

# Measuring Market Transformation

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## Synopsis

Effect chain analyses of surveys, bench-mark changes of energy performance and market penetration of new products, are used to measure NUTEK's energy-efficiency projects.

## Abstract

It is fairly easy to give a conceptual description of market transformation but far more difficult to measure it. Never the less it is possible to find reliable indications of its occurrence. The methods we use are basically the following:

- Effect chains. By interviews and statistical evaluation of responses we are trying to verify if there is a link between peoples actions and our efforts. The method is rather expensive and time consuming but gives good insight also in marketing.
- Bench-mark changes by measuring of change in performance values of the entire market or of significant segments. This can be rather sophisticated even with a little amount of data.
- Measuring of market penetration of the products. On an aggregated level this can be troublesome since capturing of statistics can be hard. The measured values are of course highly dependent on general business activities and market shares would be an even better measurement.

The paper will show how different methods have been used and how they can be used for different purposes when tracking market transformation.

## 1. The Swedish Programme for Energy Efficiency

The Swedish programme for energy efficiency aims to establish market transformation processes towards greater energy efficiency for energy using systems by combining technology procurement with targeted information such as e.g. labelling, performance requirements and incentive agreements that are expected to lead to dissemination effects.

The technology procurement method uses market forces, purchasers that set up the requirements and suppliers that compete to produce the best product what comes to the set requirements on energy efficiency and other qualities such as comfort. A wider spread and variation of the best products on the market is achieved by establishing performance requirements and labelling. This enables different actors, agents and decision makers on the market to identify the best products and to make adequate requirements on energy efficiency when they are involved in a purchasing process. Till now NUTEK has initiated about 20 technology procurement programmes within the residential, commercial and industrial sectors.

## 2. Effect Chain Analysis

This method has been used to analyse how much of the ongoing market transformation process seen as purchasing behaviour, attitudes and knowledge level among actors and agents on the market can be traced back to NUTEK's actions such as technology procurement and targeted information. The elements in the interview questionnaire are target groups, information sources, activities carried out by NUTEK and product characteristics. It is important to investigate how the respondents behave, what do they believe are advantages and disadvantages of the new product in comparison to the other products on the market. This method provides us with both qualitative and quantitative information. (Faugert S. et al. 1994 NUTEK R1994:70, Faugert S. et al. NUTEK R1993:31)

Effect chain analyses are based on testing following three main hypothesis of statistical correlation within the sampling survey:

- NUTEK's activities has increased knowledge of the new product.
- Increased knowledge changes attitudes towards more positive to new products.
- Positive attitudes give higher response within the target group. Higher response is the same as higher purchasing rate for new products.

Market transformation processes are measured with effect chain analyses that are carried out in at least two different time periods. The first survey is done when the NUTEK activities on the market are not yet known. (Faugert S. et al. 1995) Usually the timing for the first survey (*business as usual survey*) is just before announcing a technology procurement programme. The second survey (*effect measuring survey*) is conducted when NUTEK activities have been on the market for some time. Normally after one or two years.

The measurement of market transformation processes is how target groups responses has changed from the response with no activity to response with NUTEK activity. A simplified model on how effect chains can be used for analysing market transformation processes is shown below. This is however a simplified model, as it does not show e.g. positive attitudes that effect actors tendency to use received knowledge. There are also deep and strong attitudes that cannot be changed by increasing knowledge, these are not shown in the model.

The first survey (*business as usual survey*) gives information on proportion of different target groups that already have the desired response, knowledge or attitudes without NUTEK actions. The second survey (*effect measuring survey*) compared with the first survey as in the figure 1.

- firstly changing knowledge (K2-K1)
- secondly changing attitudes (At2 -At1)
- thirdly changing response (R2- R1)

The changes in these parameters correlated to NUTEK actions gives us an thorough analyse of NUTEK's influence on the market.

The target groups that where either not reached by the NUTEK activities or their response was not the desired one could be identified in the second survey. We can find out the reasons why their response was not the desired one for example: strong negative attitudes or that their knowledge of the product isn't correct. This information is used to change NUTEK activities so that results from effect chain analyses are used as an input when forming future dissemination activities. This was done e.g. after the first effect chain analyses for NUTEK's technology procurement programme on HF-lighting systems. One of the main findings in this survey was that the electrical contractors were not reached by the previous programme activities. (Faugert S. et al. NUTEK R 1994:70)

Interview surveys increases our knowledge of why the energy efficient technology is purchased. The interview surveys and effect-chain analyses can trace other reasons than purely economic ones and thereby explain the market transformation process. Purely economic models based on e.g. least cost planning fail to explain the market penetration for the energy-efficient technology which is often purchased for reasons other than purely economic. Examples of qualitative reasons are cited in the SIPU survey 1994. The report states that, in 90 % of the cases, HF lighting systems have been selected for reasons other than purely to reduce running costs. The main reason for the purchase of such lighting systems is that they eliminate flicker, producing a more pleasant lighting environment and perhaps a greater degree of well-being and reduced absence from work.

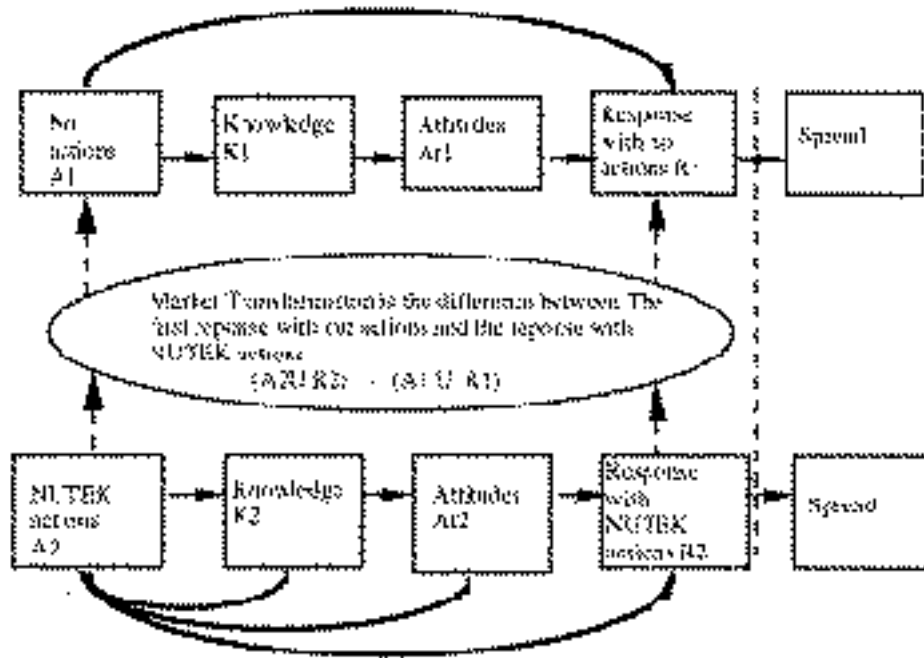


Figure 2-1. Effect chains as a measurement for market transformation

### 3. Bench-Mark Changes by Measuring of Change in Performance Values of The Entire Market or of Significant Segments.

The Swedish energy efficiency programme aims to accomplish market transformation for energy using products, end-uses and systems. The three main elements for these processes are shown in the figure 2. The first (1) instrument is the technology procurement that increases energy efficiency performance for the very best products on the market. The second (2) instrument is to focus on the best segment, the aim is to increase variety and number of energy efficient products on the market. The average performance on the market will shift towards better energy efficiency. The third (3) instrument is to create voluntary standards with the effect that the products with worst performance are taken off the market. As a result from this the entire market will shift towards better energy efficiency.

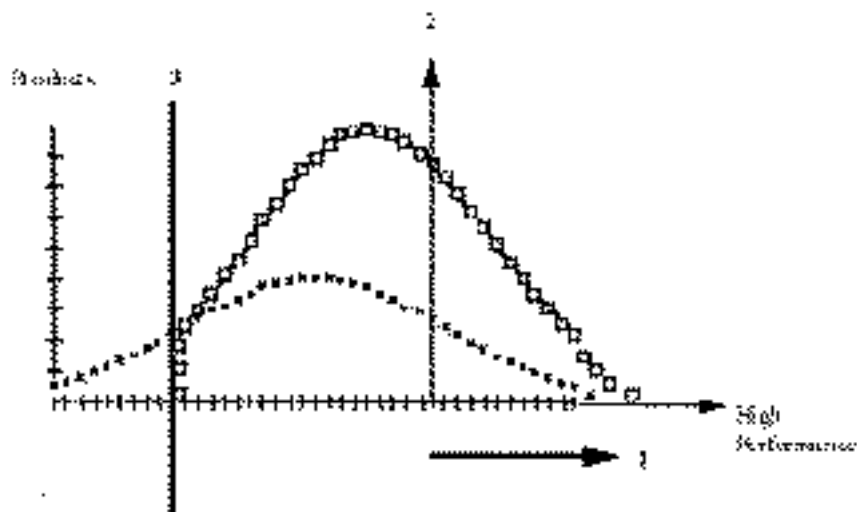


Figure 3-1. The three elements that the Swedish programme for energy efficiency uses to achieve market transformation

The Swedish programme for energy efficiency is a continuing process towards greater energy efficiency on the entire market and therefore the programme is a dynamic method to accomplish market transformation. Analyses over this dynamic process can be done through comparing bench-mark changes of;

1. improved performance for the best products on the market
2. how these improvements affect the average performance for the products on the market
3. When the entire market shifts towards greater energy efficiency.

A typical example of such bench-mark analyses is the Swedish technology procurement programme for *combined refrigerators and freezers* carried out in 1991. The performance improvement of energy efficiency was 30% compared to the best available on the market. This programme also managed to change an ongoing trend since the late eighties towards less energy efficient products on the entire market. (Salminen A. 1993).

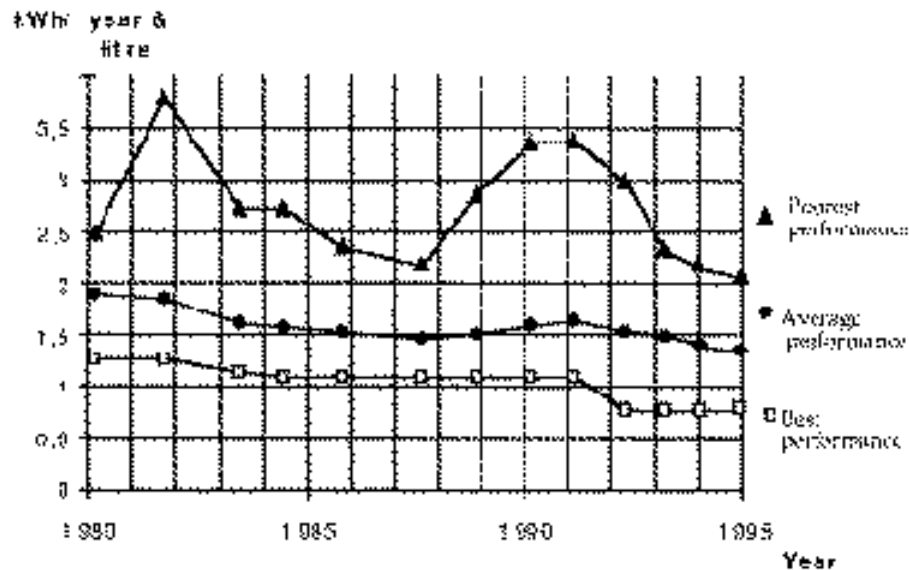


Figure 3-2. Performance as yearly energy-use per litre for the most efficient, average and least efficient combined refrigerator and freezer on the market. (Salminen 1993, updated in Dec. 1996)

Already two years after the technology procurement programme of combined refrigerators and freezers there were several producers that had as energy efficient products as the winner. The result was that approximately 20% of all models available on the market were energy efficient. (Salminen A. 1996). Their market penetration is however still fairly low. For 60% of the market the sales are about 5,5%, the assumed market penetration within the entire market of the combined refrigerators and freezer is 8,5%. (Lund P et al. 1996). The poor penetration rate could depend on different supply on the consumer and the professional markets. On the consumer market producers have a wider range of energy efficient products than on the professional market. The difference in amount of energy efficient products on these two markets is 15 %. (Salminen A. 1996). Another reason for low sales could be the sales strategy for less energy efficient refrigerator/freezers, which often are sold in campaigns with major rebate. Otherwise there is no correlation between high prices and high energy performance for combined refrigerators and freezers. (Nilsson H. 1996).

Technology procurement of *high performance windows* resulted in windows with U-value 1,0 W/m<sup>2</sup>K. The performance improvement was therefore only about 20% compared to the best available that had ever been on the market. However these windows had been available on the market for a short while during the 1980s. During the recession of early 1990s these products were taken off the market shifting the average U-value for window market to 1,8 W/m<sup>2</sup>K. The performance improvement due to the technology procurement programme compared to the average products (1,8 W/m<sup>2</sup>K) is more than 40%. Looking at the entire windows market an additional effect of the procurement programme has been a reintroduction of windows with U-value from 1,2 to 1,5 W/m<sup>2</sup>K. (Lund P et al. 1996).

## 4. Measuring of Market Penetration of The Products

Time series over sales data for products that have been an issue for the technology procurement programme, labelling or fulfilled programme requirements is used for follow up market penetration analyses of these products. To receive adequate data for time series is however somewhat difficult as NUTEK can require sales data from the winner of a procurement programme, but this is more difficult to obtain from other producers who are not benefiting from the procurement programme. Successful data collection can be obtained when good relations with companies involved and their trade associations are created. This is however a time consuming process as it takes time to create mutual understanding and trust. However as more and more companies get involved the better and more reliable data over volumes and market shares for energy efficient products can be developed.

Other issues that has to be discussed are how the relevant market for the new products are defined. It is important to focus on the market segment where the procured products compete, so that the effect of procurement is correctly measured. Should the entire market be segmented into classes and what would be a proper segmentation. Some of those market segmentations that has been used in NUTEK are:

- product classes, e.g. separating white goods such as combined refrigerators and freezers, freezers and refrigerators from each other.
- energy performance classes e.g. separating products that meet the mandatory requirements from those which do not. For consumer products this has been the same as those products that have been labelled with El Off Strömsnål.
- where the installation is done. The building stock is divided into segments such as offices, schools e.t.c. This type of segmentation has been used for products e.g. HF lighting systems or HVAC-equipments that are mainly purchased by property companies.

It is not easy to receive adequate detailed data. For some of the procurements these segmentations have been possible to make. A general problem with very desaggregated levels of data is whether it is possible to receive such a detailed data, is it reliable and who can provide us with it.

Market penetration of procured high frequency electronic ballast (HF lighting systems ) has been followed through yearly sales volumes for luminaires with HF lighting systems (units sold). This is also the best way to follow the market as the market of HF lighting systems has changed over time. Before the technology procurement programme HF lighting systems were only used in installations where dimming of the lighting level was desired. The NUTEK programme focused in the beginning on lighting of office premises where the first performance requirements where developed. These requirements where followed by lighting requirements for health care, class room lighting and industrial lighting. The adequate market for HF lighting systems today should be all fluorescent lighting. Market shares as proportion of total sales of luminaires with HF ballast has increased since 1991 from only a few percent to about 25% today. Within office premises the proportion of installations with HF lighting systems is higher, whereas within industrial premises such installations are rarely done and this keeps the market penetration rate down.

Other products where the unit sold has been used as a method to follow programme effects are heat pumps and windows. For heat pumps the relevant market segment is power class 0-6 kW with brine-water systems. The winning heat pumps has been on the market since 1995, the sales for that year was 500 units. In 1996 the sales had increased to 1 600 units.

To better understand how big the demand pull effect of the technology procurement for heat pumps has been to the entire market for heat pumps other measurements than units sold or proportion of the sales that meets mandatory requirement should be used. One of the spin-off effects from this procurement has been that the winners are introducing the same technology in other power classes, i.e. other market segments.

Market penetration can be analysed by using more sophisticated methods than e.g. time series over yearly sales

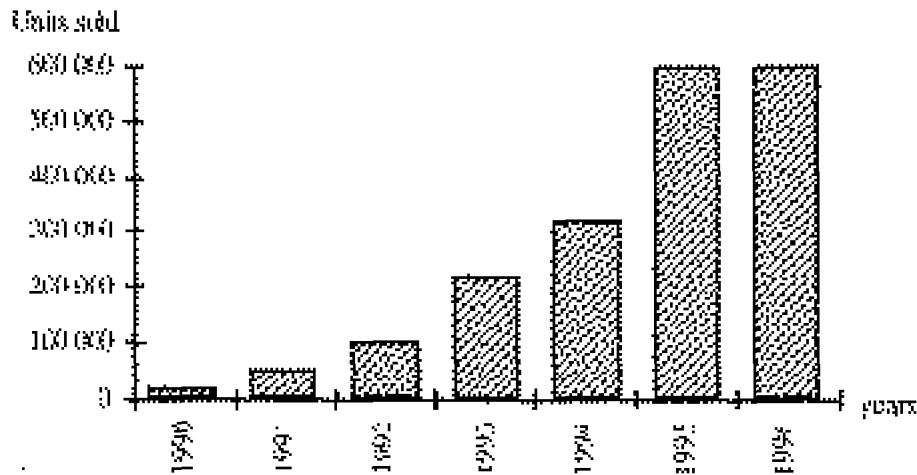


Figure 4-1. Market as units sold for HF lighting systems in Sweden

volumes. Market transformation in a societal perspective can be obtained when data on benchmark changes, findings from the effect chains analyses and data on market penetration are combined with other data over the market segments and used as an input to dissemination models. The market transformation process for HF lighting systems has been analysed at NUTEK using this method. Other more sophisticated methods that have been used to analyse market penetration are dissemination models such as e.g. Bass model. This type of models are commonly used in marketing and have also been used to analyse penetration rate for innovations. This type of modelling has been done for high performance windows, heat pumps, monitors, combined refrigerators and freezers and HF lighting systems. (Lund et. al 1996).

## 5. Energy Effects from Market Transformation: Lighting in Office Premises

The knowledge of the effects of NUTEK's activities intended to increase the efficiency of lighting in office premises is quite good. Over 100 projects have been performed within the framework of incentive agreements with office property companies and administrators. Two interview surveys (SIPU's effect chain analyses 'Effective Market Influence' in 1994 and SIFO in 1995) have provided information on awareness, attitudes and the purchasing behaviour of those buying lighting systems and of key groups such as consultants and installation contractors.

### 5.1. Direct, Indirect and Ripple Effects of Lighting Projects

NUTEK has run a technology procurement programme for HF lighting systems, aimed at establishing programme requirements as a voluntary standard within, for example, incentive agreements with property companies and administrators. The intention behind NUTEK's incentive agreements with property companies and administrators is the following. Those who sign such agreements receive financial support for the incremental investments involved in purchasing energy-efficient equipment instead of merely conventional equipment. The performance improvement when installing HF-lighting systems instead of an average new lighting system is about 20%. The main purpose is that the purchaser should continue, in the future, to specify these energy-efficient performance requirements when purchasing further equipment, as he will have been able to see at first hand that the new technology is to be preferred. In turn, when information spreads, this should result in other property companies etc. adopting the technology and specifying the same performance requirements. Consultants and installation contractors involved in connection with these incentive agreements can help to spread the message to other potential users of how the technology works.

The energy saving achieved by a purchaser installing such equipment with NUTEK's support is referred to as the '-

direct effect' of the agreement. The 'indirect effect' then refers to the saving resulting from the purchaser continuing to apply NUTEK's requirements, while the 'ripple effect' occurs as other purchasers start to apply energy efficiency.

The direct effect is documented. The indirect effect can be quantified by surveys, asking the purchasers what type of equipment they buy and what performance requirements they specify in connection with the purchase. The ripple effect is more difficult to measure with certainty, as it is difficult to isolate NUTEK's effect from what would have occurred any way. However, even here, we can get some ideas of the magnitude of the effects through interview surveys

The following are some of the results from the HF lighting survey "effect chain analyses" from 1993/94 and from the incentive agreement survey from June 1995.

44 % of the purchasers have participated in incentive agreements or the 'Light Corridors' project.

26 % of the purchasers had heard about the incentive agreements or the 'Light Corridors' project.

The services of electrical consultants had been employed in 20 % of the lighting purchases.

Electrical installation contractors had been employed in 25 % of the lighting purchases.

Those who have actually participated in incentive agreements recommend HF lighting systems to a greater extent than do those who have merely heard about the agreements, while those who have heard about the agreements in turn recommend HF lighting to a greater extent than do others. We also know how often consultants and installation contractors recommend such systems.

We know whether purchasers/consultants/electrical installation contractors 'Always', 'Often', 'Sometimes' or 'Never' recommend HF lighting.

72 % of those who were involved in incentive agreements have continued to purchase HF lighting system.

From this data, we can divide the office premises sector into segments defined by those who have been involved in incentive agreements, those who have heard about but not attended them, and others. In turn, a certain proportion within the incentive agreements sector uses HF lighting, as does a proportion within the sector relating to those who have heard of HF lighting. For the remainder, we can assign a probability that they will encounter a consultant or installation contractor who recommends HF lighting.

In addition, we have assumed that the group of electrical consultants or contractors who, in 1993, answered that they 'Often recommended' HF lighting, will by 1996 have moved up to the sector that 'Always recommends' HF lighting, as they will have been reinforced in their conviction by meeting other consultants, purchasers, manufacturers etc. who are in favour of the new method of lighting. This assumption means that there is a certain dynamic dimension in the development, but we regard it as more of an underestimation than an overestimation of the rate of acceptance. Our assumption concerning the purchasers was more than well met in 1996 which was verified in the second effect chain analysis conducted in 1996.

Knowledge of the specific savings as a function of floor area (W/m<sup>2</sup>) was obtained from those 100 projects that have been carried out in the incentive agreements. By combining energy saving and penetration rates we can calculate the energy savings that will be made by:

- those involved in the agreements when they continue to install HF lighting

- those who are aware of the incentive agreements and have been influenced to purchase HF lighting
- those who have employed the services of a consultant or installation contractor who has spread the HF lighting message.

4.2 Conclusion of the example; lighting in office premises

The direct effects of the incentive agreements are limited to those projects that has been carried out by NUTEK and their energy effects are approximately 8,6 GWh yearly. The most important effects of the incentive agreements are however those four ripple effects that the agreements have resulted:

an indirect effect among those involved in the agreements

a ripple effect among those who have heard about the programme requirements and the agreements

a ripple effect resulting from electrical consultants who have been in contact with the agreement parties or who have been involved in the 'Light Corridors' project continuing to recommend new lighting technology when working for other clients

a ripple effect resulting from electrical installation contractors who have been in contact with the agreement parties or who have been involved in the 'Light Corridors' project continuing to recommend new lighting technology when working for other clients.

The savings in the second group above (those who have heard of the incentive agreements) has been calculated on the basis of the magnitude of the specific saving (W/m<sup>2</sup>) and acceptance being the same as achieved by those involved in the agreements. As far as the consultants' and installation contractors' spin-off effects are concerned, the same probability that a consultant/ installation contractor has been involved in a lighting project (which is not always the case) and that he/she has then recommended energy-efficient lighting systems, has been applied to that portion of Sweden's office stock with which NUTEK does not have incentive agreements.

The diagram below shows the various effects both on their own and aggregated to produce a total effect. This indicates the improvement in efficiency in a given year, resulting from the installation of energy-efficient lighting

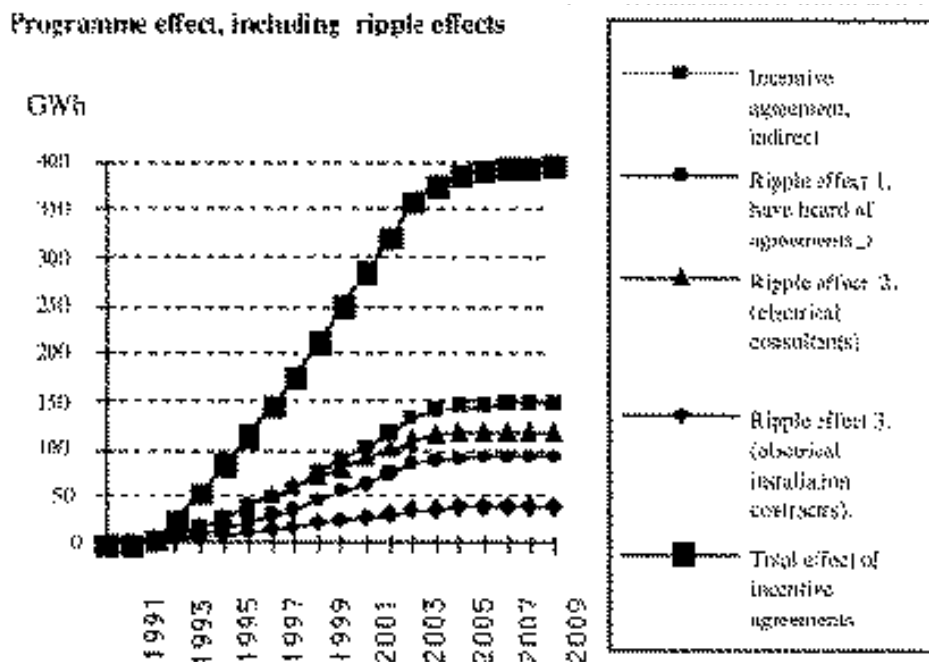


Figure 5-1. Effects of lighting improvement efforts, including ripple effects



either when replacing an older lighting system or in connection with a new building project during the previous year. Thus, for example, the saving in 1997 is the result of all the energy-efficient lighting systems installed and in use during that year, but purchased in 1996, 1995, 1994 etc. This is 'annual savings in 199x lighting stock'.

The aggregated, the direct, indirect and ripple effects of the incentive agreements amount to an annual electrical saving of 390 GWh over 20 years. This corresponds to a market penetration rate of approximately 40% each year after 1998.

## Conclusions of Measuring Market Transformation

All of the different analyse methods are needed when the market transformation processes are traced back. Market transformation processes take long time and therefore they should be measured by both short run results (indications) and long term results in energy savings. The short term results or indications can be used partly to verify if the process is advancing as expected or whether the programme should be changed e.g. dissemination activities should be added. All the three measuring methods presented in this paper can be used in the early analyses.

The very first indications of market transformation are changes in bench-marks. These measurements give important information on how the technology procurement processes, that focuses on performance improvement, has influenced the entire market. This data is also relatively easy to obtain. The bench-marks that NUTEK have followed are the performance improvement for the best products on the market, the average products on the market and the entire market.

Secondly, interview surveys and effect-chain analyses explain what impact NUTEK's activities has had on changes of response, attitudes and knowledge of the target groups. The findings from these surveys are also used to change NUTEK activities e.g. to focus more on correcting usual misunderstandings within target groups. A disadvantage of this method to trace market transformation is that it requires a larger amount of financial resources since the effect chain analyses should include interview surveys in several time periods.

Thirdly, market penetration of the new products as a portion of the total sales gives us information on what rate the new products are accepted by the decisions maker on the market. This data is however the most difficult to collect.

Thorough evaluation of the effect of market transformation programmes can be obtained when all three measuring methods are analysed. In order to estimate the long term results of the market transformation processes the data from short run indicators should be combined with other data such as stock data and the renewal rate for the existing stock.

An estimation of the total energy effects of the market transformation 'Lighting in Office premises' has been obtained through modelling using data from the three methods to measure market transformation together with other data. The annual energy savings in year 2010 from HF-lighting system is calculated to approximately 390 GWh.

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