A Preliminary Analysis of the Dutch Voluntary Agreements on Energy Efficiency Improvement

Ewald Kor evaar, Jacco Farla, Kornelis Blok, Kaat Schulte Fischedick
Dept. of Science, Technology and Society, Utrecht University, The Netherlands

Synopsis

Voluntary agreements seems very successful in Dutch energy policy. An evaluation of this success story.

Abstract

In this paper we make an interim analysis of the Dutch voluntary agreements, one of the most important policy instruments of the Dutch government for reaching energy efficiency improvements in the manufacturing industry. These agreements are concluded with 18 branches of the manufacturing industry and have mostly a goal set of 20% energy efficiency improvement between 1989 and 2000. The evaluation is done according to the concepts goal achievement and effectiveness. Further we will try to determine which sort of barriers will be influenced mostly by the voluntary agreements.

We conclude that it is very well possible that the goals of the voluntary agreements will be more or less met by the year 2000. We warn, however, for the possibility that even in the case that the goals are met, the real effect on energy efficiency and primary energy consumption may be smaller than expected.

About the effectiveness of the voluntary agreements we conclude that when the only barriers for further energy efficiency improvements were economic barriers an energy efficiency improvement of 20% would to a large extent also be achieved without the voluntary agreements. A preliminary conclusion is that the voluntary agreements mostly influence the non-economic barriers. More in-depth research is required to determine the character and magnitude of these non-economic barriers.

1. Introduction

Energy efficiency improvement is one of the most important possibilities for the manufacturing industry to decrease the emission of CO_2. To reach the emission reduction of CO_2, stated in Dutch policy, there are several investments in energy efficiency improvement necessary. To influence the investment process, the government can use different policy instruments, for instance taxes, subsidies, standard-setting, etc. The Dutch government has chosen to use voluntary agreements as the main policy instruments to stimulate energy efficiency improvements in the manufacturing industry. The overall target of this policy is to achieve an energy efficiency improvement of 20% between 1989 and 2000.

In this paper we will present a preliminary interim analysis of the Dutch voluntary agreements. The term '-interim' is based on the fact that the voluntary agreements are in their performance phase (they are not rounded off yet). The term 'preliminary' refers to the fact that we made an evaluation with the available information up till now. An in depth analysis will be made in the future when more information is available.

First we give a summary of the Dutch energy policy towards the manufacturing industry. In the same section an overview is given of the possibilities and the barriers for energy conservation in the Dutch industry. Thereafter we introduce a theoretical perspective for evaluating policy, the so-called rational-instrumental approach. In this type of policy evaluations the following three concepts have a central place: goal achievement, effectiveness and efficiency. According to this perspective the results of this evaluation are described in the sections 4, 5 and 6. In the last section the main conclusions are given.

2. Energy Conservation and Policy

2.1 Policy Instruments in the Dutch Energy Policy

In this part we will describe the policy instruments, used in Dutch energy policy, towards the manufacturing industry to reach an energy efficiency improvement of 20% between 1989 and 2000. The main policy instruments to reach this goal are the voluntary agreements. Besides these agreements the government uses also other instrument e.g. subsidies. Also other organisations, like energy distribution companies, try to stimulate energy efficiency improvements.

2.1.1 Voluntary Agreements

A voluntary agreement is a contract/agreement governed by/under the private law, in contrast with e.g. an environmental permit which is an agreement governed under the public law. In the Netherlands the voluntary agreements are not primarily concluded between the government and individual companies, but firstly between the government (Ministry of Economic Affairs) and the branch organisations of e.g. the vegetables and fruit industry or breweries. Individual companies have the possibility to accede to the agreement. Most agreements are concluded for the year 1995 and renewed for the year 2000. Mostly the target is to achieve an energy efficiency improvement of 20% between 1989 and 2000, but sometimes it differs for specific branches. The general form of a certain agreement is a document with the rights and the duties of the ministry, the branch organisation and the acceded companies. The companies agree to take the right measures to achieve the necessary energy efficiency improvement. Besides they have the duty to report the taken measures and the achieved improvements. The duty of the ministry is mostly to support the improvements by supplying information and subsidies.

The Dutch Organisation for Energy and the Environment (Novem), the agency responsible for the implementation of energy policy tasks for the Ministry for Economic Affairs, has a special role in the voluntary agreements. Novem is responsible for the implementation of the voluntary agreements and provides companies with knowledge and experience in making plans and carrying them out. Besides, she is also responsible for granting some subsidies. Therefore also Novem signs the voluntary agreements.

Nowadays 25 voluntary agreements are concluded and 10 intentions are signed to conclude a voluntary agreement (not only for the manufacturing industry) (EZ 1995/1996). The intention is to go on with this approach after 2000 and conclude new agreements for that period.

Because of the stated target it is very important to define clearly the concept of energy efficiency. For the energy efficiency improvement the voluntary agreements use the Energy Efficiency Index (EEI): This index is defined as follows (EZ 1995):

$$EEI\ (year\ x) = \frac{Energy\ use\ (year\ x)}{\sum_{i=1}^{n} (Specific\ energy\ use_i\ (1989) * physical\ production_i\ (year\ x))}$$

Where n is the total amount of products. The specific energy use is defined as the energy use per physical unit product. The denominator defines the energy use in year x if the same technology is used as in 1989. As can be seen in the formula, the EEI of 1989 is by definition 1. The EEI is firstly defined at firm level. Thereafter all the EEI's are aggregated to branch level.

There are some remarks on the EEI. Firstly, the use of energy carriers for non-energetic use (feedstock) is excluded.

Secondly companies can make some correction for instance for increases of energy consumption due to environmental measures, capacity utilisation rate and changes in the product mix compared with 1989 (for further remarks see 4.2).

2.1.2 Financial Support

Besides the voluntary agreements, the government uses some other instruments to stimulate energy efficiency improvements. One of these instruments is financial support for research on and introduction of energy conservation techniques . The supported projects can be distinguished in five categories (EZ 1994): (1) feasibility studies, (2) external advice[1], (3) research and development, (4) demonstration, (5) market introduction. All the regulations in these categories stimulate energy efficiency improvement on the short or long term. For the energy efficiency goal of 2000 the regulations for the short term (categories 'external advice' and 'market introduction) are the most important and shall be considered in 5.3.

2.1.3 Environmental Action Plan (MAP) of the Energy Distribution Companies and the Environmental Plan Industry (MPI) of the Gasunie

Besides the policy plans of the national government, the energy distribution companies developed an environmental action plan to decrease amongst other things the CO_2 emissions (EnergieNed 1994). One of the target groups in this plan is the industry. One of the initiatives to reduce the energy consumption of the industry is giving information and advise by energy companies to individual companies. Another initiative is that energy companies work together with individual companies to install combined generation of heat and power (CHP).
Also Gasunie, the national gas company, has made an environmental plan towards the industry (Gasunie 1994). The role of this gas distribution company is mostly supporting the voluntary agreements, by giving advises to individual companies.

2.2 Possibilities and Barriers for Energy Conservation

To get any idea of the possibilities and the ambitiousness of a certain policy on efficiency improvements, we need to know what is technically and economically possible.

De Beer *et al.* (1996) calculated the technical and economic energy saving potential for the manufacturing industry. The technical potential is defined as the difference between the energy demand for a given year, according to frozen efficiency (no changes in energy efficiency) and the energy demand in that year assuming that all technically achievable energy efficiency improvements have been implemented. For the year 2000 a technical potential of 25% for the heavy industry and a 40% for the light industry is calculated (these percentages are valid for the energy use including feedstocks).

The economical potential is the potential in which the benefits of the measures are higher than the costs (including interest, depreciation an operation and maintenance costs). In the case of the manufacturing industry De Beer *et al.* (1996) calculated for the heavy industry an economical potential of 20% and for the light industry an economical potential of 30%. In general, there is a substantial gap between the technical or economical potential and what is actually implemented.

Researchers have tried to explain this gap in terms of barriers for energy conservation (e.g. Blumstein 1980, Sutherland 1991). Gillissen *et al.* (1995) distinguish four types of barriers:

1. Knowledge barriers, e.g. insufficient information on energy conservation measures and their costs and benefits
2. Economic barriers, e.g. low expected energy prices, uncertainty about the development of the energy prices, budgetary problems, too high required return of investments, present technologies not fully depreciated.
3. Physical/technology barriers, e.g. reduction in product quality, technological uncertainty about performance, uncertainty about the speed of technological development.
4. Management barriers, e.g. no specialised personnel, no interest in energy conservation by management, lack of pressure.

Among other things, we will try to determine in this paper what sort of barriers will be influenced mostly by the voluntary agreements.

3. Theoretical Approach for the Evaluation of the Voluntary Agreements

One can evaluate policy at different moments: before the implementation (ex ante), during the implementation and after the implementation of policy (ex post). As already stated our evaluation is an evaluation *during* the implementation of the voluntary agreements.

There are several things that could be evaluated in policy processes, e.g. the contents of policy, the policy process, the effects of policy. In this paper we focus on the effects of policy, in this case the voluntary agreements in the energy policy. This means that questions like: ‘why is this policy chosen’ or ‘why are the targets set as they were set’, are out of scope.

For the evaluation we chose a rational-instrumental approach. In the Netherlands Hoogerwerf and Bressers are the main representatives of this approach (e.g. Bressers and Hoogerwerf 1991; Hoogerwerf 1993). For the evaluation, according to this approach, three concepts are important (Bressers 1993):

a) Goal achievement. In this concept the most important question is: “Will the goals that are set, be achieved?” For the energy policy towards the manufacturing industry this question is whether a 20% efficiency improvement will be achieved between 1989 and 2000. On the basis of the results of this policy up till 1994 we will discuss whether we may expect that the goal will be reached or not.

b) Effectiveness. Here the central question is: “To what extent does the policy instrument contribute to the goal achievement?”. On the basis of the goal achievement one cannot conclude whether the goals are achieved *because* of the used policy instrument. There could be other reasons for the results than the pursued policy. In this paper we try to find out what the influence is of the voluntary agreements on the reached efficiency improvement. Important is to get an idea of other factors and instruments that influence the decision process on energy efficiency improvement.

c) Efficiency. This concept deals with the proportion of the benefits and the costs of the policy instrument (compared with other instruments). In the discussion about the usefulness of a policy instrument one must not only look to the benefits (see b) but also to the costs. These costs and benefits have to be compared with the costs and benefits of other instruments.

One can evaluate policy on different levels, e.g. on company level, on sector level, on country level. There are also different possibilities for gathering information for policy evaluation, e.g. interviews, statistical information. We chose to make an evaluation mainly on country level[2] by using available statistical information. The reason for evaluating on country level, is that it is important to have a general overview on country level of the working of voluntary agreements, before starting a more detailed analysis. The reason we chose to use statistical information and no information from interviews, is that firstly interviews are very time-consuming. Secondly, with interviews one mostly gathers only information in a specific case. To aggregate this sort of information to a country level in a scientific sounded way one needs a lot of cases.

4. Goal Achievement

4.1 Introduction

Whether the energy efficiency goals of the voluntary agreements will be met or not cannot be assessed before the year 2000. At this moment we can only report the results up till now, and relate these results to the targets agreed upon. We will look at two different sets of estimates for the energy efficiency improvement in the period 1989-1994. The first set of data are the official monitoring results from the Ministry of Economic Affairs (EZ 1996b). The second set of data are taken from a study by Farla and Blok (1997). This study is performed more or less similar to the official methodology (cf. section 2.1.1). One of the main differences between the two monitoring studies is that in the study by Farla and Blok (1997) the results were obtained at a sector level (because data were used from the Netherlands Central Bureau of Statistics), whereas the official monitoring results are obtained at the firm level.

First, we will describe the results according to each of the data sets. Then we will compare these results, and explain the differences, where possible.

4.2 Official Results for the Energy Efficiency Improvement in the Period 1989-1994

The official results of the voluntary agreements were published by the Ministry of Economic Affairs (EZ 1996b). The results of the voluntary agreements for the period 1989-1994 are given for 18 branches of the manufacturing industry (EZ 1996b). These 18 branches together used 492 PJ[2] in 1989 (excluding feedstocks), which is approximately 84% of the industrial energy consumption (excl. refineries, excl. feedstocks), according to Ministry of Economic affairs (EZ 1996b). The 18 branches have been grouped in 5 sectors of manufacturing industry. This grouping is shown in table 4-1.

Table 4-1. Overview of the 18 branches for which monitoring results are available (EZ 1996b)

Sector	Branches	Nr of firms (locations)	Energy cons. in 1989 (in PJ)	EEI 1994
Food	Meat processing	51	6,0	9%
	Vegetables/fruits	27	1,6	6%
	Margarine/fat/oil	26	7,5	5%
	Dairy industry	21	17,3	5%
	Sugar industry	2	7,5	9%
	Coffee roasting	5 (10)	1,0	6%
	Breweries	15	4,0	15%
Building materials	Sand/limestone	11	1,2	8%
	Cement industry	1 (3)	7,1	14%
	Glass manuf.	5 (7)	11,0	10%
Basic metal industry	Iron and steel	2	61,2	10%
	Non-ferrous ind.	19	8,4	7%
Chemical industry	Chemicals	88	310,0	8%
Other industry	Textile	46	3,9	9%
	Paper and board	30	30,2	8%
	Philips ®	1 (40)	10,8	23%
	Rubber industry	25	1,9	10%
	Ind. wet cleaning	41	1,7	8%
TOTAL		416	492,0	9% (weighted average)

With the last two columns in table 4-1 we can calculate the total change in the EEI for the period 1989-1994. The thus calculated change in EEI is depicted in figure 4-1. For most of the branches the 1995 goal is a 10% decrease in specific energy consumption[4]. On average the EEI decreased with 1,8% per year, according to the data in table 4-1. The average annual decrease per sector is given in table 4-2.

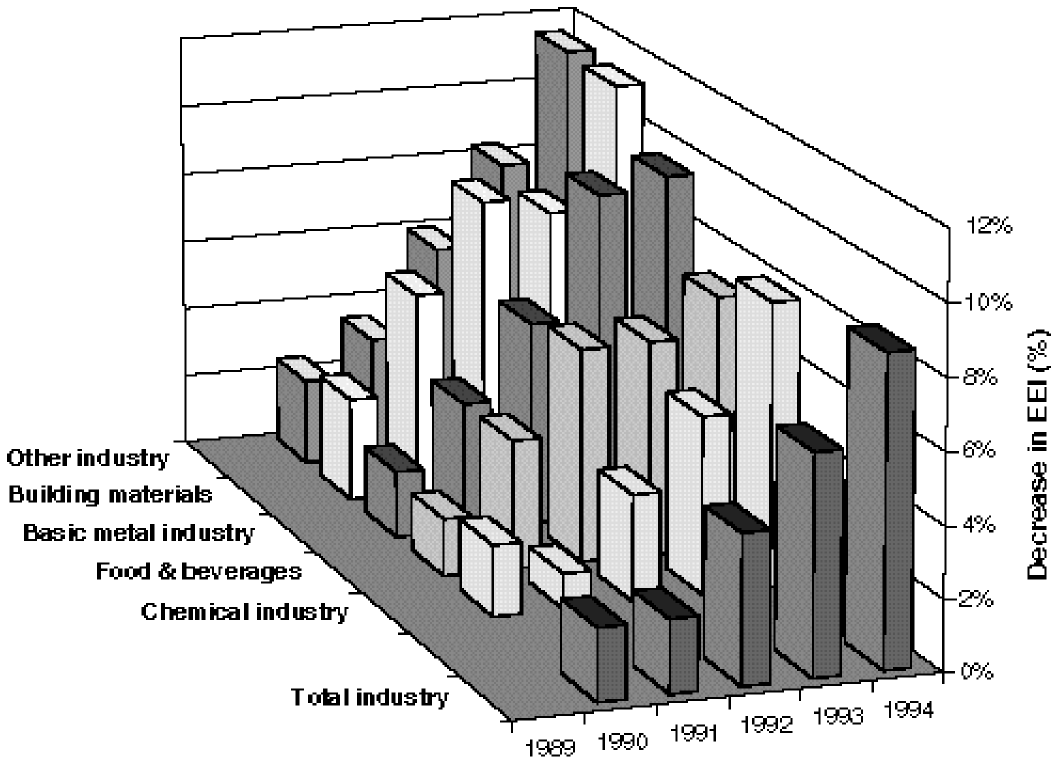

Figure 4-1. Development of the energy efficiency index (EEI) for the different sectors and the total manufacturing industry.

On the basis of the official monitoring results as depicted in figure 4-1 it looks as if the results of the voluntary agreements are well in schedule with the planned energy savings. If the results up to 1994 are extrapolated (in a linear way) to the year 2000, we find that the projected energy savings at the current pace of 1,8% per year will give a result in 2000 that is slightly lower (-18%) than the established goal for that year (-20%).

We have to remark that there is no justification for the assumption that the energy savings agreed upon should be reached in a linear way. Large investments may be scheduled for a later period with which a large part of the agreed savings can be reached. On the other hand, one could argue that the relatively cheap options might already have been implemented.

We should also mention the fact that over 60% of the total energy savings have to be achieved in one sector, namely the chemical industry. This makes the total results very much dependent on the results in that sector.

Another way of looking at the results is by comparing the results with the targets per sector. In order to do so we assumed that 5/6 of the target savings for 1995 should have been reached in the period 1989-1994. By relating the actual savings in 1994 to calculated target values for that year, we found that 9 out of the 18 branches were ahead of or on schedule.

4.3 Alternative Results for the Energy Efficiency Improvement

Because an alternative monitoring method is available in our department with which energy efficiency developments are followed since 1980 (Farla and Blok 1997), the official monitoring results by the Ministry of Economic Affairs can be compared with the results from this method.

The methodology of the study by Farla and Blok (1997) was similar to the methodology described in section 2.1.1. Because the statistical data were not available on the level of a single firm, the analysis by Farla and Blok is performed at a higher level of aggregation than the monitoring by the Ministry of Economic Affairs. The developments in energy efficiency for the heavy industry sectors were calculated on the basis of physical production data, taken from the Netherlands Central Bureau of Statistics (CBS). The developments for the light industrial sectors (food, metal processing) were assessed using volume indices of production from CBS (CBS, monthly). Another difference between the two methods is the fact that the feedstock use of fuels is included in the energy consumption in the study by Farla and Blok (1997). Also, in that study the primary energy consumption is calculated with an electricity generating efficiency of 36,3% (actual value 1980) instead of 40% as used by the Ministry of Economic Affairs.

The developments in the specific energy consumption (SEC) are given by sector in figure 4-2.

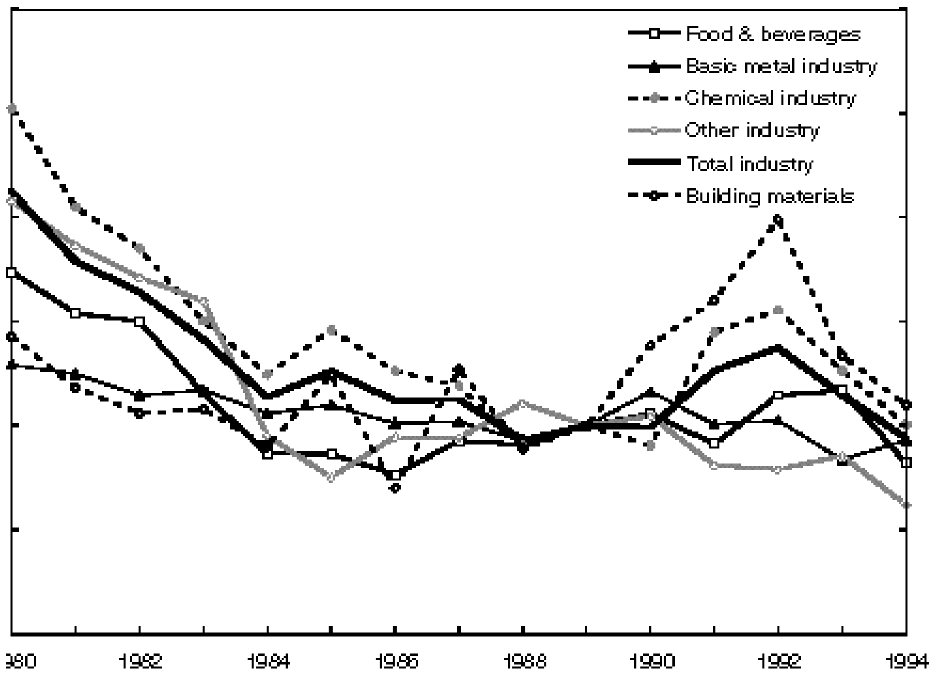

Figure 4-2. Developments in specific energy consumption by sector (Farla and Blok 1997).

In figure 4-2 we see that the specific energy consumption for the different sectors decreased in the first years of the 1980's. After this period the SECs seem to stabilise, except for a short upward spike in the early 1990's. The developments according to Farla and Blok (1997) are compared with the findings of the Ministry of Economic Affairs (EZ 1996b) in table 4-2.

Table 4-2. Average annual change in aggregate specific energy consumption, by sector

		(Farla and Blok 1997)		(EZ 1996)
Sector	1980-1985	1985-1990	1989-1994	1989-1994
Food & Beverages	-3,3%	+0,8%	-0,7%	-1,5%
Building materials	-0,7%	+0,5%	+0,4%	-2,4%
Basic metal industry	-0,7%	+0,3%	-0,3%	-2,0%
Chemical industry	-3,5%	-2,1%	+0,0%	-1,7%
Other industry	-4,8%	+1,2%	-1,6%	-2,4%
Total industry	-3,0%	-1,0%	-0,2%	-1,8%

If we extrapolate the results for the period 1989-1994 from the study by Farla and Blok to the year 2000, we find that the energy savings agreed upon will not be reached by far. In the next section we will try to explain (part of) the differences between the official results and the results according to Farla and Blok.

4.4 Discussion of the Monitoring Results

4.4.1 Comparison of the Results

The differences in the findings between the two sets of results for the period 1989-1994 are large (cf. table 4-2). We will try to explain part of these differences for each of the sectors separately.

The difference for the food industry might (partially) be explained by the fact that Farla and Blok (1997) used CBS production volume indices in their calculations instead of the real *physical*production data for this sector. This may lead to an underestimation of the efficiency developments in the Farla and Blok study.

In the building materials industry opposite trends are observed in the study by Farla and Blok and the official monitoring results. This may in part be explained by the fact that some measures in this sector are regarded energy efficiency increases in the official monitoring results whereas they are regarded structural effects in the study by Farla and Blok. Some examples are given in section 4.4.2.

In the basic metal industry large differences are seen between the two sets of results, too. A substantial part of this difference can be explained by the fact that feedstocks are included in the study by Farla and Blok (1997). The 1989 primary energy consumption in that study amounts to 168 PJ. In the results from the Ministry of Economic Affairs only 69,6 PJ of primary energy in 1989 is accounted for. A large part of the coal input in the pig iron production is regarded to be non-energy use of fuels in the voluntary agreement, contrary to what is normally assumed in energy statistics. Also, a large part of the electricity consumption in the aluminium production is considered to be non-energy use in the official monitoring results. This implies that, in order to make the results (-table 4-2) for this sector comparable, we should correct the results with a factor (69,6/168). After such a correction we still keep a difference that cannot be explained.

The differences in the results for the chemical industry are large. Because the chemical industry accounts for 60% of the industrial energy consumption, those differences affect the results for the total industry to a large extent. In order to make the results comparable, like in the basic metal industry, the influence of the feedstocks should be accounted for. In the chemical industry roughly half of the primary energy consumption is regarded to be non-energy use. After applying this correction we still keep a large difference (0,8%, see table 4-2) between the data of Farla and Blok (1997) en the data of the Ministry of Economic Affairs One reason for this difference may be that the energy consumption in the official monitoring is different from the energy consumption according to the Netherlands Central Bureau of Statistics (Novem, 1995c). This is still a point of further investigation by NOVEM and CBS.

For the ‘other industry’ a relatively small difference in the results is found. This could be partially explained by differences in the sectors covered, and the use of ‘volume indices of production’ as described for the food industry.

Besides the differences described for each of the sectors, the official monitoring method also gives rise to some questions about the usefulness and reliability of these official results. These aspects will be discussed in the next section.

4.4.2 Is it all Ener gy Ef ficiency what we get?

Energy efficiency changes occur when the same products are made with less energy consumption. If the energy consumption changes because the products or raw materials change to a large extent, we will usually call this a structural effect. Structural changes may lead to either an increase or a decrease of the energy consumption. By closely studying the voluntary agreements we found that in several cases structural changes are treated as efficiency improvements, whereas they are regarded structural changes in other cases. It seems as if this may bias the official results towards improved energy efficiency. We will elucidate this with some examples.

In the official methodology the EEI in the glass and clay brick industry can be lowered by decreasing the specific mass of the glass containers and bricks (Novem 1995b; Novem 1996a). These measures should, however, be seen more as material efficiency improvement than as energy efficiency improvement since the energy consumption per kg of glass or brick will stay the same. It is therefore considered a structural change in the study by Farla and Blok (1997).

Another structural change relates to the raw material inputs. Changes in the raw material input in the chemical industry may be corrected for in the EEI (Novem 1995c). However, changes in the raw material input in the glass industry (larger share of recycled glass) and in the cement industry (increased input of slag) are considered efficiency increases (Novem 1995b; Novem 1995a).

A last example of decreases in EEI on dubious grounds is the switch from the use of commercial fuels to fuelling with 'waste' products. This implies that the EEI may be reduced dramatically, while the (specific) energy consumption stays the same, or can even increase. An example can be found in the cement manufacturing industry, where a decrease of the EEI of over 5% was achieved by substitution of fossil fuels by a waste product (also a fossil fuel) of the chemical industry (Novem 1995a).

Overall we conclude that the so-called structural changes in the manufacturing processes are treated differently from case to case. In many cases the choice of how to treat these changes is made in such a way that it will either lead to a decrease of the EEI, or that it will be corrected for in the calculation of the EEI. This procedure may lead to an overestimation of the efficiency improvements (and an accompanying underestimation of the structural changes). It is possible that such an overestimation may explain another part of the differences found in the previous subsection.

4.4.3 Other Difficulties in the Official Monitoring Process

Another problem with the official EEI monitoring process is the impossibility to check the reported results. Every year publicly available reports about the efficiency improvements are published per sector. In these reports an overview is given of the development of the EEI and the measures taken. However, the information in these reports is incomplete. For instance, in many of these reports it is unclear if corrections are made, and on what basis. Also, the data used for the calculation of the EEI are kept confidential. As mentioned earlier in some cases the data used deviate from the data reported by the Netherlands Central Bureau of Statistics.
The treatment of feedstocks may also pose a problem. Firstly, in some branches part of the energy consumption is regarded to be feedstock (cf. section 4.2). Secondly, in some branches (e.g. the chemical industry) the feedstock use and the energy consumption may be physically inseparable. In these cases, expert estimates have to be used to assign one part of the energy consumption to the feedstock use of fuels.

4.5 Conclusions on the Goal Achievement of the Voluntary Agreements

Based on the information presented in section 4.2 we conclude that it is very well possible that the goals of the voluntary agreements (a decrease of the EEI with 20% between) will be more or less met by the year 2000. We mentioned that over 60% of the total energy savings have to be achieved in one sector. This will make the overall results very much dependent on the results in this one sector.
On the basis of our remarks in section 4.4 we must also warn for the possibility that even in the case that the goals are met officially, the actual effect on energy efficiency may be smaller due to the inclusion in the EEI of material efficiency improvement and the one-sided treatment of structural effects. The latter, together with the inclusion of fuel shifts, may also lead to an overestimation of the effect on energy consumption and CO_2 emission.

5. Effectiveness

In the preceding section we have seen to what extent the goals will be achieved. We are not only interested in the goal achievement. We also want to know what the contribution is of the voluntary agreements to the goal achievement. We analyse this in an indirect way, according to the following questions. Firstly, what would be the energy efficiency improvement when there was no energy policy at all? Secondly, what is the contribution of other policy instruments to the goal achievement. Besides, if the voluntary agreements have any effect, we also want to know more in detail what sort of effect these agreements have.

5.1 Trend Analysis of the Energy Efficiency Improvements

The main question for assessing the impact of the voluntary agreements is what would be the efficiency improvement without the voluntary agreements. This question is hard to be answered, because we cannot build the same situation without the voluntary agreements. One way to get an idea about the efficiency improvement without the voluntary agreements is to look to the trend of energy efficiency improvements in history before the voluntary agreements were concluded and assuming that this trend will continue.
Farla and Blok (1997) did some calculations about the development of the energy efficiency is different sectors. The results of these calculations are given in table 4-2 and figure 4-2 . One can see a big decrease of the SEC in the early eighties. After 1985 the SEC is somehow stabilised. One important reason for the big decrease of the SEC between 1980 and 1985 is the high level of the prices of fuel and electricity, which are important driving forces for energy conservation (see e.g. van der Doelen 1989). Between 1985 and 1990 the prices lowered again and came around the price level of the nineties. According to these developments we can conclude carefully, that for a further decrease of the SEC between 1989 and 2000 there seems additional effort necessary.
Finally, we have to remark that one has to be very cautious to draw strong conclusions from trend analysis. It only gives an indication of what was possible in the past and how big the changes should be in the future to achieve a certain goal. From the past we learned how the energy policy field can change in an unpredictable way.

5.2 Attainable Energy Conservation by Normal Investment Criteria

Another way of looking to the contribution of the policy instruments to the goal achievement, is analysing what would be the efficiency improvement if all the investments in energy conservation would be treated in the same way as 'normal' investments. For this analysis we used the model ICARUS[5]. With this model it is possible to calculate the potential of energy conservation according to different investment criteria.
An important criterion for companies to decide about investments is the pay-back period (PBP). The PBP gives an indication about the time an investment will be paid back and is defined as follows:

$$PBP = \frac{Total\ investments}{Annual\ revenues} = \frac{1}{SEPC - OM}$$

With: I = investment costs (Dfl)
SEPC = annual saved energy purchase costs (Dfl/yr)
OM = annual operation and maintenance costs (Dfl/yr)

With the results of some calculations with the database ICARUS we plotted the pay-back period against the cumulative efficiency improvement (measure for the EEI expressed in percentage instead of a index). The result is presented in figure 5-1. This figure gives an indication of the possible efficiency improvement by a certain PBP[6].

To get an idea about the efficiency improvement that is possible when the same PBP criterion is used for energy conservation investments as for normal investments, we need information about the PBP of normal investments. There has been some research on what PBP firms actually use for investment decisions. Gillissen *et al.* (1995) made a survey under 318 companies in 41 sectors. With this data we calculated an average PBP of 4,5 years for normal investments in the manufacturing industry. We must keep in mind that this data show a big range. Gruber and Brand (1991) did some research on energy conservation in small and medium-sized companies. They

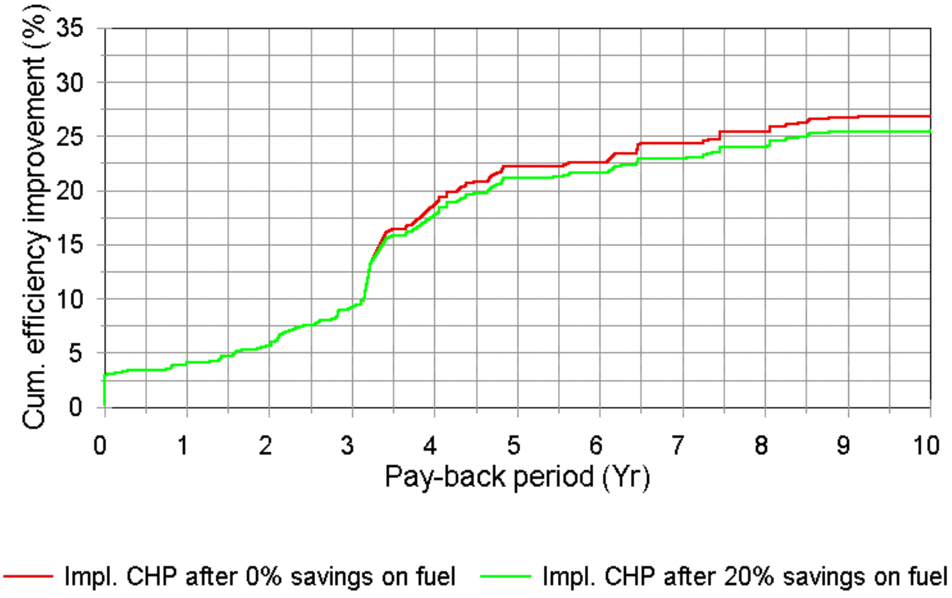

Figure 5-1. Cumulative efficiency improvement (feedstocks excluded) as a function of the PBP

interviewed 500 companies in 8 industrial sectors and found an average PBP of 4,1 years. In the same article Gruber and Brand described that only 8% of the interviewed firms use lower PBP for energy-saving investments compared with normal investments. Gillissen *et al.* (1995) concludes that the distribution of PBP's for normal investments and for energy conservation investments does not show many differences. So we can conclude that the assumption that companies use the same PBP for energy conservation investments as for normal investments is true to a large extent.

If we compare this average PBP for normal investments with figure 5-1, we can conclude that an efficiency improvement of 20% is possible, assuming that firms accept the same investment criteria for investments in energy efficiency improvement as for 'normal' investments[7]. If we compare this percentage with the goal of 20% efficiency improvement, we can conclude that for reaching this goal it is hardly necessary to take investments with higher PBP than the PBP firms usually use for investments[8]. We must keep in mind that the PBP is not the only criterion for investments. Also lack of enough financial space for investments, the uncertainty of the energy price and the lack of product improvement plays an important role in the investment decision. Besides, lack of knowledge and lack of interest are also reasons why only a part of the investments, satisfying a certain PBP is carried out.

5.3 Influence of Policy Instruments Beside the Voluntary Agreements

To make a well-founded conclusion about the contribution of the voluntary agreements to the goal achievement, we also have to determine the contribution of other instruments, as described in section 2.1.2 and 2.1.3, to the goal achievement

Firstly, for stimulating energy efficiency improvements there are several subsidy regulations, made by the Dutch central government. As said in 2.1.2 we will only look to subsidies that stimulate market introduction and/or external advice. In table 5-1 an overview is given of the most important subsidy regulations for the manufacturing industry. It must be noticed that mostly the subsidy will be assessed per project. Furthermore, there are several conditions for granting a project, e.g. the project should be innovative, it should function as an example and there should be technical or economic risks. We tried to make an indication of the contribution of these subsidies to the goal achievement. The total amount of subsidies is about 50 million DFl. in 1996. According to ICARUS the total amount of investments to reach an efficiency improvement of 20% (all investments with a PBP smaller than 5 years) is about DFl. 4000 million. We may also assume that only the investments with a certain economic risk (investments with a PBP between 3 and 5 years) will be granted for a subsidy. The total amount of investments between 1990 and 2000 with a PBP between 3 and 5 years is DFl. 2500 million[9]. This means that 10-20% of the total investment are covered by a subsidy. If this is a correct assumption, these subsidies can play a not to be neglected role in the increase of investments in energy efficiency. However, we have to be aware of a free-rider effect, the effect that an investment will also be made without a subsidy, that means that also investments with a PBP less than 3 years will be granted. Farla and Blok (1995) found a free-rider effect of 64% of the investments to which an energy-bonus was given. If the subsidies that we take into account have the same free-rider effect, the contribution the role of these subsidies is significantly decreased compared with the situation with no free-rider effect.

Table 5-1. Overview of the most important subsidy regulation for the manufacturing industry (EZ 1996a; Novem 1996b)

Subsidy regulation amount (DFl, 1996)	Category [+] (external advice or market introduction)	Max. percentage of the costs	Total available
BTIEB[a]	market introduction	25%	20 million[#]
BSEb (MINT[c])	market introduction	25%	5,9 million[#]
BSE (chemical and petroleum industries)	market introduction	25%	7,8 million[#]
BSE (light industries)	market introduction	25%	2 million[#]
BSE (other industries)	market introduction	25%	3,2 million[#]
E&M[d]	external advice	44%	4,6 million
BSET[e]	market introduction (only for heatpumps)	20%	3,7 million
NEWS[f] (only for CHP)	market introduction	40%	8 million

[a]) Decision Tenders Industrial Energy Saving
[b]) Decision Energy Programs (general)
[c]) Long-term Program Intersectoral New Technologies
[d]) Energy saving & environmental advice
[e]) Decision Subsidies Energy Savings Techniques
[f]) New Energy Efficient Combinations with CHP (all translation form Dutch)
[#]) Not only for market introduction
[+]) Most subsidy regulations can be used for more purposes

Besides these subsidies, there is a regulation for arbitrary depreciation of investments on energy conservation. This regulation makes it possible for firms to depreciate on the most financial favourable way (within certain limits) and get in this way benefits for their liquidity and benefits on their interest. What the influence is of this regulation could not be determined.

Secondly, also the MAP of the energy companies and the MPI of the gas distribution company play a role in stimulating energy conservation. Blok and Farla (1995) analysed the influence of the energy companies on the growth of CHP in the early nineties in the Netherlands. They concluded that the activities of the energy companies have played the major role in the growth of the CHP capacity. However, their role will probably decrease, as the excess of electricity production capacity has led to a reduced activity of the energy companies in this area. The influence of giving information and advice by the energy and gas distribution companies is hard to determine.

5.4 Conclusions on the Effectiveness of the Voluntary Agreements

It is not easy to determine the contribution of the voluntary agreements to the goal achievement, firstly because it is not easy to analyse what would have been the trend without the voluntary agreements. Secondly there are so many influences besides the voluntary agreements, subsidies, advises by different actors, that it is not easy to determine what the influence is of what and whom.

In 5.1 we concluded carefully, that for a further decrease of the SEC between 1989 and 2000, compared with the development of the SEC between 1985 and 1990, there seems additional effort necessary. Further we saw in 5.2 that an improvement of 20% is possible when the same PBP period is used for energy efficiency improvement investments as for normal investments (although the PBP is not the only economic criterion for investments). At last we saw that subsidies can play a not to be neglected role in the increase of investments in energy efficiency. However a big free-rider effect can significantly decrease this role.

On the basis of these results, we conclude that when the only barriers for further energy efficiency improvements were economic barriers an energy efficiency improvement of 20% would to a large extent also be achieved without the voluntary agreements[10], although this improvement can differ from sector to sector. A preliminary conclusion is that the voluntary agreements mostly influence the non-economic barriers. In what way they influence the non-economic barriers could not be determined in this type of analyses. For such an analysis it is necessary to make a more in depth study of the motives and influence of voluntary agreements on investment behaviour of firms.

6. Efficiency

When we talk about the efficiency of the voluntary agreements we have to answer what the proportion is of the benefits and the costs of the voluntary agreements compared with other instruments. To answer this question one has to make an inventory of all the benefits and all the costs of the voluntary agreements and thereafter an inventory of the efficiency of all possible alternative instruments. As we have seen in the previous section it was not fully possible to determine the effectiveness of the voluntary agreements. Besides, also the goal achievement was problematic to determine. Probably we have to deal with the same problems when we try to determine the goal achievement and the effectiveness of other instruments. Therefore it is impossible in the scope of this paper (and maybe also outside the scope of this paper) to make a quantitative analysis of the efficiency of the voluntary agreements.

To give an indication of the costs of the voluntary agreements some rough data can be given. According to NOVEM the costs of monitoring activities (costs made by the government, industries and research institutes) are about 6 million Dfl. per year (NOVEM 1996c). Besides these costs there are also costs of the negotiating and decision phase. These costs are much dependent on the length of the negotiation process. The yearly costs of subsidies regulation for energy efficiency improvements are about 60 million Dfl (NOVEM 1996c). All those costs are small compared to the total investments required by companies (approximately 400 DFl. million per annum). However these costs also lead to substantial benefits in the form of avoided energy costs.

7. Conclusions

In this paper we evaluated the voluntary agreements according to the concepts of goal achievement, effectiveness and efficiency. We did this mainly on country level by using available statistic information.

We conclude that it is very well possible that the goals of the voluntary agreements will be more or less met by the year 2000. This optimistic conclusion is based on the trend analysis of the EEI so far. Besides critiques on this trend analysis, we must however warn for the possibility that even in the case that the goals are met, the real energy efficiency improvements and the effect on primary energy consumption may be smaller, because the way data on energy-savings are monitored, may overestimate the real savings.

About the effectiveness of the voluntary agreements we conclude that if the only barriers for further energy efficiency improvements where economic barriers an energy efficiency improvement of 20% would also be achieved without the voluntary agreements. A preliminary conclusion is that the voluntary agreements mostly influence the non-economic barriers. In what way they influence the non-economic barriers could not be determined in this type of analyses we used in this paper. For such an analysis it is necessary to make a more in-depth study of the influence of the voluntary agreements on the investment behaviour of firms.

Endnotes

1. 'External advice' could also have a function for energy efficiency improvements on the long term.
2. Some analysis (e.g. analyses in section 4) are made on a sectoral level, but the results are mainly used for conclusions on country-level.
3. Primary energy consumption, calculated with an electricity generating efficiency of 40%.
4. The (aggregate) specific energy consumption (SEC) divided by the SEC in the base-year 1989 gives the energy efficiency index (EEI). Therefore, a decrease in the EEI is equivalent to a decrease in the aggregate SEC.
5. In our department, the Department of Science, Technology and Society, the model ICARUS is developed to calculate the potential of energy conservation (de Beer *et al.* 1994). In this model an inventory is made of all sorts of energy conservation measures in the Netherlands, including their savings and their costs. This is done for the periods 1990-2000 and 1990-2015.
6. The way we handled CHP needs some explanation. Normally ICARUS assumes that CHP is implemented after all the technical measures on the demand side have been taken. In practice the situation is different and CHP will be implemented as soon as it is economically feasible. Because ICARUS is a static model we could not model this. So we modelled an underestimation and an overestimation. In the overestimation we assumed that CHP is implemented before other energy saving measures and therefore scaled on the energy-use before savings. This is an overestimation because of two reasons. First, not all the CHP will be implemented before other heat saving measures. The consequence is that we scaled it too big. Secondly one can question whether other fuel efficiency measures will be taken if the CHP is scaled on the fuel use before savings. In the underestimation we assumed that CHP is implemented after the implementation of the measures that lead to a fuel efficiency improvement of 20%. This is an underestimation because some of the CHP will be implemented earlier and scaled on a bigger fuel use. The 'real' situation is somewhere in between.
7. We have to remark that the relation between the PBP and the efficiency improvement in figure 5-1 is not a linear function. The consequence of this is that we cannot simply take the *average* PBP (because it has such a big range). If we want to determine exactly the efficiency improvement according to the average PBP we have to multiply the distribution function of this average PBP with figure 5-1. Another way of dealing with this problem is assuming a linear function on the basis of the function between a PBP of 0 and 3 years (worst assumption). Then we see that there is still an efficiency improvement left of 15%.
8. This conclusion is based on an analysis on national scale. It must be noted that there can be big differences between sectors. Some sectors can probably reach an efficiency improvement of 30% by taking all the investments with a PBP between 0 and 4 years. For other sectors an improvement of hardly 10% is possible by taking the same PBP criterion for their investments. Our database ICARUS is not detailed enough to draw conclusion on sector level in a scientific justified way.
9. We have to make two remarks. Firstly, we only used data for 1996. The total amount of subsidies can differ each year (in the first years of the nineties this amount was higher, especially for CHP, see Blok and Farla 1995). Secondly, some subsidies are not only used for market introduction or external advice. However, we only used this data for making a rough analysis.
10. Fischer (1996) came to a comparable conclusion. He did some research on the influence of the voluntary agreements in decisions on energy investments in some paper producing companies in the Netherlands and in Germany. He found that there was no influence of the voluntary agreements on the profitability calculation and the financing behaviour.

References

Beer, J.G. de, M.T. van Wees, E. Worrell, K. Blok. 1994. *ICARUS, the potentials for energy conservation in the Netherlands up till the years 2000 and 2015*. Department of Science, Technology and Society, Utrecht,

Beer, J.G. de, E. Worrell, K. Blok. 1996. "Sectoral Potentials for Energy Efficiency Improvements in the Netherlands". *International Journal of Global Energy Issues*, 5-6(8):476-491

Blok, K. and J. Farla.1995. "The continuing story of CHP in the Netherlands", *International Journal of Global Energy Issues*, 8(4):349-361

Blumstein, C., B. Krieg, L. Schipper, C. York. 1980. "Overcoming Social and Institutional Barriers to Energy Conservation", *Energy*, 5(4):355-371

Bressers, J.Th.A. 1993. *Policy evaluation en policy effects*, in: A. Hoogerwerf (red.), *Government Policy*, 5th edition, Alphen a/d Rijn, 1993, p. 161-179 *(in Dutch)*

CBS. monthly publication, *Monthly statistics on industry*, Netherlands Central Bureau of Statistics, Voorburg/Heerlen, *(in Dutch)*

Doelen, F.C.J. van der. 1989. *Policy instruments and energy conservation*, thesis, Enschede, *(in Dutch)*.

EnergieNed. 1994. *Environmental Action Plan of the energy distribution sector*, Arnhem, *(in Dutch)*

EZ. 1994. *Energy conservation in the industry 1994, How, what and why*, Ministry of Economic Affairs, The Hague, 1994 *(in Dutch)*

EZ. 1995. *On energy efficiency, initial results*, Ministry of Economic Affairs, The Hague

EZ. 1995/1996, *Third white paper on energy policy*, Second Chamber (Lower House), 24 525, numb. 1-2

EZ. 1996a. *Subsidies and Financial Support*, web-pages Ministry of Economic Affairs (http://info.minez.nl, December 1996)

EZ. 1996b. *Long-term agreements, on energy efficiency, results 1994*, Ministry of Economic Affairs, The Hague *(in Dutch)*

Farla, J. and K. Blok. 1995. "Energy Conservation Investments of Firms, Analysis of Investments in Energy Efficiency in the Netherlands in the 1980's", *Pre-Proceedings of the 1995 ACEEE Summer Study on Energy Efficiency in Industry*, New York.

Farla, J. and K. Blok. 1997. *Monitoring of Sectoral Energy Efficiency Improvements in the Netherlands, 1980-1994*, Department of Science, Technology and Society, Utrecht, forthcoming

Fischer, J. 1996. *The influence of voluntary agreements on the decision-making process of firms for investments in CO2-reduction measures*, Wuppertal.

Gasunie. 1994. *Information brochure environmental plan industry*, Gasunie, Groningen, *in Dutch)*

Gillissen, M., J.B. Opschoor, J. Farla, K. Blok, *Energy Conservation and Investment Behaviour of Firms*, Department of Environmental Economics, Department of Science, Technology and Society, Amsterdam/Utrecht

Gruber, E. and M. Brand. 1991. "Promoting Energy Conservation in Small an Medium-Sized Companies", *Energy Policy*, 19(3):279-287

Hoogerwerf, A. (red.), 1993. *Government Policy*, 5th edition, Alphen a/d Rijn, *(in Dutch)*

Novem. 1995a, *Development Energy-efficiency Dutch Cement Producers*, reporting year 1993, Utrecht *(in Dutch)*

Novem. 1995b, *Development Energy-efficiency Dutch Glass Producers*, reporting year 1994, Utrecht *(in Dutch)*

Novem. 1995c, *Development Energy-efficiency Dutch Chemical Industry (VNCI)*, 1989-1994, Utrecht *(in Dutch)*

Novem. 1996a, *Energy monitoring long-term agreements energy conservation Ceramic Industry*, *1989-1993*, Utrecht

Novem. 1996b, *Financial Support*, Web pages Novem (http://www.novem/fin_nl.htm, December 1996)

Novem. 1996c, *Personal communication*, march 1996

Sutherland, R.J. 1991. "Market Barriers to Energy-Efficiency Investments", *The Energy Journal*, 12(3):15-34