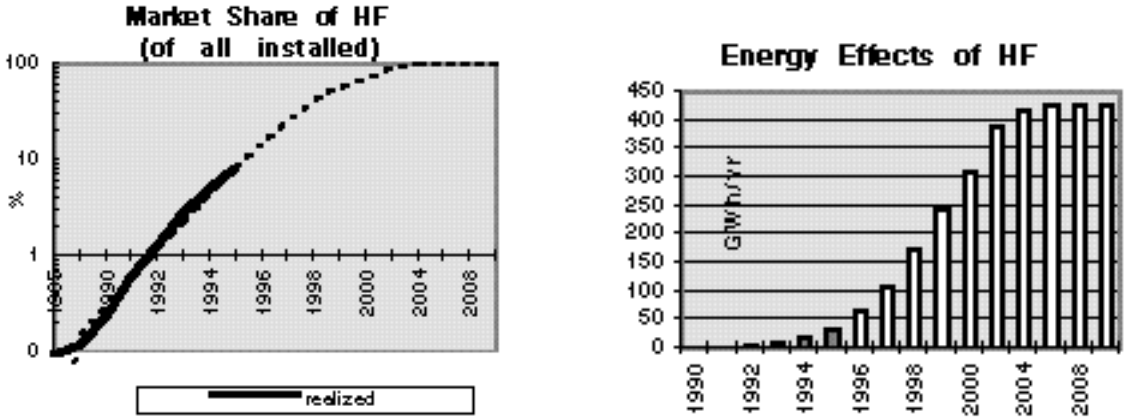

Figure 2-2. Market penetration scenario of HF in lighting systems.

Eventhough technology procurement may in general be considered as a very effective way to commercialize new technology, it has some evident draw-backs that originate e.g. from the long-term time perspective needed and TP's power as a market instrument. Possible weaknesses include the following:

- TP may launch misleading development paths if market and technology visions are inaccurate,
- risks for equipment producers if procured products do not penetrate, or, if these are wrong products for the market,
- long-term commitment may be needed to secure success, e.g. consecutive action steps with different contents,
- in TP major energy effects appear on a more long-term basis which may cause problems with short-term justification, e.g. political decision makers often require fast visible results.

3. Discussion

Based on the evaluation, its results and findings, important issues were raised. First of all, the technology procurement as an energy conservation policy measure should be considered more as a dynamic process rather than a single time-restricted project. With "dynamic process" we mean that a TP should be a set of measures that change in content with the progress of the market penetration. For instance, at the beginning of the process much attention need to be given to technical questions which will be followed by a market stimulus, ending to more of information type of activities.

The whole process should influence both internal and external information channels of the market and through an increased "information level", the sales will increase and through volume production the unit-price should also decrease. The price-information relation may be considered as one of the most important single factor effecting the diffusion of the procured product. If the price is acceptable then the information needed may be smaller but if it is clearly higher than that of existing products, then information activities need to be intensified to inform the market on the benefits.

On a long-term perspective, the price question, or the true willingness of the market (WTP) to pay more for the energy-efficient product, will be the dominating factor for the pace of the market penetration. Therefore, it will be important for the organizer of a TP to follow how the market and unit-price develops with time and also to be prepared to launch new market incentives if necessary. The market incentives need not be subventions, but could also be e.g. information related activities such as campaigning, seminar, etc. The organizer thus works with the market until the energy-efficient product takes off by itself. In practice that may mean reaching a 5-10% share of the total installed stock on the market. In case of the HF mentioned here, that point has been clearly passed and the market penetration is strong. Some information follow-up may thus be adequate. On the other hand, there are examples where strong involvement of NUTEK is still needed, e.g. in case of the energy-efficient window.

4. References

Lund, P. (Ed.), P. Kasanen, J. Heljo, E. Nippala. 1996. Evaluation of the evaluation of NUTEK's programme on efficient energy utilization. NUTEK R 1996:68. Stockholm.