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VOLUNTARY APPROACHES: TWO DANISH CASES

The Danish agreement on industrial energy efficiency, with examples from the paper sector and the milk condensing sector

This report discusses the Danish agreement on industrial energy efficiency, with examples from agreements concluded with firms within the paper sector and with the milk-condensing sector.

It was prepared by Signe Krarup, AKF, Denmark. Comments prepared by the Danish Energy Authority have later been incorporated.

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FOREWORD

At its first meeting, 23-24 April 2001, the Working Party on National Environmental Policies under OECD's Environment Policy Committee agreed to start new work on voluntary approaches used in environmental policy, building on a few selected case studies. These case studies were each to be prepared by external consultants – discussing two concrete cases of voluntary policy approaches in Canada, United States, Japan and Denmark respectively.

The present report discusses the Danish agreement on industrial energy efficiency, with examples from agreements concluded with firms within the paper sector and with the milk-condensing sector. It was originally prepared by Signe Krarup, AKF, Denmark. Comments prepared by the Danish Energy Authority have later been incorporated.

The case studies will – together with other available material – feed in to a final project report on the use of voluntary approaches in environmental policy that is expected to be released in 2003.

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VOLUNTARY APPROACHES: TWO DANISH CASES

Danish agreements on industrial energy efficiency – with examples from the paper sector and the milk-condensing sector.

EXECUTIVE SUMMARY

The Danish agreements on energy efficiency in industry are part of a policy package launched in 1996 to combat CO₂ emissions.

The Danish agreements on energy efficiency in industry are part of a policy mix aimed at reducing CO₂ emissions in industry that was introduced in 1996. The policy package introduced negotiated agreements in a combination with CO₂ taxes and investment subsidies, and the expected effect from the agreements was a decrease in CO₂ emissions by 0.6 % in the year 2005 relative to 1988. The target group for the agreements is firms with energy intensive production processes. These firms can enter into a three-year agreement with the Danish Energy Agency qualifying them for a rebate on their CO₂ tax payment. This case study examines the agreement scheme as it was implemented up to 2000, with examples from the paper sector and the milk-condensing sector.

While they cover one or several firms, they are binding for each participating firm.

The agreements can be individual (covering a single firm) or collective (covering several firms within a sub-sector with similar production processes). However, in both cases the agreement is signed by the individual firms. As the agreement is legally binding and the tax rebate is firm-specific, the problem of free-riding is not present. If firms do not comply with the terms of the agreement their tax rebate is annulled. Thus, there exists a credible regulatory threat which give firms a strong incentive for fulfilling the terms of their agreement.

The agreements were originally be based on detailed energy audits that i.a. identified investment projects to be undertaken ...

Originally, the basis of the agreements was an energy audit in the firm, which was carried out by external consultants and verified by an independent verification agency. The energy audit aimed at identifying profitable energy saving investments in the firm. After the verification, the firm sketched an action programme comprising investment projects, energy management and special investigations which provided the basis for the negotiations between the firm and the Danish Energy Agency on the content of the agreement. During the negotiations, alternative projects could replace some of the projects outlined in the action programme. The final agreement listed the firm's obligations covering special investigations, implementation of energy management systems and investment projects with a payback time of four to six years.

... based on relatively similar criteria across firms.

The agreement forced the firms to implement investment projects with leaner payback criteria than what would usually be used by firms. As similar (although not identical) criteria were used for all firms, firms with many profitable investments were forced to realise relatively larger savings than firms with no profitable investments. The agreements therefore had the potential of leading to a relatively efficient allocation of energy savings between firms, providing the audits actually disclosed the true energy saving potential and true profitability of the different investment projects.

Firms prepare annual progress reports to the Danish Energy Agency.

Once a year firms deliver a progress report to the Danish Energy Agency documenting the fulfilment of the projects specified in the agreement and the status of the energy management system. The Danish Energy Agency follows-up by checking the progress reports and with renegotiations in cases of changed conditions. If a firm fails to fulfil its obligations, the Danish Energy Agency can cancel the agreement and annul the (significant) tax rebate.

While the agreements seem to have had some environmental impact, the administrative costs of implementing them have been high ...

The Danish agreements seem to have had a positive impact on the firms' behaviour, and their expected effects seem to have been realised. However, they imposed significant administrative costs on the firms and the public authorities involved in the implementation of the agreements. Compared to the CO₂ reductions obtained, it is clear that the administrative burden from the agreements is relatively high and higher than it would be for the implementation of taxes and subsidies instead. This is especially due to high costs related to the administration of the tax rebates and from undertaking and checking the energy audits.

... triggering a major revision of the scheme in 2000.

In order to reduce the administrative burden, the agreement scheme was revised in 2000. Under the new scheme, firms are no longer obliged to make an energy audit, but only to undertake a mapping of their own energy use. The purpose of this mapping is the construction of an advanced energy management system and to specify which special investigations need to be carried out. Moreover, the Danish Energy Agency no longer examines the firms' progress reports, but the energy management system is instead tested through verification. The expected environmental effects of these agreements are the same as for the old ones, but no assessment has yet been carried out.

THE DANISH AGREEMENT ON INDUSTRIAL ENERGY EFFICIENCY

1. Brief description of the scheme

1.1 *History*

1. In 1993 a CO₂-tax on the energy consumption of trade and industry was introduced in Denmark. The level of the tax varied between different fuels, depending on their CO₂-content. However, energy intensive firms were offered a lower effective tax according to a measure of the energy intensity of the firms. The ratio between the tax burden and value added was used as a measure of energy intensiveness. All effective tax exceeding 1300 Euro per year was reimbursed to energy intensive firms that submitted themselves to an energy audit, undertook certain standard energy efficiency projects and reported their energy accounting activities to the Danish Energy Agency. This meant that the effective level of the CO₂ tax on trade and industry on average was only 35% of the level of CO₂-taxation of households, cf. Johannsen (2002).

2. In 1993, the Danish government appointed a ministerial committee to examine the possibility of extending the use of green taxes on trade and industry without losing international competitiveness and jobs in trade and industry. In the mandate of the committee it was made clear that the aim of the green taxes was to contribute to the solution of environmental problems by changing firms' behaviour and not to provide the government with new revenue, cf. Johannsen (2002). The committee pointed out that new initiatives were necessary if Denmark was going to meet its national and international commitments on reductions in CO₂-emissions. The committee suggested increasing the tax rate on CO₂ for trade and industry from 13.3 to 26.7 Euro per ton CO₂¹. While environmentalist and consumer organisations were pleased with the proposal, industry protested and called for voluntary measures. Furthermore, many political parties were concerned about the competitiveness of Danish industry and especially the energy intensive firms. After a long debate within the government a compromise was reached, which resulted in the CO₂ policy package that came into force in the beginning of 1996.

1.2 *The agreement scheme 1996-1999*

3. The CO₂ package contained an agreement scheme on improved energy efficiency in industry, in combination with subsidies for both energy efficiency counselling and investment, and the introduction of SO₂- and CO₂-taxes. The aim of this package was to force industry to contribute to the reduction in SO₂- and CO₂-emissions by placing higher taxes on industry. At the same time the principle was to recycle all revenues from the taxes back to the industry. This took place in the form of reductions in non-wage labour costs, introduction of special subsidies for small companies and by offering industry subsidies for energy efficiency measures, see Danish Energy Agency (2000) for details. Firms that entered into an agreement with the Danish Energy Agency got a rebate on their CO₂-tax.

¹. We assume throughout this paper that 100 Euro = 750 DKK.

4. Firms with both heavy and light processes could enter an agreement. While all firms with heavy processes had the right to enter into an agreement with the Danish Energy Agency, firms with light processes only had the right to sign an agreement if their yearly tax on their energy consumption amounted to at least 3% of value added. In addition, the effective tax must exceed a certain minimum value. This condition excluded many small firms from the possibility of entering an agreement, cf. Togeby et al. (1999).

5. The agreements could be either individual (covering a single firm) or collective (covering several firms within a sub-sector with similar production processes). The idea of the collective agreements was to reduce the administrative costs of entering an agreement. Collective agreements could be entered into by a group of firms from an industrial sub-sector with similar production processes. In the case of collective agreements, obligations for individual firms were also specified. The number of agreements can be seen in Table 1.

Table 1. Number of firms being part of an active agreement 1)

	1996	1997	1998	1999	2000	2001
<i>Individual agreements:</i>						
Mining and quarrying	3	6	7	5	3	3
Food and beverages	5	29	47	43	41	36
Wood industries	1	3	3	3	2	1
Paper industries	5	6	6	6	4	4
Mineral oil products	1	1	1	2	2	2
Chemical industries	5	8	11	10	14	14
Rubber and plastic industries	0	2	2	3	1	1
Stone, clay and glass industries	4	7	10	8	15	12
Metal manufacturing	1	1	2	4	4	5
Iron and steel goods industries	0	4	4	2	3	3
Sub-suppliers	4	7	7	5	7	7
Sewage work, renovation companies, maintenance companies etc.	0	0	1	1	0	0
Engineering industry	0	0	0	1	0	0
Wholesale trade	0	0	0	1	1	0
All individual agreements	30	76	101	94	97	88
<i>Collective agreements:</i>						
Greenhouses	39	81	99	60	215	215
Milk condensation	0	9	9	6	3	3
Structural clay products	0	0	21	18	18	19
Potato flour industry	0	0	0	0	4	4
All collective agreements	39	80	129	84	240	241
All agreements	69	166	230	178	337	329

1) Active agreement means an agreement, which engenders payment of subsidies to cover the CO₂ tax. This means that firms that intend to sign an agreement are included in these numbers.

Source: Ministry of Finance (1999) and The Danish Energy Agency.

6. The basis of *individual agreements* was an energy audit, which was usually carried out by a consultant certified by the Danish Energy Agency. The audit report should include mapping of the energy consumption at the firm, a list of identified potentials for energy efficiency improvements and suggestions for special investigations into ways to further reduce energy consumption to be carried out. In order to

ensure the quality of the audit report, the report should be verified by an independent agency assisted by a technical expert. The verification agency was chosen by firms from a list approved by the Danish Energy Agency, and it verified that the audit was carried out according to the rules. The firms bore the costs of the audit and the verification, but subsidies of up to 50% of the costs could be granted by the Danish Energy Agency. After the verification of the audit report, the firms sketched an action programme, which was based on the energy audit, covering:

1. *Energy saving projects*. Firms that enter into heavy process agreements must implement any energy saving projects pertaining to the heavy process, with a payback period of less than four years. Firms that enter an agreement on light process must implement any energy saving project pertaining to the light process and which have a payback period of less than six years. When calculating the payback period, energy prices *including taxes* were used. In a firm with heavy processes the energy price and a tax of 3.33 Euro per ton CO₂ was used in the calculations, while a firm with light processes used the energy price and a tax of 12 Euro per ton CO₂.
2. *Special investigations*, which comprise investigations of the possibility of energy savings in more complicated processes that cannot be thoroughly annualised within the timeframe established for compilation of the agreement. If these studies reveal energy saving projects with a payback period of less than four and six years for heavy processes and light process respectively, these projects are to be implemented within a year of submission of the result.
3. *Energy management measures* that comprises guidelines for how firms ensure that savings achieved in daily operations can be maintained and that intervention takes place in cases of ineffective operations and that new possibilities for efficiency are evaluated as an integral aspect of daily operations. As part of energy management, guidelines are laid down for the organisation of efficiency activities, energy control, energy-effective purchasing of equipment etc., and the training and motivation of staff. These guidelines have been formulated in line with a number of energy management systems, such as EMAS, ISO 14.001. [See the Danish Energy Agency (2000)].

7. The collective agreements were not based on energy audits performed in the individual firms. Instead, an analysis of energy consumption and production processes in the sector was made to identify general potentials for improving energy efficiency in firms. The results of the analysis were reported to the Danish Energy Agency and used to formulate an action programme. In addition to investment projects, special investigations and energy management, the action programme for the sub-sector could include inter-firm projects such as development projects, which were of interest to all firms in the sub-sector. Each firm covered by the agreement had to sign and was committed to the action programme. Obligations for every firm were therefore specified.

8. The action programme was the basis for the negotiations between the Danish Energy Agency and the firm or industrial association in case of a collective agreement. During the negotiations alternative projects could replace some of the “obligatory” projects outlined in the action programme. The final agreement listed the firm’s obligations covering investment projects, special investigations, and implementation of energy management systems. In the case of collective agreements, inter-firm projects were also specified. The agreements lasted three years and once a year the firm had to deliver a progress report to the Danish Energy Agency. These reports had to document the fulfilment of the projects specified by the agreement and the status of energy management systems. The Danish Energy Agency then did the follow-up, including the checking of the progress reports from the firms, the renegotiation with the firms in cases of changed conditions and the sanctioning of firms in cases of non-compliance. If firms failed to meet the obligations in the agreement, the Danish Energy Agency could cancel the agreement, and the tax rebate was annulled.

9. Examples of specific agreements within this agreement scheme were the agreements signed by firms within the pulp and paper industry, and the collective agreement concluded with the milk condensing sector, cf.. Johannsen & Larsen (2000).

1.2.1 An Individual Agreement signed by a firm within the pulp and paper industry (Paper Mill West)

10. The Paper Mill West agreement was signed in October 1997, and covered four energy saving projects, three special investigations, and an energy management system. The firm has described its energy management system in a report that follows the guidelines of the Danish Energy Agency. The investment projects are shown in Table 2.

Table 2. Investment projects -- Paper Mill West

Project	Investment (Euro)	Payback period	Energy savings	CO ₂ reduction
1. On/off drive of compressor	0	0	59 MWh/year	41 tons/year
2. Sectioning of compressed air system	7,467	5 years	34 MWh/year	24 tons/year
3. Closed down rectifier	-	-	250 MWh/year	175 tons/year
4. Improving transportation of rolls and packing procedures	-	3.1 years	597 MWh/year	218 tons/year

Source: Johannsen & Larsen (2000).

11. The special investigations were:

- Mapping of steam consumption.
- Optimal stirring time in pulpers.
- Electrical brake on roll works.

12. Of the special investigations, the optimal stirring has been completed. The stirring time has been reduced by 60% and the energy consumption was reduced by approximately the same share.

1.2.2 An Individual Agreements signed by another firm within the pulp and paper industry (Paper Mill East)

13. The Paper Mill East agreement was concluded in August 1997, and covered four investment projects, eight special investigations, and an energy management system that follows the guidelines of the Danish Energy Agency. The investment projects are described in Table 3.

Table 3. Investment projects -- Paper Mill East

Project	Investment (Euro)	Payback period	Energy savings	CO ₂ reduction
Replacement of pump	13,600	6.1 years ¹⁾	51 MWh/year	36 tons/year
Insulation of process pipes	10,400	0.75 years ²⁾	300 MWh/year	407 tons/year
Optimisation of Paper Machine 1, part two	1,600,000	-	15,768 MWh/year	8,457 tons/year
Optimisation of Paper Machine 1, part one	1,666,667	5.1 years	13,850 MWh/year	5,316 tons/year

1) Payback period of the project carried out. Payback period estimated in the audit report: 4.4 years.

2) Payback period of the project carried out. Payback period estimated in the audit report: 4.2 years.

Source: Johannsen & Larsen (2000).

1.2.3 Agreement signed by the milk condensing sector

14. The milk condensing sector agreement was concluded in September 1996 and covers 9 firms within this sector. The obligations in the agreement are:

1. 29 energy saving projects. Similar projects are carried out in several firms. Out of the 29 projects, 13 projects have a payback time of more than four years. Those projects contribute 35% of the total CO₂ reduction, Krarup, Tøgeby & Johannsen (1997).
2. 12 potential energy saving projects with payback periods over 4 years. Most of those projects concerned improved energy efficiency in the standard technologies in the sector. These projects were implemented if one of the obligatory projects was not carried out.
3. 4 development projects that concern new technology or experiments aimed at diffusion and adaptation of existing technologies to new areas. The projects are carried out at plant level, but the results are expected to be applicable in other firms in the sector.
4. An energy management plan that follows the guidelines of the Danish Energy Agency.

15. These obligations were allocated to the nine firms in the sub-sector and firms were committed to implement them. One of the firms in this sub-sector had the following energy saving projects, see Table 4.

Table 4. Energy saving projects in one milk condensing plant

Project	Investment (Euro)	Payback period	Energy savings	CO ₂ reduction
Variable speed converter	52,000	2.9 years	364 MWh/year	25 tons/year
Waste heat recovery	266,667	3.2 years	5,870 MWh/year	1,183 tons/year
Plate cooler	50,000	4.9 years	208 MWh/year	150 tons/year

Source: Johannsen & Larsen (2000).

16. The firm was committed to carrying out the two first investments, whereas the third investment was a potential project. The firm was only committed to carry out the potential project in case one of the other projects was not implemented. This firm was not involved in any development projects, but the firm was committed to the energy management plan the same as any other firm in the sector.

1.3 The revised scheme, 2000 -

17. In 2000 a revised Danish agreement scheme came into operation. The revisions concern the target group and the content and obligations in the agreements, cf. Energistyrelsen (2001). In the new scheme, energy audits are no longer obligatory. Firms must themselves carry out a mapping of their energy use and energy saving potentials etc, in order to construct an advanced energy management system. The purpose of this mapping is also to identify areas where special investigations are necessary to identify and implement energy saving projects. Firms that have high energy-use for space heating are now also able to enter into an agreement and thereby achieve a tax rebate.

18. The basis of the negotiations with the Danish Energy Agency is the formulation of the firm's energy policy and targets for its energy management system, and the specification of what special investigations should be carried out. In addition, key figures to be used to monitor whether the terms of the agreements are kept, are identified. When the firms have signed an agreement, they are obliged to carry out the special investigations and to use and maintain their energy management system. If the special investigations and energy management lead to the identification of energy saving projects with a payback period of less than four years, firms are, in general, obliged to implement those projects. The agreements

are made for three years and firms must self-report their progress to the Danish Energy Agency once a year and through a final report. The agency does not follow-up these reports. However, the energy management system is tested through verification, which takes place when the agreement is made and once more during the period of the agreement. The verification agent is approved by the Danish Energy Agency. On basis of this verification and the final report, the Danish Energy Agency approves the firms' compliance with the agreement. If no verification statement is sent to the Danish Energy Agency, this is perceived as a breach of the agreement. In this case, the Danish Energy Agency can terminate the agreement, and firms have to repay their tax rebate.

2. Environmental effectiveness

19. The following evaluation of the environmental effectiveness of the agreement scheme only applies to agreements made between 1996 and 1999, as there is no evidence yet available of the performance of the scheme introduced in 2000.

2.1 Target setting

20. In general, no quantitative assessment of the business-as-usual scenario was carried out before the agreements were signed. However, in case of individual agreements, the basis for the formulation and the setting of the targets was the energy audits, which identified the energy saving potential in firms. External energy consultants carried out the audits of firms' energy saving potential, identifying all profitable energy saving in the firms. This implies that if no profitable investments were identified through the audits, the production site was considered energy efficient. The verification of the audit report resulted in some cases in editing of the audit report. After the approval of the audit report an action programme was formulated comprising investment projects, an energy management plan and special investigations. Only then did the negotiations between the Danish Energy Agency and the firms begin, and the final target was set. However, in practice real negotiations only took place in a few cases, as the audit report was very decisive for the setting of targets in the agreements.

21. In the case of a collective agreement no firm specific audit was carried out. Instead, an analysis of energy consumption and production processes in the whole industry was carried out by a consultant to identify general potentials for improving energy efficiency in the firms. After the verification of this analysis, the projects in the action programmes for the firms in the industry were identified by the firms themselves and by the consultants making the sector analysis.

22. The targets in the agreements were qualitative and covered implementation of investment projects, energy management systems and special investigations, which all lead to energy savings and reductions in CO₂ emissions.

2.2 Target achievement

23. Once a year the firm delivered a progress-report to the Danish Energy Agency, where progress on the implementation of investments and special investigations was reported together with a status for the energy management systems. The Danish Energy Agency then did the follow up, including the checking of the firms' reports, and renegotiations took place in cases of changed conditions etc. In cases where firms did not carry out the projects and special investigations specified in their agreement, the Danish Energy Agency had the possibility of sanctioning firms by depriving them of their CO₂-tax rebate. This happened three times in the period 1996-1999, including once for a firm that did not implement all the energy saving projects that were specified in the firms' agreement.

24. The content of the agreements was not made public nor were the self-reports as they contain confidential information about firms. The results of the monitoring at firm level were not made public either. However, external parties have made several evaluations of the overall impact of the agreements and these have been made public. In Danish Energy Agency (1999) one evaluation estimates that, in firms that have entered an agreement in the period 1996-2000, CO₂ reductions of 6% is expected to be achieved by the year 2005 (see Table 5).

Table 5. Estimated impact on CO₂ emission in 2005

Agreements entered:	1996-2000
Specific projects	1.5%
Special investigations	1.0%
Energy management	3.8%
Total impact	6.3%

Source: The Danish Energy Agency (1999).

25. From Table 5 we see that approximately 40% of these reductions are due to the specific energy saving projects and the special investigations in the agreement. The remaining part is attributed to the effects of the introduction of energy management systems.²

26. In the pulp and paper firms and the milk condensing firm examined in this paper, the investments and special investigations have been carried out. However, only a few firms complied fully with the requirements for the implementation of the energy management systems, Johannsen & Larsen (2000). It appears that organisational practices in firms change much more slowly and less effectively than expected.

2.3 *Dynamic efficiency*

27. The special investigations and the energy management requirements were dynamic elements in the agreements, and could, in theory, stimulate the development and diffusion of new technology. However, according to Johannsen & Larsen (2000) the special investigations sometimes led to the implementation of investment projects, but the results were rarely communicated to other firms. This problem was especially present in the case of individual agreements where nothing in the agreements promotes the establishment of networks that could diffuse information. Furthermore, firms were resistant to diffusing information because of confidentiality. In the case of collective agreements, the projects carried out were of relevance to all firms in the branch and the consultant participates in the implementation of projects. The industrial association then promoted the diffusion of results to other firms in the industry.

28. Measures to improve energy management were also a part of the agreements that could stimulate the development and diffusion of new technologies in the long run. However, at present, only a few firms comply fully with the requirements of energy management systems, but all firms were working seriously to improve their energy management systems.³ Thus, if firms ultimately fulfil these requirements, the development and diffusion of energy-efficient technologies could be stimulated in the long run.

². The publication emphasises that “The values for special investigations and energy management must be interpreted with great care”.

³. In the revisions to the agreement scheme in 2000, more emphasis was placed on the firms energy management systems. The systems now have to be verified by an auditor approved by the energy authority – Energistyrelsen.

29. For some firms, the energy audits and the implementation of energy management systems have provided them with new information and measures to improve their energy efficiency. In the case of collective agreements, existing networks have been reinforced. These effects were therefore achieved because of the agreements in place, cf. Johannsen & Larsen (2000).

3. Economic efficiency

30. With the pre-2000 agreements payback criteria are used to identify energy saving projects in the firms. The same payback period criteria are used for all firms to identify profitable investments that were to be part of the agreements. No estimates of the marginal abatement costs for individual polluters are available. The agreement scheme forces firms to implement investment projects with a payback period of four to six years. Usually firms accept a payback period of 1-2 years for energy-efficient investments, so the agreement scheme forces firms to apply more relaxed criteria when assessing energy-saving investments, cf. Johannsen (2002). The payback criteria used imply that firms with many profitable investments have to realise relatively large savings and firms with no profitable projects are not loaded with investment projects and special investigations. This mechanism could contribute to an efficient allocation of energy savings between firms.

31. The obligations in the Danish agreements are firm specific for both the individual and collective agreements, and they are always legally binding to firms. In the case of individual agreements, the firms' investment projects and special investigations are primarily determined by the energy audits. In the case of collective agreements, an analysis of energy consumption and production processes in the sector was made to identify general potentials for improving energy efficiency in the firms. From this, the consultant and the firms have, in co-operation, identified energy saving projects for all firms, and the firms have had more influence on the specification of projects than in case of the individual agreements. According to an industrial association, controversies over the burden sharing can be avoided if objective criteria are used to determine the obligations of each firm, for example a payback period criterion, cf. Johannsen & Larsen (2000).

32. As mentioned above, the Danish agreements have the potential for catching the cheapest energy savings in all firms first. However, according to Johannsen (2002), the energy audits do not entirely eliminate the problems of asymmetric information, which implies that an efficient allocation of energy savings can not be guaranteed. A pre-condition is that the true energy saving potential and true profitability of different investment projects are disclosed through the energy audit. However, consultants are unable to identify large projects in relation to the core production processes in the firms. This implies that such projects are only carried out when firms suggest them, and this will only occur as part of the overall strategy of a firm rather than because of the agreements.⁴

4. Practical implementation

4.1 Free-riding

33. A firm that signs an agreement receives a rebate on its CO₂-tax. The tax rebate is given for energy consumption in relation to different production processes and not as an overall tax rebate. This implies that the agreements must specify obligations for all firms, even in the case of collective

⁴ Part of the revisions made to the agreement scheme in 2000 was that the special investigations should focus more on the core production processes in the firms. The intention was that the energy saving potentials in these processes should be realised to a larger extent than before.

agreements. If firms do not comply with the agreement, they have to repay the tax rebate. Thus, there is an economic sanction if firms do not fulfil the obligations specified in their agreement. The risk of free-riding is therefore limited in the Danish Agreement Scheme.

34. The question is then whether the free-riding problem would have been present had any alternative policy instrument been used. The alternative to the agreements could have been a full CO₂-tax on energy intensive firms. In that case no free-riding would have been possible.

4.2 *Regulatory capture*

35. In the negotiations on the design of the agreement scheme, parliamentary control was limited to the general design of the scheme. Third parties were also invited to contribute to the design process. Officials in the Danish Energy Agency, who consulted experts and representatives from industry and the utilities, handled the more specific design of the scheme. No third parties are involved in monitoring of the performance of the firms, and the results of the monitoring are confidential. Only aggregate data are available to the public.

4.3 *Asymmetric information*

36. The energy audit reports and the firms' self-reporting keep the Danish Energy Agency well informed about the specific production processes in the firms and the firms' potential for energy savings. The problem of asymmetric information is therefore limited. However, whether the Agency obtains all relevant information depends on whether the true energy saving potential can be disclosed through the audits. Here case studies show that the identification of large projects related to core production processes depends on the consultant's co-operation with the firm's staff, as detailed information about specialized production processes is possessed by the individual firms. One of the paper firms emphasized that the consultant was unable to contribute with practical or tacit knowledge in relation to core production processes, cf. Johannsen & Larsen (2000).

5. *Administrative/transaction costs*

5.1 *For the firms*

37. The costs prior to the negotiations between the firms or industrial association and the Danish Energy Agency are associated with the preparation phase, where the administrative costs for the firms amount to between 17,000 and 33,000 Euro on average for every firm, cf. Finansministeriet et al. (1999). These costs cover expenses for energy audits and the verification of the audit reports, both costs which, to a large extent, are covered by the firms. For the agreements with two paper mills, the costs were 20,400 and 54,700 Euro. For the milk-condensing sector as a whole the costs were 53,000 Euro, cf. Johannsen & Larsen (2000). The average amount of time used to reach an individual agreement is estimated to be 100-200 hours per firm. After the signing of the agreement, firms use in average 10-30 hours a year for producing their progress-reports for the Agency, Danish Energy Agency (2000). In order to calculate the net expenses, the tax rebate as well as the subsidies firms have received for audits, verification, and investments must be subtracted.⁵

⁵ In order to reduce the administrative costs of the firms the revisions to the agreement scheme in 2000 states that the firms before signing the agreement no longer need to have made an energy audit, but only a mapping of their energy use. This can be done by the firms themselves.

5.2 *For the public authorities*

38. The agreements give rise to a number of complicated administrative duties for the Central Customs and Tax Administration and the Danish Energy Agency. The two authorities must co-operate in the administration on tax rebates when firms enter into agreements. The estimated additional annual costs of the agreements were 4 million Euro for the public authorities, Rigsrevisionen (1998). There exists no statement of costs related to the different phases of the implementation of the agreements, e.g., the negotiations, monitoring, etc, but only how the expected administrative burden is shared between the Central Customs and Tax Administration, the Danish Energy Agency and the Energy Complaints Board, in relation to the administration of the agreements, see Table 6.

Table 6. Expected additional annual costs of the agreements

(Mill. Euro)	Payroll Costs	Operating Costs	Consultant Costs
The Central Customs and Tax Administration	0.2	-	-
The Danish Energy Agency	1.1	0.8	1.3
The Energy Complaints Board	0.3	0.3	0.1
In total	1.6	1.1	1.4

Source: Rigsrevisionen (1998).

39. According to an evaluation made by the Office of the Auditor General, it is found that the Central Customs and Tax Administration has not calculated their yearly costs associated with the administration of the whole CO₂ package, Rigsrevisionen (1998). It is also found that the observed additional costs paid by the Danish Energy Agency resulted from the CO₂ package corresponds to the expected costs outlined in Table 6. At the same time it is found that additional annual costs for the Energy Complaints Board are lower than expected. No complaints over the administration of the agreements have yet been put forward by firms.

5.3 *Relief from other administrative costs?*

40. The introduction of the CO₂ package in 1996 changed the possibility for energy consuming firms for compensation of taxes. Firms that entered an agreement were offered tax reductions for energy consumed in production processes (heavy and light), but no reductions for energy used for space heating. Firms therefore had to compute their taxable energy consumption and categorise its energy consumption if they wanted to obtain a reduced tax payment. This implied that firms that used the type of energy for space heating and production processes needed to install meters to measure the different types of energy consumption. Firms that used both energy for space heating and production processes were therefore expected to have extra administrative cost of 667 Euro on average per year. Firms that only used energy for production processes have unchanged administrative costs, Danish Energy Agency (2000).

5.4 *Measures taken to limit administrative costs related to the scheme*

41. In 2000 a revised agreement scheme was introduced. Part of the motivation for the revision was the high administrative costs related to the process of energy audits. Therefore, energy audits are not part of the new agreement scheme.

5.5 *The administrative costs related to the agreements compared to other policy instruments*

42. The question is then whether the administrative costs associated with a pure tax solution would have been higher or lower. The administrative costs for the firms arising from the different instruments in the CO₂ package have been estimated, see Table 7.

43. It seems from Table 7 that the expected firm costs associated with the taxes are relatively higher than the administrative costs of the agreements. The administration costs relating to the taxes cover purchase and running of meters. These meters measure the type of energy consumption in firms and thereby their tax burden and possibility of receiving tax exemptions. Hence, firms that use energy for space heating have lower administration costs than firms consuming energy for several purposes (production processes and space heating). However, if the administrative costs are related to the instruments' effect on CO₂ reductions in the firms, the picture is different. We see that the administrative costs arising from the agreements compared to their CO₂ reductions are highest.

Table 7. Changes in administrative burden resulting from the CO₂ package

Average Annual Change 1996-2005	Average Annual Administrative Costs (Mill. Euro)	Average Annual Reduction In Co₂ Emissions (Mill. Tonnes)	Administrative Costs Compared To Co₂ Reductions (Euro/Tonne)
Taxes	0.9 - 5.3	0.8	1-7
Investment subsidies	0.7 - 2.0	0.5	1-4
Agreements	0.9 - 2.0	0.2	4-8
Entire CO₂-package	3.1 - 9.1	1.5	2-6

Source: The Danish Energy Agency (2000).

6. **Voluntary approaches versus tradable permit schemes**

44. The main reason for not using economic instruments was because they were not politically feasible. In 1994 an inter-ministerial committee stated that taxes on the energy consumption of trade, industry and services would be the most efficient way of achieving further reductions in CO₂-emissions. However, due to a massive campaign from industry, there was a need to find a less politically sensitive alternative. Industry called for voluntary approaches. The introduction of agreements was therefore a way to exempt energy intensive firms from paying the full CO₂-tax when the tax was increased. At the same time it was emphasised that the agreements were a supplement to the tax system. Politicians who were concerned about the competitiveness of energy intensive firms supported this compromise.

45. The difference between the Danish agreement scheme and a potential tradable permit scheme is that the former specifies qualitative or implementation-based targets whereas the latter specifies quantitative targets. The focus in the agreement schemes is on firm-specific energy investments and special investigations.⁶ It therefore seems that there are large differences between a tradable permits system and the Danish agreement system, thus making it difficult to convert the Danish agreement scheme into a tradable permit scheme. However, some studies find that replacing all current Danish CO₂ policies with a tradable permit system for CO₂ emissions in some cases could be welfare improving, Jensen & Rasmussen (2000).

⁶ However, after the revisions to the agreement scheme in 2000, quantitative targets concerning reductions in specific energy consumption are included in most agreements.

7. Policy mixes

46. Both now and prior to the introduction of the agreements in 1996, various policy instruments were used in the Danish energy policy to achieve reductions in CO₂ emissions by improving the energy efficiency of industry. Agreements are therefore used in a policy mix aimed at reducing CO₂ emissions by industry. Among the measures used were economic instruments such as taxes and subsidies, and informative measures. The level of taxation depends on the purpose of the energy consumption, the energy type and whether the firm has signed an agreement. The taxes are:

- CO₂-taxes
- SO₂-taxes, and
- Energy taxes.

47. The CO₂-taxes are imposed on industrial energy consumption, and the rates of taxation increased gradually until 2000. The actual rate of taxation depends on the firm's type of energy consumption (space heating, light and heavy processes) and whether the firm has signed an agreement or not. The level of the CO₂-taxation with and without an agreement can be seen in Table 8.

Table 8. Levels of CO₂-taxes from 1996-2000. Euro per ton CO₂

	1996	1997	1998	1999	2000
Space heating⁷	26.7	53.3	80	80	80
Light processes					
- Without agreement	6.7	8.0	9.3	10.7	12
- With agreement	6.7	6.7	6.7	7.7	9.1
Heavy processes					
- Without agreement	0.7	1.3	2.0	2.7	3.3
- With agreement	0.4	0.4	0.4	0.4	0.4

Source: Finansministeriet (1995).

48. Since 1996 industry has also paid SO₂-taxes, which were phased in over the period 1996-2000. The tax is in 2002 2.7 Euro per kg sulphur, and is levied on the sulphur content in fuels, cf. Finansministeriet et al. (1999). Fuels that contain less than 0.05 percent sulphur are exempted from SO₂ taxes. This implies that coal is subjected to SO₂ where as natural gas is not. Since 1999, a basic allowance can be obtained in some cases when firms consume coal and oil for energy intensive processes, for example when they have signed an agreement.

49. Furthermore, since 1996 energy taxes must be paid for energy used for space heating. The tax level depends on the energy content in the fuels used by the firms. The energy tax has gradually increased from 5.5 Euro per GJ in 1998 (41 DKK) to 6.8 Euro per GJ in 2002 (51 DKK).

50. The CO₂ package placed higher taxes on firms. However, the revenue from these taxes is transferred back to firms by reducing employers' labour market contributions and ATP (supplementary labour market pension) payments. In addition, a special fund has been established for small business with limited payrolls, to reduce the number of fees and to reimburse administration costs.

51. Moreover, subsidies were granted to industry if it changed to more effective energy technologies and methods of production that can limit CO₂- and SO₂-pollution from the energy consumption. Subsidies are also granted for development activities. The percentage of the subsidy depended on the type of project

⁷ Overall energy and CO₂ tax rate for space heating. The CO₂ tax rate alone is 13.4 Euro each of the year 1996-2000.

and on the size of the firm. Small and medium sized firms could obtain larger subsidies than larger firms. Projects that were eligible for subsidies were, e.g., individual projects, standard solutions, combined heat and power plants, development, trial and demonstration projects, and energy management consultancy services etc. Firms could receive investment grants of up to 30% of their outlays, but subsidies were only granted for projects with a payback period of between two to nine years. For firms with an agreement, the payback period was from three to nine years. Only projects with a particular minimum CO₂ reduction in relation to the investment were subsidised. In addition, subsidies to other energy saving activities could be granted to firms. For example general information activity subsidies of up to 100% could be obtained whereas it was only possible to obtain subsidies of up to 30% for activities such as sector energy analysis. Since December 2001, subsidies are no longer granted to the industry.

52. *Informative measures* are also used to influence the energy behaviour of firms. These cover brochures enumerating the benefits of implementing energy management and how to do it, free measurements of the electricity consumption in pumps, ventilators etc., and networking activities, cf. Johannsen & Larsen (2000).

7.1 *Expected effects of different policy instruments*

53. The actual contributions of the different policy instruments to the reduction of CO₂-emissions by industry are only measured for some instruments. On the basis of the experience with the agreements, subsidies and taxes since 1996, in 1999 the effects of the three instruments were estimated. Table 9 shows the expected effects of the agreements, taxes and subsidies on the total CO₂ emissions, by 2005⁸.

Table 9. Expected environmental effects of the CO₂ package

	Reduction in CO ₂ -emissions in 2005 ¹⁾	
	Pct.	(Mill. tons)
Tax on space heating	0.8	0.5
Tax on heavy and light processes	0.8	0.5
Agreements	0.6	0.4
Investment grants	1.2	0.7
Tax on SO ₂ emissions	1.0	0.6
In total	4.4	2.8

1) As a reduction in CO₂-emissions in 2005 compared to the 1988 level caused by the different instruments. Source: Johannsen & Larsen (2000).

54. The aim of the agreements is to reduce the CO₂-emissions, by changing industrial energy demand. An empirical study by Bjørner & Jensen (2002) compares the effects of CO₂-taxes, agreements and subsidies on industrial energy demand. All three instruments are aimed at reducing energy consumption by industry. The study finds that the estimated reduction in energy consumption associated with the agreements signed before 1998 is around 9%. The study also states that if energy intensive firms in this period instead of entering into an agreement had paid a full tax on energy, they would only have reduced their energy consumption by 1%.⁹ However, the tax rebate has been increasing from 1998 to 2000.

⁸ In Finansministeriet et al. (1999) it is assessed that the energy package will reduce the CO₂-emission as expected.

⁹ The estimated emission reductions in the (hypothetical) case of full tax payments presented in the panel data study by Bjørner & Jensen (2002) should however be seen as short run effects, which may be perceived as a lower bound for the long run effects. If the estimate properly reflected behavioural changes in the longer term, the conceived "need" for introducing special tax provisions for energy-intensive firms - due to a feared loss of international competitiveness if they were to pay full tax rates - would seem

One could therefore expect that if firms had paid a full tax in these years, the reduction in energy consumption would have been larger than 1%. Note also that other empirical studies estimate the effect of the agreements to be less than 9%. For example does Ahé et al (1998) estimate the energy savings from the agreements entered in 1996 and 1997 to be around 5%

55. A study by Togeby et al. (1999) uses regression analysis to determine which variable explains why energy efficiency activities have been carried out in firms. They found that firms with an agreement had more energy efficiency activities than other firms. The study also found that a large number of the energy saving investments, specifically those that have production advantages for the firms would have been carried out without the agreements in place. However, pure energy projects, i.e. projects that have little or no other purpose than improving energy efficiency, would not have been carried out without the agreements or without subsidies to energy saving projects.

8. Conclusions

56. Hansen et al. (2002) evaluate whether the Danish and other agreement schemes follow the recommendations outlined by OECD (1999). Their findings are shown in Table 10.

57. We see that the Danish agreement scheme follows many of the OECD recommendations on how to make agreements work. Moreover, evaluation shows that the agreement scheme actually has additional effects on firms' behaviour compared to a situation without the agreements in place. Furthermore, free-riding is not a problem as obligations are always specified at the firm level in the case of collective as well as individual agreements. However, the problem with this scheme was high administration costs. This could point at a trade-off between additional effects and the administrative costs. Whether such agreements could be cost effective in the long run therefore strongly depends on the long-term effects of the implementation of energy management systems in industry.

Table 9. The Danish agreement scheme and the OECD recommendations

	Danish agreement scheme
1. Clear targets	Relatively clear
– Quantitative targets	No
– Interim targets	Yes, all
2. Characterisation of the BAU scenario	No
3. Credible regulatory threat	Yes
4. Credible and reliable monitoring	Yes, but not transparent
5. Third party participation	No
6. Sanctions	Yes, strong, but only used once
7. Information oriented provisions	Yes, limited and mostly individual
8. Anti-trust safeguards	No

Source: Hansen et al. (2002).

58. With the revised agreement scheme introduced in 2000, the Danish Energy Agency expects lower administration costs because energy audits are no longer part of the scheme. Instead, emphasis is put on energy management as a tool to build internal competence to deal with energy efficiency instead of relying on external consultancy. At the same time the Danish Energy Agency expects the reductions in CO₂ emissions from the new scheme to be the same as from the old scheme. In that case, one could expect the new agreement scheme to be more cost-effective than the old agreement scheme. However, at present no assessment has been carried out on the new agreement scheme.

unfounded. In the longer term, some of the firms benefiting from reduced tax rates at present could have to close down if they were to face full tax rates.

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