

Effectiveness and Efficiency of Product Life Cycle Policy: Monitoring Efforts and Effectiveness in Voluntary Agreements in the Netherlands

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ABSTRACT

SenterNovem is a Dutch government agency commissioned (by the Ministry of Economic Affairs) to facilitate the second long-term agreement for improving energy efficiency in industry. Long Term Agreements (LTAs) are voluntary agreements between a specific industry sector and the Ministry of Economic Affairs and in some cases, the Ministry of Agriculture, Nature and Food Quality. The second long-term agreement was put in operation in 2001, and will run to 2012. This LTA2 introduced two new energy efficiency themes: renewable energy and energy-efficient product development, the so-called "expansion themes".

The introduction of these themes means a great new potential source of energy savings, but at the same time it is difficult to assess their impact (renewable energy and energy-efficient product development are rather 'fuzzy' concepts). This led to the development of a new evaluation tool by SenterNovem. This paper describes the development of the tool, the evaluation research, the first results of the evaluation and a brief discussion of these results, with recommendations for the future.

This was the first time an evaluation of the second long-term agreement was done. The evaluation has the characteristics of a benchmark study. Every second year evaluations will follow; these will enable SenterNovem to develop reference models for the implementation of energy efficiency in industry. Also, they will provide Dutch government with valuable feedback for decision-making on the energy conservation policy.

Introduction

The Netherlands made commitments in the Kyoto agreement to reduce their emissions of greenhouse gases by six percent in 2008-2012 in comparison to 1990 (VROM, 2002). Energy efficiency improvement in industry makes an important contribution in reaching this objective. Also, the focus on energy efficiency stimulates innovation in industry (and thus improves their competitiveness and economic results).

Long Term Agreements (LTAs) for improving energy efficiency have been contracted with a large number of industry sectors since 1992, as part of energy conservation policy. The first generation of long-term agreements in the Netherlands resulted in 22.3 % energy-efficiency improvement between 1992 and 2000 (Gerrits, Oudshoff, 2003).

The second long-term agreement (LTA2) was put in operation in 2001. It will run to 2012. The first LTA focused mainly on process efficiency; the new LTA has made a shift towards energy efficiency over the product life cycle and a more integrated policy. Its goal is saving more than just the energy consumed to manufacture products. The most notable difference with the first LTA is the introduction of two new energy efficiency themes, or expansion themes: renewable energy and energy-efficient product development. Another new

feature of the LTA2 is the broad range of participants, consisting of sectoral organizations, individual companies, regional and local authorities and the central government.

LTA2 also differs from LTA1 in its lack of specific energy efficiency targets for the industry sectors. Instead of a pre-set target, the companies in the second long-term agreement were given the opportunity to formulate their own targets. The move away from a pre-set target was motivated by the government's desire to make the companies more responsible for their own energy efficiency behavior. Based on the experiences with LTA1, a yearly 2% energy-efficiency improvement in LTA2 companies was expected (EZ, 2000). Recent figures even show an average of 2.8% annual energy-efficiency improvements (Novem, 2004).

SenterNovem and LTA2

SenterNovem is an agency of the Dutch Ministry of Economic Affairs. SenterNovem's mission is to use its knowledge of innovation, energy, climate, the environment and living conditions to better the economic position of Dutch industry and to contribute to a sustainable society. About 1100 employees work at the SenterNovem offices. In 2004 SenterNovem supported and stimulated companies, knowledge institutions and local government bodies, both national and international, with EUR 1.3 billion (US dollar 1.5 billion¹). 42% of this budget is spent on tax-reduction measures, 58% in programs and projects. Beneficiaries are mainly companies (ca. 76%), most of which are small and medium sized businesses (70%).

SenterNovem is commissioned to facilitate the LTA2. One of SenterNovem's tasks is monitoring the progress of LTA2. Each company or institution taking part in LTA2 records its energy efficiency target in an Energy Conservation Plan, together with specific measures and a schedule for achieving the target. SenterNovem assesses these energy conservation plans. Apart from monitoring, SenterNovem also gives advice and support, e.g. the introduction of an energy management system or the choice for a particular (set of) expansion themes.

Many companies of international origin participate in the long-term agreement. In February 2005 the Canadian McCain Foods was the 1000th to join. In October 2004 most of the LTA2 companies (or their umbrella sectoral organizations) had completed surveys identifying the possibilities for the expansion themes and the energy efficiency improvements that could be realized through them. As from 2005 they should try to realize these possibilities.

For government, the expansion themes are important because of the potential energy efficiency gains, but also because of the strategic implications of these themes. By incorporating new concepts such as life cycle thinking and by finding new ways of collaborating with suppliers and customers across the product chain, the participating companies may broaden their horizons and gain strategic advantage over their competitors and over non-LTA companies. Above all, the expansion themes aim to combine environmental with economic goals, and thus provide an excellent method for cutting the high cost of energy. SenterNovem tools like the Lifecycle Energy System Scan (LESS) are helpful in making the potential savings concrete (Ter Avest & Gerrits, 2003).

¹ With 16 million Dutch inhabitants this can be compared to \$ 31,3 billion for a central US governmental agency (290 million inhabitants)

Expansion Themes: High Potential Energy Savings

Most of the measures for energy efficiency in LTA1 were focused on the production processes. Other possibilities for energy efficiency, like energy efficient product development or the deployment of renewable energy, had not been taken into account. These expansion themes, central in the LTA2, are briefly elaborated upon in this section.

Renewable Energy

For participating companies, use or production of renewable energy widens the scope for achieving fossil fuel savings and curtailing climate change. Switching from fossil to renewable energy sources counts as a saving option, even if the actual energy efficiency of the processes in the plant is not changed. The non-fossil energy sources include wind energy; thermal, photovoltaic and passive solar energy; geothermal energy; hydroelectric; heat/cold storage; heat pumps using ambient heat and energy generated from waste or biomass.

Energy-Efficient Product Development

Energy-efficient product development comprises the creative process of adapting an existing product or designing a new product with the aim of reducing energy consumption throughout the product life cycle (Novem, 2003 (1)). This implies a wider scope for achieving energy savings in the product life cycle. See Table 1.

Table 1. Expansion Themes

Improvement options within energy efficient product development
Energy efficient product development contributes to an improved indirect energy efficiency in eight ways:
1. Optimal functionality: Map out the functional consumer demand (need) that a product provides for and design a more energy efficient implementation that satisfies the same function, need, and product service or demand.
2. Material saving: Lower indirect energy use per unit product by decreasing the consumption of raw materials or switching to less energy-intensive materials.
3. Improved process energy efficiency: Lower direct energy use per unit product by lowering energy use in heating or cooling processes and/or driving of pumps, compressors or other process units.
4. Optimal distribution: Lower energy use per unit product in transport and storage.
5. Decreased energy consumption during product application: Lower direct and indirect energy use per unit product, during the actual life span of the product, due to innovative design or implementation changes.
6. Optimal life span: Lower direct and indirect energy use per unit product due to optimal choice of product life span. One can choose to design the product so that the actual life span will be close to the technical life span or to discontinue the life of a product prematurely when launching a less energy-consuming product.
7. Optimal product disposal: Measures taken to minimize energy consumption, per unit product, for the sub-cycle of treatment of the discarded product: collection, transport, incineration, gasification or landfill.
8. Optimal product recycling: Measures that involve recycling and thus allow reusing the energy content of materials in the discarded product, with relatively little extra energy use.

Table 1 Article 4 of the 'Protocol Expansion Themes' describes the scope of energy-efficient product development. (Novem, 2001)

Evaluating the 'Expansion Themes' Policy

Since the start of the LTA2, an increasing number of companies have been working with expansion themes. The current monitoring data model mostly reflects the amount of CO₂-

emissions prevented due to the introduction of a specific measure related to the expansion themes. What is missing, however, is data on how, and at what rate the companies adopt expansion themes. Nor is there any information on the efficiency and effectiveness of the policy with regard to the expansion themes. In order to allow for the assessment and adjustment of the expansion themes policy, an evaluation tool had to be developed.

Research Questions

The main research questions SenterNovem wants to address are listed here. In the following paragraphs, we will elaborate on the theoretical framework behind these questions.

1. To what extent do the policy measures related to the expansion themes contribute to:

- A growing awareness and competency regarding expansion themes;
- Corporate plans (projects) for energy savings through expansion themes;
- Actual energy savings and CO₂ emission prevention?

This question refers to the rate of adoption of the expansion themes. Companies that have fully adopted expansion themes will report actual energy savings and emission prevention due to the implementation of these new energy efficiency themes. On the other hand, some companies are only becoming aware of the possibilities the new energy efficiency themes can offer. And again others are in the planning stages.

2. To what extent can positive effects be contributed to the expansion theme policy measures?

In other words: would companies have worked with expansion themes regardless of government interference? Perhaps the companies are competent as a result of other – interfering- factors?

3. To what extent are the acquired results in proportion to the administrative expenditures?

Policy Evaluation Framework

The research questions address the effectiveness of the expansion theme policy and the efficiency of the implementation of this policy. The dominant question in evaluation is: 'does this policy work?' (Gysen et al, 2002). Answers on the above research questions can contribute to this general question. They are also of causal origin, asking not simply 'what has happened?' but trying to attribute the happening, the change, to the policy. For such research questions, Gysen developed a model: the policy evaluation framework (figure 1). It gives a systemic view of the different effects a certain policy can have.

Gysen distinguished three major categories: output effects, outcome effects and impact effects. The output is defined as the tangible results of a measure. The outcome refers to the response of the target groups to the output, and impact here means the ecological or environmental effectiveness (i.e. did the quality of the environment improve?). At the basis of the model are two interconnected 'environments'. On one side we have the policy process, on the other the outside world. The outside world provides for input and interaction on every stage of the policy process. The policy process comprises of three parts, the formulation of objectives, the choice and use of instruments and the output. The policy process gets input from, and produces effects for, the outside world.

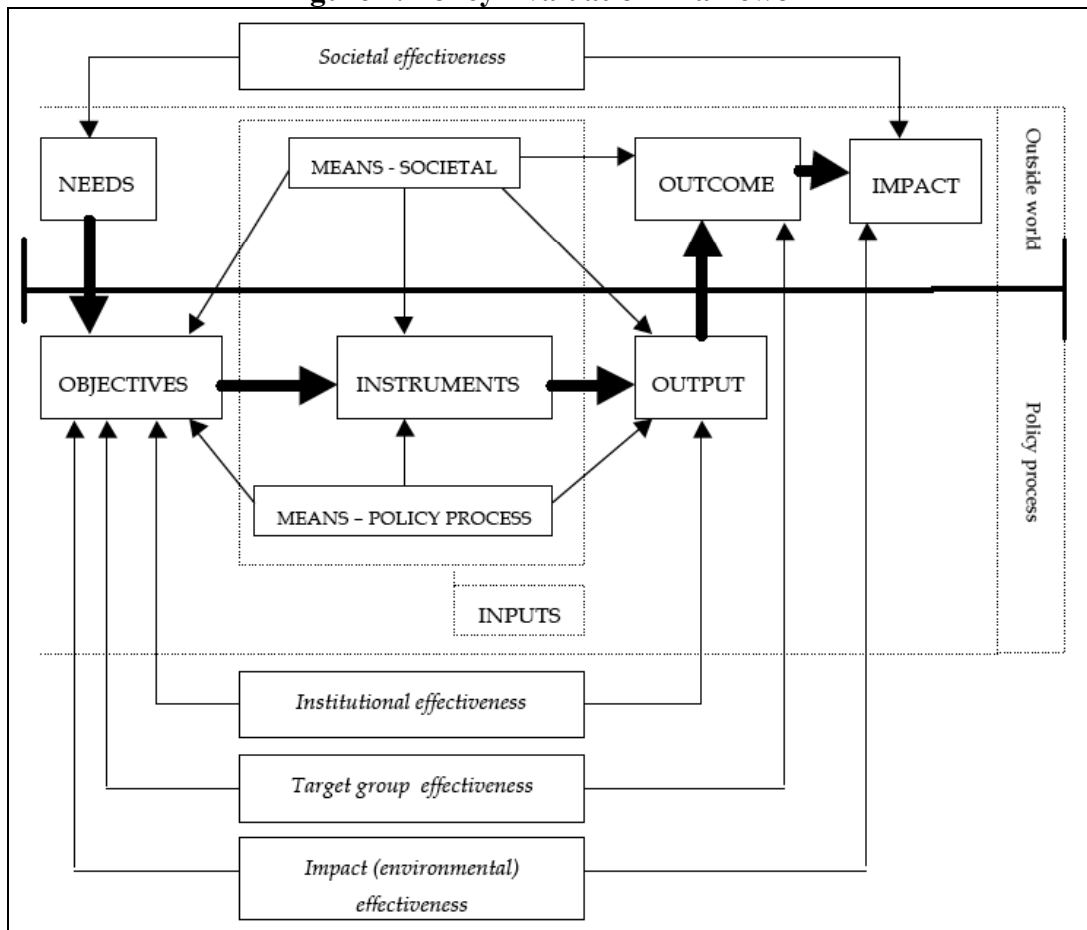
Applying the Policy Evaluation Framework to the SenterNovem Research

When applying this model to the SenterNovem research, we get the following line of reasoning. The main policy objective of the LTA2 is a prevention of CO₂ emissions through energy savings. The instrument is the LTA2, with a special focus on the expansion themes. Output refers to the number of companies participating in LTA2. This has been monitored carefully and needs no further research.

'Outcome' refers to the way (and the rate at which) the companies adopt the expansion themes. This is the main focus of SenterNovem's evaluation research. Research question one (about the rate of adoption of the expansion themes) refers to the 'outcome', and research question two is about the causal relationship between the policy measures (the introduction of expansion themes) and the 'outcome'.

Finally, 'impact' is about the prevention of CO₂ emissions (in line with the Kyoto treaty) and ultimately about the avoidance of global warming.

Figure 1. Policy Evaluation Framework

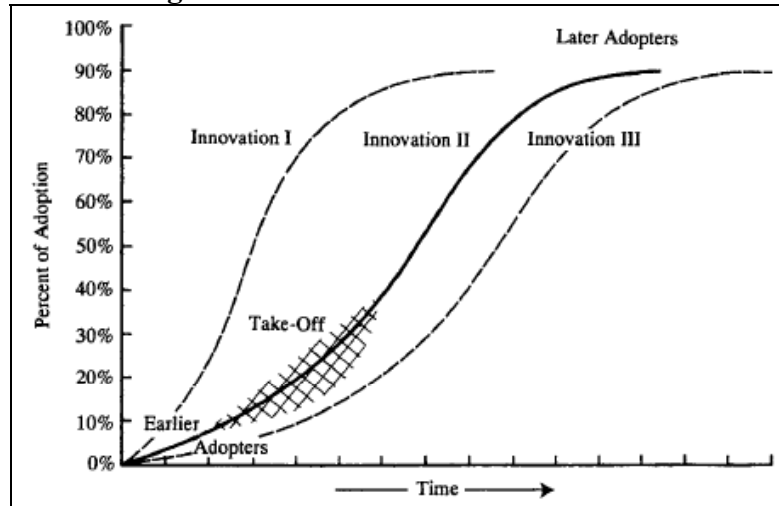


Source: Gysen et al., 2002.

Adoption of Expansion Themes

SenterNovem has used elements from the theory of the adoption and diffusion of innovations (Rogers, 2003) to describe the expected behavior of the LTA2 companies when adopting the expansion themes. Rogers' well-known model of the diffusion process by which an innovation is communicated through certain channels over time among the members of a social system is indicated in figure 2. The graph has a typical S-shaped curve. At first, only the innovators and early adopters take on an innovation. Later, as the innovation spreads through society, the early and late majorities tag on, to be followed by the 'laggards'.

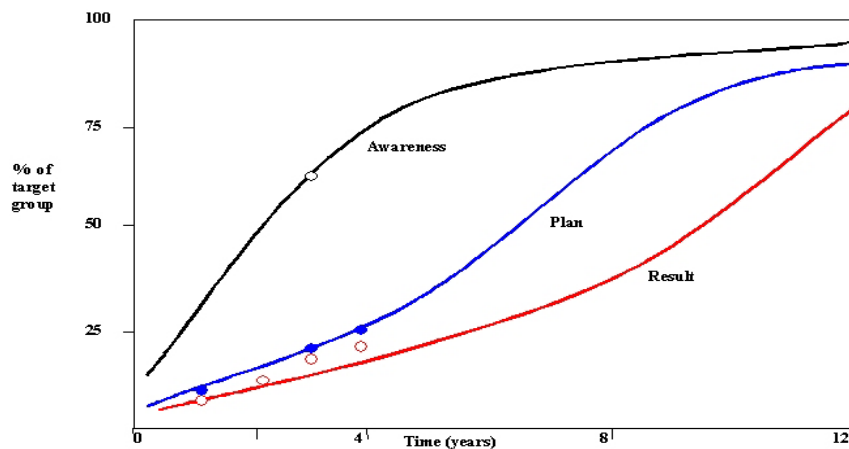
Figure 2. The Diffusion Process



Source: Rogers, 2003

A similar line of reasoning was followed in figure 3. It is the SenterNovem model for the expected behavior of LTA2 companies in their adoption of the expansion themes. The vertical axis is the percentage of companies adopting expansion themes.

Figure 3. Expected Behavior of LTA2 Companies When Adopting Expansion Themes



Source: SenterNovem, 2005

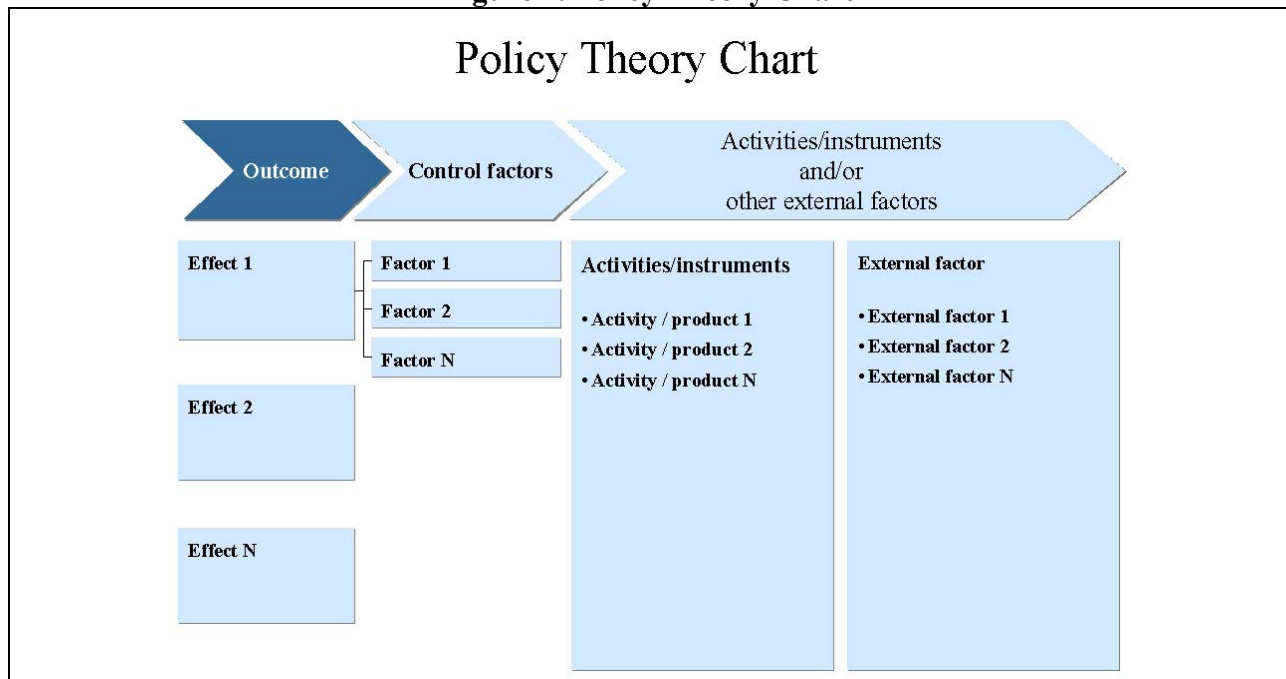
Figure 3 shows that the process of going from awareness to result takes time. It is expected to take at least until 2012 for the late majority of the companies to develop viable plans for the implementation of expansion themes. The results (CO₂ emission prevention) follow suit. The figure also shows that the adoption process is expected to follow the S-shaped curve.

In the figure the results from the first evaluation and yearly monitoring are represented with small circles. By now ('year 4'), the majority of the companies are aware of the expansion themes. The development of plans (for the implementation of these themes) is just taking off (i.e. moving from the stage of 'early adopters' to the stage of the 'early majority'), and the first concrete results are being reported. The monitoring data is in line with the expected rate of adoption, with the 'results' being slightly more positive than foreseen.

Development of a Policy Theory

The next step in the development of the evaluation tool was to translate these observations into a practical framework, a 'policy theory'. The policy theory gives practical insight in the causal relationships between SenterNovem's products and activities (instruments for the expansion themes policy) and outcomes. See figure 4. The outcome is influenced by control factors (factors that can be influenced by SenterNovem), such as the quality and accessibility of the SenterNovem activities and products. Also, external factors (economic development, environmental legislation) and the (use of) SenterNovem activities and products (computer tools, websites, workshops related to the expansion themes) have their effect on the outcome.

Figure 4. Policy Theory Chart



Source: Novem, 2003 (2)

Making the Policy Theory Operational

The policy theory was made as concrete as possible, by identifying the most important external and control factors in several workshop sessions with experts from SenterNovem and industry. The next step was to develop measurable (and clearly identifiable) indicators, and a series of sub-questions. The breakdown of the main research questions into indicators and sub-questions is described here.

Main research question 1: To what extent do the policy measures related to the expansion themes contribute to:

- A growing awareness and competency regarding expansion themes;
- Corporate plans (projects) for energy savings through expansion themes;
- Actual energy savings and CO₂ emission prevention?

The extent to which Dutch companies have adopted the expansion themes is measured in five distinct stages (indicator: stage of adoption):

- Stage 1: not aware of expansion themes;
- Stage 2: expansion themes part of corporate strategy, no budgets allocated;
- Stage 3: budgets allocated;
- Stage 4: implementation in planning stage;
- Stage 5: realization of energy savings and CO₂ emission prevention.

In order to answer research question 1, the following sub-questions were developed:

- Question 1: In what stage of adoption (stages 1-5) are the LTA2 companies?
- Question 2: How much energy was actually saved and CO₂ emission avoided for each expansion theme, per sector (LTA2 companies)?
- Question 3: What are the planned energy savings and CO₂ emission prevention (for LTA2 companies)?

Main research question 2: To what extent can positive effects be contributed to the expansion theme policy measures?

In order to establish a causal relationship here, we have to establish a covariance of cause and result (Coenen 1991). This means cause and result have to be empirically related to each other: more A means more B. Also, other explanatory factors must be lacking. If there is an effect, but there are other factors that can explain this, we cannot prove an absolute causal relationship between policy and effect. Only if we manage to eliminate, filter-out or determine the full interference of all the 'other explanatory factors', it is possible to establish a causal relationship.

In the case of the expansion themes, there are quite a few other explanatory factors that need to be dealt with. The following indicators were developed:

- Usefulness of SenterNovem products and activities. The extent to which companies are familiar with the products and activities and the extent to which they find these useful (related to their stage of adoption of expansion themes).
- Client satisfaction. The extent to which companies are satisfied with the SenterNovem services.
- Stakeholder opinions. This indicator measures the influence of opinion leaders and stakeholders in society on corporations. Important opinion leaders are for instance the consumer organizations: what is their attitude towards energy efficiency?
- Common external factors. This indicator measures external factors like economic growth, EU policy on energy efficiency, Dutch policy on energy efficiency, general attitude in society towards sustainability.
- Communication. How does the government communication on sustainability issues change in the course of time?

In order to answer research question 2, the following sub-questions were developed:

- Question 4: How familiar are the target groups with the concept of expansion themes? It is expected that the LTA2 companies overall are more aware of the expansion themes than the other (non-LTA) companies.
- Question 5: To what end do LTA-2 companies use the SenterNovem expansion theme activities and products?
- Question 6: Does a more intensive use of SenterNovem activities and products lead to better results (i.e. increased adoption of expansion themes)?

Main research question 3: To what extent are the acquired results in proportion to the administrative expenditures?

Indicators are the changes over time in the SenterNovem efforts to facilitate the adoption of expansion themes, measured as the annual budgets allocated by SenterNovem to its products and activities (for instance: workshops, software, conferences, handbooks, websites, financial support for projects, etc.).

This research question could not be addressed, because the necessary budget breakdowns for the different SenterNovem products and activities were not available at the time of research.

Evaluation Research

The evaluation research carried out here has difficult causal relationships (Gysen et al, 2002). It is very hard to say whether the adoption of an expansion theme (for example energy efficient product development) is the result of the political instrument (the LTA) or of other factors (for example a pro-active design department). This causality problem has influenced the choice of evaluation method. A questionnaire based on the indicators listed in the previous section was developed, and the results of the LTA2 companies were compared with a control group of LTA1 and non-LTA companies (i.e. companies that were not stimulated by SenterNovem to work with expansion themes). Also, the evaluation will be repeated every two years. Thus, longitudinal, comparative studies will be obtained that might help to identify causal relationships.

The table below gives an indication of the number of questionnaires that were sent out and the response. This is the first measurement (reference year 2003), to be followed by evaluations until 2012.

Table 2. Response to Questionnaires

Target group	# Questionnaires	# Response	Response %
LTA2	746	198	27%
LTA1	650	270	42%
Non-LTA	920	290	32%

Results

- Question 1: In what stage of adoption (i.e. awareness, plan, and result) are the LTA2 companies?** The companies were given a rating between 1 and 5, depending on their stage of adoption. On the whole, the LTA2 companies score between stages 2 and 3 (total average score is 2.55). Most companies have made expansion themes part of their corporate strategy (stage 2), and some have also allocated budgets (stage 3). There are remarkable differences between sectors. The building materials sector (including concrete, glass and ceramics) is generally in stage 4, whereas the food sector scores between 2 and 3. As this is the first evaluation, a reference situation is lacking, and it is therefore difficult to give a plausible explanation for these differences. These findings will serve as a reference for the next measurements.
- Question 2: How much energy was actually saved and CO₂ emission avoided for each expansion theme, per sector (LTA2 companies)?** Total energy savings (and CO₂ emissions avoided) were measured for each of the expansion themes (renewable energy and energy-efficient product development). LTA2 companies realized 78 kilotons CO₂ emission prevention with energy-efficient product development and 520 TJ through renewable energy. There were significant differences between sectors. The textile, rubber and plastics sector alone accounts for 60 kilotons of CO₂ emission prevention, whereas the chemistry and oil sectors have zero emission prevention.

As this is the first evaluation, a reference situation is lacking, and it is therefore difficult to give a plausible explanation for these differences. Also, the lack of quantitative targets for energy savings and CO₂ emission prevention make it hard to judge whether this is an acceptable result. These findings will serve as a reference for the next measurements.
- Question 3: What are the planned energy savings and CO₂ emission prevention (for LTA2 companies)?** LTA2 companies planned to realize 29 kilotons CO₂ emission prevention with energy-efficient product development and 150 TJ through renewable energy. This is the reference situation for future measurements. Again there are significant differences between sectors.
- Question 4: How familiar are the target groups with the concept of expansion themes?** The analysis shows that the LTA2 companies are more familiar with the expansion themes than the non-LTA2 companies. The familiarity with LTA2 companies (45%) is significantly higher than non-LTA companies (14%) and LTA1 companies (18%). This result is in line with the expectations.

- **Question 5: To what end do LTA-2 companies use the SenterNovem expansion theme activities and products?** In order to move from stage 1 to 3 (planning stage), most LTA2 companies use the entire range of products and activities available from SenterNovem. To make the next step, towards realization, the most popular products and activities are user groups, financial support and personal advice.
- **Question 6: Does a more intensive use of SenterNovem activities and products lead to better results (i.e. increased adoption of expansion themes)?** Our analysis shows that more intensive use of SenterNovem activities and products does indeed lead to better results. The question that remains, however: is the use of SenterNovem products the reason for the better results, or is it that only the pro-active companies use the SenterNovem products? This question will be elaborated in future measurements.

Discussion

It should be noted that this evaluation research was the first in a series. The current results largely serve as benchmark data for the ensuing measurements. Further research will come up with more satisfying answers to questions 1-6, as it will allow SenterNovem to track changes over time.

Evaluation of Monitoring Tool

Among SenterNovem's recommendations to the Ministry of Economic Affairs are the following options for improving the monitoring tool:

- Formulate quantitative targets for the rate of adoption of the expansion themes. For instance: the goal could be to increase the rate of adoption with 10% each year. The LTA2 companies will have to go from their current score of 2.55 to 2.8 in next year's evaluation (2006). Having such quantitative targets will help in drawing conclusions about the effectiveness of the extension theme policy.
- As most companies are now aware of the expansion themes, SenterNovem wants to develop new products to help companies push their plans through to realization. For instance through tax reduction schemes for companies investing in energy efficiency, or through other innovative financing schemes, such as off balance sheet financing. Examples of off balance sheet financing include joint ventures, research and development partnerships, and leases (rather than purchases of capital equipment).

Conclusions

In spite of current limitations, diligent monitoring over the next seven years (2005-2012) will allow Dutch government to:

1. Create a comprehensive 'picture' of the market situation and potentials for sustainability-issues in enterprises in the Netherlands, both in SMEs (participants and non-participants in the LTAs) and multinationals;
2. Develop a reference model for the business-sectors and companies that are participating in the second LTA and sectors/companies that are not;

3. Get increasingly valuable and reliable feedback for decision making on energy efficiency policy in product-life chains (expansion themes).
4. Use the data from this evaluation research for other research programs. Already several other SenterNovem programs have made good use of the data on the stages of adoption of the LTA2 companies, for instance when planning workshops for innovative companies.

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