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Environmentally harmful support measures in EU Member States

Report for DG Environment of the European Commission

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Disclaimer
While the preparation of the study was supported financially by the European Commission, it should be underlined that the study and its conclusions do not reflect in all parts the views of the Commission. The original title of the study was "Study on estimated environmental effects of some subsidies provided by the Member States".

Further information on this study can be obtained from the contact person, Mr. Ron Wit.

Contents

Executive summary

Background
The topic of environmentally harmful support measures has been regularly debated in recent years, for the reason that a variety of direct and indirect government support measures[1] may be acting as an unintended incentive for environmentally harmful behaviour. This may be impeding achievement of standing environmental policy targets, making it desirable to review current environmentally harmful support measures.

Policy-makers and governments are making increasing use of such economic instruments as ecological taxes. At the same time, though, there may be a number of support measures in place in EU Member States that have a significant, adverse impact on the effectiveness of environmental protection.

To date, the main focus of study has been on the nature and magnitude of environmentally harmful support measures and far less on the scope available for reducing their environmental impact. Every support measure, including those that are environmentally harmful, was initially established for a given purpose or motive. Discontinuation of a given support measure may therefore well have negative economic or social consequences, standing over and against any environmental gains that might be achieved.

Against this background DG Environment of the European Commission was keen to see a study that does not merely review the environmental harmfulness of support measures provided by EU Member States but also provides more insight into the economic, social and environmental consequences that would follow from abolition of such support measures.

Objectives and structure study
The objectives of this study can be summarised as follows:
1 *To provide an overview and brief description of potentially environmental harmful support measures provided by EU Member States in 2000 which are still in effect.*
2 *To examine in detail the environmental effects of 10 types of support measurenot implemented for environmental policy reasons (case studies).*
3 *To analyse the economic, social and environmental impact of abolishing those support measures under 2) that were considered to have environmentally harmful effects.*

Main findings and conclusions
Based on an inventory of support measures provided by the 15 EU Member States, the main findings and conclusions of the study are as follows:
1 The first result of this study is a list of 236 support measures with a total budget of € 25 billion provided by EU Member States that are potentially harmful to the environment. These measures were identified from among an EU-wide inventory of 451 support measures with a total budget of € 31 billion carried out especially for this study. The cited budgets are minimum estimates, because information on budget magnitude was not available for each individual measure and because some

[1] For definitions, see chapter 2 and Annex A.

measures are ‘open-ended’[2]. It should furthermore be emphasised that without detailed analysis it is not possible to make a final judgement on how harmful to the environment the 236 measures *actually* are. This would require a detailed case study on each of the support measures.

2 The support measures on the original inventory differ in structure:some are direct support measures, while others are fiscal measures providing exemption from taxes[3].

3 Table 1 shows the distribution over the EU Member States and over the four sectors considered in this study of the 236 support measures identified as being potentially harmful to the environment.

Table 1 Distribution of support measures deemed potentially harmful to the environment over EU Member States and sectors.

Country	Number of support measures				Budgets (in 2000, € million)			
	Transport	Energy	Mining	Nuclear	Transport	Energy	Mining	Nuclear
Austria	2	6	-	-	0	766	-	-
Belgium	5	1	-	-	3	0	-	-
Germany	10	3	2	1	1918	683	4700	179
Denmark	12	7	-	-	690	66	-	-
Spain	21	12	12	2	980	57	2	0
Finland	8	2	-	2	40	10	-	23
France	31	3	2	2	5705	44	488	518
Greece	8	1	2	-	614	25	1027	-
Ireland	7	-	-	-	2302	-	-	-
Italy	11	2	3	-	19	0	0	-
Luxembourg	-	-	-	-	-	-	-	-
Netherlands	38	3	-	-	4019	127	-	-
Portugal	1	-	-	-	11	-	-	-
Sweden	4	1	-	-	92	0	-	-
United Kingdom	3	4	-	2	319	51	-	39
EU Total	161	45	21	9	16712	1829	6215	759

Table 1 shows that support measures potentially damaging to the environment are prevalent mainly in the transport sector, in terms of both numbers and budgets.

In comparison with the original inventory of support measures in force in EU Member States, it is mainly support in the energy sector that is geared to improving environmental quality. All such measures were therefore removed from the original list, as they are not deemed potentially harmful to the environment.

4 From the list of 236 potentially environmentally harmful support measures we selected 10 case studies in order to analyse the environmental and socio-economic effects of removing the support measure in question. Table 2 summarises the respective results of these case studies.

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2 On the other hand, where cases are based on state aid reports, the declared budget does not say that much as it is not always entirely consumed.

3 See Annex A for a more detailed explanation of the various forms of support that can be distinguished.

Table 2 Environmental and socio-economic impacts of support removal for ten selected case studies

No	Case study	Environmental impact	Socio-economic impact
1	**Direct aid to coal industry** *Germany* Budget:: € 4.7 billion	- 19 Mtonne CO_2 - -56 ktonne NO_x - 33 ktonne SO_2	- increased economic efficiency in Germany - increased economic growth in Germany - loss of 63,000 jobs in mining sector - loss of 215,000 jobs in mining-related sectors - employment growth: approx. 250,000 jobs in other sectors
2	**Support to power generators for coal transport** *Spain* Budget: € 3 million	- negligible	- possible shift of employment between regions
3	**Refund of fuel excise duty to road freight carriers** *The Netherlands* Budget:: n.a.	- 84 ktonne CO_2 - 828 tonne NO_x - 27 tonne PM_{10}	- negligible
4	**Refund of social security premiums to maritime carriers** *France* Budget: € 22.8 million	- negligible	- economic effects: shift from deployment of EU workers to non -EU workers
5	**Capital support to airline company** *Portugal* Budget:: € 11.4	- 13.5 ktonne CO_2 - 45 tonne NO_x	- loss of 83 jobs
6	**Operating and investment aid to rail operator** *Denmark* Budget: € 464 million	- -27 ktonne CO_2 - -784 tonne NO_x	- large socio-economic impact due to higher ticket prices and substantial loss of quality and supply of public transport services in Denmark - shift of employment from rail to other sectors, with about 4000 jobs - overall, net positive effect on employment
7	**Insurance coverage on behalf of nuclear generators** *France* Budget:: € 0 - 120 million	- depends on assumed/ estimated damage costs of severe accidents - decrease of risks - less nuclear storage sites	- n.a.
8	**Support to nuclear waste management and R&D** *EU Member States* Budget: n.a.	- n.a.	- n.a.
9	**refund of fuel excise duty to farmers** *Germany* Budget:: € 179 million	- 226 - 302 ktonne CO_2 - 3.6 – 4.8 ktonne NO_x - 354 - 472 tonne PM_{10}	- negative economic impact on horticulture
10	**Tax deduction for investments in energy saving and renewables** *The Netherlands* Budget: € 100 million	- **-/-** 530 - 660 ktonne $_{CO2}$ - **-/-** 255 - 320 tonne NO_x	- 50% use by free riders - 'rebound effect' between 0 and 20%

5 Removing support, particularly that tied to input or production processes, would encourage wider-ranging technological innovation than continuation thereof. The overall environmental benefits of support removal are therefore likely to be greater than the estimates made in the respective case studies. This is due both to the growing benefits with time and the greater range of technological developments made possible by removal.

6 The mechanisms linking support levels and environmental degradation are complex. Three basic mechanisms can be identified: (i) the impact of the support on the volume and composition of economic output, (ii) the mitigating environmental policies in place, and (iii) the assimilative capacity of the affected environment. As a result, the level of support to a particular economic sector will not necessarily reflect the level of environmental damage occurring as a result of the support.

7 Support measures tend to be particularly distortionary if they apply to environmentally harmful fuels (like coal for power plants and gasoil for road transport), as the price of fuel tends to dominate the long-term choice of energy supply technology.

8 Removal of support to (i) the coal industry, as in Germany, and (ii) to the transport industry, through tax expenditures or refund of fuel excise duties, would both improve environment quality significantly and increase economic efficiency and the net welfare of the countries considered. Within individual countries, however, some sectors will gain while others (e.g. mining) will lose employment. In the short term the socio-economic impacts of these shifts may be significant.

9 Depending on the appraisal of the risk of nuclear accident and potential ensuing damage, the impact on the nuclear power sector of governments assuming part-liability for these risks (via insurance premiums) may be large. Several international studies report higher potential damage than is currently provided for by insurance premiums. Internalising these higher liabilities would increase the price of nuclear power substantially, adversely affecting its competitiveness relative to other forms of energy. As a result, the share of nuclear might decrease substantially. This would lead to a proportional decrease in nuclear risks, nuclear waste volumes and the demand for nuclear waste storage facilities.

10 In the case of support to rail transport in Denmark, the potential environmental gains are expected to be fairly low, with socio-economic losses high. This is due to an anticipated shift to road transport for some people and a loss of transport potential for others. This latter effect may have major social consequences, while the shift to road transport will largely offset the environmental gains of less rail transport.

11 From the results of the case studies we anticipate that the possible environmental gains accruing from support removal will be especially high in those cases involving direct support to coal production and refunds of excise duties. As the inventory shows, refunds for excise duties are provided in many EU Member States.

12 In the analysis of the refund of gasoil excise duty to German farmers we were confronted with the fact that similar support is also provided in neighbouring countries (France, Belgium, the Netherlands). These latter support measures were not included in the inventory, however, because they were not listed in any of the official sources consulted. This might reflect the fact that in these countries such refunds are not regarded as deviations from the standing primary excise duty arrangements.

1 Background and objectives

1.1 Background

The topic of environmentally harmful support measures has been regularly debated in recent years, for the reason that a variety of direct and indirect government support measures[4] may be acting as an unintended incentive for environmentally harmful behaviour. This may be impeding achievement of standing environmental policy targets, making it desirable to review current environmentally harmful support measures.

At the international level a report entitled *Subsidies and Environment, Exploring the linkages* was published in 1996 by the OECD. *Reforming Energy and Transport Subsidies* followed the next year. In this second report it was estimated that in the OECD countries as a whole environmentally harmful support measures worth an approximate total of US$ 100 billion were being extended. Reviewing these support measures could lead to a 400 to 500 million tonne reduction of CO_2-emissions.

In the same year, 1997, the Earth Council published a report entitled *Subsidizing Unsustainable Development - Undermining the Earth with Public Funds*. This report concludes that many of these support measures not only harm the environment but are also economically inefficient.

Policy-makers and governments are making increasing use of such economic instruments as ecological taxes. At the same time, though, there may be a number of support measures in place in EU Member States that have a significant, adverse impact on the effectiveness of environmental protection - directly or indirectly, potentially or actually.

To date, the main focus of study has been on the nature and magnitude of environmentally harmful support measures and far less on the scope available for reducing their environmental impact. Every support measure, including those that are environmentally harmful, was initially established for a given purpose or motive. Discontinuation of a given support measure may therefore well have negative economic or social consequences, standing over and against any environmental gains that might be achieved.

Against this background the European Commission was keen to see a study that does not merely review the environmental harmfulness of support measures provided by EU Member States but also provides more insight into the economic, social and environmental consequences that would follow from abolition of such support measures.

[4] For definitions, see chapter 2 and Annex A.

1.2 Objectives

The objectives of this study can be summarised as follows:

1. *To provide an overview and brief description of potentially environmental harmful support measures provided by EU Member States in 2000 which are still in effect.*
2. *To examine in detail the environmental effects of 10 types of support measure not implemented for environmental policy reasons (case studies).*
3. *To analyse the economic, social and environmental impact of abolishing those support measures under 2) that were considered to have environmentally harmful effects.*

1.3 Scope of the study

Sources

To prepare an inventory of European support measures we scrutinised the following sources:

- the State Aid Register of the EU, including accompanying annual reports, surveys and available decision lists;
- available annual reports on State Aid of the individual Member States;
- official registers of expenditure of national governments on support measures;
- the national budgets of EU countries: these budgets report the funds earmarked as support measures by each Member State and their purpose;
- regional economic development companies[5], which in some regions of the EU play an active role in developing the local and regional economy. Support measures often constitute a useful tool for supporting specific activities within a development area;
- specific institutions for the transfer of national support measures that some Member States have established.

For an review of definitions of support measures included in these sources, the reader is referred to Annex A. The starting point of this study, however, is not a particular definition of support but the aforementioned sources. In the remainder of this report we take a detailed look at the support measures in force in the European Union, some but not all of whichfall under the EU definition of state aid. In this study we shall therefore in general speak of support measures rather than state aid.

Implicit support provided to the nuclear energy sector is not notified to the European as such, nor is it included in the above sources. We therefore undertook an additional literature search to identify sources reporting on this implicit support.

Sectors

The study has been limited to support measures in three sectors: energy (including nuclear), mining and transport. In some cases, however, clear and significant energy or transport support measures provided to other sectors (e.g. agriculture) have been included as well.

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[5] To the extent that they are responsible for national subsidy programmes.

EU Member States
The present study has been confined to support measures provided by individual Member States. Support measures funded by the European Union are thus not included.

Time frame
The survey of potentially environmentally harmful support measures is limited to measures in force in 2000 or decided upon in that year (if officially published).

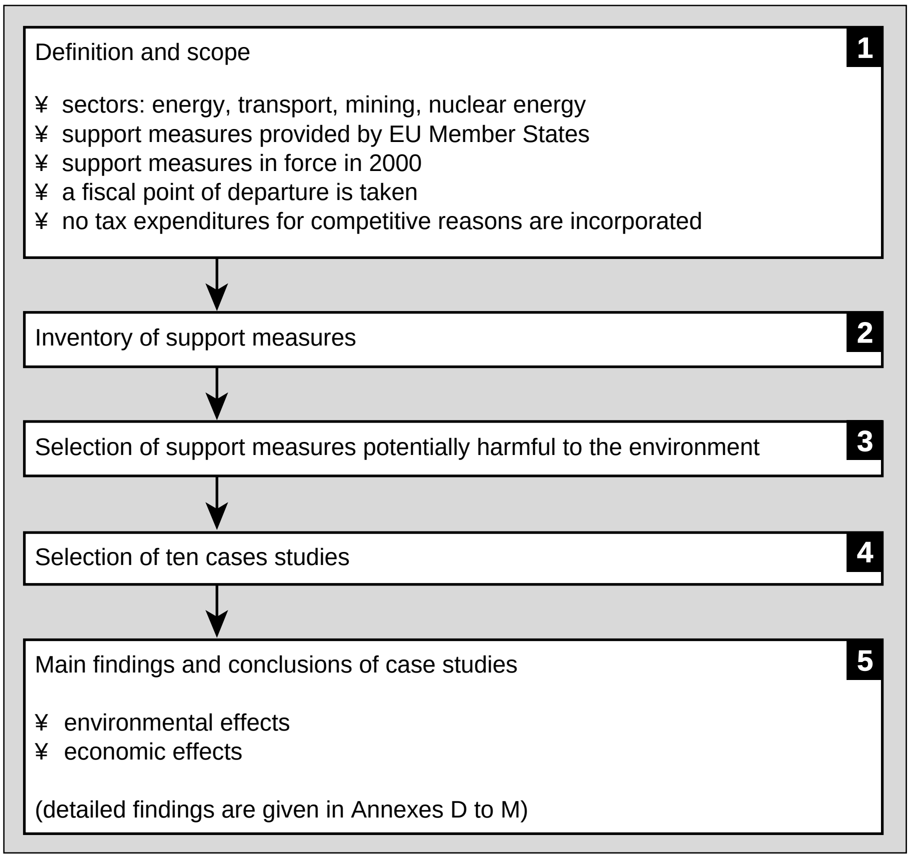
Environmental taxes and competitiveness
The survey does not include tax measures introduced for competitive reasons. Examples of such measures include the energy tax exemptions for large-scale energy consumers in The Netherlands, Denmark and Sweden.

No internalisation
In defining the scope of the study and thus the types of support measures to be included, a fiscal point of departure has been taken. This implies that the economic perspective - non-internalisation of external costs - has been ignored.

1.4 Structure of the report

The structure of the present report is shown in Figure 1, in which the numbered boxes show the content of the respective chapter.

Figure 1 Structure of the report



In chapter 2 we describe the results of the inventory of support measures provided to the energy, transport and mining sectors by the 15 EU Member States.

In chapter 3 the original list of support measures is reduced by removing those measures that are probably not harmful to the environment or even aim at improving environmental quality. This yields a shortlist of support measures in force in the 15 EU Member States that are potentially harmful to the environment.

In chapter 4 we provide brief descriptions of the 10 support measures selected for more detailed analysed in the case studies.

Chapter 5 reports the main findings and conclusions of the case studies, focusing on the environmental effects of the measure in question and the likely consequences of removal.

The Annexes to this report provide the following information:
- Annex A: Definitions of support measures used in different studies;
- Annex B: Review of sources and contacts in Member States used for the inventory;
- Annex C: Review of support measures considered potentially harmful to the environment;
- Annex D - M: Analysis of case studies.

2 Inventory of support measures

2.1 Introduction

In this chapter we present the results of our extensive survey of support measures provided by EU Member States to the energy, mining and transport industries in 2000. Given its length, we do not present this full inventory here, only a shorter list of measures identified as having a potentially damaging effect on the environment, as detailed in the next chapter.

We first report on the sources used for the inventory, going on to evaluate our survey and finally providing a tabular overview of the distribution of support measures over the EU Member States and sectors considered.

The procedure followed in preparing the inventory was as follows:
- EU sources were checked;
- the amount of support reported was cross-checked using aggregated sources (such as IEA, 9th Survey on State Aid), directing our further search for data;
- in each Member State national surveys were checked in detail at relevant departments;
- individuals at departments and other relevant organisations were contacted for further information on specific support measures.

In the following sections we describe in greater detail the procedure adopted in preparing the inventory.

2.2 Sources for the inventory

The project consultants prepared an inventory of relevant support measures provided by EU Member States. This inventory was restricted to those support measures within the scope established in section 1.3 of this report.

The inventory is based on the following sources of information:
- the State Aid Register of the EU, including accompanying annual reports, surveys and available decision lists;
- available annual reports on State Aid of the individual Member States;
- official registers of expenditure of national governments on support measures;
- the national budgets of EU countries: these budgets report the funds earmarked as support measures by each Member State and their purpose;
- regional economic development companies[6], which in some regions of the EU play an active role in developing the local and regional economy. Support measures often constitute a useful tool for supporting specific activities within a development area;
- specific institutions for the transfer of national support measures that some Member States have established.

[6] To the extent that they are responsible for national subsidy programmes.

2.2.1 EU Sources

First, the State Aid Register was consulted. The information in this register relates to support measures which:

- have been evaluated from 2000 onwards;
- are provided by Member States;
- may be State Aid schemes, i.e. acts on the basis of which individual awards of aid may be made to enterprises without further implementing measures being required;
- may concern individual applications: under certain conditions laid down in the various Community State Aid guidelines, individual awards of aid must be notified even if they are made on the basis of an already approved aid scheme. If they not are based on such a scheme they must be notified.

It is not possible to recover a full review of all the support measures in force in EU Member States in 2000 using only the State Aid Register, for several reasons:

- support measures that are not notified are included in the Register only in those cases brought to the Commission's notice despite the lack of notification (so-called NN cases);
- support measures that were decided upon *before* 2000 and that are still in effect in 2000 are not included in the State Aid Register;
- some schemes that were in effect in 2000 were not (yet) registered during the period of this study.

Besides the State Aid register, the ninth survey on State Aid in the EU was also used as a reference. As this survey provides aggregate figures per sector (not per support measure) for the years 1998 and 1999, it could not be used as a basic source. However, it was used as a reference for further inquiries into the overall volume of support provided in Europe and the funds involved in individual Member States.

At the European level several other general sources were furthermore used for cross-checking purposes:

- the IEA (International Energy Agency) reports extensively on aggregate support given to national energy sectors in selected countries for most recent years. As no data is provided on individual support measures, though, these reports were used merely to guide further research;
- the Netherlands Agency for Energy and the Environment (Novem) reports on renewable energy and government support, also at the detailed level of measures per Member State.

2.2.2 National surveys, registers and reports

In order to extend the list of support measures provided by EU Member States, we also consulted a variety of national sources for information on support measures.

These national sources included the annual budgets and official registers of the following national departments:

- Department of Economic Affairs;
- Department of Transport;
- Department of Industry and Trade;

– Department of Finance;
– Department of Agriculture and Fishery;
– Department of Environment.

Where applicable, our consultants also examined the annual budgets and official registers of other departments such as:
– Department of Public Enterprise;
– Department of Science.

In addition, we contacted regional economic development companies where these were judged able to extend the list of support measures in force in Member States.

To complete the inventory we contacted relevant government departments to obtain additional information on:
– measures subsumed under aggregate statistics in annual reports;
– budgets for specific support measures;
– the temporal validity of support measures.

Annex B provides a comprehensive review of all the sources and contacts in the Member States employed in drawing up the support measure inventory. These are listed State by State, as are the experts of Ernst & Young[7].

2.3 Special focus on support to the nuclear industry

Besides preparing a comprehensive inventory of support measures, as discussed in the previous section, we paid special attention to (indirect) support measures to the nuclear industry. Although official publications report on direct government support to the nuclear sector, certain types of indirect support are not notified to the European Commission and are not included on official lists. Because the European Commission has requested that this study pay particular attention to support to the nuclear industry, we have searched additional sources for relevant information.

In this sector there are essentially two types of indirect support measure that may not be omitted in official sources:
1 Government support in the form of insurance coverage for the risks accruing from nuclear power generation.
2 Government support covering (part of) the costs of nuclear waste management, disposal and R&D.

To estimate the amount of indirect support under the first category we calculated the difference between the insurance premiums appropriate for covering the damage ensuing from nuclear accident and the premiums actually paid by the nuclear sector. The requisite information was taken from [OECD-NEA, 2000], which provides estimates of this damage as a cost per KWh generated and from [AIDEnvironment, 1997], which reviews nuclear sector insurance premiums as a percentage of the damage to be covered.

2.4 Results - an overview

The inventory described in section 2.2 resulted in a long list of support measures provided to the energy, mining, nuclear and transport industries in

7 These experts prepared the inventories for the individual EU Member States.

all EU Member States. The list also includes support measures to other sectors where these are strongly tied to energy, mining, nuclear or transport.

Following the procedure described above with respect to sources and scope, an inventory of 451 support measures was drawn up for initial consideration in this study. Table 3 provides a snapshot of the sectors supported and the volume of support provided in individual EU countries.

Table 3 Distribution of inventory of 451 support measures over countries and sectors, prior to selection on environmental grounds

Country	**Number of support measures**				**Budget (in 2000, million €)**			
	Transport	Energy	Mining	Nuclear	Transport	Energy	Mining	Nuclear
Austria	4	38	-	-	3	766	-	
Belgium	5	1	-	-	3	-	-	-
Germany	12	47	2	1	1933	1268	4700[8]	179
Denmark	16	18	-	-	1076	109	-	-
Spain	24	35	14	2	980	486	2	0
Finland	9	20	-	2	41	85	-	23
France	31	10	2	2	5705	340	488	518
Greece	8	14	3	-	614	1217	1027	-
Ireland	7	5	-	-	2302	0	-	-
Italy	13	2	3	-	19	0	0	-
Luxembourg	-	-	-	-	-	-	-	-
Netherlands	38	21	1	-	4019	186	182	-
Portugal	1	1	-	-	11	699	-	-
Sweden	4	15	-	-	92	1160	-	-
United Kingdom	5	12	1	2	319	428	46	39
EU Total	**177**	**239**	**26**	**9**	**17117**	**6744**	**6445**	**759**

Total support under these 451 measures amounted to € 31 billion in 2000. As Table 3 shows, the transport sector as a whole received over € 17 billion support in 2000 (in all Member States), followed by the energy sector, which received almost € 7 billion. Support for mining is provided in fewer countries, but the overall budget is still over € 6 billion. Finally, support to the nuclear power industry is estimated at € 800 million[9].

It should be stressed that the precise annual budget of all support measures taken together is hard to estimate because for many measures no budget was provided in the sources consulted. This was due to:

- a lack of budget data or of clarity on the relationship between an individual budget and overall budget;
- the intrinsic problem of determining the budget of open-end support measures such as tax expenditures.

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8 The total amount of aid officially notified by Germany is only € 2518 million. However, a multiplication of the total coal production in Germany by the subsidy per tonne of coal (price difference between the production costs and price of this coal on the world market) results in a much higher amount of € 4700 million. An official of the German Ministry of Economic Affairs confirmed the latter amount by personal communication.

9 This number is exclusive of indirect support to the nuclear industry, which is not reported as such in official sources. The sources we have employed here are referenced in section 2.3, while the five additional support measures we found are detailed in Annex C.

Two consequence follow with respect to the budget figures given in Table 3:

1 The cited budget figures should be seen as a lower bound[10].
2 Due caution should be exercised when comparing budgets for individual countries and sectors, because some of these could not be identified, so that any comparisons will be based on incomplete data.

10 On the other hand, where cases are based on state aid reports, the declared budget does not say that much, as it is not always entirely consumed.

3 Support measures potentially harmful to the environment

3.1 Introduction

From this initial inventory of support measures we next identified those measures most likely to have little or no environmental impact. The criteria adopted for this purpose are set out in section 3.2.

The aim of this preliminary step was to facilitate selection of support measures considered interesting for further investigation. The resulting list is shorter and unburdened of measures aimed at environmental improvement or energy saving, for example. These are likely to have little (or no) environmental impact, or at least less environmental impact than those on the final shortlist, which is given in full detail in Annex C. This annex thus provides a comprehensive review of support measures in force in the EU in 2000 that are potentially harmful to the environment.

3.2 Criteria for selection

How is the potential environmental harm of a support measures to be determined on the basis of the limited information available in the official lists of such measures provided by Member States?

According to OECD (1998b) the best way to identify or prioritise support those measures with greatest environmental impact is to inventory the following information:
– price elasticities in supply and demand in the recipient sector (i.e. the price sensitivity of the sector);
– the environmental effects of production and consumption in the recipient sector compared to competing sectors;
– the circumstances determining how sensitive the environment is to the particular change in emission or waste levels brought about by the support measure.

To employ the OECD approach would require an in-depth analysis of all 451 support measures in force in the individual Member States in 2000 (i.e. 451 case studies). Obviously, the duration of such a project would far exceed the time frame of the present study.

Given these considerations, we established our own criteria for whether a support measure is to be earmarked as *potentially* harmful to the environment. To this end we adopted a negative procedure, removing from the inventory those support measures *not* deemed harmful in this respect, viz.:
1 Support aimed at improving environment quality:
   – aid for energy conservation;
   – aid for renewable energy;
   – specific environmental aid.
2 Support with any of the following prime objectives:
   – aid for training;
   – aid for employment;
   – social welfare schemes.

As mentioned in the previous section, measures in category 1 are not likely to have any (significant) environmental impact. Measures in the second category we likewise consider to have no significant environment impact, because their point of leverage is *not* related directly to the locus of environmental impact in the supply chain.

3.3 Results of selection

Using the selection criteria described, we arrived at a list of support measures considered potentially harmful to the environment. This list is presented in full detail in Annex C, while Table 5, below, provides an overview.

The numbers of support measures excluded for *not* being potentially harmful to the environment is given in Table 4.

Table 4 Support measures excluded from the inventory according to criterion employed

Criterion	**Number of support measures excluded**
Energy conservation	39
Renewable energy	144
Environmental improvement	43
Training aid	3
Employment aid	-
Social welfare schemes	3

As can be seen, there were a lot of support measures for energy conservation and renewable energy in the original inventory. However, a number of these are aimed at both these policy areas and after allowing for double counting we arrived at a total of 166 measures targeted at promoting energy conservation and/or renewable energy, 68% of the support measures in force in the energy sector.

On the first criterion a further 43 measures were excluded because their prime aim was to improve environmental quality. On the second criterion only six measures were excluded.

All in all, then, we identified 236 support measures as being *potentially harmful to the environment*, accounting for a total annual budget of approximately € 25.5 billion[11]. Full details of these measures are presented in Annex C.

Table 5 once again provides a snapshot of the distribution of the measures over countries and sectors[12].

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11 This budget is a subtotal, because the budget of some support measures is unknown. See section 2.4 for more details.

12 As in Table 3 we present this overview exclusive of the implicit support to the nuclear sector. This is because this implicit support is not on official lists.

Table 5 Distribution of 236 potentially environmentally damaging support measures over countries and sectors

Country	Number of support measures				Budgets **(in 2000, million €)**			
	Transport	Energy	Mining	Nuclear	Transport	Energy	Mining	Nuclear
Austria	2	6	-	-	0	766	-	-
Belgium	5	1	-	-	3	0	-	-
Germany	10	3	2	1	1918	683	4700	179
Denmark	12	7	-	-	690	66	-	-
Spain	21	12	12	2	980	57	2	0
Finland	8	2	-	2	40	10	-	23
France	31	3	2	2	5705	44	488	518
Greece	8	1	2	-	614	25	1027	-
Ireland	7	-	-	-	2302	-	-	-
Italy	11	2	3	-	19	0	0	-
Luxembourg	-	-	-	-	-	-	-	-
Netherlands	38	3	-	-	4019	127	-	-
Portugal	1	-	-	-	11	-	-	-
Sweden	4	1	-	-	92	0	-	-
United Kingdom	3	4	-	2	319	51	-	39
EU Total	161	45	21	9	16712	1829	6215	759

4 Selection of case studies

4.1 Introduction

Having established an inventory of support measures provided by the EU Member States that are *potentially* harmful to the environment, in this chapter we describe:

- the criteria used for selectingten case studies;
- a brief description of these case studies, including in each case: (i) the Member State providing the support, (ii) the goal of the support, (iii) the recipients, and (iv) the budget.

In the next chapter and in Annexes D – M, detailing the individual case studies, the environmental effects of the respective support measures are appraised as well as the estimated socio-economic impact of their removal.

4.2 Selection criteria

To select ten support measures provided by EU Member States as case studies from the list of 236 identified in chapter 3 as being potentially harmful to the environment, three criteria were employed. The selected measures should:

- have a large estimated environmental impact;
- together provide a representative spread over sectors, countries and types of support;
- be sufficiently backed up by hard data.

In line with the overall aim of this study, greatest weight was attached to the first of these criteria. Below, the three criteria are briefly discussed.

4.2.1 Large environmental impact

The first and main criterion for selecting case studies was the expected environmental impact of the support measure in question. We therefore sought to select cases anticipated *a priori* to have a relatively large environmental impact, defined as the sum total of environmental effects to be ascribed to by the support measure, viz.[13]:

- emissions contributing to global warming, such as carbon dioxide and methane;
- emissions contributing to acidification, such as nitrogen dioxide and sulphur dioxide;
- emissions contributing to eutrophication, such as phosphates;
- waste;
- damage to biodiversity;
- etc.

[13] These include the environmental effects with the characteristics specified in the SEA Common Position (CEC, 2000) in terms of probability, duration, frequency and reversibility of effects, cumulative and transboundary nature of effects, risks to human health or the environment, magnitude and spatial extent of effects (geographical area and size of population likely to be affected).

To assess the extent to which the support measures considered can cause such effects we adopted the following procedure:

1 As far as possible, environmental impact was assessed on the basis of earlier studies on environmentally harmful support measures[14].
2 Where no reasoned estimate was available, the potential environmental harm of the support measure was gauged on the basis of two indicators:
   - support volume;
   - estimated price elasticity.
3 Where no information was available on the latter point, the leverage point of the support measure in the production chain was taken as an indication of its environmental impact. In this respect, a support measure granted for burning fossil fuels will generally be more environmentally harmful than equivalent support to the end product of the sector in question.

4.2.2 Representative spread

With this criterion we aimed at selecting case studies divided evenly over the four sectors considered and over a variety of types of support measure (e.g. investment subsidies, grants, price support, risk coverage and tax expenditures).
In addition, we aimed at selecting case studies from at least six different EU countries, in order to arrive at a representative spread over countries.

4.2.3 Availability of information

Finally, we also looked at earlier studies of possible relevance for the case studies under consideration. On the one hand, such studies can provide additional information with which to improve estimates of the environmental impact of the support and the economic and social consequences of its removal.

On the other hand, we also considered the extent to which further examination of the support measure might *add* to the knowledge and understanding available in existing reports (e.g. OECD (1998c), Wit et al. (1999), Ruijgrok and Oosterhuis (1997)). The principal aim here was to avoid duplication of work.

4.3 The ten case studies selected

Table 6 presents the ten support measures selected on the basis of the three criteria set out in section 4.2.

14 E.g. CE, 2000, "Study into environmentally damaging subsidies"; OECD, 1998, "Improving the environment through reducing subsidies"; CE, 1999, "Efficient prices for transport".

Table 6 The ten support measures selected as case studies

	EU Member State	Support measure	Theme	Goal	Recipients	Budget (million €)
1.	Germany	Direct aid to the German coal industry	Mining	To compensate the price difference between the cost of domestic coal production and world market coal prices. Federal aid as well as for Saar and North Rhine Westphalia.	German coal industry	4,700
2.	Spain	Support to power generators for coal transport	Mining	To promote the consumption of Spanish coal from selected regions by cutting transport costs from mines to power stations. The grant, from the National Coal Institute, varies from 723 ptas to 1919 ptas / tonne	Spanish power generators	3.1
3.	Netherlands	C26/2001 – Refund of fuel excise duty to road freight carriers	Transport	To compensate road hauliers for fuel price rises through a tax refund	Dutch road freight carriers	budget not defined
4.	France	N88/2001 – Refund of social security premiums to maritime carriers	Transport	To improve the competitiveness of French maritime shippers	French maritime shippers	22.8
5.	Portugal	N336/2000 - Capital support to airline company	Transport	To assist the Portuguese airline company Transportes Aëreos Portugueses SA financially during privatisation	TAP airline	11.4
6.	Denmark	Operating and investment aid to railoperator	Transport	To maintain and improve the quality of services by Danish state-owned railroads (DSB) through aid for investments in rolling stock and maintenance of non-profitable lines	Danish Railroads	464
7.	France	Insurance coverage on behalf of nuclear generators	Nuclear	To bear part-liability for the risk of severe nuclear accident, for which French nuclear power plants are underinsured	French nuclear power industry	0.1 - 120
8.	EU Member States	Support to nuclear waste management and R&D	Nuclear	To cover the costs of nuclear waste management and support R&D on waste disposal technologies in various EU Member States	European nuclear power industry	Budget not defined
9.	Germany	Refund of fuel excise duty to farmers	Energy	To increase the competitiveness of German agriculture in the EU market	German agricultural sector	448.4
10.	Netherlands	Tax deduction for investments in energy saving and renewables	Energy	To save energy by stimulating investments in energy saving technology and renewable energy	All Dutch companies and organisations paying corporate taxes	100

The resulting list, presented in Table 6, shows a good spread over types of support measure (investment subsidies, tax expenditures, grants, insurance coverage of nuclear risk) and over countries (six countries).

There is, furthermore, a good spread over sectors:
- two support measures to the mining sector;
- four support measures to the transport sector, spread over road, rail, maritime and air transport;
- two support measures to the nuclear sector: one covering risk of nuclear accident, the other providing support for nuclear waste management schemes;
- two support measures to the energy sector.

It is important to note that one of the ten selected case studies was not selected from the inventory of support measures considered potentially harmful for the environment (see chapter 3). On the contrary, the aim of this tenth support measure, to the Dutch energy sector, is to *improve* environmental quality. More specifically, it aims to promote energy savings and use of renewable energy. This exceptional case enables us to assess the effectiveness of this particular investment subsidy for environmental purposes.

We now move on, in chapter 5, to describe the main findings of the ten case studies.

5 Case studies: methodology and results

5.1 Introduction

This chapter discusses the methodology employed in the ten selected case studies and presents the main results. A more detailed description of each of the case studies is provided in Annexes D to M of this report.

The structure of this chapter is as follows:
- section 5.2 reviews the main methodologies used in the international literature for assessing the environmental impact of support measures and identifies some common elements;
- section 5.3 describes the methodology used in this study for analysing the environmental impact of the selected support measures and for the socio-economic impact of their removal;
- section 5.4 describes the main findings and conclusions of the ten case studies with regard to the environmental effects and socio-economic consequences of support removal.

5.2 Methods used in international literature

The first question to be addressed having selected the ten cases is: how to analyse the environmental effects of a support measure?

Below we briefly review a number of studies that have, in analysing specific support measures, endeavoured to address this question. We subsequently summarise the common elements on which the methodology used in this study is based.

Literature review[15]
As Chen (1999) argues, when analysing the economic effects of any given financial support measures it is essential to adopta suitably broad perspective. Although support will obviously influence the economic performance of the recipient sector, that performance will also be affected by current depreciation rates, input structures and other taxes (e.g. on labour, capital).

Chen's analysis yields a so-called Marginal Effective Tax Rate (METR) on different, competing markets such as primary production and recycling. However, he does not present a methodology for determining the environmental effects of individual support measures.

Rainelli and Vermersch (1999) analyse the effects of support measures that influence French farmers' decisions to use irrigated or non-irrigated cereal systems. They do so by determining all the major factors playing a role in producer decision-making (micro); their theoretical findings are illustrated by empirical observations. Ultimately, their analysis boils down to comparing the environmental impact of the farmers receiving and not receiving support.

Pillet (1999) analyses the impact of effective tax rates on the marginal costs of different modes of freight transport. The author concludes that the labour tax in Germany has a much greater influence on total transport costs than in other countries, implying that support removal would lead to a different re-

15 Based on OECD (1999).

sponse in that particular country. This illustrates the fact that relatively similar markets (in this case freight transport) may have different cost structures in different countries.

Vollebergh (1999) provides a meta-analysis of energy subsidy case–studies. For each study he presents, among other issues, the method used to assess environmental effects. The following methods are mentioned:

- simulation analysis: bottom-up analysis to estimate the responses of different actors in the energy market to changes in relative prices. This requires information on cost structures, market power and sectoral objectives;
- computable general equilibrium analysis: top-down analysis requiring information on substitution potential between energy sources; these are dependent on the elasticities of energy demand and the assumption on perfect markets;
- simulation analysis using input-output matrices.

Normann, Fritz and Springfeldt (1999) use a model to analyse the effects of removing support measures to electricity generation and newsprint production in Sweden. This model is neither an econometric model nor a computerised general equilibrium model, but rather a comprehensive calculation tool. It builds on a number of assumptions and incorporates estimates of behavioural responses from earlier research.
It looks first at change-related adjustments in the production process (i.e. substitution between oil, biofuels, electricity and capital). The authors use own-price elasticities and cross-price elasticities from earlier research.
They estimate producer responses in terms of production mix and total output, using elasticities in production levels with respect to changes in profit. The magnitude of elasticities is highly dependent on the openness of the economy (an open economy will lose more production to other countries).
The final step is to estimate emissions in Sweden and neighbouring countries, applying the cited adjustments.

Obersteiner, Nilsson and Wörgötter (1999) analyse the effects of support to the Austrian pulp and paper industry. They mention that at the outset of the study they tried to use econometric methods to tackle the problem, but soon realised that the problem was too complex and the necessary data collection, if possible at all, would have been far too time-consuming. They then decided to use an institutional analysis, which included a quantitative analysis of how the levels of financial support compared with the economic and ecological performance of the industries under consideration.

Common elements

From the above review, several common methodological elements can be distilled:

- it is important to define the relevant competing markets, so that relative price differentials between the supported product and more environmentally sound competing products can be properly determined;
- upstream and downstream leakages should also be analysed; this is important, because in some cases support aimed at a specific sector may be transferred to suppliers or consumers, which might alter conclusions on the environmental impact of the support measure;
- different assumptions are applied in different case studies. Depending on the sector analysed, authors assume cost-minimising or profit maximising behaviour. We conclude that it is important to state the assumptions underlying any micro-economic analysis of a specific support measure;

– a full analysis of support measure removal (or redesign) cannot be built on econometric methods or development of general equilibrium models unless time and budget are less constrained;
– a description of key relations between support measures, production structures within and between sectors and possible competition with neighbouring countries, based on quantitative information from earlier studies, seems a good second-best solution.

5.3 Methodology

Analysis of the ten case studies examined in this study sought, in principle, to establish two sets of results:
– the environmental effects of the support measure in question;
– the economic consequences of support measure removal; these were established only for those measures associated with a relatively large environmental impact.

The methodological steps followed in each case are now presented in more detail.

Step 1: Environmental analysis
Assessment of the environmental impact of the selected support measures comprised the following steps:
– calculate the overall price change of the product supported following removal of the support measure ;
– estimate the volume effects on production and consumption, of volumes produced or consumed based on available elasticities;
– estimate incremental effects on emissions.

Important demarcations were the following:
– the cost structures in specific sectors and countries were determined using the indicators most commonly cited in the international literature. In cases where information on a certain country or sector was lacking, the researchers based themselves on the direction of adjustment of cost structures in similar countries or sectors;
– only first-order effects were assessed quantitatively, with knock-on impacts on other sectors or products described only as relevant;
– analysis was based on available data on own-price elasticities and cross-price elasticities as necessary;
– the environmental impact analysis focused mainly on CO_2 and NO_x-emissions and on nuclear risks and waste, with other impacts considered only when particularly relevant.

Step 2: analysis of consequences of support measure removal
Most studies conclude that removing support measures and recycling the revenues via reduced taxes on marginal earnings or capital investments would have a beneficial effect on the economy. The findings concerning the social and environmental consequences of such a move are mixed, however. Abolition of certain support measures would have major environmental benefits, while abolition of others might, in the absence of additional environmental regulations or charges, lead to increased environmental damage. In addition, there may be economic and/or social impacts that conflict with key government policy objectives.
Attempts to date to chart the various intended and unintended effects of support measure schemes have not always been satisfactory, making balanced decisions on discontinuation problematical. In this context it is often

forgotten that the impact of support measure removal (on the economy, for example) is very dependent on the alternative purpose to which the government funds are then put. Another aspect meriting consideration is whether and how the support measure is embedded within a broader policy framework (associated schemes and standards, for example).

To assess the economic and social consequences of support removal, additional analyses were performed. Table 7 gives an indication of the economic and social aspects investigated. As stated above, these were assessed only in those case studies where the support measure was associated with significant environmental impacts.

Table 7 Economic and social aspects of support measure removal investigated

Support measure	Aspects
Economic effects	Estimated unsubsidised market price Estimated change in sectoral production value Impact on market structure (qualitative)
Social effects	Estimated employment effects (qualitative)

5.4 Main findings and conclusions of case studies

In this section we present the main findings and conclusions of the ten case studies analysed. A detailed description of each study is provided in Annexes D to M.

Before presenting the main findings of the ten case studies, it should be emphasised that all these analyses focused on the demand-side effects of support removal. Within the scope of this study it was not feasible to quantify supply-side effects – for example, the extent to which renewable energy technologies might be developed and implemented faster following removal of support to the coal industry.
OECD (1998) has addressed the importance of supply-side effects. Support removal, particularly in the case of support tied to input or production processes, will encourage a broader range of technological developments than under continued support. As a result, the aggregate environmental benefits of support removal are likely to be greater than the estimates calculated here in the respective case studies. This is due both to the increasing benefits accruing over longer periods of time and to the broader range of technological developments facilitated by support removal.

We now present the main findings of the individual case studies.

1 Direct aid to the coal industry in Germany

State financial aid tor the German coal industry totalled around € 4.7 billion in 2000. The stated aims of this support are the following:

- to make, in the light of coal prices on international markets, further progress towards economic viability with the aim of achieving degression of aid;
- to solve the social and regional problems created by total or partial reductions in the activity of production units;
- to help the coal industry adjust to environmental protection standards.

The focus of this case study was the estimated effect on emissions of CO_2, SO_2, NO_x and particulates (PM_{10}) and on employment of removing this support to the German coal industry. The main findings of the case study are as follows:

- removing support to the German coal industry would lead to an increase of some 200% in the price of German coal, from about € 46 to € 138 per tonne coal equivalent (tce). This is the difference between the production cost of Germany coal and the price of imported coal;
- support removal would consequently lead mainly to substitution from German coal to import coal. At least in the short term, the energy mix in Germany will remain the same. In the longer term, the energy mix may shift to less environmentally harmful fuels;
- increased German imports may tend to raise world coal prices. This price rise may lead to lower demand worldwide or greater use of other fuels, such as natural gas, than would otherwise occur;
- decreased global demand for coal will lead to a slight decline in CO_2, SO_2 and particulate emissions. For CO_2 the implied reduction is around 19 Mtonnes, equivalent to over 2% of total German CO_2-emissions in 1990;
- removing this support to the German coal industry would cause the loss of up to 63,000 jobs in the mining sector, mainly in the Ruhr and Saar regions. In addition, about 150,000 jobs would be lost in mining-related sectors. However, alternative uses of the saved support would increase the efficiency of the German economy as a whole. By implementing an across-the-board cut in labour taxes, for example, about 250,000 jobs might be generated in other sectors. According to a recent international study by IEA[16], removal of energy support in the OECD countries would even increase economic growth by 0.7%. A policy targeted at the relatively severe economic consequences for the Ruhr and Saar regions might generatefewer jobs, but would succeed better in mitigating regional socio-economic impacts.

2 Support to power generators for coal transport in Spain

The focus of this case study was the environmental impact of removing the support given to power generators for coal transport from designated Spanish coalfields. The aim of this support is to compensate mining enterprises in the Thermal Central habitual zone of coal acquisition which have reduced capacity under restructuring, modernisation, rationalisation and other downscaling programmes. This has led to the closure of several coalfields, thereby increasing the average transport distance between the mine and the power plants burning the coal. The budget of this support measure is € 3.1 million. The support covers no more than 3.7% of total hard coal consumption in Spain.

The aim of the support is to compensate the transport costs of the *additional* number of kilometres from the coalfields in the thermal central habitual zone to the power plants. The recipients of the support are the power plants. The findings of the case study are the following:

- Removing the support for coal transport would probably have a very limited environmental impact because we conclude that the recipients of the support, the power plants, can be considered free-riders: they will purchase the same amount of coal from the same mines in the scenarios with and without support. In addition, support removal might increase end user electricity prices. However, given the relatively small amount of support (€ 3 million), the rise in energy prices would be negligible and thus, too, the impact on demand and potential emission reductions;
- The obligation for power plants to purchase a minimum amount of domestically produced coal will keep the shift to imported coal low, and thus soften national employment effects as well.

[16] International Energy Agency*, Looking at energy subsidies: getting the prices right, World Energy Outlook, IEA*, Paris, 1999.

3 Refund of fuel excise duty to road freight carriers in the Netherlands

The aim of this support measure was to compensate Dutch road freight carriers for the higher gasoil prices paid in 2000 through a part-refund of fuel excise duties. The unweighted average refund under the scheme amounted to 3.97 Eurocents a litre in 2000, 4.7% of the total average fuel price in that year.

The findings of the case study can be summarised as follows:

- discontinuing the refund of excise duties to road freight carriers would have as its most pronounced effect a more efficient transport sector;
- the main direct impact of the resultant increase in fuel price for carriers would be higher fuel efficiency and higher vehicle load factors, both with a small direct economic impact on the businesses concerned. They would seek a new economic optimum, which would in turn reduce the overall environmental burden of road freight;
- the economic effects, in terms of production value, employment and trade flows, of the refund of excise duty to road carriers would be only minor. Because of the rise in fuel price, the competitiveness of the road freight sector would decline somewhat relative to other transport modes and foreign competitors.

4 Refund of social security premiums to maritime carriers in France

The focus of this case study was the environmental effects of discontinuing the refund to French maritime carriers of social security and unemployment premiums paid on behalf of EU employees. The primary aim of the support measure is to make the French maritime sector competitive with that of other, non-EU maritime sectors. A secondary aim is to promote the employment of EU citizens in the French maritime sector. The annual budget of the scheme is estimated at € 22.8 million [European Commission, 2001].

The findings of the case study can be summarised as follows:

- the support causes no environmental effects, as the ocean shipping industry, the sector under support, consists of price takers. Higher costs of input factors such as labour can hardly be passed on in prices to users of the maritime transport. In addition, the companies have plenty of scope for hiring more non-EU workers to compensate for the higher labour costs paid for EU workers after support removal. Employment effects for the EU as a whole may therefore be significant.

5 Capital support to airline company in Portugal

The focus of this case study was the environmental and economic impact of removing capital support provided to the Portugese airline company TAP. The aim of the support was to compensate for a lack of capitalisation on pension schemes that occurred during the first phase of the privatisation of the airline company in 1999. The amount of capital injected was € 11.4 million (precisely the lack of capitalisation on pension schemes) [European Commission, 2000].

The findings of the case study can be summarised as follows:

- as the support given to TAP is an incidental and non-recurring revenue, the environmental impact of this support are likely to be fairly small in the longer term. The anticipated increase in ticket prices for TAP services is relatively small, leading to only a slight decrease in TAP flight volume. This decrease in demand for TAP air services might be substituted by increased transport by other airlines. A small fraction of the decline in TAP transport volume will not be substituted at all, however, causing an environmental gain through lower overall consumption of air transport.

6 Operating and investment aid to rail operator in Denmark

The focus of this study was the environmental and socio-economic impact of removing operating and investment aid to the Danish railway company DSB. In the year 2000, DSB received € 464 million of contract payments from the Danish government [DSB, 2001]. In return, DSB has committed itself to providing a certain quality of rail services, by investing in rolling stock, for example, and maintaining non-profitable lines.

The findings of the case study can be summarised as follows:

- the contract payments account for approximately 40% of the total turnover of DSB [DSB, 2001]. This means that without the payments DSB would have to cut costs or increase revenues dramatically to remain profitable;
- removing the support would probably imply DSB having to charge higher prices to compensate for loss of revenue. In addition, DSB would probably reduce costs by, for example, closing non-profitable lines, reducing investments with a low return or putting on fewer trains in off-peak hours. However, this conflicts with the Danish government's aim to maintain a certain standard of rail services in all areas;
- support payments to DSB result in a small shift from road to rail transport. In addition, enabling more people to travel at reduced cost increases total transport demand in absolute terms (passenger kilometres);
- removal of the support may result in higher CO_2 and NO_x-emissions; relative to the total emissions of rail and road passenger transport, respective increases of 0.4% and 2.3% are projected;
- the socio-economic impact of support removal is anticipated to be large. The two main consequences would probably be line closure and higher ticket prices, both of which would reduce people's travel opportunities and thus restrict social contacts;
- Furthermore, about 4,000 jobs would be lost at DSB; however, alternative use of the support may create over 10,000 new jobs.

7 Insurance coverage on behalf of nuclear generators in France

Risk studies show that nuclear reactor operations are generally accompanied by the risk of severe accident, even though that risk may be small. Severe nuclear accidents are accident sequences that lead to a loss of confinement of the radioactive inventory of the reactor. Certain accident sequences may lead to the release of relevant parts of the inventory to the environment; subsequent dispersion would result in health, environmental and economic damages.

Industrial risks are usually evaluated as a function of their probability and the projected magnitude of damages. They are usually covered by an insurance policy, for which the operator of the hazardous plant pays premiums. The premium paid depends on the quantitative risk involved, as calculated by the insurance company covering it. These insurance premiums usually form a standard element of production costs and contribute to the product price. Insurance premiums for high-risk production facilities thus result either in higher production costs or in efforts to avoid or limit risks and associated costs, or in both.

The potential damages accruing from a severe nuclear accident are covered by insurance to a limited extent only. A considerable part of the risk remains financially underinsured, leaving the bulk to government treasuries and reducing nuclear power production costs considerably. The portion of risk covered by the state is subject to international frameworks and EU regulations, within which national regulations operate.

Even though this is general practice in most countries where nuclear reactors are operated, we have selected France as an example to evaluate the effect of this indirect support measure. This is because this country currently has 58[17] operational nuclear reactors, accounting for about 40% of the reactors and over 50% of nuclear generation capacity in the EU15. In France, furthermore, the insurance sum required for severe nuclear accidents is among the lowest in the OECD.

The findings of the case study can be summarised as follows:

- Current legislation and practice in France do not require the owners or operators of nuclear power plants to cover the entire risk of severe accident but limits their liability. Current practice in France limits owner/operator liability to below 10% of current, internationally agreed liability limitations. This insufficient provision for future liability for potential severe nuclear accidents at French nuclear power plants may be considered an environmentally harmful indirect support measure.
- Adopting an insurance model in which French nuclear owner/operators themselves shoulder all *currently agreed* national and international liabilities through private insurance implies a price increase of nuclear energy of less than 1%. The environmental and economic effects of this scenario are negligible. Adopting the *upper estimate* range of damages reported in international studies however, would probably have a significant environmental and economic impact, however, because other base-load generation technologies would become more competitive as nuclear became more expensive. This scenario would thus lead to higher CO_2-emissions, on the one hand, and probably reduced nuclear waste storage requirementsand attendant risks, on the other.
- However, the probability and consequences of severe nuclear accidents are currently the subject of debate, and estimates of potential damages and their consequences for health, environment and the economy vary over more than six orders of magnitude according to a range of international studies. We therefore recommend (i) to review these international damage studies, including a sensitivity analysis of all assumptions, and subsequently (ii) to strive for consensus on a smaller range of cost estimates.

8 Support to nuclear waste management and R&D in EU15

Production of nuclear power generates high-level radioactive wastes as by-products. Because of its hazardous properties this waste must be appropriately managed during storage and handling and in later final disposal underground repositories. This case study investigated how different tasks in this respect are organised in EU Member States and how the associated costs (of nuclear waste management, for example) are covered by standing provisions.

The findings of the case study can be summarised as follows:

- in all the EU countries considered the costs of nuclear waste management and final disposal associated with *current* reactor operations are generally paid by power plant operators;
- in some countries, however, power plant operators are not required to provide long-term funding guaranteesfor the requisite final disposal of waste from *future* operations. Such funds are essential for covering very long-term liabilities that may exceed the lifetime of the companies operating nuclear power plants;

[17] This figure does not include the Phenix facility, for which a decision on future operation is currently pending.

– only a few countries have regulations in place to guarantee that the costs of R&D aimed solely at improving nuclear power technology are assigned specifically to the nuclear sector. In Sweden a promising *modus operandi* ihas been established that requires nuclear waste producers to bear the full cost of the essential R&D work;
– in many EU member states there is a lack of transparency with regard to the organisation of public services and cost coverage in the nuclear industry. This may lead to public misconceptions and economic distortions in the energy industry throughout the EU.

9 Refund of fuel excise duty to farmers in Germany

The focus of this case study was the environmental and socio-economic impact of discontinuing the refunds to German farmers of excise duties paid on gasoil ('Gasölverbilligung') that was in force from 1967 until the end of 2000. This support was provided to agricultural firms to improve the competitiveness of German agriculture in the EU marketplace. Under the scheme farmers were compensated at the end of each year for the excise duties paid on gasoil. In 2000 this compensation was about € 0.15 per litre, roughly 40% of total duties, with a maximum refund of DM 3,000 per enterprise. This means that only the duty on the first 10 thousand litres was (part-)refunded. It proved impossible to establish an exact figure for the refunds paid out in the year 2000, but these are estimated at about € 179 million.
The findings of the case study can be summarised as follows:
– given the fierce competition on the world market for agricultural products, there is little chance of German farmers being able to raise their prices to cover the higher fuel costs in the absence of support. Agricultural fuel consumption would probably fall slightly, but more important will be the incentive to search for niche agricultural markets and perhaps a slight decline in overall German agricultural output. The agricultural sector will thus respond to support removal by searching for a new economic optimum better reflecting the true price of energy, i.e. gasoil, use;
– removal of this support measure will have limited environmental benefits, mainly because fuel use in the agricultural sector is relatively low compared to the German economy as a whole. In addition, the elasticity of agricultural gas oil use is fairly low;
– in greenhouse horticulture, however, the economic impact may be larger. We looked more specifically at this subsector because it is responsible for 36% of total agricultural gasoil consumption and fuel expenses average 5.3% of total business expenditure. Without any adjustments to the production process, removal of the support would increase total horticultural expenses by 1.5%. Depending on the specific product concerned and given the relatively small profit margins involved, this may lead to closure of some businesses.

10 Tax deduction for investments in energy saving and renewables in the Netherlands

As already remarked, this case study differs from the others in not addressing a support measure expected to have a negative environmental impact. It has been appended to the study in order to investigate the effectiveness of support aimed at improving environment quality.

The focus of this case study was a tax deduction scheme for energy investments introduced in the Netherlands at the beginning of 1997[18]. The aim of the scheme is to improve environmental quality by stimulating energy saving and the use of renewable energy. Companies in the Netherlands that invest

[18] The title of the support measure is *Energie Investerings Aftrek*.

in either of these areas can deduct part of their investment costs from their fiscal profit, providing the investments fulfil certain criteria in terms of energy performance. The scheme applies to investments in the following areas:

- buildings;
- machinery and processes;
- combined heat-power installations;
- transport equipment;
- use of renewable energy.

The percentage of investment costs that can be deducted varied in 2000 from 40% to 52%. An estimated € 100 million of support was provided that year [Senter, 2001].

The findings of the case study can be summarised as follows:

- compared with other policies, this tax deduction scheme is not an efficient means of reducing CO_2-emissions. This implies that the government has spent more than necessary on achieving a predefined emissions reduction goal;
- about 50% of the calculated energy savings can be attributed toso-called free-riders. This means that roughly half these savings are not due to the support scheme, because the efficiency measures would have been taken without support as well;
- the so-called 'rebound effect' of the support measure has been estimated by the Dutch Bureau for Economic Policy Analysis (CPB 2000) at 0 - 20% of overall energy savings. In other words, between 0 and 20% of initial energy savings later vanish because of the lower energy bill following implementation of efficiency measures: cheaper energy leads to higher energy use. For 2000 this implies a possible rebound of 1,300 TJ of energy savings;
- if the full amount of support is allocated to the reduction of CO_2-emissions, the effectiveness of the tax deduction can be calculated to be between € 150 and € 190 per tonne CO_2. These figures are relatively high compared to the cost-effectiveness of another recently introduced measure to reduce CO_2-emissions by selling these on an 'auction' market. The cost-effectiveness of this new scheme varies, but ranges between € 4.9 and € 11.1 per tonne CO_2 reduced;
- a possibly large effect that has not been assessed quantitatively is the incentive for developing innovative saving or renewable energy technologies. Removing the support could put developers of such technologies at a competitive disadvantage compared with producers of conventional technologies.

Summary

Table 8 provides a summary of the results of the ten case studies, showing in each case the country in which the support is given, the potential environmental impact that can be attributed to the support, and the socio-economic impact that would follow support removal.

All environmental and socio-economic impacts are given for the situation in which the support is not provided, relative to the situation with support. This implies that positive environmental effects imply a possible environmental gain when removing the support.

Table 8 Environmental and socio-economic impacts of support removal for ten selected case studies

No	Case study	Environmental impact	Socio-economic impact
1	**Direct aid to coal industry** *Germany* Budget:: € 4.7 billion	- 19 Mtonne CO_2 - -56 ktonne NO_x - 33 ktonne SO_2	- increased economic efficiency in Germany - increased economic growth in Germany - loss of 63,000 jobs in mining sector - loss of 215,000 jobs in mining-related sectors - employment growth: approx. 250,000 jobs in other sectors
2	**Support to power generators for coal transport** *Spain* Budget: € 3 million	- negligible	- possible shift of employment between regions
3	**Refund of fuel excise duty to road freight carriers** *The Netherlands* Budget:: n.a.	- 84 ktonne CO_2 - 828 tonne NO_x - 27 tonne PM_{10}	- negligible
4	**Refund of social security premiums to maritime carriers** *France* Budget: € 22.8 million	- negligible	- economic effects: shift from deployment of EU workers to non -EU workers
5	**Capital support to airline company** *Portugal* Budget:: € 11.4	- 13.5 ktonne CO_2 - 45 tonne NO_x	- loss of 83 jobs
6	**Operating and investment aid to rail operator** *Denmark* Budget: € 464 million	- -27 ktonne CO_2 - -784 tonne NO_x	- large socio-economic impact due to higher ticket prices and substantial loss of quality and supply of public transport services in Denmark - shift of employment from rail to other sectors, with about 4000 jobs - overall, net positive effect on employment
7	**Insurance coverage on behalf of nuclear generators** *France* Budget:: € 0 - 120 million	- depends on assumed/ estimated damage costs of severe accidents - decrease of risks - less nuclear storage sites	- n.a.
8	**Support to nuclear waste management and R&D** *EU Member States* Budget: n.a.	- n.a.	- n.a.
9	**refund of fuel excise duty to farmers** *Germany* Budget:: € 179 million	- 226 - 302 ktonne CO_2 - 3.6 – 4.8 ktonne NO_x - 354 - 472 tonne PM_{10}	- negative economic impact on horticulture
10	**Tax deduction for investments in energy saving and renewables** *The Netherlands* Budget: € 100 million	- **-/-** 530 - 660 ktonne CO_2 - **-/-** 255 - 320 tonne NO_x	- 50% use by free riders - 'rebound effect' between 0 and 20%

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Environmentally harmful support measures in EU Member States

Annexes

Project No. ENV.B.2/ETU/2000/0056

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A Definitions of support measures

A.1 Introduction

In preparing the inventory of 'support measures' for examination in this study we have employed no specific definition of the term.. Instead we have used a number of public sources, described in chapter 2 of this report.

In this annex we describe what a number of key institutions understand under 'state aid' and 'support measure' (**section A.2: definitions**) and delineate which support measures have been examined and which have been ignored in this study (**section A.3: scope**).

While considering it useful to present these definitions, however, we emphasise that these have **not** been applied as selection criteria for our inventory nor for the case studies selected.

The support measures considered in the main report and in the case studies of Annexes D to M correspond broadly to the state aid definition. We will in general speak of support measures rather than state aid.

A.2 Definitions

In order to clarify this framework of concepts, we performed an additional literature study to review current use of the concept 'support' in general and 'subsidy' in particular. In this section we report – although not exhaustively – on the results and consider these concepts in the light of the study at hand. In doing so, we shall give separate consideration to the perspectives of the European Union and the OECD.

A.2.1 European Union

State Aid

The basic assumption of EU policy with regard to State Aid is stipulated in article 87, section 1, of the EU Treaty establishing the European Community (hereinafter: the Treaty). In this article it is stipulated that any aid from the states is in principle incompatible with the common market. In article 88 of the Treaty, the Commission is given the task of supervising State Aid. In this article the member states are also required to inform the Commission in advance of any intention to grant State Aid ('obligation to notify').

The Community rules with regard to State Aid apply only to measures meeting all the criteria of article 87, section 1, to wit:

1 Transfer of government resources.
2 Economic advantage.
3 Selectivity.
4 Effect on competition and trade.

Ad 1 Transfer of government resources
State aid refers to measures, which are associated with transfer of government resources (national and regional as well as local budget resources, resources of public banks and foundations, etc.). The support does not necessarily have to be attributed to the state itself. It may also be granted by a private or public institution designated by the state. This might be the case when a private bank is commissioned to manage a support arrangement, financed by the government, for medium and small companies. Financial transfers providing support may take on many forms: not only support measures or interest bonuses but also loan guarantees, accelerated write-off, capital injections, etc.

Ad 2 Economic advantage
The aid must provide an economic advantage that the company would not have obtained in the normal course of running its business. We are concerned here not only with clearly recognisable forms of state aid, but also less clear instances of transactions providing economic advantage for example:
– a company purchases/leases land from the government below market prices;
– a company sells land to the government above market prices;
– a company gains favoured access to infrastructure without paying for it;
– a company receives risk capital from the state under conditions more favourable than a private investor would allow.

Ad 3 Selectivity
State aid is selective and thus touches on the balance between individual companies and their competitors. 'Selectivity' differentiates state aid from so-called 'general measures'. That is to say, general measures are measures, which automatically apply to all companies in all economic sectors of a member state (for instance most national fiscal measures). An arrangement is considered 'selective' if the authorities managing the arrangement may act, to a certain extent, the way they think best. The selectivity criteria arealso met if the arrangement applies only to part of the territory of a member state (as is the case for all regional and sectorial support arrangements).

Ad 4 Effect on competition and trade
State aid may potentially affect competition and trade between the member states. It is sufficient if it can be demonstrated that the receiver of support carries out economic activities and is active in a market involving trade between member states. The capacity of the receiver of support is not relevant in this context. The Commission in general takes the point of view that small amounts of support (minimum support up to € 100,000 in 3 years as a maximum) have no potential effect on competition and trade between member states[19]. Therefore it is of the opinion that such support remains outside the sphere of influence of article 87, section 1. It has followed similar reasoning in certain other decisions, approving support for activities limited to the local market.

[19] However, this rule does not hold for the agricultural sector, the transport sector, export-related activities, aid contingent upon the use of domestic over imported products, or measures falling under ECSC at least until the expiry of ECSC Treaty.

Exception to State Aid prohibition

On the basis of article 87, section 1, state aid meeting all the aforementioned criteria is in principle incompatible with the common market. The principle of incompatibility does not, however, imply an absolute prohibition. In article 87, sections 2 and 3, of the Treaty a number of cases are mentioned in which state aid can be considered acceptable (the so-called '*derogations*'). The existence of these derogations also justifies the proposed state aid measures being studied by the Commission, as stipulated in article 88 of the Treaty. In this article it is determined that the member states are to inform the Commission of every intention of granting state aid before implementing such a proposal. It also provides the Commission with discretionary authority for deciding whether the proposed support measure is under consideration for a derogation or that '*the state concerned shall abolish or alter such aid*'[20].

For derogations, as stipulated in article 87, section 3, under a) and c), three main categories can be differentiated:

- regional support: Article 87, section 3, under a) and c), forms the basis for accepting State Aid granted in order to tackle local problems;
- horizontal arrangements: intersectorial or 'horizontal' arrangements are included in the Commission's point of view with regard to special categories of support intended to tackle problems that could occur in any random sector or region;
- sectorial arrangements: the Commission has also made regulations for specific sectors, the so-called sectorial arrangements, in which its approach to State Aid for specific sectors is set forth.

State aid in practice

The Eighth synopsis of government support in the European Union (1994-1998) covers the national aid, as described in article 87 of the Treaty, that is provided by the fifteen member states. General measures and government support measures which do not have a negative effect on trade and do not cause competition or which take place in accordance with article 86, section 2, 2 of the Treaty, are not mentioned in the synopsis.

Categories of support

Every support measure causes the government in question to spend or lose income and provides the beneficiary with financial advantage. How extensive the 'support component' is, in other words how much financial advantage the beneficiary will draw from the favourable effect of the nominal amount transferred, depends to a large extent on the form in which the support is granted. It is therefore useful to subdivide support measures according to the manner in which the support is granted. We distinguish four categories, referred to here as A, B, C and D.

Group A. The first category involves measures in which the support is transferred to the beneficiary entirely. The support component, in other words, is equal to the nominal value of:

- subsidies;
- interest subsidies which are directly accredited to the beneficiary;
- tax credits and other tax measures for which the advantage does not depend on the taxes owed (in cases where the tax credit is higher than the amount of taxes owed, the difference is paid back);
- tax deduction, exemptions and rate reductions for which the advantage does not depend on the question of whether taxes are owed;

[20] The Commission, however, has no discretion for measures, which fall under article 87 (2) once it finds that the conditions are fulfilled.

- reduction in social security contributions;
- measures equivalent to support measure, such as sale or lease of government terrain and government property below market price.

Group B. It must be decided whether the transfer of financial resources by the government in the form of participation in the company capital is a form of support to the beneficiary, or rather a commercial action by the government which acts in this as a private investor under normal market conditions. This is the reason the divergent forms of capital participation are not included in the first category, but in a separate category B. One measure falling into this category is participation in company capital, regardless of the form (including conversion of debt).

Group C. The third category of support measures consists of the transfer of financial resources of which the support component corresponds to the amounts of interest saved by the beneficiary during the period in which he has the transferred capital available. Transfer of financial resources may take the form of a soft loan or tax breaks. The support component in this category is much lower than the nominal value of the support. Measures in this category include:
- soft loans from both public and private resources (interest subsidies are included in A);
- participation loans from public or private resources;
- advances that can be reclaimed if the company makes a profit;
- tax breaks (reserves, normal or accelerated write-off, etc.).

Group D. This final category comprises support measures granted in the form of guarantees expressed as a nominal sum. Here the support component is usually considerably lower than the nominal amount; after all, the support component corresponds to the advantage the beneficiary enjoys, without costs or – in the case of paying a risk premium – below market rates. Measures in this category include:
- amounts covered within the framework of guarantee arrangements;
- losses as a result of guarantee arrangements, minus premiums paid.

Community guidelines on State Aid for environmental protection
Within the community guidelines, the Commission has determined to what degree and under what conditions support measures may be necessary to safeguard protection of the environment and long-term development without having a disproportionately negative effect on competition and economic growth. General conditions for approval of support measures to benefit the environment have also been included in the guidelines.

In these community guidelines the following observation on the definition of support measures is also made:
'The purpose of these guidelines is not to discuss the concept of State Aid, which derives from Article 87 (1) of the EC Treaty and from the case law of the Court of Justice and the Court of first Instance.'

Conclusion
The objective of this more detailed consideration was to establish a clearer demarcation of the concept 'support measure' for the purpose of studying potentially environment harmful support measures. To this end the European concept of 'State Aid' has has been taken as a basic point of departure. As far as the definition of State Aid is concerned, this ensues from articles 87 and 88 of the Treaty. Essential for this are deviations from prohibition of

State Aid: regional support, vertical support and horizontal support. Subsidies can be considered as one of the potential forms of providing State Aid. The support measures considered in the main report and in Annexes D to M. broadly correspond to the state aid definition. We will in general speak of support measures rather than state aid.

A.2.2 Support measures defined in other studies

Support measures have been defined in many ways in the literature (Center for International Economics; 1988; Steenblik; 1995; OECD; 1997 and 1998b). The most commonly applied distinction is between direct and indirect support measures. As clear-cut definitions are generally lacking, however, this distinction may be rather confusing. Below we endeavour to clarify the definitions of direct and indirect support measures using a framework developed by the OECD (OECD, 1998b)[21].

First, support measures can be divided into on-budget support measures and off-budget support measures (see OECD, 1998b). Budget refers here to official governmental budgets. Budgets of, for example, state companies which provide subsidies or profitable loans to certain sectors of the economy are then considered as off-budget support measures, for the government pays only indirectly.

Second, support measures can be categorised according to whether they are on the debit or credit side of the government's balance of payments. Hence, support measures can be divided into measures having an effect on government revenue (e.g. lowered tax revenues) and measures involving direct expenditure.

Table 9 Classification of various support measures

	On-budget	Off-budget
Revenue-side	Accelerated depreciation allowances Debt write-off Preferential sales tax and VAT rates	Border protection Market access restrictions Lower rate of returns for state-companies Exemption from environmental standards
Expenditure-side	Deficiency payments Support to R&D Provision of infrastructure Sales premiums Risk insurance (export, hazards)	Free provision of goods from state-owned companies

With this table, direct support measures can now be defined as on-budget support measures that are government expenditures. Indirect support measures are then on-budget support measures that result in lower government revenues.

[21] Note that support measures are broader than subsidies. Whereas subsidies involve direct financial transfers from the government to the recipient, there is also a category of measures that can be taken to protect certain industries, say, which do not involve a direct financial transfer. Tariff barriers are a classic example of the latter type of support measure. Although these are not subsidies, they may have the same impact.

The OECD differentiates and defines a range of specific support measures, as outlined below (OECD, 1998b).

Direct payments

Deficiency payments (grants to cover losses) and operating subsidies

> Monetary payments by government[22] to producers in order to cover their losses or operating expenses.

Consumer subsidies

> Monetary payments by government to consumers that reduce prices for consumer goods or increase the volume thereof.

Price premiums

> Monetary payments by government to producers of certain goods that enable them to lower prices or increase profits per product sold.

Tax policies

- preferential treatment under the general tax code;
- exemption from excise tax;
- tax credits;
- preferential treatment in local rates.

All these tax policies can be regarded as forms of tax expenditure, i.e. loss or delay of tax receipts arising from a provision in the tax code, arising from a provision for exemption under the prevailing tax code. Their definition depends on establishing a reference tax rate and determining whether or not a provision constitutes an exemption.

Policies that reduce the costs of inputs and complements (investment subsidies)

Budgetary subsidies to inputs

> Monetary payments by government to producers of inputs that reduce the prices of inputs.

Price controls for inputs

> Regulations that put a cap on input prices.
> Example: a maximum price for energy provision.

Land expropriation for roads, plant sites, etc.

> Changes in the ownership of specific lands in order to provide land for specific sectors or activities at socially suboptimal prices.
> Example: expropriation of land for construction of the Betuwe rail link in the Netherlands.

Equity participation

> This intervention in the form of risk-sharing constitutes aid when a private investor operating under normal market conditions would not otherwise have undertaken a given investment.
> Example: government participation in energy producing firms in Australia led to a higher investment rate in coal than occurred after privatisation of the energy firms.

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[22] Government is here taken to refer to any governmental body at national, regional or local level.

Loans at preferential rates

Government loans to producers and consumers at lower than normal interest rates.

Loan guarantees

Guarantees that a loan will be paid off by the State if the economic actor in question proves unable to do so.

Infrastructure financing

Provision of infrastructure to users at prices below the long-term marginal social cost.

Liability guarantees

Guarantees that a liability will be paid off by the State if the economic actor in question proves unable to do so. This constitutes a certain reduction of risk for the actor, which may influence the prices charged for certain products.

Policies that create transfers through market prices

Trade policies

Import and export taxes and subsidies.

Non-tariff trade barriers.

These trade policies lead to different prices being asked for similar goods in the national and international market, by changing either prices or the amount that can be traded. These policies may obstruct trade and will distort markets. For example, the restricted scope for energy imports to the Netherlands induces uncertainties for energy production firms in that country.

Domestic energy and related policies

- procurement preference;
- managed non-commercial contracts;
- energy planning;
- price regulation (ceilings, floors, rate-basing);
- protection for monopolies.

All these measures can be summarised as having an impact on the amount and kind of energy consumed and the origin of these energy resources. Examples include:

- the Dutch government's standardised method for calculating the transportation costs of energy;
- monopolies of the energy distribution networks;
- obligations to procure a certain amounts of energy from a given (domestic) provider;
- local regulations prescribing which types of energy are to be used in a given new housing development.

A.3 Scope of support measures

From the definitions employed within various frameworks, as outlined above, a number of common elements can be distilled:

- support measures make claim to financial resources;
- these financial resources are provided with a stated objective, which may be formulated either specifically or generically;
- support measures are provided by a government agency or an institution mandated accordingly;

– no direct, economically equivalent performance is provided to the government in return.

To investigate the *direct* support measures provided in the EU means scanning all the official government budgets of the Member States for expenditures earmarked specifically as support measures (or some synonym). Once the sum total of these support measures has been established and the sectors to which they are addressed, quantitative and qualitative analyses of the effects of the support on the environment can be undertaken. This we did in the present study, for ten representative case studies, according to the methodology outlined in section 3.5 of the main report.

Although we understand that the potential impacts of *indirect* support measures may be substantial, identification of such measures would ideally take quite a different, and more difficult route. The term 'indirect support measures' refers to such arrangements as tax exemptions, preferential tax rates and anomalous schemes of debt write-off. These measures influence government budgets by reducing revenues, but cannot be specifically identified by examining these budgets because no special provisions are made for reduced revenues. There are simply no data available on the many government provisions that might be classed as indirect support. The main analytical problem, however, is to establish an appropriate reference value, i.e. the price or tax to be paid if the provisions were withdrawn.

A second problem in investigating support measures, of any kind, lies in the fact that it is not only governments but also state companies that may provide other sectors with favourable contracts, loans, etc. Almost all countries have special banks that provide loans below market rates. These are mostly private firms, but with the state as sole shareholder. In some countries the operating costs of such banks are cited on the state balance sheet. However, their precise operations and the loans they provide to customers are not always publicly available.

To circumvent the aforementioned problems, in inventorying 'indirect support measures' in individual Member States we have not employed any particular definition of the concept, but rather made use of a variety of sources that are publicly available.

B Sources used for the inventory

Table 10 Sources used for the inventory

	Austria	Belgium	Germany	Denmark	Spain	Finland	France	Greece	Ireland	Italy	Nether-lands	Portugal	Sweden	UK
Agreed sources in Inception Report														
State Aid Register of the EU (including reports, surveys, decision lists)	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Annual Reports on State Aids of the member states	n.e.	n.e.	n.a.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.
Official registers of expenditure of the Central (national) govern-ments	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	√	n.a.	n.a.	n.a.
National budgets of the following ministries														
- Economic Affairs / Transport / Mining / Industry and Trade	√	√	√	√	√	√	√	√	√	√	√	√	√	√
- Finance	√	√	√	√	√	√	√	√	√	√	√	√	√	√
- Agriculture and Fishery	√	√	√	√	√	√	√	√	√	√	√	√	√	√
- Transport	√	√	√	√	√	√	√	√	√	√	√	√	√	√
- Environment	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Regional development companies (only those responsible for National policy)	√	√	√	n.a.	√	√	√	n.a.	n.a.	n.a.	√	√	n.a.	√
Institutions for transfer of national support measures	√	n.e.	√	n.e.	√	√	√	n.a.	n.e.	n.a.	√	n.e.	n.a.	√

n.e. = non-existent / not public

n.a. = not available

In the remainder of this annex we present the following information:

- the contacts within Ernst & Young that prepared or were consulted on the inventories of individual countries;
- government departments and other national institutes approached and contacts that furnished useful information for the respective inventories;
- printed sources used for the inventories.

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Institutes approached
Federal Department of Science; www.bmwa.gv.at
Federal Department of Transport, Innovation & Technology; www.bmvit.gv.at
Federal Department of Landuse, Forestry, Environment & Water Management; www.bmlf.gv.at
Chamber of Commerce; www.wk.or.at
Austrian Energy Agency; www.eva.wsr.ac.at
Austrian Industrial Research Promotion Fund (FFF); www.fff.co.at
ERP-Fonds; www.erp-fonds.gv.at
Bürges Förderungsbank Gesellschaft m.b.H.; www.buerges.com
Kommunalkredit Austria AG; www.kommunalkredit.at
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Belgium

Institutes approached

Department for the Flemish Community; www.vlaanderen.be
Department for the Brussels Region; www.parlbru.irisnet.be
Federal Department of Economics; www mineco.fgov.be
Institute for Innovation Science & Technology: www.iwt.be
Federal Office for Scientific, Technical and Cultural Affairs: www.belspo.be
Department of Transport & Infrastructure: www.vici.fgov.be
Department of Small enterprise, Trade and Agriculture: www.cmlag.fgov.be
Department of Finance: www.minfin.fgov.be
Department of the Walloon Region: http://gov.wallonie.be
Department of Equipment and Transport: http://met.wallonie.be
French Community in Belguim: http://www.cfwb.be

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Denmark
Department of Finance; www.fm.dk
Risö National Laboratory; www.risoe.dk
Department of Energy; www.energistyrelsen.dk
Department of Transport; www.trafikministeriet.dk
Danish Transport Council; www.transportraadet.dk
Department of the Environment; www.miljoeogenergiministeriet.dk
www.mem.dk/ukindex.htm
Danish Energy Agency: www.ens.dk
Department of Economics: www.oem.dk
Danish Environmental Protection Agency: www.mst.dk
Department of Trade and Industry:
http://www.erhvervsministeriet.dk

Finland

Institutes approached
Department of Finance: www.vn.fi/vm
Department of Transport & Communications: www.mintc.fi
Department of the Environment: www.vyh.fi/ym
Finnish Environment Institute: www.vyh.fi
National Agency for Nuclear Energy: www.posiva.fi
Department of Agriculture & Forestry: www.mmm.fi

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France

Institutes approached
Department of Industry: www.industrie.gouv.fr
Department of Public Works, Transport and Housing:
www.equipement.gouv.fr
Department of Economic Affairs and Finance: www.minefi.gouv.fr
Agency for the Environment & Energy Management: www.ademe.fr
Regional Department for Industry, Research & the Environment: www.drire.gouv.fr

Redevelopment Organisations, Sofirem, Sodie & Sofred

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Germany

Institutes approached
Federal Environmental Agency: www.umweltbundesamt.de
Federal Department of Transport, Housing and Building: www.bmvbw.de
Federal Department of Finance; www.bundesfinanzministerium.de
Federal Department of Economics and Technology: www.bmwi.de
Deutsche Ausgleichsbank; www.dta.de
Kreditanstalt für Wiederaufbau; www.kfw.de
Federal Ministry for Environment, Nature Conservation and Radiation Protection: www.bmu.de
Federal Office for Finance: www.bff-online.de
Federal Ministry of Consumer Protection, Food and Agriculture:
www.verbraucherministerium.de

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Greece

Institutes approached
Ministry for the Environment, Physical Planning and Public Works:
www.minenv.gr
www.greece.gr/ENVIRONMENT/

Contacts
Department of Development (Energy Division)
tel. 7482770 / 7793711

Department of Finance (Energy, Industry & Transportation Division)
tel. 3332282 / 3332825

Ireland

Institutes approached
Department of Finance; www.irlgov.ie/finance
Department of Public Enterprise; www.dpe.ie

Contacts
Department of Public Enterprise, Oil & Coal Division (data collection)
Tom Kennedy, tel. 353 1 604 1674, e-mail. TomKennedy@dpe.ie

Department of Public Enterprise, Renewable Energy Division (general information), Nualla Free, tel. 353 1 604 1677, e-mail. NuallaFree@dpe.ie

Department of Public Enterprise, Public Transport Division, EU-transport policy issues, Dave O'Donughue, tel. 353 1 604 1630, e-mail. davidodonaghue@dpe.ie

Italy

Institutes approached
Department of Industry, Commerce and Crafts (DG energy and coal resources), Tel. 06 47 88 78 16
Department of Budget/Treasury, Tel. 06 47 6 11
Department of Transport, Tel. 06 44 10 1
Department for the Co-ordination with the European Union,
Tel. 06 67 79 51 97
Department for the Environment, Tel. 06 57 22 1
Department of Agriculture and Forestry, Tel. 06 46 65 1
Service for the EU-Structural Funds, Tel. 06 44 57 57 1 / 06 44 57 57 2
Public Entity for Intervention and Incentives in Agricultural Markets, Tel. 06 49 49 91

Luxembourg

Institutes approached
Minstry of Finance: www.etat.lu/FI
Ministry of Economics: www.etat.lu/ECO
Ministry for the Environment: www.mev.etat.lu

Portugal

Institutes approached
Ministry of Finance: www.min-financas.pt
Ministry of Economics: www.min-economia.pt
General Directorate of Energy: www.dge.pt
Geological and Mining Institute: www.igm.pt
General Directorate of Land Transport: www.dgtt.pt
Institute for SME's and Investment: www.iapmei.pt

Spain

Institutes approached
Department of the Environment (General Directorate of National Conservation), Tel. +34 91 597 54 00
Department of Public Works (General Directorate of Railway and Road Transport), Tel. +34 91 597 70 91
General Subdepartment of Local Entities Economical Analysis, Tel. +34 91 586 10 00
National Institute for Natural Resources, Tel. +34 91 597 60 00
National Coal Institute, Tel. +34 985 511 90 90
Nuclear Safety Council, Tel. +34 91 346 01 00
Spanish Federation of Local & County Administrations, Tel. +34 91 364 37 00
Spanish Agricultural Guarantee Fund, Tel. +34 91 347 63 40
Energy, Environment and Technology Institute, Tel. +34 91 346 60 00
Diversifying and Energy Saving Institute, Tel. +34 91 456 49 00
Official Credit Institute, Tel. +34 900 121 121

Sweden

Institutes approached
Ministry of Agriculture: www.jordbruk.regeringen.se
Ministry of Industry, Employment and Communications: www.naring.regeringen.se
Ministry of Finance: www.finans.regeringen.se
Department of the Environment: miljo.regeringen.se
National Road Administration: www.vv.se
NationalRailway Administration: www.banverket.se
Civil Aviation Administration: www.lfv.se
National Maritime Administration: www.sjofartsverket.se
Swedish Environmental Protection Agency: www.environ.se
National Audit Office: www.rrv.se/net/rrv_master/rrv
National Board of Forestry: www.svo.se
Institute for Agricultural and Environmental Engineering: www.jti.slu.se
Council for Forestry and Agriculture Research: www.sjfr.se
National Nuclear Power Inspectorate: www.ski.se

UK

Institutes approached
Environment Agency: www.environment-agency.gov.uk
Department of Trade & Industry: www.dti.gov.uk
Department of Transport, Local Government & Regions: www.dtlr.gov.uk
National Environment Research Council: www.nerc.ac.uk
Financial Service Authority: www.fsa.gov.uk
Treasury Department: www.hm-treasury.gov.uk

General websites
- www.iea.org
- www.eureka.be
- www.europa.eu.int/comm/competition/state_aid
- www.novem.org

www.oecd.org/env

C Review of support measures potentially harmful to the environment

This annex contains a full list of support measures provided in EU Member States, as delineated inscope in section 1.3 of the main report and omitting those measures that are not potentially harmful to the environment, following the criteria in section 3.2.

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
AT	Subsidy funds for research activities of trade and industry (Austrian programme)	E	M	T	R&D support to trade and industry, research institutes, scientists, inventors, special partnerships, trade associations and joint ventures	Companies in trade and industry, research institutes, scientists, inventors, partnerships and associations	Different subsidies possible: non-refundable subsidy; Loan (2 years' grace for repayment of principal); assumption of liability; contribution to borrowing fees; combinations of above measures
AT	ERP loans (Austrian programme)	T			ERP-loans to transport sector to improve rail and inland waterway transportation (Loan amount: min. 100,000 ATS, at least 25% of total investment to be own funds. Credit period: 2 years' grace for repayment of principal)	Transport companies	
AT	Wirtschaftsförderung	E			Support for infrastructure, technology, innovation	Companies and energy-users	Project costs up to 25%
AT	Technologiefonds Kärnten	E			Support for technology, including energy and infrastructure	Companies and natural persons	Up to € 4,000 euro per project
AT	Niederösterreich: Gasförderung der EVN	E			Credit for switch-over to gas	Companies, government and private persons	Min. 20 % of the cost, up to € 11,000 per project
AT	Oberösterreich: energy contracting impulse programme	E			Support for infrastructure	Companies, government and private persons	Min. € 60,000, max. € 2.1 mln.
AT	Österreich: ERP-großprogramm für kombinierten güterverkehr	T			Support for combined transport	Transport and logistics enterprises	€ 726,728 Euro up to € 1.45 mln.
AT	Non-nuclear energy	E			R&D support	Companies	766
BE	Distribution centres for foreign companies	T			Support for transport and delivery to non-group members for account of members in integrated distribution systems	Large distribution centres for multinationals	Cost plus taxable profit after ruling
BE	Walloon plan for waterway transport	T			Support for fleet modernisation	Walloon maritime transport sector	21% of investments
BE	Walloon plan for waterwa transport	T			Support for ship-loading equipment	Walloon maritime transport sector	30% of investments
BE	Walloon plan for waterway transport	T			Support for ICT and electronics equipment	Walloon maritime transport sector	Maritime fleet. € 7,500 per vessel
BE	**Federal level**: Category 15 for a higher deductible tax level	E			Support to users of coal as energy source	Production of heat and power (exclusive of steam condensation)	Higher deductible tax level

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
BE	N 142 /2000 - AIDE D'ETAT AU TRANSPORT MARITIME	T			Support to the merchant service and dredging sector	Merchant service and dredging sector	3
DE	N156/2000 Navigation and marine technology	T			Development of new technologies for maritime industries	Hydrodynamics, information & communication systems and newer, bigger & better offshore-technology	44
DE	N110/2000 Aid to shipbuilding	T			To enhance the competitivenesss of the German shipbuilding industry	Shipbuilding yards	368
DE	"Verkehrsinfrastruktur" programme	T			Infrastructure programme in addition to the European Fund for Regional Development	10 predefined transeuropean networks	1,604
DE	C 63 /2000 - Bahntrans GmbH	T			Aid to road transport	Transport sector	Not available
DE	N 180 /2000 - NAVIGATION INTERIEURE - AIDE A LA FORMATION (2000-2003)	T			Aid to inland shipping	Inland shippers	6
DE	Shipbuilding C23/2001	T			Investment aid to Flender Werft Lubeck	Individual, specific	Not available
DE	Shipbuilding C6/2000	T			Excess payment for restructuring aid to Kvaerner Warnow Werft	Individual, specific	Not available
DE	Coal subsidies	M			To compensate the price difference between the cost of domestic coal production and world market coal prices	Domestic coal producers	358
DE	Airbus sales financing	T			To finance Airbus sales	Airbus	138
DE	Aviation research	T			To finance aviation research	Aviation sector	106
DE	Interest subsidies for shipbuilders	T			To enhance the competitiveness of the German shipbuilding industry	Shipbuilding yards	20

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
DE	Refund of fuel excise duty to farmers	E			To increase the competitiveness of German farmers in the EU market	Agricultural firms	448
DE	Adaptation of expenditure to the change in nuclear policy	N			Investments and budget for R&D to improve nuclear plants safety	Nuclear power plants	179
DE	Insurance coverage on behalf of nuclear generators [23]	N			To bear part-liability for the risk of severe nuclear accident, for which German nuclear generators are underinsured	Nuclear power plants	0.1 - 60
DE	"Energieforschung und –technologien" programme	E			Support to energy R&D programmes	R&D organisations RE producers Equipment/component manufacturers Government/general means	120
DE	Energy research	E			To secure long-term energy supplies	For enterprises with up to 50 employees and for non-commercial institutions	115
DE	Direct aid to the German coal industry	M			Federal aid as well as to Saar and North Rhine Westphalia to compensate the price difference between coal production costs world market prices	German coal industry	2,160
DK	Pilot studies to investment projects	E			Support to companies for evaluating energy efficiency programmes	Industrial enterprises and gardening companies (focus on SMEs)	57
DK	Energy examination and other forms of energy counselling	E			To identify scope for more effective use of energy resources	Industrial enterprises only	↑[24]
DK	Hiring of an employee focused on energy resources	E			To enhance company focus on energy resources	SMEs in industry, gardening and agriculture and other relevant organisations	↑
DK	Development projects	E			To promote development and implementation of new technologies and methods	Enterprises and organisations	↑
DK	Demonstration and market penetration	E			To show companies how to use energy resources more efficiently	Enterprises and organisations	↑

[23] This support measure is not taken from an official list, as it is an implicit support measure. The budget has been estimated by the researchers. It should be stressed that similar types of support might be provided in other Member States as well. However, it would be very time-consuming to calculate this support in other countries. This support is probably very small compared with that in the three countries mentioned here, as other countries have installed significantly less nuclear power.

[24] The budget is not divided further. This support measure and the four mentioned below, together make up for € 57 million.

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
DK	11) Information- and education activities	E			To spread information and knowledge about the energy sector	Enterprises, organisations, public administration and universities	↑
DK	Support programme to Eastern Europe	E			To support Danish enterprises in exporting knowledge and energy-saving products to the energy sector in Eastern Europe	Industrial enterprises	9
DK	Restructuring Aid to COMBUS A/S	T			To faciltate privatisation of COMBUS A/S	COMBUS A/S	22
DK	"Trafikpulje"	T			To promote coordination of various means of transport	Public sector	7
DK	N 441 /2000 - AIDE A LA FORMATION DES GENS DE MER	T			To improve maritime know-how in Denmark and develop maritime skills	Shipping companies	0.12
DK	Operation and maintenance of national roads	T			To maintain road infrastructure	The Road Directorate	252
DK	Grants to promotion of public transport	T			To promote public transport	Banestyrelsen and The Danish Railroads	70
DK	Airport investments	T			To modernise safety at the Copenhagen state-owned airport, through investments aid	Copenhagen Airport	99
DK	Airport investments	T			To modernise state-owned airports	Airports serving Greenland	3
DK	Operating and investment aid to rail operator	T			To improve the competitiveness of Danish Railroads	Danish Railroads	464
DK	Support to privately owned railroads	T			To provide country-wide public transport	Private railroad owners	Undefined
DK	Grants to investments in and operation of Danish harbours	T			To modernise Danish harbours	State-owned harbours	13
DK	Modernisation of the harbour and ferries connected to the island Bornholm	T			To enhance security after the accident of the ferry Estonia	The harbour and ferries of Bornholm	6
DK	Guarantee Fund for shipyards	T			To help shipyards financially	Danish shipyards	1
ES	National Energy Programme	E			To invest in energy projects.	Office of Scientific and Technology Policy (Ministry of Science and Technology)	Not available
ES	Support to power generators for coal transport	M			To promote consumption of Spanish coal by cutting transport costs from mines to power stations. The grant, by the National Coal Institute, varies from 723 to 1,919 ptas / tonne.	S. A. Hullera Vasco Leonesa	Total budget undefined
ES	Support to power generators for coal transport	M			To promote consumption of Spanish coal by cutting transport costs from mines to power stations. The grant varies from 723 to 1,919 ptas / tonne.	Coto minero del Sil, S.A.	Total budget undefined

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
ES	Support to power generators for coal transport	M			To promote consumption of Spanish coal by cutting transport costs from mines to power stations. The grant varies from 723 to 1,919 ptas / tonne.	Cuenca Mequinenza.	Total budget undefined
ES	Support to power generators for coal transport	M			To promote mining security and avoid mining accidents. 1. miners' training; 2. promotion of technical qualifications; 3. mining accident prevention.	State office for Economy	Total budget undefined
ES	National Mining Security Plan	M			To promote mining security and avoid mining accidents. 1. miners' training; 2. promotion of technical qualifications; 3. mining accident prevention.	State office for Economy	Total budget undefined
ES	National Aeronautic Programme	T			To support the Spanish aeronautic industry, facilitate its access to the international market and improve its technological know-how.	Office of Scientific and Technology Policy (Ministry of Science and Technology)	Not available
ES	National Transport and Country Planning Programme	T			To improve transport security and management of the sector.	Office of Scientific and Technology Policy (Ministry of Science and Technology)	Not available
ES	Grants related to Nuclear Safety and Radiological Protection	N			To carry out a programme aimed to improve nuclear safety and radiological protection.	Nuclear Safety Council	Not defined
ES	Valencia Electrification Plan	E			To expand and improve the electric power network in the Valencia Region	Comunidad Valenciana, Industry and Commerce Office	4
ES	Rural Electrical Infrastructure Programme	E			To improve the rural electrical infrastructure	Castilla Y Leon, Industry, Commerce and Tourism Office.	45% or 75% of overall costs
ES	Valencia Supply of Piped Gas Programme	E			To promote construction of natural gas infrastructure in underdeveloped towns	Regional Valencia Administration	52
ES	CANARIAS ENERGY PLAN	E			To support and promote third-party initiatives in energy R&D	CANARIAS, INDUSTRY AND ENERGY GENERAL OFFICE	1.2
ES	GRANTS TO RENOVATE ELECTRIC CABLING IN MADRID	E			To bury Madrid city's electric cables wherever possible.	MADRID, INDUSTRY, MINING AND ENERGY OFFICE	33% of overall costs
ES	GRANTS TO IMPROVE ENERGY INFRASTRUCTURE IN GALICIA	E			To promote rational use of the energy by industry and transport	GALICIA, INDUSTRY AND COMMERCE OFFICE	1

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
ES	GRANTS TO IMPROVE ENERGY INFRA-STRUCTURE IN GALICIA	E			To renovate the electric infrastructure	GALICIA, INDUSTRY AND COMMERCE OFFICE	0.43
ES	GRANTS TO IMPROVEENERGY INFRASTRUC-TURE IN GALICIA	E			To support investments in natural gas distribution to isolated towns	GALICIA, INDUSTRY AND COMMERCE OFFICEW	0.46
ES	GRANTS FOR ENERGY DISTRIBUTION AND COGENERATION IN RURAL TOWNS	E			To support tinvestments in cogeneration and of rural town electrification	ANDALUCIA, EMPLOYMENT AND INDUSTRY OF-FICE	10.2 (per project)
ES	GEOLOGICAL/MINING EXPLOITATION INCEN-TIVES	M			To promote use of locally mined coal	CASTILLA Y LEON. INDUSTRY, COMMERCE AND TOURISM OFFICE	Total budget undefined, 75% of overall project cost
ES	GRANT FORIMPROVEMENT OF MINING OP-ERATIONS	M			To support investments in geological exploration and contin-ued operation of mines	ANDALUCIA, EMPLOYMENT AND TECHNOLOGY DEVELOPMENT OFFICE	Max 0.1 max per recipient
ES	RESEARCH AND TECHNOLOGY DEVELOP-MENT FOR MINING INCENTIVES	M			To support mining research	CASTILLA Y LEON, INDUSTRY, COMMERCE AND TOURISM OFFICE	70% of overall project cost
ES	BUSINESS INNOVATION ENCOURAGEMENT IN MINING SECTOR	M			To encourage business innovation in the mining sector	GALICIA, INDUSTRY AND COMMERCE OFFICE	1
ES	GRANTS FOR MINING PROTECTION AND SAFETY	M			To promote mining safety	MURCIA, INDUSTRY, COMMERCE, TOURISM AND NEW TECHNOLOGIES OFFICE	0.15
ES	FINANCING OF CITY TRANSPORT	T			To providepublic transport access to all the towns of Navarra Commune.	NAVARRA, PUBLIC WORKS, TRANSPORT AND COMMUNICATIONS OFFICE	0.083
ES	GRANTS FOR PUBLIC TRANSPORT TRAINING	T			To modernise the public transport sector	NAVARRA PUBLIC WORKS, TRANSPORT AND COMMUNICATIONS OFFICE	1
ES	GRANTS FOR MODERNISING PUBLIC TRANS-PORT SECTOR IN NAVARRA	T			To modernise the public transport sector	NAVARRA PUBLIC WORKS, TRANSPORT AND COMMUNICATIONS OFFICE	0.36
ES	GRANTS FOR MODERNISING COMMUNICA-TIONS IN LA RIOJA	T			To modernise communications, e.g. computer systems, Internet connections	LA RIOJA, ECONOMIC DEVELOPMENT AGENCY	Not defined
ES	GRANTS FOR ISLAND TRANSPORT	T			To co-finance the charter of maritime and air transport be-tween the various islands of the archipelago	CANARIAS, TOURISM AND TRANSPORT OFFICE	1

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
ES	GRANTS FOR PROMOTING TRANSPORT SECTOR RESTRUCTURING	T			To promote associations and mergers of transport companies and improvements to their computer and other technology	CANARIAS, TOURISM AND TRANSPORT OFFICE	0.12
ES	GRANTS FOR MARITIME PASSENGER TRANSPORT	T			To reduce the adverse impact of particular islands' location	CANARIAS, TOURISM AND TRANSPORT OFFICE	8
ES	GRANTS FOR UPGRADING PUBLIC TRANSPORT VEHICLES	T			To upgrade public transport vehicles	CASTILLA LA MANCHA. ROAD AND TRANSPORT OFFICE	0.02 for new vehicles, 0.07 for operational vehicles
ES	GRANTS FOR PUBLIC PASSENGER TRANSPORT BECAUSE OF PRICING REDUCTION	T			To compensate price cuts designed to benefit large families	LA RIOJA, PUBLIC WORKS, TRANSPORT, TOWN PLANNING AND HOUSING OFFICE	Not defined
ES	GRANTS FOR OVERDRAWN PUBLIC TRANSPORT OPERATIONS	T			Grants to companies with overdrawn operations	LA RIOJA, PUBLIC WORKS, TRANSPORT, TOWN PLANNING AND HOUSING OFFICE	Not defined
ES	LOANS TO RENEW PUBLIC TRANSPORT VEHICLES	T			To renew public transport vehicles	CASTILLA LA MANCHA, PUBLIC WORKS OFFICE	Not defined
ES	Shipbuilding N757/2000	T			To modify the existing aid regime	Sectoral	10
ES	Shipbuilding C40/2000	T			To further restructure publicly owned shipyards in Spain	Sectoral	45 price compensation
ES	Nuclear Safety/Radiological Protection	N			Grant from National Spanish Budget	Nuclear sector	0.1
ES	Promotion of Road Transport	T			Grant from National Spanish Budget	Road transport sector	1
ES	Promotion of Maritime Transport	T			Grant from National Spanish Budget	Maritime transport sectpor	0
ES	Promotion of Air Transport	T			Grant from National Spanish Budget	Air transport sector	0
ES	Promotion of Road Transport	T			Grant from Ministry of Public Works for national road infrastructure and safety programmes and (truck) driver training; projects defined and identified by this ministry	Transport companies, public works companies	786
ES	Promotion of Sea Transport	T			Grant from Ministry of Public Works budget	Maritime transport sector	30
ES	Promotion of Air Transport	T			Grant from Ministry of Public Works budget	Air transport sector	153
ES	C22/2001 Support for agriculture	E			Support measure, tax deduction and interest-free loans for agricultural enterprisess to compensate the high price of diesel (gasoil)	Agricultural enterprises	Total not defined, € 207 mln. for loans
ES	Alternative development of coal-mining towns	M			Grant from National Spanish Budget	Spanish coal industry	0
ES	Mining exploitation	M			Grant from National Spanish Budget	Spanish coal industry	1
ES	Energy	E			Grant from National Spanish Budget		0

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
FI	N53/2000 Transport aid	T			Aid for regional long-distance road transport within Finland in remote regions with a low population density	Transport enterprises	Annual appropriation reserved in government budget
FI	N 33 /2000 - MESURES DANS LE SECTEUR DES TRANSPORTS MARITIMES	T			To promote the use of maritime transport	Every ship that is registered in Finland and sails under the Finish flag	3
FI	N531/2000 Contract-related aid to shipbuilding	T			To refit ships with automatic hydraulic systems	Shipyards	Not available
FI	Selective newspaper subsidy	T			To reduce newspaper transport, delivery and other costs	Newspapers	5
FI	Support to Posiva Oy	N			Support to Posiva Oy for management and storage of the nuclear waste of the two owners (Teollisuuden Voima Oy, Fortum Power and Heat), as well as related R&D.	Posiva Oy	8
FI	Finnish National R&D programme on Transport Telematics Infrastructure 1998-2000	T			To promote multi-modal and interoperable services and systems	Government agencies, companies, R&D institutes, collaborations	10
FI	KETJU - International Transport Chains	T			To increase Finnish kKnow-How on international transportation chains	collaboration of members of transport chain	6
FI	ProMOTOR	E			To support industrial development of internal combustion engine-related products	Research institutes, companies, governments	
FI	FFUSION 2: Fusion Energy Research Programme 1999-2002	N			To promote research on fusion plasma, reactor materials, superconductors, remote handling and reactor monitoring systems	Research institutes, SME-companies, universities, polytechnics	15
FI	KESTO technology	E			To improve the international competitiveness of companies and reduce energy generation costs	Finnish companies manufacturing equipment for the energy industry	10
FI	N 856 /2000 – REMBOURSEMENT AUX ARMATEURS DES QOUTISATIONS SOCIALES PATRONALES	T			Aid to the maritime sector	Maritime sector	16
FI	Shipbuilding	T			Contract-related operating aid	Sectoral	
FR	N564/2000	T			Aid for air transport	Small air transporters	1

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
FR	N593/2000 Refund of social security premiums to maritime carriers	T			To improve the global competitiveness of French maritime carriers	Carriers based entirely or partly in France and paying taxes there	15.2
FR	N540/2000 Extension of Autoroute concessions	T			To perform construction work and provide services	Motorway concession market	6
FR	C25/2001 Measures in favour of road transport	T			To compensate road hauliers for higher petrol prices	Road hauliers	Not available
FR	N 766/2000 – France Remboursement des contri-butions sociales patronales aux entreprises	T			To improve the global competitivenessof the maritime carri-ers	French maritime sector	33
FR	N 639 /2000 - DESSERTE AERIENNE DE LA CORSE – LYON	T			Not available	Not available	Not available
FR	N 638 /2000 - DESSERTE AERIENNE DE LA CORSE – MONTPELLIER	T			To promote public transport use by several categories of passenger	Several categories of passenger	2
FR	C 14 /2001 - Aide à la société Nationale Maritime Corse-Méditerannée	T			Aid to the maritime sector	Maritime sector in the Mediterranean	Not available
FR	C 65 /2000 - AIDE AU DEMARRAGE DE LIGNES DE TRANSPORT MARITIME	T			Aid to the maritime sector	Not available	Not available
FR	N 24 /2000 - DESSERTE AERIENNE DE LA CORSE	T			Transport subsidy for several categories of passenger	Passengers from Corsica younger than 25 or older than 60, students under 27, and passengers travelling with children	23
FR	NN 122 /2000 – SERNAM	T			Restructuring aid for Sernam	Sernam	448
FR	Subsidies to enterprises of national interest	T			To promote use of short-distance public transport through subsidies for employees of major French companies	Employees of French companies	913
FR	Aid for air construction	T			Support for development of the Airbus A340-500/600 and AXXX	Airbus	503
FR	Investment subsidies	E			To secure energy supplies, reduce environmental impacts of energy use and maintain a low-cost energy supply, through regulations on the following 4 goals:	Enterprises in general; central and local authorities and CEA	101,.3 in all; see 4 regulations below

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
	Actions concourant à la maîtrise de l'énergie	E			To continue actions to promote the rational use of energy resources and to develop and diversify renewable energy production and consumption	Enterprises in general	20
	Energie et matières premières. Cooperation internationale	E			To support sustainable technologies and business operations through of international cooperation	Central and local authorities	1.3
	Fonds de soutien aux hydrocarbures	E			To support operation and development of hydrocarbon refinement	Enterprises	23
FR	Commissariat à l'énergie atomique[25]	N			To support R&D in the following fields: optimising existing facilities waste management and environmental control design of new nuclear systems fundamental research	CEA, the French Atomic Energy Commission	518
FR	Exploitation subsidies for BAAC - Civil Aviation Budget	T			State civil aviation budget for safety-related programmes, e.g. technical inspections, certification, investment in infrastructure and training	Companies and governments executing BAAC programmes	32
FR	Subsidies to enterprises of national interest	T			Support to railway companies for improving the rail network and reducing aggregate corporate debt	French railway companies	2,707
FR	N88/2001 Remboursement aux enterprises maritimes des cotisations d'allocations familiales et assedic	T			To improve the global competitiveness of French maritime carriers	French maritime sector	23
FR	Investment subsidy	T			Support to regional transport	Transport sector	4
FR	Investment subsidy	T			To improve freight transport productivity	Freight transport sector	4
FR	Investment subsidy	T			Support to waterways and inland ports	Maritime sector	4
FR	Investment subsidy	T			To modernise transport infrastructure	Transport sector	4
FR	Investment subsidy	T			Support to land transport R&D	Land transport sector	1.5
FR	Assistance et solidarity	T			Support to Paris public transport system	Paris transport sector	823
FR	Assistance et solidarity	T			Support to public transport	Public transport sector	296

[25] This measure probably contains a share of support for national research and military programmes not to be deemed support to the nuclear power sector.

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
FR	Exploitation subsidies	T			Support to civil aviation R&D	Civil aviation sector	217
FR	Subsidies and financial participation for studies, projects and investments	T			Support to ETW wind tunnel		0
FR	Subsidies and financial participation for studies, projects and investments	T			Subsidies to various organisations		3
FR	Investment subsidy	T			Support to a flight simulator		14
FR	Donation to the agency for geological and mining research (BRGM)	M			Support to BRGM for industrial site rehabilitation, waste management, waste storage improvement and implementation of alternatives	BRGM	55
FR	Donation to Charbonnages de France	M			Charbonnages de France was created in 1946 by the Nationalisation law, with the objective of exploiting French coalfields. This exploitation will stop in 2005, within the framework of the coal pact.	French coal industry	433
FR	Fonds de conours	T			To improve traffic safety	Transport sector and others	13
FR	Investment subsidy	T			Support to national roadways	National road-building sector	15
FR	Investment subsidy	T			Individual actions	Individual actors	10
FR	Investment subsidy	T			Subsidies to local and national associations and other local organisations	Local and national associations	56
FR	Insurance coverage on behalf of nuclear generators[26]	N			To bear part-liability for the risk of severe nuclear accident, for which French nuclear generators are underinsured	Nuclear power plants	0.1 - 120
GR	Aid for Athens public transport	T			To replace old buses	Athens Public Transport	107
GR	N788/2000 shipbuilding aid scheme	T			Support for ailing rshipyards	Shipyards	Not available
GR	N541/2000 Olympic Airways state aid decision	T			To relocate Olympic Airways	Olympic Airways	206
GR	Retex programme	T			To promote SME exports	SME	
GR	Public transport scheme	T			To replace old buses	Athens public transport	195

[26] This support measure is not taken from an official list, as it is an implicit support measure. The budget has been estimated by the researchers. It should be stressed that similar types of support might be provided in other Member States as well. However, it would be very time-consuming to calculate this support in other countries. This support is probably very small compared with that in the three countries mentioned here, as other countries have installed significantly less nuclear power.

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
GR	Public transport scheme	T			To support the rail system	Greek rail operators	106
GR	Aid for the Greek electricity company	E			To support an underwater power cable connecting Greece and Italy	Greek electricity company	25
GR	Aid for the Ipiros mining industry	M			To promote the Iprios mining industry	Ipiros mining industry	1.027
GR	Grants for quartz mining	M			To promote quartz mining	ALBAQUARTZ SHRK	0.055
GR	Shipbuilding aid	T			To modernise a ship interior	Express SANTORI Shipping Company	0,38
GR	Shipbuilding aid	T			To modernise and improve a ship interior	LASHITI Shipping Company	0.1
IE	Regional Airports	T			(National Development Plan)	The six Regional Airports in Ireland	13
IE	Public Transport	T			(Annual programme subject to Government approval)	Córas Iompair Éireann (A state company who provide bus, rail and ancillary services throughout the country) Note 1	189
IE	Public transport system in the Greater Dublin Area	T			(National Development Plan)	Córas Iompair Éireann	2
IE	Regional Public Transport Programme	T			(National Development Plan)	Córas Iompair Éireann	823
IE	Investment aid	T			Ianród Éireann rail investment	Rail transport company	582
IE	Investment aid	T			Rail safety programme	Rail transport company	548
IE	Investment aid	T			Bus Éireann	Transport company	145
IT	Law 488/92 ob.1 – Industry	T			Investments in less developed/depressed areas of southern Italy: restructuring, reconversion, reactivation and – reloca-tion of production unitst	Extraction and manufacturing industries	Dependent on annual availability ofgovernment funds
IT	Law 488/92 ob.1 – Industry	M			Investments in less developed/depressed areas of southern Italy: restructuring, reconversion, reactivation and relocation of production units	Power, steam and water production and distribution sector	Grants cover de facto only 1/3 of the requests coming form the enterprises
IT	Law 488/92 ob.2 – Industry	T			Investments in areas of central northern Italy: restructuring, reconversion, reactivation and relocaation of production units	Extraction and manufacturing industry	Dependent on annual availability of government funds

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
IT	Law 488/92 ob.2 – Industry	M			Investments in areas of central northern Italy: restructuring, reconversion, reactivation and delocalisation of production units	Power, steam and water production and distribution sector	Grants cover de facto only 1/3 of company applications
IT	Law 341/95	T			Fixed investments in e.g. new machinery and manufacturing plant and modernisation, expansion and restructuring of existing plant	Extraction and manufacturing industries	Tax reduction according to investment location and company size (small, medium, large)
IT	Law 341/96	M			Fixed investments in e.g. , new machinery and manufacturing plant and modernisation, expansion and restructuring of existing plant	Power, steam and water production and distribution sector	Tax reduction according to investment location and company size (small, medium, large)
IT	Law 388/2000, Art. 8	T			Investments in new capital goods, material or intangible assets	To support companies investing in capital goods in the southern (ob.1) or central -northern depressed areas (ob.2) of Italy	Tax credit in compensation for other company taxes
IT	Law 140/97 Art.13 - R&D	T			Investments for innovation in industrial enterprises	Enterprises carrying out industrial activities	Grants according to enterprise location and size
IT	Law 1329/65 - "Sabatini"	E			To encourage investments in new machinery	Transport-related SME	Reduction of interest paid on loans or leasing costs
IT	N502/2000 - Shipbuilding aid	T			To promote modernisation of the Italian fleet	Shipyards	10
IT	N733/2000	T			To support new qualifications for the taxi industry	Taxis	Not available
IT	N292/2000 - Aid to road transport sector	T			To compensate for higher petrol prices	Sectoral	0.1
IT	N58/2000 - Promotion of integrated airport systems	T			To integrate three airports in the Piemonte region: infrastructure and portal systems	Three airports in the Piemonte region	9
IT	C24/2001 - Aid to road transport	T			Tax –aid/reduction for road haulierss to compensate for higher petrol prices	Road hauliers	Not available
IT	C42/2000	T			To support cableways in the province of Bolzano	Cableway installations in the province of Bolzano	Not available
IT	C 13/2000 - Environmental aid to ECSC steel companies	E			To support CSC steel companies	ECSC steel companies	0.141
NL	Subsidieregeling voor openbare inlandterminals	T			To encourage transport modal shift (road - waterway)	Transport companies	8

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
NL	Subsidieregeling kennisprojecten verkeer en vervoer (ICES / KISS)	T			Support to transport sector for R&D on congestion and other traffic issues	Companies	26
NL	Investeringssubsidie NLR, Stb. 1995, 105	T			Support for fundamental aviation research to improve secto-ral competitiveness	NLR	5
NL	Exploitatiebijdrage luchthavens Eelde, Texel, Maastricht en Twente	T			Operational support to regional airports to maintain airport operability of	Region A	2
NL	Bijdrage LVB-exploitatie regionale luchthavens en vrijgestelde vluchten, Stb. 1992, 368	T			To improve aviation safety and performance	LVB	7
NL	Bijdrage Koninklijke Nederlandse Vereniging voor Luchtvaart (KNVvL) Overeenkomst	T			Support for executing government tasks	KNVvL	1
NL	Bijdrage aan de Zoute Vereen (Pas 65+)	T			Operational support to Wadden Sea ferries	Wadden Sea ferries	0
NL	Bijdrage aan Provincie Zeeland in de exploitatie-kosten veerdiensten Westerschelde, Stb. 1991, 255 art.3	T			Operational support to Westerschelde ferries	Zeeland province	24
NL	Centrum voor Regelgeving en Onderzoek in grond-, weg- en waterbouw en verkeerstechniek (CROW)	T			Support toroad, waterway and soil engineering R&D	CROW	0
NL	Exploitatiesubsidie NLR, Stb. 1995, 105	T			Support tofundamental aviation research to improve sectoral competitiveness	NLR	17
NL	Bijdragen primaire waterwegen provincies Fries-land en Groningen	T			Support for waterway maintenance	Primarily waterways in Groningen and Friesland provinces	13
NL	Bijdragen infrastructuur OV; Wet en Besluit Infra-fonds	T			To improve public transport infrastructure	Provincial andlocal authorities	933
NL	Bijdragen infrastructuur OV; Wet en Besluit Infra-fonds	T			To improve public transport infrastructure	Provincial and local authorities	543
NL	Bijdragen infrastructuur OV; Wet en Besluit Infra-fonds	T			To improve public transport infrastructure	Provincial and local authorities	522
NL	Bijdragen infrastructuur OV; Wet en Besluit Infra-fonds	T			To improve public transport infrastructure	Provincial and local authorities	401
NL	Gebundelde Doeluitkering (GDU); Wet en Besluit Infrafonds	T			To improve transport infrastructure	Provincial and local authorities	161

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
NL	Bijdrageregeling exploitatie OV; Wet en Besluit Personenvervoer; Ministeriële regeling; Stcrt. 1992 251/252/253	T			Support to public authorities for public transport operations	Provincial and local authorities	1.006
NL	Subsidieregeling De Boer; Ministeriële regeling; Stcrt. 1996, 66	T			Support to public authorities for extra investments in local public transport	Provincial and local authorities	56
NL	Stimulering OV; Wet en Besluit Personenvervoer; Stcrt. 1992, 251/252/253	T			Support to public authorities or extra investments in local public transport	Provincial and local authorities, public transport own-ers	1
NL	Spoorwegaansluitingen, Stcrt. Nr. 245 1994	T			To improve rail access for employees	Companies	5
NL	Vaarwegaansluitingen; DGV/G3/V-525119 01-10-1996	T			To stimulate waterway access	Companies near waterways	6
NL	Regionale terminals; regeling SOIT	T			To stimulate regional transfer points	Transfer companies	2
NL	Bijdrage Binnenvaart Nederland; DGG/S/99000423, 15-01-1999 & DGG/S/98006415, 01-07-1998	T			To improve the competitiveness of Dutch inland shipping	St. Binnenvaart Ned.	0
NL	Nieuwe toetreders spoor; DGV/WJZ/V-325.664, 1-1-1995	T			To stimulate new rail transport operators	New rail companies	1
NL	Nederlands Instituut voor Maritiem Onderzoek (NIM); brief feb. '95 van EZ namens V&W, DEF, OCW en FIN	T			To cocoordinate maritime R&D	NIM	0
NL	Nederland Distributie Land (NDL);	T			To improve the competitiveness of Dutch inland shipping services and associated service companies	Shipping service companies	0
NL	Bijdrage aan haveninterne projecten	T			To stimulate regional investments in and sustainable devel-opment of harbour areas	Dutch sea harbour owners	11
NL	Besluit subsidies zeescheepsnieuwbouw 1994, 1994, 437, 1995, 309, 1997, 618	T			To maintain shipbuilding capacity	Shipbuilding companies	32
NL	Energieonderzoek door Energie Centrum Neder-land (=ECN)	E			To acquire g fundamental knowledge and experience in several energy technology fields, incl. nuclear	ECN	29
NL	Internationale ruimtevaartprogramma's	T			To enhance Dutch industrial know-how through participation in international space projects	ESA and NIVR	57
NL	C 26 /2001 - Refund of fuel excise duty to road freight carriers	T			To compensate road hauliers for fuel price rises through a tax refund	Road freight carriers	

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
NL	Regeling subsidie tankstations grensstreek Duitsland	T			To compensate petrol stations near the German border	Petrol stations nearthe border	5
NL	Shipbuilding N244/2000	T			Development aid to a Sri Lankan company to buy 1 dredger in Holland	Individual	3
NL	Shipbuilding N232/2000	T			Development aid to a Bangladesh company to buy 1 tug ship	Individual	1.27
NL	Shipbuilding N230/2000	T			Development aid to a Syrian company to buy 2 tug ships	Individual	3.5
NL	Shipbuilding N151/2000	T			Sectoral aid scheme	Maritime sector	77.1
NL	Shipbuilding C6/2001	T			Development aid to a Djibouti company to buy 1 remorqueur	Individual	Not available
NL	Shipbuilding C12/2000	T			Development aid to china	Individual	72,.6
NL	Shipbuilding C3/2000	T			Development aid to Indonesia	Individual	13.6
NL	Technologische Samenwerkingsprojecten	E			To support industrial technology partnerships, incl. renewable energy (RE)	R&D organisations RE producersEquipment/component manufacturers Government/general means	60
NL	TOK, Besluit Technisch OntwikkelingsKrediet	E			To stimulate technology not yet applied in the Netherlands, incl. renewable energy (RE)	Biomass producers R&D organisations RE producers Equipment/component manufacturers RE distributors Government/general means	38
PO	N 336 /2000 - Capital support to airline company	T			To assist the Portuguese airline company Transportes Aëreos Portugueses SA financially during privatisation	TAP airline	11.4
SE	Grant to Swedish shipping	T			To support the Swedish shipping industry	Swedish shipping companies/ship owners	54

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
SE	Guarantee to shipbuilding	T			To support Swedish shipyards	Swedish and foreign shipping companies	Unclear
SE	Regional transport grant	T			To compensate the cost disadvantages of long-distance transportation	Companies	37
SE	Research grants	T			Six (for 2001) subsidy programmes to support transportation development	Competent universities and institutes	1
SE	Research grants	E			About 30 programmes to support development of new energy technologies	All competent sectors	0
UK	N687/2000 Innovative solutions in rail-based logistics	T			To raise awareness and disseminate new ideas for the wider freight market and encourage logistics to build on these new ideas and increase their use of rail	Projects confined to rail-track network	10
UK	Nuclear support of the UK government[27]	N			Nuclear support to the former Soviet Union	Former Soviet Union	6
UK	Nuclear support of the UK government[28]	N			Support to the Nuclear Energy Agency	Nuclear Energy Agency, subscriptions, fusion, other	33
UK	OG competitiveness offshore	T			Support to improve competitiveness of the offshore industry	Offshore industry	12
UK	Offshore geology	E			Support to offshore geology	Offshore industry	6
UK	SHARP	E				SHARP	20
UK	UNCLOS (United Nations Convention on the Law of the Sea)	E			To protect the waterways from pollution	Member States of the United Nations	2
UK	Other expenditures on non-nuclear energy	E					23
UK	Insurance coverage on behalf of nuclear generators[29]	N			To bear part-liability for the risk of severe nuclear accident, for which British nuclear generators are underinsured	Nuclear power plants	0,1 - 30
UK	Transport 2010: 10-year plan comprising the following 5 programmes:	T			To deliver a quicker, safer, more punctual and environmentally benign transport system	Transport companies in the UK	297

27 It is expected that similar payments are made by other Member States. However, these payments were not cited in the official sources on which our inventory was based.

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29 This support measure is not taken from an official list, as it is an implicit support measure. The budget has been estimated by the researchers. It should be stressed that similar types of support might be provided in other Member States as well. However, it would be very time-consuming to calculate this support in other countries. This support is probably very small compared with that in the three countries mentioned here, as other countries have installed significantly less nuclear power.

EU Member State	Subsidy programme	Theme			Goal	Target group	Annual budget (€ million)
	Rail transport	T			To achieve a 50% increase in rail passengers and 80% growth in rail freight	Railway companies	99
	Local transport	T			To reduce congestion and improve public transport	Rural areas, towns and cities	97
	London transport	T			To transform the London Underground and improve commuter rail services	London	41
	Strategic roads	T			To deliver a quicker, safer, more punctual and environmentally benign transport system	Transport companies in the UK	35
	Future projects and other transport areas	T			To deliver a quicker, safer, more punctual and environmentally benign transport system in the future	Transport companies in the UK	25

D Germany - coal production

D.1 Description of the support measure

Direct state aid to the German coal industry totalled around € 4.7 billion (DEM 9.2 billion) in 2000, as reported in [EC, 2001a]. This aid is in accordance with the community guidelines laid down for state aid to the coal industry in the European Commission's Decision No. 3632/93/ECSC [EC, 1993]. The aims of this aid, also described in this document, are thus also valid for the specific aid given to the German coal industry:

- to make, in the light of coal prices on international markets, further progress towards economic viability with the aim of achieving degression of aid;
- to solve the social and regional problems created by total or partial reductions in the activity of production units;
- to help the coal industry adjust to environmental protection standards.

The aid, totalling € 4.7 billion in 2000, is divided over the following financial measures [EC, 2001a]:

- operating aid, totalling € 2.0 billion (DEM 3,847 million);
- aid for the reduction of activity, totalling € 1.6 billion (DEM 3,138 million);
- aid to maintain an underground labour force, totalling € 36 million (DEM 71 million);
- aid to cover exceptional costs, totalling € 1.1 billion (DEM 2,124 million).

Aid to German coal producers has declined over the past decade and will continue to do so following three decisions[30].
In the following section, we briefly outline the mechanisms that might come into play if this support were removed. The resultant environmental impact and socio-economic effects are subsequently calculated.

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[30] More specifically, a national German agreement and a European Commission proposal and decision. As these provide a perspective on the current support (i.e. for the year 2000), we shall briefly describe them here.

Domestic agreement on support to coal industry

In 1997 the Federal government, the State governments of North-Rhine-Westphalia and Saarland, coal producers and trade union federations for mining and power production reached an agreement on new guidelines for the German coal industry for the period 1998 to 2000. Under this agreement, aid to coal mining will fall to DEM 5.5 billion (€ 2.8 billion) in 2005.

However, in its Decision 1999/270, the Commission has so far only approved the various measures (on modernisation, rationalisation, restructuring and reduction of activities) up to 2002, more specifically the date of expiry (23 July 2002) of the ECSC Treaty and of Decision No 3632/93/ECSC.

Proposal for a Council Regulation on State Aid to the coal industry

In July 2001 the European Commission set out new proposals concerning state aid to the coal industry [EC, 2001b]. Under these proposals German aid would fall to € 2.8 billion in 2005, which does not differ greatly from the domestic agreements of 1997. The € 2.8 billion does not represent a formal approval; the proposal merely sets out the conditions for future aid to the coal sector.

Commission decision of 2 October 2001 on German aid to the coal industry for the period from 1 January 2002 to 23 July 2002 (Official Journal L 056, 27/02/2002 P.0027 – 0031).

D.2 Mechanisms

Removing state aid to German coal mines would lead, *ceteris paribus*, to an increase in the price of German coal. This might lead to a phasing out of coal production in Germany, as production costs are relatively high in this country[31].

As German coal prices increase, demand for German coal will decrease. This may lead to imports of cheaper coal, or a switch to other fuels if these are cheaper.

Increased imports by Germany may tend to raise coal prices on the world market. One possible mechanism is increased supply by other coal producers. Alternatively, the world market price of coal may increase, leading to lower global demand or greater use of other fuels, such as natural gas, than would otherwise be the case.

Environmental benefits of removing domestic support to German coal producers might thus accrue through effects on the fuel mix and through reductions in final energy demand. Either or both effects might occur in Germany as well as in other countries (due to a possible rise in the world coal price).

D.3 Environmental impact

In this section we examine the environmental impact of the support measure relative to the situation without it. First we discuss the demarcation of this analysis and the assumptions on which it is based. We subsequently present the research method and results.

D.3.1 Demarcation

The first limitation of scope is the amount of support we consider. As set out in section D.1, support to German coal mining is divided over four different measures. Here we shall consider these measures together, as if they were one.

Secondly, our analysis will be restricted to operating aid only[32]. The reason for this is a Commission Decision stating that the amount of aid given "may not cause delivered prices for Community coal to be lower than those for coal of a similar quality of third countries". This implies that the aid provided

31 Another option would be substantial technological development to cut production costs, to make the German coal sector internationally competitive. However, [EC, 2001b] states that the objective of a Community coal industry that is commercially competitive on international markets is out of reach once and for all, despite substantial efforts by mining companies to improve productivity, both technologically and organisationally.

32 Given the total coal production in Germany, 39,621 million tce in 2000 (*Statistisches Bundesamt*, 2000), and the difference between production costs in Germany and world market prices, € 96 per tonne of coal equivalent (see paragraph on results), the aid under consideration is equal to € 3.8 billion. This figure differs from the figure of € 4.8 billion (see D 1) cited as operating aid in [EC, 2001]. This difference can be explained from differences in the definition of production costs. The cost of producing one tonne of coal equivalent is difficult to establish and largely determines the amount of operating aid. From personal communication with the German Federal Ministry of Economic Affairs on this topic, we understood that the operating aid we have calculated covers the aid granted under the four articles in [EC, 1993].

on top of the operating aid does not alter the competitive position of German coal relative to coal from third countries, at least in terms of prices. The remaining aid is not linked to current production and we therefore expect no additional environmental impact[33].

Thirdly, we confine ourselves to quantitative estimates of CO_2-emissions, NO_x-emissions, SO_2-emissions and emissions of fine particulates. Effects on landscape and biodiversity will be discussed in qualitative terms.

Although it appears that German domestic coal production (about 33 Mt in 2000) would not be difficult to absorb in global production, it would be a significant shock to the international coal market, where the total volume of hard coal trade was 574 Mt in 2000[34]. The resulting changes in world coal demand and the world price depend upon what assumptions are made about coal trade. Based on the analyses of Light (1999) and Welsch (1998), we assume that in the short run, following removal of support, producers with excess capacity (US as 'swing supplier') will divert domestic production to the export market, softening price increases.

An important final demarcation is that we have not considered the impact of the support on technological development, either within the coal mining sector or elsewhere. The support provides no incentive to seek opportunities to improve underground mining technologies and, more importantly, it narrows opportunities for developing clean fuels. Given the complexity of supply-side dynamics, these effects are generally difficult to estimate and were beyond the scope of the present project.

D.3.2 Method

To calculate the estimated environmental impact of removing support to German coal producers a three-step procedure was followed:

1 Determine how much the price of German coal will increase after full removal of support.
2 Estimate the extent to which rising world market coal prices lead to changes in fuel mix and reduction of global energy demand.
3 Calculate the resulting environmental impact due to a change in consumption of coal and other fuels such as imported coals and renewable energy in Germany and the rest of the world.

D.3.3 Results: environmental impact

Impact on coal price and fuel mix
The starting point of the analysis is the coal price increase to be expected in the absence of support. Article 3 of [EC, 2001a] indicates that the support to the German coal industry under the heading of operating aid is such that the price of domestically produced coal is equal to the price of imported coal. In 2000 production costs were around € 138 (DEM 270)[35] per tonne coal

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33 Economic efficiency might increase, however, by confronting the coal mine operators with all their business risks and accompanying costs.

34 IEA Statistics (2001), Coal Information 2001.

35 Personal communication, Federal Ministry for the Environment, Nature conservation and nuclear safety. Estimated production costs are in the range given in [EC, 2001A]: production costs should fall from DEM 288 per tce in 1992 to DEM 242 per tce in 2002. Import prices fluctuated in 2000, as can be seen from [EC, 2001c]. The import price for steam coal rose from DEM 70 per tce to a little over DEM 90 per tce (figure 2.5.3. of [EC, 2001c]).

equivalent (tce) in Germany, while the price of imported coal was between € 41 (DEM 80) and € 46 (DEM 90) per tce [EC, 2001a]. Precise figures on the production costs are difficult to establish[36], but the estimates presented here give a good indication of the price difference between German coal and imported coal.

Given the price difference between German and imported coal and the amount of German coal under support, we see that the support necessary to close this gap is equal to 39.6 million tce times € 96[37]. This amounts to € 3.8 billion[38].

Removal of this € 3.8 billion financial aid to the German coal industry would push up the price of German coal by approximately 200%, from € 43.5 (average of DEM 80 and DEM 90) to € 138 (DEM 270) per tce. This is the price difference between the German cost of production and the price of imported coal per tonne of coal equivalent.

This price increase will affect the mix of fuels used in Germany. More specifically, it may lead to imports of cheaper coal or a switch to other fuels if these are cheaper (see also [OECD, 1997]).

In the current situation, i.e. with financial aid to the German coal industry, there is demand for a certain amount of hard coal in Germany. This demand is based on the price, which is equal to the price of imported coal, as a direct consequence of the formulation of Article 3 in [EC, 2001a]. Given this price, German energy consumers have chosen the currently prevailing fuel mix.

Generally speaking, the situation after support removal would not change the price of coal, because import coal is available at the same price. This means that aid removal will lead only to a substitution: from German coal to import coal. This is also the conclusion of [Meyer, 2001].
In [DRI, 1997] the power generating costs of different energy options are calculated and existing coal-fired power plants are shown to be competitive with gas-fired plants. Although the latter type of plant might gain an edge if current German generating capacity became inadequate, this will only be of very slight influence in the coming years [DRI, 1997].

This implies no change in the domestic German situation: the current fuel mix will remain unchanged, but with German coal substituted by imported coal.

Environmental impact
To calculate the environmental effects of this shift from German to imported coal we distinguish three factors:
1 There might be changes in NO_x and SO_2-emissions per tonne of coal equivalent due to quality differences between German and imported coal.

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36 Personal communication, IEA Coal Research.

37 Calculated as the average difference between production cost (DEM 270) and import price (average of 80 DEM and 90 DEM is DEM 85).

38 This amount is lower than the total amount of support mentioned in section D.1. Personal communication with the Federal Ministry of Economics has led us to conclude that this difference can be explained from the definition of production costs. The production cost of € 138 includes support to both mines that will remain open and those that will close down in the foreseeable future. Production cost figures also include part of the inherited liabilities of sites that have already been closed down

2 Increased coal imports to substitute for domestically produced coal will lead to higher transport volumes, causing extra environmental impact.
3 Increased coal imports will change supply on the world market due to closure of German mines[39]. This change in supply might increase the world market coal price, leading to lower global demand.

Ad 1 Differences in coal quality (German versus import)
A switch to a different quality of coal for electrical power generation will have only a minor environmental impact in Germany, for two main reasons:

- today's generation of German power plants are designed for burning coal satisfying tight quality specifications. Any coal imports must therefore fulfil minimum quality standards;
- flue-gas desulphurisation is widely applied in Germany (see [OECD, 1999]), as are low-NO_x installations, causing low SO_2 and NO_x-emissions, regardless of the input[40].

We conclude that the environmental impact of using imported coal instead of domestically produced coal is likely to be low, because in the short run imported coal must meet the specifications of German power plants.

Ad 2 Changes in transport volumes
As discussed above, in the absence of aid to the German mining industry, demand for coal will be fulfilled through growing substitution by imported coal. This will lead to higher transport volumes, with corresponding environmental effects. Given the complex nature of the coal trade, it is difficult to precisely estimate the resultant (negative) environmental impact within the scope of this study. However, below we present an indication of this impact, based on the assumption that the decreased output of German coal is fully substituted by export from the USA. This assumption has been made because the USA still has a dominant position on the export market. In [DRI, 1997] the USA is also taken as the marginal exporter.
The change in transport distance that this substitution would generate consists of two elements:

1 Changes in the overland transport volume, as distances between mines and harbours in the USA differ from distances between mines and power plants in Germany. In comparison with the second element, however, we assume that this will have a negligible overall effect, as emission factors for land transport and the number of additional kilometres are very small compared with the additional sea kilometres between the USA and Germany.
2 Change in the ocean transport volume, as the coal needs to be transported from the USA to Germany. We estimate this additional distance to be 6,000 kilometres.

The total amount of import coal that will have to be transported is 39,612 million tce. The increase in transport volume, i.e. tonnes of coal imported times additional transport distance, is thus estimated to be nearly 240 billion tonne kilometres. As regards mode of transport, there is but one option for this additional transport volume: maritime transport.

Emission factors per tonne kilometre have been taken from [CE, 1997], a study reviewing the energy consumption and emissions of all the main

[39] In the absence of financial aid, the German coal industry will be unable to compete and production sites will therefore be closed down.

[40] There is a limit to the sulphur content of the coal used in power plants. If it is too high the coal cannot be used because it is does not meet process specifications.

modes of freight transportation. In the table below we present the figures for maritime transport[41].

Table 11 Emission factors for CO_2, NO_x, and SO_2 per tonne kilometre

Transport mode	CO_2 (g/tkm)	NO_x (g/tkm)	SO_2 (g/tkm)
coaster (fuel oil)	12.3	0.32	0.24

Source: CE, 1997. More information on the assumptions underlying these emission factors can be found in D.3.6.

Combining these emission factors with the calculated increase in transport volume indicates that substituting imported coal for German-mined coal will have the following environmental impact

Table 12 Negative environmental effect of increased coal transport due to imports substituting for domestic production

	Increase in transport emissions
CO_2	2.9 Mtonne
NO_x	76 ktonne
SO_2	57 ktonne

Ad 3 Change in emissions following change in world coal prices

The price increase in the no-support scenario was calculated from [Light, 1999]. This publication reports the results of an analysis of the consequences of subsidy elimination in a dynamic model of the international coal market. The model incorporates aspects of the current coal market structure[42] and is not driven only by supply and demand elasticities like many other studies. The study concludes that coal prices and output would not be affected much by complete removal of European and Japanese coal production subsidies. According to the study the world coal price would rise only 0.8% in the first five years and 2.7% within 20 years[43].

In this case study, we only consider a gradual removal of support in Germany, over the period 2000 - 2010. Using the results of Light (1999), we assume that a complete elimination of European and Japanese coal production subsidies would lead to a 1.35% rise in world coal prices in 2010. Assuming this price increase to be proportional to the additional demand in 2010 from

41 We have taken one single coaster to be representative for the range of ship types used for transatlantic transport. Within this study it was not possible to collect detailed information on different types of ships, engines, speeds and corresponding emission factors.

42 In the model the following assumptions are made with regard to the international steam coal market: (i) Steam coal is treated as a homogeneous energy good, with premiums paid for higher caloric values for specific characteristics. (ii) The USA is emerging as the residual supplier, so that the world price for coal follows the US domestic coal price closely. (iii) Transportation and production capital serve to constrain the supplier's response to market shocks.

43 The findings of Light (1999) are similar to those of a study by Welsch (1998) on how accelerated German coal subsidy removal might impact on fuel demand and carbon emissions. Welsch also concludes that German CO_2-emissions would be reduced only slightly, because domestic coal is largely replaced by imported coal.

Japan and the Western European countries, we calculate that aid removal in Germany alone would lead to a 0.9% higher world coal price by in 2010[44].

This calculated price rise should be considered very tentative, because energy prices are subject to a multitude oft economic mechanisms in the world market. The estimated price rise is thus very uncertain. However, we do provide an order of magnitude estimate of the probable effect of this rise on world coal demand. Using an own price elasticity of –0.3 as indicated by [IEA, 1999], the reduction in global coal demand can be estimated as 0.27% or 10 million tonnes of coal equivalents[45]. The CO_2-emissions associated with this coal use would have totalled 23 Mtonne.

The possible environmental impact of this decrease in coal use depends on the emission factors per tonne of coal equivalent, the degree of substitution by other energy carriers and the reduction in electricity consumption due to higher coal prices. With regard to the last of these effects we assume that the price rise of less than 1% will have a negligible effect on global electricity demand. This is confirmed by the modelling results of studies by Welsch (1998) and Light (1999).
Below, we discuss the environmental effects of substitution by other energy carriers induced by the relatively small price rise of coal on the world market. First, the emission factors used here are briefly described.

Emission factors
In section D.3.6 we present typical emission factors for the main pollutants per tonne coal equivalent for power plants in developed countries. As different types of hard coal are associated with a range of emission factors, we have had to make assumptions as to the countries in which demand for coal decreases most. It has been assumed that reduction of coal consumption for power generation will occur primarily in developed countries with no potential potential to increase domestic coal production. These countries have the financial means to invest in alternative energy sources and have no economic benefits to gain from continued use of coal for power production. We have therefore used the emission factors for the coal currently used in seven UCPTE countries[46].

The given emission factors relate only to the part of the fuel cycle in which the coal is actually burned to generate power and no other parts of the fuel cycle are incorporated in our analysis. In other words, the environmental effects of mining, transport to and from the coal fields and other parts of the cycle are not considered here. This leads to an underestimate of overall environmental effects. The calculations underlying these emission factors are presented in D.3.6. These represent a typical tonne of coal equivalent, with typical end-of-pipe measures to reduce emissions. We also present a range in this table, to provide insight into the sensitivity of the emission factors.

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44 See also Annex D.3.6.

45 A conservative estimate of coal consumption in 2010 has been taken, using the World Coal Institute's estimate for 2000: 3,738 million tce (www.wci-coal.com). We have assumed that this level will be maintained until 2010. However, the trend of global coal consumption has been rising and is projected to rise further in the coming years. The possible decrease in global coal consumption is given as a percentage and will therefore be higher if global consumption in the reference scenario is higher.

46 Germany, Austria, Belgium, France, Italy, the Netherlands and Spain. For a detailed description of the calculation see D.3.6.

Table 13 Emissions per tce (power generating part of fuel cycle only)

Pollutant	Emissions in kilogram per tonne coal equivalent (medium)	Emissions in kilogram per tonne coal equivalent (range)
CO_2	2,319	2,070 – 2,450
NO_x	3.3	1.4 – 6.3
SO_2	8.9	1.2 – 17.5
PM_{10}	0.58	0.1 – 1.5

Source: see section D.3.6.

Substitution by other energy carriers
The decrease in demand for coal will be (partly) substituted for by other energy carriers. Because the decrease in coal demand would be spread over many different countries, it was not possible to estimate the environmental effects of this substitution in detail. We therefore assumed that the countries involved would build Combined Cycle Gas Turbines (CCGT) rather than coal-fired plant. Based on [Michaelis, 1997], Table 15 illustrates that substitution of coal-fired plant by natural gas-fired CCGT can reduce CO_2-emissions by about 50% and NO_x-emissions by a factor four and can almost eliminate SO_2-emissions.

Table 14 Pollutant emission factors for natural-gas fired Combined Cycle Gas Turbine as a percentage of emissions from coal-fired power production

Pollutant	Emissions from combined cycles per KWh (% of emissions from coal fired power generation)
CO_2	50%
NO_x	25%
SO_2	0%
PM_{10}	not known

Source: based on Michaelis, 1997. For particulates we use the same relation in emissions per KWh between coal and combined cycle as for NO_x.

As a result, the decrease of CO_2-emissions due to the increase of the world coal price would be about half that associated with the reduced coal burn: 23 million tonnes, as estimated above.

Table 15 Estimated emissions reduction in 2010 due to increase of world coal price resulting from coal support removal in Germany

Pollutant	Decrease in emissions due to lower global coal demand (million tonnes) (a)	Increase in emissions due to substitution to other energy carriers (million tonnes) (b)	Net decrease in emissions (million tonnes) (c) = (a) -/- (b)
CO_2	-23	+11.5	11.5
NO_x	-0.03	+0.01	0.02
SO_2	-0.09	0	-0.09
PM_{10}	-0.006	+0.0014	0.0046

Estimated overall environmental impact

From the above analysis we draw the following conclusions (see also table 19):

1 Removing support for coal producers in Germany would probably lead to a complete switch to imports of cheaper coal. This would have little or no effect on emissions of pollutants such as CO_2, NO_X and SO_2.
2 The resulting increase in sea-traded coal would lead to increased transport emissions.
3 Increased German coal imports would tend to raise world coal prices only slightly and would therefore probably reduce global coal demand and associated emissions only slightly.
4 The estimated increase in world coal price would probably lead to a very small additional expansion of the use of other fuels in Germany and in other countries over and above what would have occurred without support removal in Germany.

Table 16 Estimated overall effect on emissions of removing support to coal producers in Germany

Pollutant	Increase in transport emissions (2)	Decrease in emissions due to lower global coal demand (3)	Increase in emissions due to substitution to other fuels (4)	Overall effect (2+3+4)
CO_2 (Mtonne)	+2,9	-23	+11.5	-18.6
NO_x (ktonne)	+76	-30	+10	+56
SO_2 (ktonne)	+57	-90	0	-33
PM_{10} (ktonne)	NQ	-6	+1	NQ

From the table it can be concluded that removing support to the German coal industry may reduce CO_2-emissions by about 19 Mtonnes, over 2% of aggregate German CO_2-emissions in 1990.

It should be stressed again that this estimate is merely indicative, because within the scope and time frame of this project it proved impossible to make a precise estimate of the effect of removing German coal aid on the world market price. It is obvious that forecasts of coal supply and demand are subject to major uncertainties, given future economic developments and policies with respect to energy provision and the environment.

Comparison with other results

A recent modelling analysis by [Anderson and McKibbin, 2000] reveals that removing OECD production subsidies and import restrictions would lead to a 5% decrease in global CO_2-emissions.

[DRI, 1997] estimates the overall effect on CO_2-emissions of removal of all support in the six OECD countries under consideration to be 10 million tonnes. The relatively large difference compared with the results of this study can be explained by the fact that DRI did not take into account the effect of higher world market prices and thus the potential reduction of coal demand and substitution to cleaner fuels.

[OECD, 1997] indicates that the possible effect could be higher than 50 million tonnes in the case of coal support being removed in all six countries considered in [DRI, 1997]. However, only the effect of higher world market prices on coal demand in the USA was considered on top of the results of [DRI, 1997].

Other environmental effects
Contrary to the environmental effects mentioned above might be the effect that German mining, mainly underground, would be substituted for by mining in countries possibly applying less strict labour regulations (especially safety), local environmental quality and spatial planning. If the German coal were substituted by imported coal mined on the surface under less strict regulations, this might lead to deterioration of landscape and biodiversity in those countries. In the present study this effect will not occur, however, as we have assumed that German coal will be substituted by coal from the USA, where regulations are similar to those in Germany.

D.3.4 Socio-economic effects

Production volumes and workforce
Before analysing the socio-economic effects of support removal, below we first describe recent developments in German coal mining vis-à-vis production volumes and workforce in the mining sector. Over recent years support to the German coal industry has gradually declined, following the closure of several mines. Total production of hard coal in Germany has also decreased substantially, as can be seen from Table 17. The table also shows the development of the mining workforce and the number of mining companies over the last few years.

Table 17 Decrease of number of companies, employment and production in the German hard coal industry in recent years

Year	Number of companies	Workforce	Production (million tce[47])
1995	59	95,668	53,564
1996	58	87.577	48,197
1997	56	80.348	46,792
1998	51	74.612	41,642
1999	48	69.353	39,623
2000	46	63,153	39,612

Source: Statistisches Bundesamt, 2000 (production), Statistisches Bundesamt, 2001 (number of companies and workforce)

Socio-economic effects of support removal
Removing support to coal in Germany would cause the loss of up to 63,000 jobs in the mining sector, mainly in two regions: Ruhr and Saar. This can be seen as the direct employment effect. A declining coal industry will also have employment effects in sectors providing goods and services to the coal industry and its employees as well as in sectors consuming goods and services provided by that industry. Input/output analysis can shed light on the linkages between different sectors of the German economy. We have obtained an input/output table for domestic output[48]. This table gives a multiplying factor of 2.42 to calculate second-order employment effects. This factor was confirmed by a German labour market expert[49]. Based on this factor, support removal in Germany might lead to an overall employment

[47] Tonnes of coal equivalent.

[48] Input-Output Accounts and National Wealth Accounts, *Statistisches Bundesamt*.

[49] Personal communication, Dr. Herbert Buscher, Halle Institute of Economic Research.

effect of 215,000 jobs lost in economic sectors related to coal mining. In this calculation no adjustment is assumed.

There are several options for alternative use of the support removed. One option would be to lower income tax rates. This would lead directly to higher employment rates and, given increased purchasing power, creation of even more jobs in the second round. Further to these alternative uses of the funds, overall economic efficiency would increase. Assuming a general tax reduction, more jobs would be generated in other sectors of the German economy. According to [IEA, 1999] removal of energy support in the OECD countries would even increase economic growth by 0.7%. Assuming a linear relationship between economic growth and employment growth, this would lead to the creation of over 250,000 jobs[50].
A general tax reduction might be a first best option from the point of view of economic efficiency, but this would scarcely soften the strong negative regional economic impacts of coal support removal. Another option for alternative use of funds is therefore to boost employment at (new) governmental organisations in the Ruhr and Saar regions. Assuming that those who lose their jobs can adjust to other employment and assuming annual labour costs of € 70,000 per employee, this use of the funds could create employment for over 50,000 people[51]. Of course in this case, too, the second-round effect would be higher. There is no multiplying factor available for calculating this additional number of jobs, however.

D.3.5 Sources

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50 From www.destatis.de we see that in Germany 36.6 million people were employed in 2000. An increase of 0.7% would therefore lead to 256,000 additional jobs.

51 Calculated as follows: € 3.8 billion divided by € 70,000 per employee.

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D.3.6 Annex: calculations

In this section we present in more detail the calculations made to analyse the environmental and socio-economic effects of removing support to the German coal industry.

Increase of transport emissions following substitution of domestically produced coal by import coal
There is full import substitution of German-produced coal: 39,612 million tonnes in 2000 [Statistisches Bundesamt, 2000]. This leads to additional

transport volumes, as the distance between the origin and destination of the coal increases.

The additional transport volume can thus be calculated as: 39,612 million tonnes of coal times 6,000 kilometres.
Total: 237.7 billion tonne kilometres.

Emission factors are taken from [CE, 1997] for a marine vessel burning fuel oil. We assume that the emission factors of this type of coaster vessel are representative for the fleet providing the additional transatlantic transport. This study gives the following characteristics for a coaster burning fuel oil:
- maximum load (tonnes): 40,000;
- average load factor (mass%): 50%;
- detour factor: 1.4.

For this typical coaster the emission factors are as shown in Table 18.

Table 18 Emission factors for CO_2, NO_x, and SO_2 per tonne kilometre

Transport mode	CO_2 (g/tkm)	NO_x (g/tkm)	SO_2 (g/tkm)
Sea ship (fuel oil)	12.3	0.32	0.24

Source: CE, 1997, table 2.

Combining these emission factors with the increase in transport volume calculated above indicates that substituting imported coal for domestically mined coal in Germany will have the following environmental effects.

Table 19 Negative environmental effect of increased transport due to coal imports substituting for domestic production

	Increase in transport emissions
CO_2-emissions	2.9 Mtonne
NO_x-emissions	76 ktonne
SO_2-emissions	57 ktonne

Share of German hard coal production
To isolate the effect of support removal in Germany we used the generated demand for imported coal in Japan and the West European countries under consideration as weighting factors. This generated demand was calculated as the net value of production in 2000 and forecast production in the absence of support.

Hard coal production in 2000 in Western Europe and Japan is given in the second column of Table 20. The third column shows projected hard coal production in 2010 in the absence of support, as reported in [DRI, 1997]. These figures can be seen as the economically viable coal reserve in the countries concerned. The last column shows the net increase in demand for imports if all support is removed. These figures were used to isolate the effect of support removal in Germany.

Table 20 Hard coal production (2000), projected hard coal production (2010) and net demand for imports in France, Germany, Japan, United Kingdom and Spain in million tce

Country	Hard coal production (Mtce) (a)	Projected hard coal production in 2010 in absence of support (b)	Increased demand for imports (c) = (a) - (b)
France	4.05	0	4.05
Germany	34.52	5	29.52
Japan	2.48	0	2.48
United Kingdom	27.5	25	2.5
Spain	8.06	2	6.06
TOTAL	76.61	32	44.61

Sources: [IEA, 2001] for hard coal production; [DRI, 1997] and Commission of the European Communities, Report from the Commission on the application of the Community rules for state aid to the coal industry, COM(2002) 176 final/2 for projected hard coal production in 2010.

We assumed the price increase following support removal is proportional to the increased demand for import coal. Removing support to the *German* coal sector only would then lead to the following price increase: 29.52/44.61 times 1.35% is 0.9%.

Emission factors

The emission factors determining the environmental impact of the change in worldwide coal consumption are given in Table 21 below.

As different types of hard coal are associated with a range of emission factors, we had to make assumptions as to the countries in which demand for coal decreases most. It was assumed that reductions of coal consumption for power production will occur primarily in developed countries with no potential to increase domestic coal production. These countries have the financial means to invest in alternative energy sources and have no economic benefits to gain from continued use of coal for power production. We therefore used the emission factors for the coal currently used in seven UCPTE countries.

Table 21 Emission factors for coal use in different countries

	Germany		**Austria**		**Belgium**		**France**		**Italy**		**Netherlands**		**Spain**	
Net heating value (in GJ per tce)	26.4		23.5		25.2		25.4		24.6		26.4		21.5	
input of coal (Mton/year)	53.2		1.5		6.1		4.5		25.0		10.8		32.5	
Emission factors (per country)	(tce/TJ)	(kg/tce)	(tce/TJ)	(kg/tce)	(tce/TJ)	(kg/tce)	(tce/TJ)	(kg/tce)	(tce/TJ)	(kg/tce)	(tce/TJ)	(kg/tce)	(tce/TJ)	(kg/tce)
- CO_2	92.5	**2,442**	94	**2,209**	94	**2,369**	93	**2,358**	94	**2,312**	93	**2,452**	96	**2,066**
- NOx	0.07	**1.8**	0.06	**1.4**	0.14	**3.5**	0.25	**6.3**	0.24	**5.9**	0.06	**1.5**	0.21	**4.5**
- SO_2	0.12	**3.1**	0.05	**1.2**	0.46	**11.5**	0.50	**12.8**	0.55	**13.4**	0.09	**2.4**	0.81	**17.5**
- dust	0.007	**0.2**	0.004	**0.1**	0.040	**1.0**	0.013	**0.3**	0.011	**0.3**	0.006	**0.2**	0.070	**1.5**

Source: emission factors per country: ETH, 1996

From the various emission factors given above (in kilogram pollutant per tonne of coal equivalent, **in bold**) we deducted a set of average emission factors using the input of coal in the respective countries as weighting factors.

This set of average emission factors is given in Table 22.

Table 22 Emissions per tce (power generating part of fuel cycle only)

Pollutant	Emissions in kilogram per tonne coal equivalent (medium)
CO_2	2,319
NO_x	3.3
SO_2	8.9
PM_{10}	0.58

Source: own calculation

E Spain - coal transport

E.1 Description of the support measure

The measure considered in this case study is the support provided to electrical power generators for coal transport from designated Spanish coalfields. The aim of this support is to compensate mining enterprises in the Thermal Central habitual coal mining zone that have reduced capacity under restructuring, modernisation, rationalisation and other downscaling programmes [Ministry of Economics, 2000]. This has led to the closure of several coalfields, thereby increasing the average transport distance between the mine and the power plant burning the coal.

The aim of the support is to compensate the transport costs of the *additional* number of kilometres from the cited coalfields in to the power plants. The recipients of the support are the power plants.

The support provided for the various coalfields to power plant connections are given in Table 23 per tonne of coal.

Table 23 Grants provided under the support scheme

Power station (destination)	Mining enterprise (origin)	Maximum amount of coal supported (kilotonne)	Support[52] (€/tonne)
Iberdrola, Guardo	Sociedad Anónima Hullera Vasco Leonesa	129.9	4.25
Iberdrola, Guardo	Coto Minero del Sil, Sociedad Anónima	214.3	11.53
Endesa, Escatrón	Cuenca Mequinenza	121.1	4.34
Generación Fecsa-Enher II	Cuenca Mequinenza	87.1	8.28
Endesa Generacion, Andorra	Cuenca Mequinenza	3.7	6.09

Source: Ministry of Economics, 2000

The total budget of this support measure amounts to a little over € 3 million.

Further to this, the grant applies only to coal with a minimum calorific value:
- 4,700 Kcal/kg for the coal from Sociedad Anónima HulleraVasco Leonesa and Coto Minero del Sil, Sociedad Anónima;
- 1,800 Kcal/kg for the coal from the Mequinenza coalfields.

It is the support described above that we consider in this case study. It is important to note that this support is only a relatively small fraction of total

[52] The differences in grants reflect differences in the additional number of transport kilometres due to the restructuring process. However, the institute responsible for implementing this grant was unable to provide information on the *additional* number of kilometres. This is the *Instituto para la Restructuración de la Minería del Carbón y Desarrollo Alternativo de las Comarcas Mineras* (Institute for the Coal Mining Restructuring and the Mining Region Alternative Development Coalfields), resorting under the Ministry of Economics.

support to the Spanish coal industry. [IEA, 2001] reports two other forms of support:
- financial measures to support Spanish coal producers for 1) operation, 2) output reduction, 3) early retirement of miners and 4) technical costs of mine closure; this support amounted to a little over € 700 million in 1999 [IEA, 2001];
- statutory obligations for power producers to use a certain amount of domestic coal.

Furthermore, the support to coal transport considered in this case study is for a maximum of 556 kilotonne per year (see Table 23), while total hard coal production in Spain amounts to 15,100 kt [IEA, 2001]. This implies that the support under consideration is given to a maximum of 3.7% of hard coal production in Spain.

In the remainder of this annex we will analyse the environmental and economic effects of this support, comparing the data to those for the situation in which the grant is not provided.

E.2 Mechanisms

In the absence of government support, coal transport from the designated coalfields[53] will become more expensive. As transportation costs are passed on in the tonne price of coal, the price of domestic coal from the designated coalfields will rise. This may lead to a change in demand by power generators, due to various factors:
- higher coal transport load factors, to minimise transport costs;
- less use of coal from the designated coalfields due to higher prices;
- greater demand for coal from other *domestic* coalfields;
- greater demand for import coal.

Another possible mechanism is that the coal price will increase to such an extent that certain other energy sources reach their economic threshold. This could lead to an increase in demand for other energy forms as a substitute for coal in general.

Besides the *fuel mix* in Spain being affected by these various mechanisms, the *volume* energy demand in Spain might decrease following a possible overall increase in the price of energy.

E.3 Environmental impact

This section analyses the environmental impact of the support measure relative to the situation without support. We start by demarcating the analysis, then present the method used and, finally, the calculated results.

E.3.1 Demarcation

The first demarcation is that our analysis ignores possible changes in coal transport load factors. This implies that we assume that the increase in transportation costs leads directly to higher coal production costs. The reason for this is twofold. First, load factors for bulk transport by rail are fairly

[53] As cited in the table above. throughout this annex we shall refer to these as the designated coalfields.

high: there is not much space for improvement in this respect. Second, information on changes in load factors following price changes is scarce.

The second demarcation is that possible shifts to other forms of energy have not been taken into account. Domestic coal from the designated sites will become more expensive but, overall, coal will retain its competitive advantage over other energy forms, owing mainly to its lower price.

The third demarcation is that demand for imported coal has been assumed not to increase. This follows from an agreement between the government and power generators that the latter use certain minimum quantities of domestic coal.

E.3.2 Method

To calculate the estimated environmental impact of removing the described support a three-step procedure was employed:

1. Determine the increase in the production cost of coal from designated coalfields.
2. Determine the response of power stations using coal from designated coalfields.
3. Determine the change in transport emissions following the shift to other domestic coalfields, imported coal or other fuels.

E.3.3 Results: environmental effects

Change in production cost of coal from designated coalfields
First, we determine the increase in the production cost of domestic coal from the designated coalfields that would result from removing the support. The production cost of domestically extracted coal is nearly twice the price of imported coal[54]. The import price is € 46 per tonne of coal equivalent (tce), implying production costs of roughly € 92 per tce. From Table 23 we see that the support varies between € 4.25 and € 11.35 per tce. Taking as weighting factors the maximum quantities receiving support, the weighted average of this support is € 7.7 per tce.
On average, then, the production cost would increase from € 92 per tce with support to about € 100 per tce without, an increase of 9%.

The remaining deficit between production cost and world market price is covered by the other financial support measures, including the statutory obligation for power generators to purchase a certain amount of domestically produced coal. This domestic coal is purchased at world market prices, with the difference between production cost and world market price covered by the government.

Response of coal-fired power plants
We assume that, following coalfield restructuring (and thus closure of some mines), the power stations have selected mines for their coal supply that provide coal of the desired quality from as close as possible. Furthermore, we assume that government support is provided for the additional kilometres to the mine that is closest as well. If this last assumption did not hold, the

[54] Personal communication, Mr. Carrizo, Institute for Coal Mining Restructuring and Alternative Development of Coalfields in the Mining Region.

government would provide support to power stations for coal bought at distant sites[55].
This implies that in the absence of support power generators will still purchase their coal from the same mines, implying no substitution to other domestic mines or coalfields.

Given the assumption that no further substitution to imported coal is possible (see Demarcation), we can conclude that the recipients of the support, the power plants cited in Table 23, can be considered free riders: they will purchase the same amount of coal from the same mines with and without support.

The total amount of coal transported would therefore be unaffected by support removal.

The only difference between the two scenarios is the cost to generators. They will be confronted by higher generating costs, which might be reflected in higher production costs per KWh generated.

Given the relatively small amount of support, any rise in energy price would be negligible, as the following calculation shows. The maximum amount of coal receiving support is 556.1 kt (see Table 23), which converts to 4,526 GWh[56]. Removing the support would then raise the cost per KWh by approximately € 0.0007. If this cost increase were passed on fully in higher prices, we would see a price rise of less than 0.5% for a small fraction, 3%, of total domestic supply.

E.4 Results: Economic effects

Given the current obligation for power generators to purchase a certain amount of domestically produced coal, the only economic impact will be distributive. The following effects can then be distinguished:

- any distributional effect occurring would be small because the support considered here covers only 3% of Spain's overall coal supply;
- according to the Spanish Institute for Coal Mining, *designated mining companies* that would lose part of their output to other mines following support removal could easily shift supply to local customers. This implies that with regard to the designated mines there would be no adverse regional employment effects;
- *power stations* using coal from designated coalfields could be confronted with higher production costs after support removal. This could reduce their competitive position compared with other generators operating on the same market and may thus impact adversely on the economics of the power stations concerned. However, given the price increase of 0.5%, we estimate any adverse economic impact to be very minor.

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55 An example illustrates the logic of this assumption. Let us assume that power station A had three possibilities for purchasing coal of the desired quality. Mine 1 is 10 kilometres away, Mine 2, 50 kilometres and Mine 3, 100 kilometres. Owing to Spanish restructuring policy Mine 1 is closed and power station A therefore has two options left. We now assume that power station A chooses Mine 2 as the new supplier and that the government supports only the difference in coal transport kilometres between site 1 and 2. In the case of support removal, Mine 2 is still preferred by Power Station A.

56 See http://www.iea.org/statist/calcul.htm

Resumé

The results show that initial expectations during selection of this case study were mistaken. The main reason is that we did not know of any specific budget for this support measure beforehand. After detailed study of descriptions, it was found that the measure considered here accounts for only a very small fraction of total government support to restructuring of the Spanish coal sector.

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F The Netherlands - road transport

F.1 Description of thesupport measure

This case study reviews support provided to the Dutch road transport sector. The specific support considered here is an extension of a regulation concerning the refunding of fuel excise duty that was originally implemented in 1997. We start by describing the extension and its raison d'être, subsequently arguing why only the extension is relevant for this case study.

Because of the high gasoil prices in 2000, the Dutch government gave road freight carriers a refund of excise duty paid on this fuel. The refund level depended on when the fuel was purchased, according to the following scheme[57]:

– first quarter of 2000: 6.35 € ct per litre;
– second quarter of 2000: 4.76 € ct per litre;
– third quarter of 2000: 3.18 € ct per litre;
– fourth quarter of 2000: 1.59 € ct per litre.

The government agreed on this support measure in September 2000 and excise duty refunds began immediately afterwards.

This compensation scheme is an extension of Article 71a of the Dutch Excise Duty Act (*Wet op de Accijns*), which was implemented in 1997. Under the original Article, fuel excise duty had been increased to link motoring costs to actual vehicle usage. Under the extension, the government opted to recycle the revenues of this measure by decreasing the vehicle tax[58]. It was, in other words, a revenue-neutral measure for the government [ECN, 1996].

This scheme applied to private cars, vans, taxis and buses. However, under European law it was not permitted to lower the vehicle tax for heavy goods vehicles, or HGVs[59]. The government therefore compensated operators of these vehicles by providing a grant on gasoil use up to a maximum of 50,000 litres a year, as laid down in Article 71a.

In practice, nothing changed for freight carriers as long as their vehicles consumed less than 50,000 litres of fuel a year (the refund was the same as the increase in excise duty, viz. 2.40 € ct per litre). Article 71a remained in force in the following years to compensate HGV operators for the higher duty on gasoil.

In this case study we analyse the effects of the *extension* of the refund of excise duties. This implies that we consider only the *extra* compensation described in the above scheme, without a ceiling on consumption. The original refund introduced in 1997 is not considered below, as this was a budget-neutral policy package for the transport sector (see above).

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57 Personal communication, Mr. Takens from the Dutch Ministry of Finance.

58 This vehicle tax (*Motorrijtuigenbelasting*) is an annual fixed tax paid by all car owners. It is differentiated according to weight and fuel type but is independent of actual vehicle usage.

59 Heavy goods vehicles are defined as lorries with a maximum vehicle weight of over 12 tonnes.

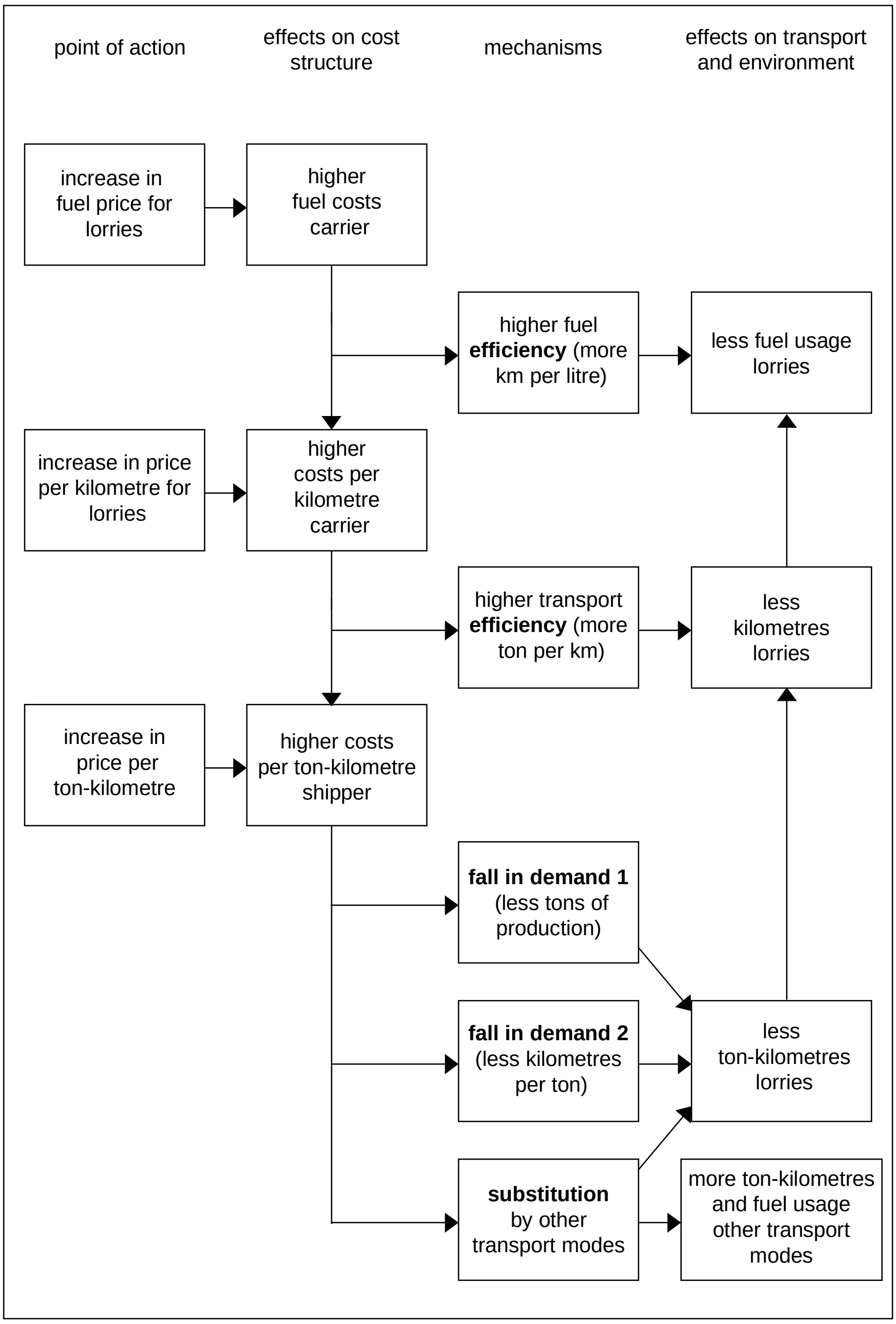
F.2 Mechanisms

In this section we briefly describe the mechanisms that might come into play if the support were removed.

Without support, fuel costs for road freight carriers would be higher. Although some fraction of these extra costs might be offset by improved fuel efficiency and/or vehicle load factors, the bulk would be passed on to consumers in higher prices. To what extent this would occur depends largely on the financial situation of individual carriers.

The resultant increase in prices will mean the road freight sector will lose some of its competitiveness relative to other modes of transport. There is therefore likely to be some shift to other modes of goods transport and some decrease in overall transport demand (see Figure 2).

Figure 2 Outline of elasticities and their interrelationships



This figure is taken from a recent literature survey of freight transport price elasticities in the Netherlands [CE and NEI, 1999]. It summarises the mechanisms that come into play when the price of transport rises at any point in the chain. The relationship between effects, on the right side of the figure, and price increase, on the left, indicates the various price elasticities. In this case study our focus will be on the price elasticity between a rise in fuel price and HGV fuel consumption.

The unweighted average refund on excise duty under the additional support scheme for 2000 amounts to 3.97 € ct a litre, which is 4.7% of the total average fuel price in 2000[60]. Because implementation of the scheme was only decided on in September 2000, this can be regarded as an unexpected reduction in operating costs. As a result, the financial results of the transport industry in the year 2000 were better than initially expected.

Does the fact that the support was given unexpectedly over a preceding period mean that no change in behaviour was expected? For the long term, it does not really matter if support is unexpected and over a preceding period, or expected and over a future period. Had the support been given beforehand, carriers could have lowered their prices in 2000. However, the support was given afterwards, and unexpectedly, so that carriers were unable to lower their prices in that year (otherwise they would run their business below marginal costs). The unexpected subsequent support meant a better financial situation for the next year, allowing carriers to lower their prices in 2001. The overall result for the years 2000 and 2001 together will be the same, whether the support is given unexpectedly and afterwards or expectedly and beforehand.

F.3 Environmental impact

F.3.1 Demarcation

We here confined ourselves to transport by heavy lorry, or HGV, and the main competing modes, viz. rail and inland shipping.

As mentioned in the first section, vans, taxis and buses also make use of the scheme. For a number of reasons, however, we have not calculated the environmental effect of the scheme for these modes of transport.

According to an annual report of Connexxion, a major Dutch bus company, bus operators have no scope for increasing bus ticket prices in response to rises in fuel price [Connexxion, 2001]. The increase in fuel prices at issue here will thus lead to an equivalent decrease in operator profits. The environmental effects are therefore likely to be negligible. In addition to the difficulty of passing on higher fuel prices in ticket prices, the extent to which bus operators use the refund is found to be limited, compared with lorries.

For taxis and vans, information about consumer behaviour in response to higher prices is very scarce. It is also very uncertain how the taxi sector would respond to higher fuel prices. After liberalisation of this sector in the Netherlands, prices went up [Timmermans, 2001]. This is contrary to the expected decrease in prices, given greater competition. This indicates that price setting in the taxi sector is complicated and hard to predict.

On the basis of actual kilometres driven and figures on fuel consumption by the relevant transport modes[61], we can now estimate overall allocation of the support scheme budget. Approximately 84% of the budget is allocated to lorries (see F.6 for calculations). This figure shows that in analysing the effects on HGV transport only, we are assessing a very large share of the budget.

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[60] See section F.6 for details of the calculations.

[61] Lorries, vans, taxis and buses.

Higher fuel prices for road freight carriers will lead to some degree of substitution to other transport modes, the most competitive in this case being rail and inland shipping. Ocean shipping and air transport are generally used for longer distances and are therefore not good substitutes for road transport. We therefore confine ourselves to the effects of substitution to rail and inland shipping.

With respect to environmental effects we limit ourselves to emissions of CO_2, particles and NO_x, the three principal emissions for these sectors from an environmental point of view.

F.3.2 Method

As concluded in section F.2, we can apply the same analysis as would hold if the support had been expected and specified in advance. We can now define a reference scenario, i.e. the situation *without* compensation to the road transport sector for higher fuel duty. To calculate the environmental effects of this support we compare the current situation (in 2000) with this reference scenario.

Having done so, we can calculate the total environmental impact of the support measure as follows:
1 Determine the percentage difference in gasoil price between the current situation and reference scenario.
2 On the basis of existing fuel price elasticities, determine the difference in gasoil demand in the road transport sector between the two scenarios.
3 On the basis of existing substitution elasticities, determine the difference in gasoil demand in the rail and inland shipping sectors between the two scenarios; we here assume that load factors in the substituting modes remain constant.
4 On the basis of total emission figures, determine the environmental impact of the lower demand for road transport and higher demand for rail transport and inland shipping.

F.3.3 Results

In this section we calculate the environmental effects that can be attributed to the cited support to the road transport industry. Detailed calculations can be found in F.6.

The average price of gasoil in the Netherlands in 2000 was € 845 per 1,000 litres [CBS, 2001], including VAT, excise duties and other taxes. The support measure lowers the average fuel price for HGV operators to € 805 per 1,000 litres. The price difference between the current (2000) situation and reference scenario is thus 4.7 per cent.
In a literature survey of freight transport price elasticities [CE and NEI, 1999] fuel elasticity in the Dutch road transport sector was calculated to be –0.3 [CE and NEI, 1999][62]. This means that a 10% increase in fuel price leads to a 3% decrease in vehicle fuel consumption. This figure takes into account increased fuel efficiency and vehicle load factors in response to higher fuel price.

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62 This fuel price elasticity is specific to the Netherlands and thus accounts for the specific competitive situation in the Netherlands.

The effect of a 10% increase in road transport fuel price on demand for rail transport was calculated as +2.2% and for inland shipping as +0.6% (both relative to respective current demand). For rail transport and inland shipping we assume that a given increase in tonne kilometres performed leads to a proportional increase in fuel use. This implies that we assume constant load factors and fuel efficiency for these transport modes[63].

Table 24 shows the percentage difference in fuel consumption in the different sectors between the current situation and the reference scenario.

Table 24 Fuel demand in reference scenario (no support) compared to current situation

	Change in fuel price in reference scenario compared to current situation	Effect on fuel consumption of 1% higher fuel price for lorries	Change in fuel demand in reference scenario compared to current situation
Lorries	+4.7%	-0.30%	-1.41%
Inland shipping	none	+0.06%	4.7 * 0.06 = +0.28%
Rail (cargo)	none	+0.22%	4.7 * 0.22 = +1.03%

We assume that the difference in fuel demand between the two scenarios leads to an equivalent difference in emissions. This is a reasonable assumption because there are no considerations leading to the conclusion that fuel specifications will alter as a result of support removal. Emission figures for freight transport in the Netherlands for the year 2000 are available separately for lorries, inland shipping and rail [CBS, 2001].

Table 25 summarises the environmental impact of the gasoil compensation scheme for road freight carriers.

Table 25 Environmental effect of fuel duty refund to the road transport sector

	CO_2-emissions (tonnes)			NO_x-emissions (tonnes)			PM_{10}-emissions (tonnes)		
	with Support	without support	effect of support	with support	without support	effect of support	with support	without support	effect of support
Lorries	6,439,000	6,348,229	+90,771	67,500	66,548	+952	2,300	2,268	+32
rail (cargo)	54,000	54,558	-558	1,200	1,212	-12	negligible	Negligible	negligible
Shipping	2,069,000	2,074,833	-5,833	39,700	39,812	-112	1,700	1,705	-5
Total	**8,562,000**	**8,477,620**	**84,379**	**108,400**	**107,572**	**+828**	**4,000**	**3,973**	**+27**

We estimate that the part-refund of excise duty to HGV operators will have the following environmental effects:
- CO_2-emissions: increase of 1%;
- NO_x-emissions: increase of 0.8%;
- PM_{10}-emissions: increase of 0.7%.

These differences can be explained by the differences in emission factors between lorries, rail transport and inland shipping. Substitution to rail and

[63] This assumption is based on the very indirect relationship between fuel prices for road transport on the one hand and load factors and fuel efficiency in competing modes on the other. There are no reliable data available on the impact of increased (road transport) fuel prices on load factors and fuel efficiency in competing modes. We expect no significant change in environmental impacts if this assumption is disregarded.

shipping affects NO_x and PM_{10}-emissions in particular and these emissions therefore increase less as a consequence of the support.
The environmental effects cited above are relative to current emissions of HGV transport. When relating these figures to national Dutch emissions, it should be borne in mind that lorries account for less than 2% of aggregate CO_2-emissions in the Netherlands.

F.4 Economic effects

In this section we discuss the economic effects of the refund scheme.

Although fuel demand without support would fall by 1.4%, the reduction of the number of tonne kilometres performed will be far smaller. Table 26 gives an indication of the expected effects of a 4.7% increase in fuel price for the Dutch road transport sector.

Table 26 Effects of a 4.7% increase in fuel price for the Dutch road transport sector

Fuel demand	-1.41%
Vehicle kilometres	-0.61%
Tonne kilometres	-0.33%

Source: based on [CE and NEI, 1999]

Most of the reduction in fuel demand is attributable to higher fuel efficiency and load factors. Of the 1.4% decrease in fuel demand, 0.8% is due to improved fuel efficiency. Of the remaining 0.6%, almost half can be attributed to higher load factors. This means that the number of tonne kilometres carried decreases by only 0.33%.

Because of the higher fuel efficiency and load factors triggered by the higher price of fuel, as well as the fact that only a portion of total carrier costs consists of fuel costs, the price per tonne kilometre increases only slightly. The price increase per tonne kilometre due to a 4.7% increase in fuel will be around 0.4% [NEI and CE, 1999]. The remainder of the fuel price rise leaks away through a variety of efficiency mechanisms.

The above figures, especially the very low expected decrease in tonne kilometres, show that the economic effects, in terms of production value, employment and trade flows, of the refund of excise duty to the road (HGV) transport sector are low.

There are several options for alternative use of the government budget. One option would be to lower general taxes for all sectors. Given the budget embodied in this support measure, this would lead to only minor positive employment effects and efficiency improvements in the economy. A second option is to find environmental grounds for differentiating vehicle taxes, within the European legislative framework, for example by reducing vehicle taxes for those lorries that perform better than a defined “industry-average energy efficiency performance standard”. Carriers with a relatively energy-efficient vehicle fleet would then gain, with others losing out somewhat.

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F.6 Annex: Calculations

In this section we present the more detailed calculations made in analysing the environmental and socio-economic effects of the cited support to the road transport sector.

Calculation of average fuel price decrease for HGVs due to tax refund
Absolute: (6.35 + 4.76 + 3.18 + 1.59) / 4 = 3.97 Eurocents per litre
Relative: € 39.70 per 1,000 litre / € 845 per 1,000 litre = 4.7%

Calculation of budget allocated to different transport modes
Approximately 6% of the budget is allocated to taxis, 2% to vans, 8% to buses and 84% to lorries. This is calculated as follows.

Table 27 Allocation of the budget

Transport mode	Kilometres driven (a)	Source	Fuel consumption/ km (relative to taxis, see RIVM, 2000) (b)	Estimated total fuel consumption under support (c) = (a) x (b)	Estimated share of support budget (c) as % of total[64]
lorries	6,523 million	RIVM, 2000	4.6	30,071 million	83.8%
Vans	470 million	NIPO, 1997	1.3	633 million	1.8%
taxis	2,400 million	RIVM, 2000	1	2,400 million	6.7%
buses	613 million	RIVM, 2000	4.6	2,801 million	7.8%
total	-	-	-	39,687 million	100%

This implies that roughly 84% of the budget is allocated to lorries.

64 Due to rounding the total does not add to 100%.

Calculation of change in fuel demand due to fuel price decrease for lorries

Lorries:	- 4.7% * - 0.30 = + 1.41%
Shipping:	- 4.7% * + 0.06 = - 0.28%
Rail:	- 4.7% * + 0.22 = - 1.03%

Calculation of environmental effect of tax refund (in tonnes)

Lorries:	CO_2: 6,439,000 * + 1.41% = + 90,771
	NO_x: 67,500 * - 1.41% = + 952
	PM_{10}: 2,300 * -1.41% = + 32
Shipping:	CO_2: 2,069,000 * - 0.28% = + 5,833
	NO_x: 39,700 * - 0.28% = - 112
	PM_{10}: 1,700 * - 0.28% = - 5
Rail:	CO_2: 54,000 * -1.03% = + 558
	NO_x: 1,200 * - 1.03% = - 12
	negligible
Total:	CO_2: + 90,771 – 558 – 5,833 = + 84,379
(absolute)	NO_x: + 952 – 12 – 112 = + 828
	PM_{10}: + 32 – 5 = + 27
Total	CO_2: (+ 84,379 / 8,562,000) * 100% = + 1.0%
(relative)	NO_x: (+ 828 / 108,400) * 100% = + 0.8%
	PM_{10} (+ 27 / 4,000) * 100% = +0.7%

Calculation of economic effects

Vehicle km:	+ 4.7% * -0.13 = - 0.61
Tonne km:	+ 4.7% * -0.07 = - 0.33
Price increase	+ 4.7% * (0.7% / 8.3%) = + 0.4%

G France - maritime transport

G.1 Description of the support measure

The support measure analysed in this case study is the refund of social security and unemployment premiums to maritime carriers in France.

The target group of the tax compensation scheme consists of French ocean shippers. The carriers can obtain a refund of the social security and unemployment premiums paid on behalf of employees from the EU, to the extent that these employees work on French ships. The scheme does not apply to French-owned vessels sailing under a foreign flag. .

The aim of the support measure is to improve the competitiveness of the French maritime sector outside the EU. A secondary aim is to promote the employment of EU citizens in the French maritime sector.

The yearly budget of the scheme is estimated at € 22.8 million [European Commission, 2001].

G.2 Mechanisms

The result of the fiscal compensation scheme is that EU workers become cheaper relative to non-EU citizens. In this section we discuss what effects this could have on the maritime sector. On the one hand the fiscal compensation gives an incentive to the carrier to employ EU citizens rather than non-EU citizens. On the other hand, labour becomes cheaper (assuming that French carriers already employ EU citizens). This results in a cost advantage, compared to other carriers.

The change in business strategy resulting from this kind of support measure depends on the relative cost savings for the companies in question and on the market situation. If the cost reduction is substantial and the carriers are price setters, the companies could increase their market share by lowering their prices. This would have an environmental impact, because demand for maritime shipping would increase. If the carriers are price takers, a price reduction is not a likely option.

If the cost reduction is negligible relative to total operating costs, the environmental effects are likely to be negligible as well. Hiring a higher share of cheaper labour from non-EU countries may, in this case, compensate for the higher costs in the absence of support.

G.3 Environmental impact

In this section we investigate the environmental impact of the fiscal compensation in the form of refund of premiums.

G.3.1 Demarcation

In calculating the environmental effects, we take into account possible substitution to the competitive transport modes air and rail. Only if a higher share of cheaper labour from non-EU countries could compensate for the loss of support for the maritime sector would there be no substitution to other modes.

G.3.2 Method

We start by defining a reference scenario in which the fiscal compensation is no longer given. For determining the environmental impact of the compensation, we compare the reference scenario with the current situation. We determine the environmental impact as follows:

1. Estimate the cost reduction for carriers due to the support scheme.
2. Given the cost reduction and the maritime shipping market, work out the most likely response of French carriers.
3. Determine the environmental effects of the fiscal compensation, based on the predicted response of French carriers.

G.3.3 Results

The total turnover of the French maritime sector was € 3.9 billion in 1997[65] [Ifremer, 1999]. In that year the biggest French carrier, Holding CMA CGM S.A., achieved a turnover of € 1.2 billion [CMA CGM S.A., 2000].

The total operating expenses of CMA CGM amounted to € 1.9 billion in 2000, with personnel costs making up **6%** [CMA CGM S.A., 2001]. We assume that the total support is distributed over all recipients proportionally to their turnover, which implies that one third of the total budget of the support scheme goes to CMA CGM. Underlying this assumption is the assumption that the percentage of EU employees at CMA CGM is equal to the percentage in the French maritime sector as a whole.

This assumption is necessary because there is no information available on the composition of the labour force of the French fleet. With a third of the total budget going to CMA CGM, this means a cost reduction for CMA CGM of € 7.6 million, or 6.7% of total personnel costs. Although this cost reduction seems quite significant, it is only 0.4% of total operating costs. This implies that the scheme reduces the total costs of French carriers by 0.4%.

This means that in the reference scenario, total costs are approximately 0.4% higher than in the current situation. These higher costs might induce the following difference between the two scenarios:

- higher prices for maritime transport in the reference scenario, to compensate for the higher labour costs;
- more non-EU employees in the reference scenario, to compensate for more expensive French employees;
- no difference, so that the maritime sector accepts the loss of the higher costs, leading to lower profit margins.

Carriers are mainly price takers[66]. This means that individual carriers are unable to increase their prices without risking a substantial loss of market

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65 The most recent year for which data are available.

66 Personal communication, dr. ir. F. Waals, TU Delft.

share. It is therefore more likely that carriers will try to reduce costs by employing more foreign personnel or simply accept the extra costs. The profit margin of CMA CGM was 5.3% in 2000; it would be 4.9% without support, if the share of EU employees remained the same. If the share of EU employees decreases, this effect on the profit margin is an overestimate.

The environmental effect of this support scheme is negligible. Abolishing the support would lead to a maximum cost increase of 0.4%. Moreover, there is reasonable evidence that this small increase in costs will not even lead to a price increase. This is because carriers are price takers and because they have options to cut their costs by hiring cheaper personnel on the ships. Therefore, no substitution effects to air and rail transport are to be expected.

G.4 Economic effects

We expect, from the above analysis, no change in prices and only a small change in profits for French maritime carriers. Therefore, the only substantial economic effects relate to the number of employers from EU countries.

Abolishing the refund will encourage French carriers to employ relatively more non-EU workers. The extent of this shift depends on the change in costs for EU personnel in the scenario without support. In order to calculate the effect on the cost of EU ship labour, we need to know the current share of EU workers *on the ships* in the French maritime sector.

From [CMA CGM, 2002] we obtained an estimate of the share of sailors in total personnel of 20%. This implies that roughly 20% of total personnel costs at CMA CGM can be attributed to sailors, assuming similar labour costs for sailors and other personnel. As total personnel costs amount to € 113.5 million, sailors will account for roughly € 23 million.

Given that of 75% of the sailors are EU workers[67], the labour costs of the EU workers amount to 75% of € 23 million, i.e. € 17 million.

In section G.3.3 it was calculated that abolishing the support would lead to increased costs for EU workers among the sailors of € 7.6 million, which is thus equal to 44% of the total labour costs of EU sailors.

This is a substantial difference and abolishing the support could therefore lead to major substitution from EU to non-EU workers. Demand elasticities in this specific sector are unclear, but the effect is likely to be large.

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G.6 Annex: Calculations

In this section we present the detailed calculations made in the analysis above.

Calculated support to CMA CGM
€ 22.8 million (total support) times € 1.2 billion/€ 3.9 billion (share of CMA CGM in total turnover of French maritime sector) = € 7.6 million

Calculated cost reduction for CMA-CGM due to the support measure
(€ 22.8 million / 3) / (€ 1.9 billion) = 0.4%

Calculated economic effects of the support measure
EU personnel costs: 80% of € 113.5 million = € 90.8 million
Effect on costs of EU personnel: € 7.6 million / € 90.8 million = 8.4%

H Portugal - air transport

H.1 Description of the support measure

In 2000, Portugal notified the European Commission about the first phase of privatising the airline company TAP. This phase consists of increasing the company's own capital by floating new equities, offered to SAirGroup. The value of these equities was based on the company's estimated value: € 299 million in February 1999. However, at the end of 1999 it was found that pension schemes were undercapitalised, a fact not known when the company was valued. To compensate for this lack of capitalisation, the Portuguese government agreed in February 2000 to inject additional capital into the company, to an amount of € 11.4 million (precisely the lack of capitalisation on pension schemes) [European Commission, 2000]. This capital injection of € 11.4 million is the amount of support examined here.

H.2 Mechanisms

Against this background, the question of interest here is how TAP would most likely have behaved if this capital injection had not been given. As the Portuguese government had already made an offer for equities to SAirGroup, we think it unlikely that SAirGroup would have furnished the additional capital required[68]. What were the options for TAP then, had the capital injection not been given? Below, we examine several possibilities.

The first possibility is rather drastic, namely bankruptcy of the company. If this had happened, other companies would have (partly) taken over the services provided by TAP. This might have resulted in price changes and changes in the destinations offered, both influencing demand for TAP's air services.

The second option for TAP is to accept the losses and pursue its business strategy unchanged, i.e. charge the same ticket prices. In that case the capital injection would have effectively had no environmental impact.

To compensate for the loss of capital injection, in part or whole, TAP could also increase its prices. A price rise would lead to a fall in demand for TAP services. TAP could raise its prices particularly on routes where competition from other airline companies is low. In that case, a price increase would result mainly in lower demand for TAP services and hardly result in any increase in demand for other airlines.

H.3 Environmental impact

In this section we investigate the environmental impact of the capital injection in 2000.

[68] Another possibility is that renegotiation of the value of TAP with SAirGroup could have led to the latter paying a lower price for its share in TAP. This would have led to a situation without government support and the case would not then have been taken as a case study heret.

H.3.1 Demarcation

First, we confine ourselves to effects in the air transport sector itself. We assume that a price increase in the Portugese air transport sector has a negligible effect on demand for other transport modes. The most obvious substitute for air transport in general are high-speed trains, but Portugal has none. For longer distances, the car is a very poor substitute because of time considerations.

To calculate the emissions of the TAP fleet we use emission factors for two representative types of aircraft operated by TAP. We assume that load factors are constant. This means that we consider long-term effects only. In the short term, load factors will probably change before TAP decides to alter the number of flights.

In terms of environmental effects we confine ourselves to the three most important aircraft emissions: CO_2, NO_x and noise.

H.3.2 Method

We compare the actual situation, that with capital injection, to the situation without: the reference scenario. The difference in environmental impact between those two scenarios is taken to equal the environmental impact of the capital fund. We calculate this difference as follows:

1. We assume that TAP raises the price of its air services in the scenario without capital injection, to compensate fully for the foregone capital. We determine the percentage price increase necessary to compensate for the absence of these funds.
2. The higher price of air transport in the reference scenario will lead to lower transport volumes **and** to fewer landing and take-off cycles (LTO cycles). We use available own price elasticities to determine the difference in transport volumes and number of LTO cycles, for both passenger and freight transport.
3. Emissions per tonne kilometre and passenger kilometre differ substantially between small and large aircraft. We therefore estimate the fraction of tonne kilometres and passenger kilometres flown in each.
4. Using this information and respective emission factors for small and large aircraft, we calculate the extent to which the lower demand for air transport in the reference scenario leads to a lower environmental impact.

H.3.3 Results

If we look at TAP's profit figures over the last years, we observe very low (often negative) profits in the period 1996-1999 [BAE Systems, 2001]. Still, the net results are above budget forecasts [TAP, 2002]. Comparing the capital injection (€ 11.4 million) with net results in the period 1996-1999 (from minus € 50 million in 1999 to plus € 40 million in 1997), it seems unlikely that a lack of capital injection would have led to TAP's bankruptcy.

However, for a company operating with very low profit margins, € 11.4 million could make just the difference between loss and profit. TAP may not go bankrupt because of such funds, but they may trigger a change in behaviour. In this case study we chose as the most likely response the option in which TAP increases its prices. The detailed calculations of this analysis are provided in H.6.

Figures for 1999 show total revenues for TAP of over € 1 billion [BAE Systems, 2001]. In 2000, total passenger kilometres increased by over 10%. There is no information available on revenues in 2000 and we therefore had to make an assumption on this point. If we assume that total revenues increased proportionally to total passenger kilometres in 2000, the support amounted to 1% of total revenue. This means that in order to cover the lost support, the price of air transport in the reference scenario must be 1% higher. To estimate the effects of this price increase, we gathered information on price elasticities.

Recent analysis estimates the price elasticity of passenger air transport at around –1.0 [Brons et al., 2001]. MVA Consultancy works with the same elasticity for freight transport in their ADEM model [Hancox and Lowe]. We therefore take an elasticity of –1.0 to estimate the impact on passenger volumes as well as freight volumes, yielding respective reductions of 1% each in response to a price increase of 1%.

We assume that TAP will increase their prices particularly on routes where competition from other airlines is low. With such a price discrimination strategy, the chances of TAP losing customers to other airlines are smaller. From this assumption it follows that TAP's price rise will not have much influence on demand for flights by other airlines. Our assumption that TAP does not increase the price of *all* routes by 1% has no consequences for the average own price elasticity of –1.0. The *average* price increase will be 1%, so the average fall in demand will be 1% as well.

To estimate the environmental impact of a change in passenger and freight volumes we need information on the emission factors valid for the TAP fleet[69]. This fleet comprises 34 Airbus planes. In AERO (2001) emission factors for different types of aircraft are calculated using the Flights and Emissions Model (FLEM). This model was developed under the auspices of the Dutch Civil Aviation Authority within the framework of the AERO project. In this case study we use these figures to calculate the environmental effects.

Because emissions per passenger and tonne kilometre differ substantially between small and large aircraft, we here differentiate between the two. The TAP fleet can be divided into 16 'small' and 18 'large' aircraft, with weighted average seating capacities of 132 and 200, respectively. Using these figures to allocate transport volumes proportionally to the two categories of aircraft, we calculate that the large aircraft are responsible for 63% of total passenger kilometres[70]. We use this number in our calculations.
The next table summarises the impact of a 1% increase in the price of air transport on number of passenger kilometres and tonne kilometres and LTO cycles.

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69 For noise, these emission factors are not available. We will therefore consider noise separately after the emissions analysis.

70 Calculated as the weighted average of small and large aircraft: 200*18/(200*18+132*16). Implicit in this calculation is the assumption that the number of kilometres flown by large aircraft is equal to the number of kilometres flown by small. Although large aircraft fly longer distances, small aircraft fly more frequently. Figures for TAP destinations from Portugal's largest airport Lisbon show that if destinations further away than 1,800 km are flown by large planes and the rest by small, the number of kilometres flown by each is about the same [Ana, 2002]. See also section H.6.

Table 28 Effect of a 1% price increase on number of passenger kilometres and tonne kilometres and LTO cycles

	Current situation	Situation without support	Difference	
			Small aircraft	Large aircraft
passenger km (millions)	10,393	10,288	39	66
tonne km (millions)	381[71]	378	1.4	2.4
LTO cycles	34,800	34,448	166	186

Source: http://www.tap-airportugal.pt/portal/v10/PT/jsp/index.jsp and own calculations (CE)

Now, using the emission factors of the FLEM model [AERO, 2001] and load factors given by TAP [BAE, 2001][72] we can calculate the environmental impact of the support measure. The results are shown in Table 29.

Table 29 Estimated environmental impact of capital injection to TAP

	Emission factors (gram per kilometre/Landing and Take-Off cycle)	Total effect (tonnes)
CO_2		
Passenger km, small aircraft	106	4,104
Passenger km, large aircraft	74	4,891
Tonne km, small aircraft	1,056	1,506
Tonne km, large aircraft	739	1,795
LTO cycles, small aircraft	2,553,371	422
LTO cycles, large aircraft	4,307,501	802
Total CO_2-emissions		**13,521**
NO_x		
Passenger km small aircraft	0.31	12
Passenger km large aircraft	0.26	17
Tonne km small aircraft	3.07	4
Tonne km large aircraft	2.57	6
LTO-cycles small aircraft	8,340	1
LTO-cycles large aircraft	26,994	5
Total NO_x-emissions		**45**

We estimate that the predicted price change in the situation without capital injection would reduce CO_2-emissions by over 13,500 tonnes and NO_x-emissions by 45 tonnes. For both pollutants this implies emissions are about 1% higher in the situation with capital support, relative to that without.

In addition to these reductions in gaseous emissions, aircraft noise emissions will also decrease. However, this latter effect is rather more difficult to calculate, because of the non-linearity of noise production. A 1% decrease in aircraft movements will not lead to a 1% decrease in noise. In [CE, 2000] the relationship between aircraft movements and noise is described as logarithmic. This implies that, given the decrease in LTO cycles in the situation without support, noise emissions will decrease by (much) less than 1%.

71 The TAP figures relate only to number of tonnes carried. The FLEM emission factors are given per *tonne kilometre*, however. To calculate these tonne kilometres we assumed that the ratio of the average flight distance of freight to the average flight distance of passengers is the same for TAP as for KLM airlines.

72 The load factor used for TAP is 67.8%.

These environmental effects might be smaller, depending on the potential for substitution by other (air) carriers. As pointed out above, however, within the scope of this case study it was not possible to estimate this substitution.

H.4 Economic effects

We estimate the market price of TAP air services without capital injection to be 1% higher than in the current situation (see section H.3). Because we assume an elasticity of –1, TAP turnover will remain practically unchanged. Sales will be 1% down, and prices 1% higher.

Effects on employment can be estimated as follows. TAP has nearly 8,300 employees [EIRO, 1999]. If employment decreases proportionally to the reduction in tonne kilometres and passenger kilometres performed, i.e. 1%, there would be a loss of 83 jobs without capital injection. The fall in demand for TAP flights might, however, be partly compensated by an increase in demand for flights by other airlines. This would reduce employment effects in the airline industry as a whole, although there will be some substitution of jobs from TAP to competing airlines.

Further to this, using the public budget alternatively, for example by reducing labour taxes, might increase the overall efficiency of the Portuguese economy, resulting in employment growth in other sectors. Given the small amount of support concerned, this effect would not be large but it would lower the initially anticipated job loss at TAP.

Resumé

The results show that initial expectations during selection of this case study were mistaken. The main reason is that, after detailed study of the measure, we found that the total budget announced in the state aid register was significantly higher than the actual budget. A major portion of the amount cited appeared to be a transfer of private money, so that only a small fraction can be regarded as government support.

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H.6 Annex: Calculations

In this section we provide the detailed calculations used in the analysis of the environmental and socio-economic effects of support removal.

Calculation of impact of capital injection on price of TAP air transport
€ 11.4 million / (€ 1,020 million + 10%) * 100% = 1.0%

Calculation of total kilometres flown by large and small aircraft

Table 30 Destinations and distances flown on a random day (Thursday June 30, 2002) from Lisbon by TAP

Destinations > 1,800 km	Distance	Destinations < 1,800 km	Distance
Amsterdam (3x)	1,861 * 3 = 5,583	Barcelona (4x)	996 * 4 = 3,984
Copenhagen	2,477	Brussels (3x)	1,713 * 3 = 5,139
Caracas	6,512	Faro (4x)	297 * 4 = 1,188
Fortaleza	5,834	Funchal (7x)	963 * 3 = 6,741
Frankfurt (2x)	1,880 * 2 = 3,760	Geneva	1,497
Luanda	7,145	Horta	1,564
Munich	1,965	London (5x)	1,585 * 5 = 7,925
New York	5,438	Madrid (5x)	501 * 5 = 2,505
Recife	5,834	Milan (3x)	1,685 * 3 = 5,055
Roma (2x)	1,873 * 2 = 3,746	Paris (5x)	1,452 * 5 = 7,260
Sal	2,783	Porto (7x)	312 * 7 = 2,184
Sao Paulo	7,927	Terceira (2x)	963 * 2 = 1,926
		Zurich (2x)	1,722 * 2 = 3,444
Total	59,004		50,412
Total per aircraft	59,004 / 18 = **3,278**		50,412 / 16 = **3,151**

Source: Ana, 2002 for destinations. Distances from US Census data using the 'geod' program available from the website http://www.indo.com/tips/distances.html

Calculation of increase in demand due to capital injection

Million passenger km:	1% of 10,393 = 105, of which:
Large aeroplanes:	63% of 105 = 66
Small aeroplanes:	37% of 105 = 39
Million tonne km:	1% of 381 = 3.8
Large aeroplanes:	63% of 3.8 = 2.4

Small aeroplanes:	37% of 3.8 = 1.4
LTO cycles:	1% of 34,800 = 352
Large aeroplanes:	(18 large/ 34 total) * 352 = 186
Small aeroplanes:	(16 small / 34 total) * 352 = 166

I Denmark - rail transport

I.1 Description of the support measure

In the year 2000, the Danish railway company DSB received € 464 million of contract payments from the government [DSB, 2001]. In return, DSB has committed itself to providing a certain quality of rail services, by investing in rolling stock, for example, and maintaining non-profitable lines.

The Danish Ministry of Transport is currently restructuring the rail transport sector. At the end of 2001, part of the rail network was tendered. From 2003 onwards, Arriva is to handle 15% of rail passenger transport. After evaluation of this move towards competition in the Danish rail sector, another 10% may possibly be tendered. Together with these changes in market structure, the cost of maintaining a certain level of rail transport service will be reduced.

In this case study we consider the € 464 million support provided to DSB as it existed in 2000. In the next section we first describe the mechanisms that might come into play in the absence of this support to DSB. These mechanisms will largely determine the environmental impact of support removal, as calculated in section I.3, and the economic effects, as described in section I.4.

I.2 Mechanisms

In this section we take a closer look at the mechanisms that come into play in the absence of contract payments to DSB. The relative magnitude of the support is obviously a key factor here. It turns out that these contract payments account for approximately 40% of DSB's overall turnover [DSB, 2001]. This means that without the payments DSB would have to cut costs or increase revenues dramatically in order to remain profitable.

Removing the support would cause a major deficit and might even cause DSB to go bankrupt[73]. However, this scenario might be avoided by reducing costs or increasing revenues.

DSB has various options for reducing costs in the absence of contract payments. DSB receives the payments on condition that it fulfils certain obligations; without contract payments, these obligations would disappear. This means DSB could reduce costs by, for example, closing non-profitable lines, reducing investments with a low return, or putting on fewer trains in off-peak hours. However, this conflicts with the Danish government's aim to maintain a certain standard of rail services in all areas[74].

Another possibility is to increase ticket prices to compensate for the loss of government payments. Both options would induce a shift from rail transport to road transport, because the quality/price ratio of DSB services will fall.

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[73] Personal communication, Danish Ministry of Transport.

[74] Personal communication, Danish Ministry of Transport.

I.3 Environmental impact

In this section we investigate the environmental impact of the contract payments to DSB compared to a reference scenario in which no such payments are provided. We first demarcate the analysis, then describe the method we used and conclude by presenting the calculated environmental effects.

I.3.1 Demarcation

We assume that DSB will not go bankrupt after discontinuation of contract payments, nor that any lines will be closed. If DSB could reduce costs dramatically by closing certain non-profitable lines, they would probably do so. The profitable lines will remain in service and we do not therefore expect DSB to go bankrupt. However, price increases and closing of non-profitable lines both lead to the same outcome: a reduction in demand and a substitution to other transport modes. Whether the reduction in demand is due to line closures or higher prices is irrelevant to an analysis of environmental effects. For a better understanding of our calculations, we will base these on the assumption that no lines are closed. If certain lines were to be closed, the resulting decrease in rail transport, increase in road transport and corresponding environmental effects as considered here would be the same.

To estimate the environmental impact we will examine the effects on rail transport itself as well as the effects of substitution to the principal competing transport mode, road.

We confine ourselves to passenger transport, because goods transport comprises only a very small portion of total rail transport [DSB, 2001]. An analysis of this part would provide very little additional insight into the expected effects of the support measure.

Unless otherwise stated, we assume that the load factors[75] of the various transport modes remain unchanged after removal of support[76].

In terms of environmental effects we confine ourselves to CO_2-emissions and NO_x-emissions, the two most important emissions when considering rail and road transport.

I.3.2 Method

The method we apply starts by defining a reference scenario in which contract payments are not given. We assume that in this reference scenario DSB must charge higher prices to fully compensate for the loss of payments. In all likelihood, DSB will also introduce a range of cost-cutting measures, which will lead to a lower quality/price ratio. Therefore, regardless of how DSB responds, abolishing the support will lead to a lower quality/price ratio.
Having made this assumption, we adopt the following method.

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[75] Load factors are defined as the ratio of actual number of passengers handled to passenger transport capacity. For DSB this load factor was roughly 30% in 2000.

[76] Potential changes in load factors are difficult to predict, because the response of DSB may vary. One possible response would be to cut the number of trains while still serving the same number of passengers. This would reduce costs through higher load factors. However, the extent to which DSB will respond thus is impossible to predict, given the large price rise.

1 The higher price of rail transport in the reference scenario leads to lower rail transport volumes, partly substituted for by higher road transport volumes. We assume that price differences have no influence on load factors.
2 On the basis of existing own price elasticities we determine the difference in rail transport emissions between the two scenarios. We assume that the ratio of passenger kilometres in diesel trains and passenger kilometres in electric trains is equal in the two scenarios[77].
3 On the basis of existing substitution elasticities we determine the difference in road transport emissions between the two scenarios. We assume that the ratio of diesel vehicle kilometres and petrol vehicle kilometres is equal in the two scenarios[78].
4 On the basis of emission factors we determine the extent to which the lower demand for rail transport and higher demand for road transport lead to a reduction in environmental impact.

I.3.3 Results

In 2000, DSB's total operating revenue (with support) was € 569 million. To arrive at the same revenue without support, prices in the reference scenario would have to increase by 82%[79] relative to the current situation. More on the calculation of this price increase and other calculations can be found in section I.6.

With such high price rises one must be careful when choosing elasticities. The own-price elasticity is defined as the percentage change in demand in response to a 1% increase in the price of rail transport. Substitution elasticity is defined as the change in demand for another transport mode in response to a 1% increase in the price of rail transport.

[MuConsult, 1997] found that the own-price elasticities of large price rises are lower than for small rises. Data from COWI[80] show that the own-price elasticity for rail is –0.5 for commuting and –0.9 for leisure travel, with an average of –0.7. Because those elasticities reflect the response to small changes in prices, we use a conservative elasticity of –0.5.

There is no information available about the increase in road traffic that would be induced by higher train prices in Denmark. We therefore deduce the substitution from rail to road transport from information available in the Netherlands [Dutch Ministry of Transport, Public Works and Water Management, 1999].

This document states that the impact on car usage of price changes in public transport is very low. The first explanation of this phenomenon is that many commuters and business travellers are refunded their travel expenses by employers. Another explanation is that the price does not change the quality of public transport. The shorter travel times for car usage are particularly relevant in this respect. The introduction of free public transport in the Belgian town of Hasselt may serve as an example here. The number of bus users increased threefold, with six times the number of rides and a doubling of

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77 The basis of this assumption is that support removal is of no direct influence on this ratio.

78 Support removal would have no direct effect on this ratio either.

79 Calculated as follows: € 464 million of support, divided by € 569 million, current DSB revenues exclusive of support.

80 Personal communication, Mrs. Bøgelund, COWI.

of lines. However, only 16% of the (new) bus users had done the same journey earlier by car.

An increase in train ticket prices leads to a fall in demand for rail transport. Because of the minor response of car users to changes in train ticket prices, a 10% increase in the latter leads only to a 0.2% increase in car usage [Dutch Ministry of Transport, Public Works and Water Management]. This means that 25% of the fall in demand for rail transport shifts to road transport (see calculations in section I.6). For Denmark, this implies that a 10% increase in the price of rail transport will lead to an increase in demand for road transport of 0.16%[81].

This substitution boils down to the following: of each rail passenger passenger kilometre less in Denmark, one-quarter shifts to road transport. The remaining 75% is a mixture of decline in passenger transport and an increase in car load factors.

The next step is to retrieve emission factors for rail and road transport. For rail transport we took these figures from a DSB annual report, for road transport from the Danish Statistics Bureau[82].

Table 31 shows the differences in emissions from rail transport between the reference scenario and the current (i.e. 2000) situation.

Table 32 shows the increase of emissions through substitution to road transport and we conclude with Table 33 in which the net effects of the support measure are given.

Table 31 Difference in rail transport emissions between current situation and reference scenario

	current emissions (tonne) (a)	price difference in reference scenario (b)	own-price elasticity (c)	% difference in emissions (d) = (b) * (c)	absolute difference (tonne) (e) = - (a) * (d)
CO_2	274,546	82%	-0.5	-41%	+111,914
NO_x	2,944	82%	-0.5	-41%	+1,200

Source: [DSB, 2001]

The above table shows that the support measure leads, unintentionally, to increases of almost 112 kilotonne CO_2 and 1,200 tonne NO_x in rail transport emissions.

With the support in place, however, road transport emissions will be lower. The following table shows the difference in road transport emissions between the actual and reference scenario.

81 In the Netherlands this elasticity is slightly higher: 0.2%. Applying this figure to Denmark, the shares of road and rail transport in the respective countries must be taken into account. The share of rail transport in Denmark is smaller than in the Netherlands and thus the same number of kilometres shifting from rail to road transport equals a lower percentage of road transport (0.016 instead of 0.02). See also the calculations in section I.6.

82 COWI provided the figures.

Table 32 Difference in road transport emissions between current situation and reference scenario

	current emissions (tonne)[83] (a)	price difference reference scenario (b)	substitution elasticity rail to road (c)	% difference in emissions (d) = (b) * (c)	absolute difference (tonne) (e) = - (a) * (d)
CO_2	6,533,000	82%	0.016	1.31%	-85,218
NO_x	31,298	82%	0.016	1.31%	-416

Combining the last two tables, we can calculate the net environmental impact of the contract payments to DSB (Table 33).

Table 33 Environmental impact of contract payments to DSB

	CO_2 (tonnes)	NO_x (tonnes)
Impact on rail emissions	+111,914	+1,200
Impact on road emissions	-85,218	-416
Total impact of payments to DSB	+26,696	+784

We estimate that the contract payments lead, relative to the reference scenario, to higher CO_2 and NO_x-emissions. The increase in CO_2-emissions is 0.4% (of total emissions from rial and road passenger transport); the increase in NO_x-emissions is 2.3%.

Based on the above calculations, we conclude for this case that support to rail transport in Denmark leads to higher overall emissions. Hence, removal of the support would lead to lower emissions compared with the current situation. This result depends to a large extent on the relatively low substitution elasticities between road and rail transport.

I.4 Economic effects

First, the contract payments have a substantial influence on the market price of rail transport. Assuming constant quality of rail transport services, the price of rail transport without such payments would be approximately 82% higher. This price rise might be kept down by DSB reducing the quality of its rail services, or increasing overall company performance. Abolishing the contract payments might trigger both these measures.

Reduced quality and higher prices will reduce the competitiveness of rail transport compared to other modes (especially road transport), while any increase in efficiency will boost competitiveness. Because the contract payments make up such a relatively large share of DSB's operating budget, increased efficiency could never compensate fully for the loss of contract payments. The competitiveness of rail transport would therefore decline if this support were to be abolished.

The expected price rise calculated in section I.3.3 was 82%, which, together with a price elasticity of – 0.5, would lead to a 41% decrease in passenger rail transport. What would be the likely social impact of this change in market structure?

[83] On the basis of information from COWI.

The biggest anticipated social impact of removing this support is probably associated with line closure and higher ticket prices. Both these impacts would reduce travelling opportunities for the disabled and elderly and for those that cannot afford to drive a car. Given the lack of information on which lines might be closed and the specific characteristics of the customers formerly served on these lines, it is not possible to describe this social impact in quantitative terms. It is, however, the social impact that is feared most by the Ministry of Transport in Denmark[84].

DSB employs almost 10,000 people [DSB, 2001]. If we assume that a reduction of passenger kilometres leads to a proportional decrease of employment, a reduction of approximately 40% of passenger kilometres would cost some 4,000 jobs in the rail transport sector. Abolishing the support would reduce government expenditure by € 464 million. Assuming annual wage costs of € 45,000, the support budget could be used to deploy more than 10,000 people (€ 464 million divided by € 45,000).

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I.6 Annex: Calculations

In this section we present the detailed calculations used in the analysis above.

Calculation of impact of support on price of rail transport
€ 464 million support / € 569 million current revenues without support = 82%

Calculation of rail to road substitution elasticity in Denmark
0.02 % * [(15,400 / 89,100) / (5,381 / 38,186)] = 0.016%
Rail km, Denmark: 5,381 million kilometres
Road km, Denmark: 38,186 million kilometres
Rail km, Netherlands: 15,400 million kilometres
Road km, Netherlands: 89,100 million kilometres

Calculation of environmental effects of support
Rail CO_2 274,546 tonne * (0.5 * 82%) = 111,941 tonne
Road CO_2 6,533,000 tonne * (- 0.016 * 82%) = - 85,218 tonne
Total absolute effect CO_2: + 111,941 – 85,218 = 26,696 tonne
Total relative effect CO_2: 26,696 / (274,546 + 6,533,000) * 100 % = - 0.4%
Rail NO_x 2,944 tonne * (0.5 * 82%) = 1,200 tonne
Road NO_x 31,298 tonne * (- 0.016 * 82%) = - 416 tonne
Total absolute effect NO_x: + 1,200 – 416 = + 784 tonne
Total relative effect NO_x: + 784 / (2,944 + 31,298) * 100 % = + 2.3%

[84] Personal communication, Danish Ministry of Transport.

J France - Covering the risk ofsevere nuclear accident

J.1 Description of the support measure scheme

Risk studies show that nuclear reactor operations are generally accompanied by the risk of severe accident, even though that risk may be small. Severe nuclear accidents are accident sequences that lead to a loss of confinement of the radioactive inventory of the reactor. Certain accident sequences may lead to the release of relevant parts of the inventory to the environment; subsequent dispersion would result in health, environmental, and economic damages.

Industrial risks are usually evaluated as a function of their probability and the projected magnitude of damages. They are usually covered by an insurance policy, for which the operator of the hazardous plant pays premiums. The premium paid depends on the quantitative risk involved, as calculated by the insurance company covering it. Throughout the economy these insurance premiums usually form a standard element of production costs and contribute to the product price. Insurance premiums for high-risk production facilities thus result either in higher production costs or in efforts to avoid or limit risks and associated costs, or in both.

The potential damages from a severe nuclear accident are covered by insurance to a limited extent only. A considerable part of the risk remains financially underinsured, leaving the bulk to government treasuries and reducing nuclear power production costs considerably. The portion of risk covered by the state is subject to international frameworks and EU regulations, within which national regulations operates.

Even though is common practice in most countries where nuclear reactors are operated, we have selected France as an example to evaluate the effect of this indirect support measure. This is because this country currently has 58[85] operational nuclear reactors, accounting for about 40% of the reactors and over 50% of nuclear generation capacity in the EU15. In France, furthermore, the insurance sum required for severe nuclear accidents is among the lowest in the OECD. This may be an indication that the French nuclear industry receives indirect support through insufficient insurance coverage of nuclear risks.

J.2 Mechanisms

Removal of this indirect support measure, viz. part-liability for the risk of severe nuclear accident, may induce the following mechanisms and environmental effects:

- Internalisation of the total insurance costs of such risk by plant operators may worsen the market position of nuclear power and may consequently reduce overall consumption thereof.
- A specific environmental effect of nuclear power generation is the (unavoidable) co-generation of highly radiotoxic, very long-lived and heat-producing radioactive wastes. These wastes require thorough isolation from the biosphere for extremely long periods of up to 10 million years. Reduced consumption of nuclear power could reduce the overall amount

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[85] This figure does not include the Phenix facility, for which a decision on future operation is currently pending.

of waste and reduces the very long-term risk associated with disposal of such wastes in deep geological formations[86].

- State coverage of the bulk of nuclear risk reduces internal incentives for risk reduction. The potential costs of any such measures to reduce risks are not balanced by economic benefits (e.g. reduced premiums). Importantly, the operational lifetime of older reactors is prolonged, even though these reactors tend to meet current safety requirements less perfectly than reactor types of more modern design.

J.3 Environmental impact

In this section we investigate the environmental impact of the support measure compared with the situation without.

J.3.1 Method

To assess the environmental effects of the support measure a five-step procedure was employed:

- determine the range of damage costs of a severe nuclear accident per kiloWatt hour (kWh) based on different international studies;
- describe current insurance practice with respect to coverage of these damages;
- determine the amount of indirect support by assessing the extent to which damages for which insurance is necessary remain uncovered;
- determine the degree to which insurance costs are not yet included in nuclear power production prices and the consequences of full cost internalisation for the per kWh price of nuclear power;
- analyse the impact of the implied price changes and the associated environmental and economic effects.

J.3.2 Severe-accident frequencies and damages

Risk studies on nuclear reactors have been carried out for over 30 years. Common results for core melt accidents in USA, France and Germany yield probabilities of $5 \cdot 10^{-5}/a$[87]. For the approx. 140 nuclear power plants (NPP) currently operating in the EU, and assuming an operational lifetime of 25 years each, the probability of such an accident is thus around 20%. Around one fifth of the accidents studied are associated with very large release fractions. The uncertainties in these analyses cover approximately one order of magnitude, demonstrating that risks of this kind are not purely hypothetical but must be considered a rational possibility. Note that the core damage frequencies calculated for French NPP types fit well within the international bandwidth of results (see also annex J.5).

Estimates of the potential damages resulting from a severe nuclear accident extend across a wide range. Combined with the variations in estimated accident frequency, reported costs per kWh generated vary over more than 6 orders of magnitude. Figure 3 reviews the results of key impact analysis

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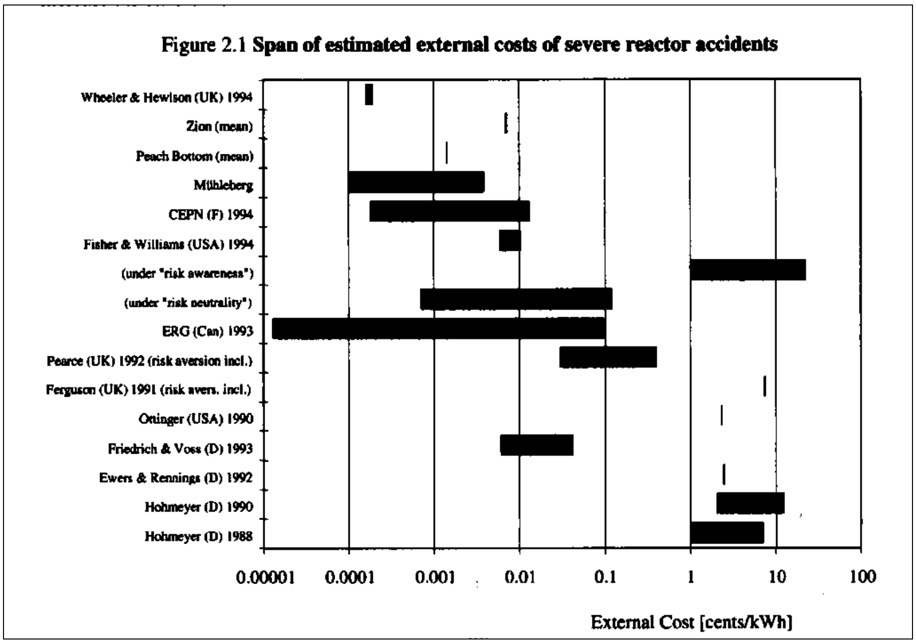
[86] The fraction of long-lived isotopes in the waste to be disposed of plays a key role in the probabilistic risk analysis of final nuclear waste disposal (numbers of repositories required, extent of disposal drift, potential for water contact and dispersion, collective doses following repository isolation failure, human intrusion probabilities and damages, etc.).

[87] For a detailed description of severe accident probabilities see the annex to this chapter.

studies. The “ExternE”-study, conducted for the European Commission, is listed in this figure as “CEPN 1994”.

Figure 3 Span of estimated costs of severe reactor accidents per generated unit of electricity



Source: NEA[88]

The NEA document from which this figure is taken[88] discusses several important reasons for the wide differences apparent in the figure (p.36):

– accident frequencies: site-specific and generic data differ by up to three orders of magnitude;
– impact analysis: the source terms used in the different analyses vary[89];
– location: plant location is of major influence (population density, etc.);
– scope: modelling of the accident spectrum varies and may be specific or systematic; some studies consider only radiation-induced health damage, others a wide range of economic consequences (such as loss of

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88 NEA: Methodologies for Assessing the Economic Consequences of Nuclear Reactor Accidents. – Paris 2000, p.34.

89 Possibilities for the source term include: (i) estimates, (ii) plant-specific analyses, and (iii) adoption of the collective dose equations familiar from the Chernobyl accident. It should be stressed that the latter option refers *only* to the calculation of collective dose *after* the Chernobyl accident. Some of the studies listed in figure 3 only use the results of the collective dose calculations provided with sufficient accuracy by the UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) for the source term. The collective dose for this source term is then used to calculate the dose for the source term of the respective specific facility. This method is not unusual, because probabilistic safety assessment (PSA) studies do not make a full calculation of the collective dose, especially not for longer-term effects. The adjustments made with respect to population density, source term composition, etc. do not sound implausible.

It should further be stressed that the **probability** of severe accidents is usually taken from the results of the PSA for the respective facility, **not** from the Chernobyl accident. Some differences result from the source term taken for the facility, because source terms for most modern reactor types and for relevant accident scenarios (e.g. for core damage at high pressure) are generally higher than those for the Chernobyl accident.

land, economic consequences for densely populated and highly industrialised areas, etc.);
– risk calculation: some studies use a risk aversion approach, because studies show an increase of economic damages by 2 to 3 orders of magnitude for events with very large consequences;
– economic parameters: there is variation in the monetary values assigned to loss of life, land and property.

According to the the NEA Group of Experts (NEA 2000) “there is no disagreement that the external costs associated with normal operation of nuclear power plants are small, i.e. typically of the order of 0.1 cent per kWh[90].” And “a normalised cost of past nuclear accidents will be in the range of 0.3 to 3.6 cents per kWh”. According to NEA these figures are not representative for current plants with good safety standards, since neither Three Mile Island in 1979 nor Chernobyl in 1986 in particular were designed to meet these standards. However, it should also be stressed that the estimated external costs of a nuclear accident are based not only on accident probability (and are thus governed not only by safety standards) but also on other parameters such as population density and the monetary value assigned to loss of life (see above)[91].

In this context, the NEA group of experts concludes:

> “*The expert group felt strongly that there is no single “cost of an accident”. Various perspectives exist from which accident costs are approached, each based on different goals, rationale and needs. Earlier studies had focused on the cost of countermeasures in the perspective of accident management. Since that time, the interest has shifted to the external and the compensation costs. Debate of these issues continues among both professionals and the public.*” (NEA 2000, p.57)

As none of the studies displayed in the figure have any obvious shortcomings, being based rather on different scopes and assumptions each with its own rationale, all the above results must be encompassed by our analysis.

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90 See also ExternE, Externalities of Energy, Vol. 5, Nuclear EUR 16524 EN (Commission of the European Communities, 1995) and Damages and Benefits of the Nuclear Fuel Cycle: Estimation Methods, Impacts and values (Oak Ridge National Laboratory, 1993).

91 It should be noted that none of the studies in figure 3 is based on past experience. The assumption that the Chernobyl accident might be responsible for the upper bound of the results is not valid. Even if a ‘top-down’ approach is used, the only Chernobyl-related figure influencing the result of the analysis is the worldwide collective dose due to this accident, as calculated by UNSCEAR. This figure depends only on the nuclide inventory of the reactor and the release fractions of the different nuclides. For relevant accident paths in other reactors, both figures are at least equal or in some cases even higher than those for the Chernobyl reactor. Matters relating to the different safety standards in force in no case contribute to the differences among the results of these external cost studies. These differences are not due to the chosen accident frequencies alone. Whether the respective plant on which the analysis is based has ‘high’ or ‘low’ safety standards is only one of the factors involved. All the aforementioned factors play a role in the end result. In the case of the French reactors discussed here, the whole range of results is applicable.

We therefore consider two typical scenarios representing the main range of the ongoing debate[92]:

- in scenario A the typical costs for covering damages from severe accidents are around € 0.02 cent/kWh. This selection covers the lower range of damage estimates from € 0.0001 up to 0.1 cent/kWh;
- scenario B is defined with costs around € 5 cent/kWh. This covers the upper range of damage estimates from € 1 up to 20 cent/kWh.

Under typical operating assumptions[93], the costs in scenario A and B would be € 750,000 and € 375,000,000 per reactor per year, respectively.

J.3.3 Insurance requirements and -practice in France

Under regulations that came into force in France on the 22nd of July 1987, operators of nuclear reactors generating more than 10 MW electric power are liable for damages of up to 600 million French Francs (approx. 100 M€). Liabilities above this margin, but below 1,500 mln. FF (approx. 250 M€), are covered by the state and are thus not the responsibility of the plant operator/owner. Damages beyond 1,500 mln. FF but below 2,520 mln. FF are insured by an international pool of states, constituted by the Brussels convention[94].

These provisions indicate that:

- current insurance requirements for severe nuclear accidents do not cover the full anticipated damages of such an accident, but are limited to internationally agreed liabilities of 2,520 mln. FF[95];
- roughly a quarter of this limited liability is borne by the reactor owner/operator, while three-quarters are borne by the public, either the national public (damages within French borders) or a transnational public (damages in countries that have signed the Brussels convention);
- this portion is further reduced to less than 10% of the aforementioned limited liability by the decision of EDF not to fully insure against these liabilities[96].

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92 Note that this selection has been made for the sole purpose of showing the typical consequences of the selection for the end result. The selected values are not representative, because there is no scientifically sound method to derive a ‘correct' result from different values with such a broad bandwidth. Calculating medium values from studies that vary over several orders of magnitude is not scientifically justified. The selection of the two scenarios demonstrates in our view that the decisions on which values to adopt have a huge influence on the results, changing the results of overall evaluation dramatically. This result is uncomfortable, but we consider it the only appropriate way to deal with the current state of the scientific debate.
Further to this, a recent article by the Nuclear Energy Agency [NEA, 2002] describes the foreseen higher ceilings for insurance covering by private parties. The foreseen changes could modify the results and conclusions obtained in scenario A, but this would require a separate analysis.

93 Specifically: 1,000 MW reactor (mean), 85% load factor.

94 Convention on jurisdiction and the enforcement of judgements in civil and commercial matters of 27.9.1968 (Brussels Convention) and following protocols. The limits set by this convention and the related Paris Convention are currently under discussion and may in the future be raised to cover a higher proportion of damage.As detailed figures for the planned changes are not publicly available, the current limits have been used.

95 For a more detailed analysis of the shortcomings and problems of the conventions on nuclear liabilities and the current discussion on extensions, see:
http://www.huri.harvard.edu/workpaper/chornob1.html

J.3.4 Quantification of the cost price effects of insurance decisions

Current nuclear power generating costs in France were recently calculated by a group of experts[97]. Their analysis, based on longer term future operation of currently operational nuclear plants, yields a figure ranging from 13.65 to 15.13 FFct/kWh (approx. 2.5 €ct/kWh), depending on various modalities (including waste management policies).

By comparing the current situation with the two typical scenarios described above, we calculated the impact on generating costs of different forms of insurance against the risk of severe nuclear accident:

- *Reference scenario:*
  This reflects the current situation in France.

- *Scenario A:*
  This scenario assumes that the plant owner/operator himself covers all currently agreed national and international liabilities by means of private insurance. No state or international coverage of risks is assumed (i.e. no support). Insurance premiums are scaled-up linearly.

- *Scenario B:*
  Again, the operator is privately insured for the full risk of severe accident, but in this scenario the higher estimate of damage costs is used for premium calculation.

The results of these calculations are shown in Table 34. In the reference (i.e. current) scenario insurance premiums (column 2) are 0.0017 c€/kWh, roughly 0.07% of the current total generating costs of 2.5 c€/kWh. In scenario A, in which EdF is privately insured against all national and international liabilities, premiums are 0.019 c€/kWh. This premium would raise total generating costs to approx. 2.52 c€/kWh, 0.8% above current costs. Scenario B, in which all liabilities are covered at the upper damages estimates, results in premiums of 5.0 c€/kWh. This insurance scenario would thus lead to a tripling of current total generating costs.

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[96] Operator Electricité de France (EdF) has chosen to cover 400 mln. FF of its 600 mln. liabilities by a fixed capital stock for that purpose, while 200 mln. FF are covered by an external insurance (Assuratome). The premiums for the latter insurance amount to approx. 42 mln. FF per year for all 58 reactors operated by EdF. The insurance premium for each reactor hence costs EdF about 720,000 FF (€ 120,000) a year.

[97] Charpin/Dessus/Pellat: Études par le cout de energy nucléaire par Premier Ministre Lionel Jospin. - Paris 2001.

Table 34 Typical decision scenarios for insuring against the risk of severe nuclear accident

Decision scenario	Premiums, c€/kWh	Total generating costs, €ct/kWh	% price change
Reference: no change to current situation	0.0017	2.50	-
A: Full private insurance covering limited national and international liabilities (all EdF reactors)	0.019	2.52	+ 0.8 %
B: Full private coverage of all liabilities, upper estimate of damages (ditto)	5.0	7.50	+ 300 %

Source: Öko-Institut, calculated using data described in the text

These three typical scenarios have very different consequences. Full insurance coverage of currently limited liabilities by the operator alone (no national or international public contribution) leads to a small price increase of approx. 1% relative to current price estimates. This result is roughly in accordance with scenario A, as defined above. Scenario B shows that operator insurance of full potential liabilities would contribute about two thirds to total generating costs, and triple the price of the generated electricity.

J.3.5 Results: environmental and economic effects

Depending on the insurance scenario adopted, there is a huge span of environmental and economic effects.

Shifting responsibility for the limited international liabilities to the plant owner/operator has practically no environmental or economic effect. As the price change is below 1% of the current nuclear power price, the energy market's elasticity is not stressed. Changes of this scale remain below the threshold of market perception of producers and consumers.

Adopting scenario B for addressing the currently discussed range of damages from severe nuclear accidents would have a distinct environmental as well as economic impact. Tripling the price of nuclear power generation would not only reduce consumption of nuclear power in France compared to today, but even breach economic thresholds for a number of energy sources that are not economically viable at present, and for substitution of electricity by other energy carriers.

To understand these effects, the current price of 2.5 c€/kWh for French nuclear power and the elevated price (including the calculated premiums) of 7.5 c€/kWh should be compared with current prices for electricity generated by other means. The average price of electricity ranges from 4 to 5 c€/kWh, with new modern coal or gas powered plants in a lower range of about 3.2 c€/kWh. Wind park electricity generation is currently in the range of 3.6 to 5.1 c€/kWh. Compared to the above-calculated 7.5 c€/kWh, nuclear power would become extremely uneconomic and be replaced by any of the aforementioned energy sources.

Given these economics and the anticipated sizing down of the nuclear industry, the main environmental consequence of adopting scenario B would be amajor reduction in the amount of nuclear waste produced.

Nuclear waste is an unavoidable and extremely hazardous by-product of nuclear energy production, characterised as follows:

– the amount of radioactive substances generated in the fission process and by neutron capture in fuel and cladding material is small in terms of mass per kWh, but very high in terms of activity per kWh[98];
– a considerable fraction of the generated substances have long or very long half-life-times (e.g. Np-237: 2.14 mln. years), so that radioactive decay effectively never leads to complete elimination of the dangerous substances generated (approx. 200 MBq/kWh after 1,000 years)[99];
– the wastes therefore require thorough long-term isolation from the biosphere over a very long time scale (stable geological barriers, isolation from water flow, etc.);
– even careful selection of geological formations and disposal conditions does not reduce the remaining risks absolutely; thesecan only be minimised[100].

The remaining long-term risk is roughly proportional to the amount of nuclear waste produced, as is demonstrated with two examples in the annex below.

Adopting scenario A has almost no effect on the amount of waste produced, the reduction of less than 1% compared with the reference scenario being insignificant. The quantification of scenario B, with complete substitution of nuclear generating capacity, with respect to the nuclear waste produced is as follows.

The reactors currently operated in France unload approximately 1,500 tHM[101] of spent nuclear fuel per year. This means that over an active operational life of 25 years approximately 37,500 tonnes of spent fuel will accumulate. Either the spent fuel itself or the waste products resulting from reprocessing thereof[102] require final disposal as high-level-radioactive, very long-lived and heat-producing waste (see annex).

It depends on the thermal and geological properties of the depository chosen for final disposal whether the cited amount of approx. 37,500 tHM requires one or two repositories and/or sites (see annex). If clay formations are preferred, as is currently the case in France, the thermal load is limited by the heat sensitivity of the formation (clay is very sensitive owing to its high water content and chemical composition) and by its size (which is also limited by the necessary quality of the clay in terms of inhomogenities, impurities and geological faults). This thermal load requires, to a high degree of certainty, at least two repositories. A reduction of nuclear energy production by a factor of two to three would thus also reduce the need for more than one site and disposal facility.

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98 See G.Schmidt: *Die Entstehung radioaktiver Abfälle und ihre Endlagerung*. – In: IPPNW: *Die Endlagerung radioaktiver Abfälle*. – D-Stuttgart/Leipzig 1995.

99 Ibid.

100 *Der Rat von Sachverständigen für Umweltfragen: Umweltgutachten 2000*. – D-Stuttgart 2000.

101 tHM: tonnes of heavy metal in the nuclear fuel before burn-up. This figure is nearly identical to the quantity of uranium and plutonium in the fuel, being higher if metal cladding and other metal structures of the fuel or packaging and shielding casks are included.

102 Part of the spent fuel in France is reprocessed. After the remaining uranium and plutonium have been separated from the spent fuel a highly radioactive liquid results, which contains the fission products and part of the activation products. To immobilise this waste the liquids are evaporated and the solid waste is mixed into molten glass (vitrification) which is poured into steel containers and cooled. Like the spent fuel, this vitrified product requires long-term isolation and generates virtually the same amount of heat over approximately the next 500 years.

J.4 Summary and conclusions

Current legislation and practice in France does not require the owner or operators of nuclear power plants to cover the entire risk of severe accident, but limits their liability. Current practice in France limits the liability of the owner/operator to below 10% of the current internationally agreed liability limitations. This insufficient provision for future liability can be considered a form of environmentally harmful indirect support to the owner/operators of French nuclear power plants.
Adopting an insurance model in which nuclear generators themselves cover currently agreed national and international liabilities by means of private insurance implies a an increase in the price of nuclear power of less than 1%. The environmental and economic effects of this scenario are negligible.
Adopting the upper estimate in the range of damages reported in international studies as the figure to be privately insured by owners/operators would probably have a significant environmental and economic impact, because the elevated nuclear generating costs would make other base-load generating technologies (vastly) more competitive. This scenario would probably lead to higher CO_2-emissions, on the one hand, and possibly reduced nuclear waste storage requirements and attendant risks, on the other.

However, the probability and consequences of severe nuclear accidents are currently the subject of debate, and estimates of potential damages and their consequences for health, environment and the economy vary over more than six orders of magnitude according to a range of international studies. We therefore recommend (i) to review these international damage studies, including a sensitivity analysis of all assumptions and subsequently, (ii) to strive for consensus on a smaller range of cost estimates.

J.5 Sources

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J.6 Annex: Severe Accident Probabilities and Damages

Severe accident sequences in nuclear reactors are failures that result in a loss of containment of the radioactive inventory. The failure sequences result in a loss of sufficient cooling capacity to remove the heat generated in the reactor. The core subsequently melts and releases part of the radioactive inventory to the containment structure. If the containment breaches, owing to hydrogen explosion or reactor vessel failure, for example, or if the containment isolation is bypassed, part of the released inventory will be released to the environment. Subsequent dispersion of the radionuclides will result in damages to public health and the economy.

Accident probabilities (core damage frequencies)

The probability of severe accidents, i.e. accidents leading to a core meltdown[103], has been studied for a variety of reactor types and in different countries. The initiating events for severe accidents most commonly studied are:

- station black-out;
- anticipated transient without scram (ATWS);
- loss-of-coolant-accidents (LOCA).

Studies investigating the sequence of technical events occurring in such scenarios are called Probabilistic Safety Assessments (PSA), Level 1. Table 35 shows reviews the core damage frequencies reported in the principal PSA studies.

[103] 'Core meltdown' or 'core damage' means the melting of much or all of the reactor core material (oxide fuel and metal cladding) due to a loss of capacity to remove the heat of radioactive decay. Damaging of single fuel elements or exceeding technical limits of operation for fuel elements are not considered a core damage in a PSA. The given probabilities are those for damages of the core as a whole, not for small parts of the core or single fuel pins.

Table 35 Core damage frequencies reported in PSA studies

Study	Country	Reactor/reactor type	Accident management measures	Core damage frequency, per reactor-year
NUREG-1150	USA	Surry/PWR	-	$4*10^{-5}$
NUREG-1150	USA	Peach Bottom 2 / PWR	-	$4.5*10^{-6}$
WASH1400	USA	PWR	-	$2.6*10^{-5}$
WASH1400	USA	BWR	-	$4.6*10^{-5}$
Sequoyah	USA	Sequoyah/PWR	-	$5*10^{-5}$
EPS900	F	CP2/PWR	Yes	$4.95*10^{-5}$
EPS1300	F	1300MW/PWR	Yes	$1*10^{-5}$
Hinkley Point	GB	610MW/AGR	-	$1*10^{-6}$
Japan	JA	1100MW/PWR	-	$1*10^{-7}$
DRS-B	D	Biblis-B/PWR	yes	$3*10^{-5}$
SWR Phase II	D	-	yes	$2.7*10^{-6}$
Ringhals 3/4	S	915MW/PWR	-	$3*10^{-6}$

Sources: Compiled from data in CEPN 1994[104], Werner 1995[105] supplemented by other sources

The reviewed studies, for different countries and types of facility and reactor, yield core damage frequencies between 10^{-4}/a and 10^{-6}/a. It should be noted that these studies do not employ the same methodologies and assumptions, making comparison of results problematical. The error bandwidth of these methods usually adds an uncertainty of around a factor 10.

Core damage frequencies of $5*10^{-5}$/a are a common result, a figure often adopted in further risk studies (e.g. selected for the ExternE study[104]).
Note that the results for the French reactor types EPS900 and EPS1300 are in line with the general international trend.

Release fractions

For the fraction of the radioactive inventory released to the environment, or source term (calculated in PSA Level 2) a wider range of values are found in the literature: from 0.01% up to several 10%[106]. These differences are due to different accident sequences and results and different assumptions concerning the reliability of containment.
If the containment remains intact during and after core meltdown and is not bypassed, the release fraction is low. If the containment loses its integrity as a consequence of the accident or is bypassed due to additional failures, the release fraction is high[106]. Containment damage may result from such events as:

– reactor vessel failure during melt-down under high pressure (release category FKA: 3% of core melt accidents, release fraction >50% of caesium and iodine inventory);

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[104] CEPN: Externalities of Fuel Cycles "ExternE" Project, Nuclear Fuel Cycle; European Commission, DG XII, Working Document No.3, F-Fontenay-aux-Roses 1994.

[105] W.Werner: *Auswertung und Dokumentation des internationalen Standes und der aktuellen Entwicklungen der probabilistischen Sicherheitsanalysen für Kernkraftwerke. – Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit*, BMU-1995-429, D-Bonn 1995.

[106] For a detailed analysis of the release fraction for different initiating events see: H.Löffler et al.: Correlation of initiating events with the PSA Level-2 results. – Presentation, EUROSAFE, 6. & 7. November 2000, D-Köln 2000.

– containment ventilation (FKB: 0.5% of core melt accidents, release fraction 13 to 24%);
– hydrogen explosions resulting from metal-water reactions involving the molten core material, etc.

Containment bypass can be caused by e.g.:

– failure of steam generator relief valves (FKC: 7% of core melt accidents, release fraction 2.5 to 15%);
– later containment failure through degradation (FKE: 6% of core melt accidents, release fraction 0.02 to 5%);
– filter failure, etc.

Accident sequences without massive containment failure or bypass (e.g. FKI: 38% of core melt accidents) or with a small containment leak (FKJ: 24% of accidents) have release fractions from 10^{-8}% (caesium, lower bound) up to 0.01% (iodine, all cases).

This wide range of results for the different release categories means that severe nuclear accidents involve a very broad set of source terms ranging over more than 8 orders of magnitude for caesium and more than 3 orders of magnitude for iodine.

Accident consequence assessment

The source term calculated in the Level-2 analysis is then used for an accident consequence analysis (PSA Level 3) to calculate the economic damages caused by the accident. Health damages are also converted to economic damages.

Accident consequence analysis yields similarly wide-ranging results. In this case the variations in results are due to the necessary assumptions concerning such factors as:

– economic conversion factors, e.g. for converting health detriments to economic values;
– population densities in the near-field (local);
– calculation of collective doses;
– dose conversion factors;
– etc.

Type of nuclear waste storage required

The risks from long-term disposal of nuclear wastes in geological repositories are directly proportional to the amount of waste contained, as is demonstrated by two examples:

– 'Operational' releases from the repository: a leaking nuclear waste repository spreading nuclides to the biosphere, even at levels well below currently accepted dose limits, can still cause collective dose effects, even if the risk to any particular individual is very small. These effects are very long-term in nature and depend on the population exposed (assuming any population at all). The time over which such effects will occur and the accumulated doses are directly proportional to the volume of substances disposed of.
– 'Accidential' loss of isolation, caused for example by violent natural events or unintentional human intrusion. These risks can be minimised by proper selection of geological formation and the overall geological setting of the site. The remaining risk of loss of isolation is proportional not only to the number of repositories in use, but also to their individual magnitude and design underground (number of canisters potentially involved, distances to most exposed pathway openings, etc.).

As in these two examples, it can be demonstrated in detail that most of the risks from long-term disposal of nuclear wastes are proportional to the number of repositories and the amount of waste disposed of there.

The number of repositories required is associated with an additional, non-linear effect, because each geological formation has its own specific, and limited, capacity for absorbing the heat generated by the waste over the longer term. This decay heat of the radionuclides may potentially lead to thermal effects in the repository geology (cracking, etc.). Relevant in the first phase of long-term disposal is the period up to 500 years, with elevated heat production. The maximum heat absorption capacity depends on the type of geological formation, its size, and so on.
For the first 500 years, heat production is a limiting factor for final disposal of these long-lived wastes. The aggregate heat production of the disposed wastes heats up the geological formation as a whole. This results in a volume increase, followed by tensions in the disposal formation and the surrounding formations. To avoid fissures and subsequent water intrusion into the repository, the heat load in the formation must be limited. Depending on the heat sensitivity of the selected formation, the limits currently discussed vary from 25,000 tHM (very sensitive formations) via medium sensitive sites (e.g. Gorleben with heat-insensitive salt, but with overlying protective clay formations) to 50,000 tHM (very insensitive formation, example: US-Yucca Mountain site).
Given these issues, pre-disposal, above-ground storage (medium term, several dozen years) is applied as standard practice to reduce the total heat load of the waste. The effectiveness of longer storage is limited, because the decay properties of the relevant nuclides (Cs-137 and Sr-90, with a half-life of around 30 years) requires a very long storage period to yield any major reduction in heat generation. Above-ground storage for an additional 30 years would then add to around 20 to 30 years of pre-disposal-storage, which are necessary either way. This would require additional technical means (doubling of storage container lifetimes, handling of risks from huge above-ground storage sites over very long periods, prolongation of technical measures for repackaging and repair, human resource requirements, etc.). Extension of pre-disposal storage times therefore provides only a very limited opportunity for reducing the heat load on the repository formation.

K Europe - Private and public responsibilities in nuclear waste management and disposal

K.1 Description of the support measure

Production of nuclear power generates high-level-radioactive wastes as by-products. Because of its hazardous properties this waste must be appropriately managed during storage and handling and in later final disposal in underground repositories. This final disposal in deep geological strata seeks to isolate the waste and its harmful contents from re-entering the biosphere, potentially causing radioactive doses to the future population over a very long time scale.
The tasks of siting, construction, operation, closure and post-operational management of the required High-level waste (HLW) disposal facilities as well as the associated R&D must be fulfilled. These tasks are the responsibility of either the waste producers or state(-owned) agencies.

While the generation of electricity, its trade and application, is mainly a private affair in all EU15 countries, performed by private companies, this does not generally hold for the management (transport, handling, treatment, interim storage) and disposal of the wastes arising in the nuclear power industry. The private-public interface between nuclear power generation and nuclear waste production on the one hand and subsequent management and disposal of that waste on the other has developed in a wide variety of organisational and legal forms. In the various EU countries the current status differs widely, depending on a number of factors, including the historical development of the nuclear industry, and economic and legal traditions.

In the context of the present study, we consider as a support measure to nuclear waste management, disposal and R&D any funding regime contravening one or more of the following conditions:

- Financing of current expenditures on siting and operating geological repositories is completely covered by the waste producers ("polluter pays principle").
  This requirement guarantees that the necessary costs for managing the wastes are part of the price for the product (electricity) and not passed on to the public.
- Future expenses are covered by a fund guaranteeing full coverage even in event of bankruptcy of waste producers.
  Taken together, the pre-operational, operational and post-operational phases of an HLW repository extend to at least 50 years, probably even much longer. This gives rise to expenses over far longer periods than the operating life of the waste-producing facilities and requires extraordinary long-term stability of the waste producers responsible. To guarantee cost coverage even in cases where the former waste producer is unable or unwilling to pay, certain backup funds must previously have been built up. To be reliable, given the limited stability of the involved institutions. this fund must be formally independent of the waste producers.

– Expenses for appropriate R&D activities (general and project-related) are covered by the waste producers.
  Disposal of HLW is a scientifically and technically ambitious task, requiring substantial R&D in many areas (e.g. materials research, dynamic geological modelling, site characterisation methods, hydrochemical properties of wastes, packaging, backfill, geological strata). This R&D demands substantial financial resources. As these efforts are part of the process, the associated expenditure must be included in the cost coverage analysis.
– The above expenses and funds and their re-adjustment are managed as an open and transparent process.
  Waste disposal issues are a public-private task. To ensure that the necessary steps are taken to achieve long-term isolation of the wastes and that due resources are in place, a certain degree of transparency is essential.

If one or more of these conditions are not met, we are concerned in this case study with a support measure. However, it is not presently feasible to quantify the support thus provided by EU Member States (or state how significant it is), nor estimate the consequences of its removal. Neither national expenditure on the activities in question (siting, R&D, regulation, etc.) nor clear data on the financial contributions of the waste producers are currently available. It is beyond the scope of this study to compile this data for one or more EU states. It is therefore not possible to assess whether significant support is given by EU member States. Nonetheless, we consider the results of this case study a valuable contribution to decision making.

K.2 Demarcation

This study is limited in scope to high-level radioactive wastes (HLW). Low- and intermediate-level wastes are not covered, because their disposal conditions (time scales, isolation requirements, etc.) are more comparable to those for conventional wastes. Support measures are only considered in countries of the EU15 operating nuclear reactors for electricity generation (8 countries)[107]. Even though nuclear wastes also arise in others sectors (e.g. research reactors, non-nuclear-research, medical applications, military uses) and will have to be disposed of properly, the wastes from electrical power generation dominate in respect of their activity, volume, heat production, shielding requirements and short- and long-term isolation requirements.

K.3 Support or not?

All countries have financial provisions for fulfilling their own tasks in nuclear waste management, as defined by law, and in final disposal (as applicable) as well as for their regulatory control tasks. These provisions are very different from country to country.

[107] Another country where nuclear production reactors were operated in the past is Italy. The reactors were taken off-line in 1986/1987 and are in the decommissioning phase. Italy was therefore not included here. The selected list of 8 countries will require some extension over the next few years, when former eastern bloc countries enter the European Union (e.g. Czech Republic, Hungary, the Baltic states). These have not been included here, because they require special analysis.

In general terms, the following *modi operandi* apply:

– *Waste management*: the responsible organisations recover their costs, mostly by offering services. No market conditions apply. This mode is not considered a financial support measure. Indirect support effects are possible, if not all services, including indirect activities, are reimbursable;
– *final disposal*, *current activities*: some countries recover their expenses from a defined pool of waste producers. This is not considered a support measure;
– *final disposal*, *future activities*[108]: some countries require waste producers to either contribute to a fund (e.g. by yearly fees) or build up set-aside capital fund covering the expenses of necessary future activities following reactor or company closure. Maintaining a public fund ensures required activities will continue to be carried out, even in the event of waste producers proving unwilling or unable to fulfil their obligations, e.g. in the case of bankruptcy of the waste producer company. If no such guarantees are required we are concerned with a support measure, because the risk of failure then remains with the public. Building up internal company funds must be considered a support measure, too, because the risk of organisational failure is still not entirely covered.

The financial and regulatory provisions in place in the EU15 countries for nuclear waste management and disposal are reviewed in Table 36. The table shows that:

– the costs of nuclear waste management and final disposal of current activities are generally recovered in the EU countries considered (**see column 2 and 3**);
– many countries do not require their nuclear power plants to provide long-term funding the necessary final disposal of future activities, including those following reactor decommissioning. Other countries, such as Finland, the Netherlands[109], Sweden, do have state-controlled funds to cover the long-term costs of final disposal in the future. These funds are important for covering very long-term liabilities that may exceed the lifetime of companies operating nuclear power plants **(column 4)**;
– the situation regarding regulatory control activities is anything but clear, as only a very few countries operate transparently in this respect **(column 5)**.

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[108] This concerns the very long term costs of nuclear storage activities after closure of the reactor or the responsible company.

[109] In this country the fund is administered by the public-private COVRA, i.e. it not under the control of the waste producers.

Table 36 Financial and regulatory provisions for nuclear waste management and disposal in EU15 countries with nuclear power generation[110]

Country	Waste management	Final disposal, current activities	Final disposal, future activities[111]	Regulatory control
Belgium	Cost recovery for services provided	Cost recovery through services provided	Fund set up by ONDRAF/NIRAS	(no information available)
Finland	(private, not applicable)	(private, not applicable)	Annual fee, securities	Cost recovery
France	Cost recovery through services provided	Cost recovery through services provided	Internal company fund	(no information available)
Germany	(private, not applicable)	Annual fee for major waste producers	Internal company fund	Cost recovery
Netherlands	Cost recovery through services provided, spent fuel facilities: special regulations in place	Fees	Provisions at COVRA	(no information available)
Spain	Cost recovery through services provided	Cost recovery through services provided, management fund by ENRESA	Fund set up by ENRESA	Part cost recovery through charges
Sweden	Annual levy to state fund, based on electricity generated	Annual levy to state fund, based on electricity generated	Annual levy to state fund, based on electricity generated	licensing fees, in part state
United Kingdom	Loans by waste producers	Cost recovery through services provided, part privately, part state-funded	None	(no information available)

Based on the results shown in the table we conclude that the costs of current activities are, generally, covered. This is not the case, however, for the costs of very long-term activities for final waste management and final disposal. In the UK these are not covered at all, while in other countries they are covered by internal company funds. Both may be considered as an indirect support measure, because the necessary expenses after the reactor or company lifetime are not (entirely) covered by current electricity prices. An internal company fund may also be considered as a support measure as it provides no guarantee that long-term storage costs will be covered after closure (e.g. bankruptcy) of the power plant operator. In such an event the risk of longer-term failure of waste producers to fulfil their obligations is shifted to the public.

Below we provide a tentative estimate of the magnitude of what will now be considered as a single support measure.

Estimate of magnitude of support for final disposal in future

The quantitative extent of the support given under this indirect support measure depends on the nuclear generating capacity in the respective countries, because the bulk of the costs associated with a disposal facility are fixed and do not depend on the amount of waste disposed of. Calculations are not easy, however, because European HLW disposal facilities are:

- at the site selection stage (e.g. Germany, Sweden);
- at the site characterisation stage (e.g. Germany, Finland);
- at a pre-site-selection or laboratory stage (e.g. Belgium, France, Sweden);
- not yet at any of these stages (e.g. Netherlands, Spain, UK).

[110] UK Nirex et al.: Schemes for Financing Radioactive Waste Storage and Disposal. – EUR 18185 EN, Luxemburg 1999.

[111] Only longer-term funds for future HLW waste disposal activities are considered here, that exceed the life time of companies operating nuclear power plants.

No disposal facility has yet been licensed or is yet at the planning stage to provide a more reliable reference for detailed cost analysis.

As a rough figure to estimate the effect of this support measure the following model assumptions were made:
- Operation of 20 reactors of 1,000 MW_e for 25 years (12,500 tHM, 3.5 TWh);
- Total cost of a HLW disposal facility: 10 G€[112].

These modelled costs for future activities (construction, operation, closure of a HLW facility) would result in an increase of about 0.3 €ct/kWh in nuclear generating costs. This calculation is an estimate for countries with medium or high nuclear generation capacities (France, Germany, Sweden, UK). Note that due to the fixed costs of a HLW disposal facility this figure is rapidly increasing as the number of operational reactors declines (e.g. in Belgium, Finland, Spain, Netherlands). The upper bound is estimated at around 1 €ct/kWh.
As all European HLW disposal projects are at an early stage, the majority of the costs will arise in the future. As only current expenses are recovered from waste producers in most countries, the bulk of the overall cost of disposal does not fall under current expenses and remains under the waste producer's financial control. The risk that these resources may not no longer be available when needed is not accordingly covered. The price of nuclear power does not therefore reflect total future expenses.

Provisions for requisite R&D activities
Nuclear waste management and especially final disposal of HLW requires substantial support by a variety of Research and Development activities. The challenge of final disposal alone requires such activities as:
- R&D on the barrier quality of geological formations (e.g. fundamental research on geological strata, influence of ice ages on barrier quality, long-term hydrogeology, geochemical aspects of radionuclide dispersion, to name a few relevant research areas);
- construction and operation of above- and underground laboratories;
- long-term studies on certification of engineered barriers (e.g. packaging materials, corrosion mechanisms of canister materials, long-term predictions of waste degradation).

Only a few countries have regulations in force to guarantee that the costs of these R&D activities are covered by the waste producers. A possible *modus operandi* requiring waste producers to take over the costs involved in this necessary work has been established in Sweden. Here waste producers are required by law to draw up organisational and financial plans and provide state regulators and parliament with details of current R&D programmes activities in relevant fields. This regulatory model ensures that the requisite activities are undertaken and that all expenses are covered by waste producers.
In contrast to this model, nuclear R&D activities in most other countries are publicly funded, with or without recovery of all or part of the costs by waste producers. Thus, the costs of R&D aimed exclusively at improving the operation and waste disposal performance of nuclear power plants are not always attributed in budgets to the nuclear sector. In this respect, then, nuclear power generation has a distinct advantage over other forms of genera-

[112] These total costs include all direct and indirect expenses for site selection, site characterisation, permission procedure, construction, operation, closure and post-closure activities. It is a rough estimate by the *Öko-Institut* authors for a medium-sized national disposal site.

tion, where these or similar R&D requirements are either unnecessary or are fully funded by the companies supplying or applying the fruits of this R&D in conventional generating plant.

In practice, quantification of the effects of this support measure is not an easy task. No systematic compilation of the research costs is currently at hand. National and international (EU) support to these activities must be considered. Additionally, there is no clear-cut line between basic nuclear research and more application- or project-related nuclear R&D. In some countries (e.g. France, Germany) the latter kind of research is covered by specific fees, while the more general basic research is financed by public bodies. To attribute these current and future research activities to the costs of nuclear power generation is practically impossible. Nevertheless, this research is aimed solely at providing solutions to problems that would not exist without nuclear power generation and the associated wastes.

K.3.1 Environmental effects

This support measure cannot be quantified in any precise fashion. The range of costs for future HLW disposal activities is roughly is estimated to be between about 0.3 and 1 c€/kWh. Companies in a position to set aside this level of resources under their own control have an advantage over companies obliged to see such funds built up outside their control. Compared to total generation costs of around 2.5 to 7.5 €ct/kWh the support is in the order of 10%.
This estimated price increase is not enough to generate significant substitution effects to other fuels. Due to very high fixed cost shares in nuclear compared to other electricity generation techniques, the support measure does not lead to substitution efforts on the supply side. The direct environmental effects of removal of this support are therefore estimated to benegligible.

K.4 Sources

Nirex et al., 1999
Schemes for Financing Radioactive Waste Storage and Disposal, EUR 18185 EN
Luxemburg

K.5 Conclusions

This case study concludes the following:

- in all the EU countries considered the costs of nuclear waste management and final disposal associated with *current* reactor operations are generally paid by power plant operators;
- in some countries, however, power plant operators are not required to provide long-term funding for the requisite final disposal of waste from *future* operations. Such funds, managed independently of the waste producers, are important for covering very long-term liabilities that may exceed the lifetime of companies operating nuclear power plants and for ensuring the necessary costs are covered;
- only a few countries have regulations in place to guarantee that the costs of R&D aimed solely at improving nuclear power technology are assigned specifically to the nuclear sector. In Sweden a promising *modus operandi* has been established that requires nuclear waste producers to bear the full costs of the essential R&D work;

- in many EU member states there is a lack of transparency with regard to the organisation of public services and cost coverage in the nuclear industry. This may lead to public misconceptions and potential economic distortions in the energy industry throughout the EU.

L Germany – agricultural fuel

L.1 Description of the support measure

The scheme for refunding German farmers for excise duty paid on agricultural fuel (the 'Gasölverbilligung') was in force from 1967 until the end of 2000. Thissupport was provided to agricultural firms to improve the competitiveness of German agriculture in the EU marketplace. The support measure is described in [Deutscher Bundestag, 2000].

The refund scheme worked as follows. Agricultural firms were compensated at the end of each year for the excise duties paid on gasoil. In 2000 this compensation was 30 Deutsch Marks per 100 litres, roughly € 0.15 per litre[113], roughly 40% of total duties. The refund was given in the year after the gasoil was bought by the farmer. In 2000 it was given only up to a maximum of DM 3,000 per enterprise, rso that only on the first 10 thousand litres was duty (part-)refunded[114].

It proved impossible to establish an exact figure for the refunds paidout in the year 2000, but these are estimated at about DM 350 million[115]. The support measure thus amounted to an estimated € 179 million in the year 2000.

The refund scheme was discontinued in 2000, but in 2001 a similar support measure was introduced with the same aim. Now, however, there is no longer any ceiling on the individual refund per agricultural firm. In our analysis of this case we used the amount of support given in 2000, without considering the ceiling then in force, for this would have complicated the analysis substantially and from 2001 on is not applicable.

Government support for agricultural fuel use is by no means unique to Germany. Similar forms of support are common in other EU Member States. This support is in accordance with EU Council Directive 92/81/EEC of 19 October, 1992, on harmonisation of the structures of excise duties on mineral oils.

L.2 Mechanisms

The annual fuel duty refund to the agricultural sector amounts to around € 179 million. To assess the potential environmental effects associated with this scheme, the question to be effectively answered is what would happen to agricultural gasoil consumption in the absence of compensation? Farmers might respond to the resultant price rise in a variety of ways, which we shall now consider.

The first option for German farmers would be to cover their extra fuel costs by raising product prices. Relative to the gross added value of the agricul-

113 Throughout the case we will use the following exchange rate between DM and Euro. One euro is equal to DM 1.95.

114 This is calculated from a maximum compensation of DM 3,000 per company and DM 0.30 per litre compensation: 3,000/0.3 is 10,000 litres.

115 Personal communication, financial specialist at the Federal Ministry of Food, Agriculture and Forestry (*Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft*).

tural sector, roughly € 5.5 billion in 2000[116], this would mean a price rise of 3% on average for all agricultural products[117]. Because the aim of this support is precisely to improve the competitiveness of the German farming sector, such a price rise is unlikely to occur.

The second option for farmers is to replace the gasoil by other energy carriers. In the short run this option is not open, because most farm machinery and vehicles are designed for gasoil rather than other fuels. In the long run changes in the prices of different energy carriers might trigger development of differently powered farm equipment. This is crucially dependent on supply-side effects.

The third option is fuel saving. Although higher prices generally lead to lower consumption, the extent to which the German agricultural sector could reduce fuel use following removal of support is anything but clear. There might be an incentive for farmers to seek niche markets such as organic farming and production of regional products, both markets with a relatively high added value[118].

L.3 Environmental impact

The aim of this section is to investigate the environmental impact of the support measure. We take as a reference the situation without support, in which the agricultural sector pays the same excise duty on gasoil as other users in Germany: in 2000, DM 0.74 (€ 0.38) per litre.

In the remainder of this section we first demarcate the terms of our analysis and outline the method used to assess the environmental impact of the support measure. We then present the environmental results.

L.3.1 Demarcation

In assessing the environmental effects of the support measure we demarcate our analysis as follows:

1. We confine ourselves to the input market, i.e. (the change in) gasoil use by the enterprises in question. This implies that we ignore the mechanism of a possible increase in agricultural product prices to compensate for higher fuel costs. The reason for this is that farmers have little scope for raising prices, owing to the fierce competition in the (world) market for agricultural products.
2. We do not analyse the potential shift to niche markets such as organic farming or production of regional products. Although these markets could prove interesting from both an environmental and an economic perspective, within the scope of this project it was not feasible to estimate the likely magnitude of such a switch.
3. We ignore any substitution by other energy carriers following reduced demand for gasoil. This assumption is reasonable because most farm machinery and vehicles are designed exclusively for using gasoil. In the

116 *Statistisches Bundesamt*, www.destatis.de.

117 Calculated by dividing the amount of compensation by the gross added value of the agricultural sector.

118 The attractiveness of switching to organic farming depends on fuel use in this niche market compared to the regular agricultural sector. One important factor in this respect is the use of land, which is more extensive in organic farming. In addition the number of trips to work the land might be higher because of little or no pesticide use.

longer term alternative plant might well be developed, but no information on this supply-side effect could be found in the literature and it would take extensive analysis of innovation in supply chains to calculate the potential for using other energy carriers in agriculture.

4 Additional to 3, we ignore any potential switch to use of other energy carriers in greenhouse horticulture. Roughly 36% of all gasoil covered by the support scheme is consumed by this subsector[119]. Here it is not machinery or vehicles designed for gasoil but the current energy infrastructure that limits the switch to other energy carriers. In the longer run, a switch to solar energy, natural gas or other energy carriers might be an option, however, allowing for a sharper reduction of gasoil use than calculated in our analysis.
5 With respect to environmental impact, we confine ourselves to emissions of CO_2, fine particles and NO_x. Other pollutants arising are either less harmful or emitted in very low quantities by burning gasoil.

L.3.2 Method

To estimate the environmental effects of the gasoil duty refund scheme we took as our reference the situation without support, i.e. with farmers paying the same duty as other users and thus paying higher fuel prices. This scenario was then compared with the situation in 2000 with compensation provided.

A rise in the price of agricultural fuel would lead to some reduction of demand, and it is this reduction that will determine the environmental effects of support removal.

We calculated the total environmental impact of the support measure as follows:

1 Determine gasoil consumption by agricultural firms in the business-as-usual scenario.
2 Determine the initial price of gasoil for the enterprises in question.
3 Determine the percentage gasoil price increase after support removal.
4 Using available own price elasticities[120], determine the decrease in gasoil consumption by these enterprises (relative to business-as-usual).
5 Using emission factors for CO_2, fine particulates and NO_x per litre gasoil, determine the resultant environmental effects.

L.3.3 Results

The starting point is the amount of fuel used by the agricultural sector in 2000. From [Deutscher Bundestag, 2001] we see that annual agricultural gasoil consumption stands at about 2 billion litres. This figure has been fairly constant over the last couple of years and is also used to forecast the compensation that will be given over the next couple of years, as presented in [Deutscher Bundestag, 2001].

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119 According to a fax from the Federal Agency for Agriculture and Food (*Bundesanstalt für Landwirschaft und Ernährung*), dated April 18th. It is estimated that total energy use in the greenhouse horticulture is equivalent to 1.1 billion litres of heating oil-equivalents. Of this, 65% is accounted for by gasoil. This means that 65% of 1.1 billion litres gasoil is used in the glasshouse culture: 715 million litres, which is 36% of total gasoil use in Germany (715/2000 times 100%).

120 These are defined as follows: the percentage change in gasoil consumption resulting from a 1% change in the price of gasoil.

The environmental effects of the support measure are determined by the change in gasoil consumption, which is in turn determined by the price increase and the sector's response. The following table shows the structure of the gasoil price with and without support, allowing the hypothetical price rise to be deduced.

Table 37 Gasoil prices for the German agricultural sector, with and without fuel duty refund

	Without support	With support
	€ per litre gasoil	€ per litre gasoil
price, net off excise duty	0.32	0.32
excise duty	0.38	0.22
price, including excise duty	0.70	0.54

As can be seen, support removal implies a fuel price increase of 28%. The question now, as mentioned in section L.3.3, is to what extent this price rise reduces agricultural fuel demand.

The potential for fuel saving in the German agricultural sector has not previously been researched. Ideally, gasoil consumption in the various subsectors would need to be analysed, permitting study of the scope for reducing consumption under different cost regimes. In Germany, such information is not available.

In [RWI, 1999] it is assumed that agricultural fuel use is proportional to production value. This assumption leads to the conclusion that there is zero potential for fuel saving: more production leads to proportionally more consumption of gasoil. However, a personal communication with the author indicates that this own-price elasticity of zero (i.e. a price rise does not reduce fuel demand) merely indicates the *short-term* price elasticity[121]. In the long run we estimate the price elasticity to be around –0.15 to –0.2[122]. This implies that in the long term a 1% increase in fuel prices will lead to a 0.15 to 0.2% decrease in fuel demand. In [Annema, 1998], a publication dealing specifically with the effects of raising excise duties on agricultural gasoil, a long term price-elasticity of –0.2 is used as well. There is no information available that suggests large differences in the price elasticities between, for example, German horticulture and other agricultural subsectors. We have therefore used the cited own price elasticity of –0.2 as indicating the likely decrease in agricultural fuel demand following removal of support.

Given the approx. 28% rise in litre fuel price relative to the situation without support, agricultural gasoil consumption can thus be expected to decrease by 4.2% to 5.6% in the long run[123]. Some studies (e.g. MuConsult, 1997, see Annex I) find lower price elasticities for relatively high price rises. This would justify using a lower price elasticity here. However, in [Annema, 1998] a similar price increase, of around 30%, is analysed, so adjustment is considered unnecessary.

121 Personal communication, B. Hillebrand, November 26, 2001.

122 This demand elasticity is lower than that presented in IEA (1999). In that publication the demand elasticity for all mobility-related fuels is estimated to be –0.25, and even higher (-0.5) for all other forms of energy demand.

123 Calculated using the cited range of price elasticities.

Given the original figure of about 2 billion litres of gasoil consumed by the German agricultural sector a projected reduction of 4.2% to 5.6% boils down to savings of between 85 and 113 million litres of gasoil a year.

In our analysis we used the emission factors per litre gasoil shown in the following table.

Table 38 Emissions per litre gasoil

	gram per litre gasoil
CO_2	2,661
NO_x	42
PM_{10}	4.2

Source: Traffic and transport in the environmental balance 2000 [in Dutch], own calculation to convert to gram per litre instead of gram per MJ.

The total environmental impact of the German gasoil price compensation scheme can then be calculated as follows.

Table 39 Environmental effects of fuel duty refund in 2000

	Price elasticity	Decrease in fuel consumption (relative to business-as-usual)	Decrease in emissions (relative to business-as-usual)
low elasticity	- 0.15	85 million litres	226 ktonne CO_2
			3.6 ktonne NO_x
			354 tonne PM_{10}
high elasticity	- 0.2	113 million litres	302 ktonne CO_2
			4.8 ktonne NO_x
			472 tonne PM_{10}

The potential reduction of emissions relative to the situation with support is thus calculated to be a little under 300 ktonne CO_2, roughly 4 ktonne NO_x and 400 tonne PM_{10}.

Compared to aggregate emissions due to gasoil use by the agricultural sector, this boils down to a reduction of roughly 5% for each of the pollutants mentioned. If we compare these emission reductions to total emissions of these pollutants in Germany, we see that the reductions are fairly small in relative terms.

Table 40 Emission reductions compared to total German emissions in 2000

	Emission reduction - absolute, in ktonne	Emission reduction as a percentage of total German emissions
CO_2	300	0.003%
NO_x	4	0.02%
PM_{10}	0.4	0.2%

Source: own calculations, based on information in [Statistisches Bundesamt, 2002].

Compared to national CO_2-emissions of 861 million tonnes in 2000, the projected reduction is therefore very small, roughly 0.003%. In the case of NO_x the potential reduction is 0.02% of national emissions, which were 1637 ktonne in 1999. Relative to national PM_{10}-emissions of 259 ktonne, in the absence of support emissions are expected to decrease by rather more, 0.2%.

L.4 Economic effects

In the scenario without support the price of agricultural gasoil is expected to rise by 28%. The economic effects of support removal depend crucially on the farming sector's response to this price increase.

Given the fierce competition on the world agricultural market, we have assumed that German agricultural firms will be unable to raise the prices of their products. This implies that the production value of the agricultural sector will remain unchanged. The profit margin of the sector will change, however, depending on the share of fuel costs in overall business costs. For some farmers the higher fuel price will lead to negative profit margins, which cannot be maintained for any length of time. Present farm operations will then not be sustainable in the longer term. This might provide an incentive for some enterprises to seek niche markets offering higher prices for agricultural products.

For some agricultural firms this will lead to bankruptcy. For others the profit margins will be lower than in the current situation with support, inducing them to seek options for reducing fuel consumption. This might have minor knock-on employment effects in the energy sector. Although this effect cannot be quantified, given the only slight impact of support removal on overall gasoil demand, it is likely to be fairly insignificant.

For greenhouse horticulture, however, the economic effects might be greater. We have looked more specifically at this subsector for two main reasons:
- 36% of total agricultural gasoil consumption is by this subsector;
- fuel expenses make up an average 5.3% of total expenditure[124].

In the horticultural sector, removal of the support might lead to negative productivity figures[125]. Average horticultural productivity is currently 0.4%[126]. Removal of the support would, in the absence of adjustments to the production process, lead to an increase of 1.5% in total expenses[127].

Productivity would then shift from slightly positive (0.4%) to negative (-/- 1.1%). Negative figures cannot be sustained for long and might induce

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124 See www.verbraucherministerium.de/landwirtschaft/ab-2002/ab02/blau.htm, a bookkeeping evaluation providing detailed information on 674 horticultural enterprises in Germany. As separate information on the cost share of energy in greenhouse cultivation is not available, we have used an estimate of 5.3% (average for horticulture) in the remainder of the calculations. This figure might however be an underestimate because it includes plant nurseries for trees, where greenhouse use is uncommon, as well as farms growing vegetables or flowers outdoors This is illustrated in the cited bookkeeping evaluation, which gives a figure of 12.5% for the share of energy costs for the cut flowers subsector.

125 A large majority of greenhouses in Germany are used by horticultural enterprises.

126 Taken from www.verbraucherministerium.de/landwirtschaft/ab-2002/ab02/blau.htm. This is the productivity of total capital (code 520 in the Excel-sheet Garten.xls).

127 Calculated as follows: without support fuel expenses are 5.3%, prices rise by 28% when the support is removed. This implies that fuel expenses increase from 5.3% to 1.28 times 5.3: 1.5%.

horticultural enterprises to shut down. Within the scope of this case study it was not possible to calculate the likelihood or speed of this process. Adjustments in production processes, such as shifts to other energy carriers, cannot be predicted in the long run.

Another option for farmers is to change their input mix, i.e. use less fuel and more labour in production. This scope for such changes is limited, however, and might hamper the development of organic farming. A switch to organic farming is, in many respects, desired by policy-makers and will have positive environmental effects, as reported for example in [Stolze et al., 2000]. However, organic agriculture generally makes more extensive use of farmland, leading to harvests spread over wider areas. This will mean more kilometres driven with agricultural machinery and thus more fuel use. With higher prices for gasoil, this switch might be rather more difficult.

The overall employment effect is difficult to predict, but likely to be slightly negative. On the other hand, an incentive is introduced to substitute one input factor (labour) in the production process for another (fuel). In the long run, this incentive might balance out the initial loss of jobs.

Over and above these considerations, decreasing marginal taxes on labour and other alternative tax regimes might increase the efficiency of the German economy as a whole, resulting in the longer run in higher employment rates. In the case of the gasoil price compensation scheme, there might even be better alternative options, given the relatively small sum involved compared to the national German budget.

One interesting option for alternative use of the € 179 million budget might be to support organic farms by compensating for any negative effects of a rise in fuel price. Another option would be to use the budget for modifying the energy supply infrastructure to horticultural greenhouses so they can switch to natural gas. Further research is required to assess the possible economic effects of such a reallocation of budgets.

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L.6 Calculations

In this section we present the detailed calculations of the environmental and economic effects of support removal.

Price increase following support removal
Support removal will alter the price of the gasoil used in the agricultural sector. The German price for gasoil, net off excise duties, has been taken from [EC, 2000] where the following prices are reported for the end of each month.

Table 41 Monthly gasoil prices in Germany (2000)

Month	Price in € per 1000 litre
January	281.26
February	290.06
March	303.61
April	246.24
May	265.16
June	278.96
July	285.45
August	312.09
September	396.61
October	398.71
November	385.72
December	354.53

Source: European Commission, 2000, Oil Bulletin 1000 to 1046

The German gasoil price, net off taxes, is calculated as the arithmetic average and boils down to € 315.6 per 1,000 litre.

Gasoil excise duties in Germany have been taken from [Deutscher Bundestag, 2000] and are € 0.38 (DEM 0.74) per litre. The compensation provided in 2000 was € 0.15 (DEM 0.30) per litre [Deutscher Bundestag, 2000]. This information is given in Table 42.

Table 42 Gasoil prices for the German agricultural sector, with and without fuel duty refund

	Without support	With support
	€ per litre gasoil	€ per litre gasoil
price, net off excise duty	0.32	0.32
excise duty	0.38	0.22
price, including excise duty	0.69	0.54

The price increase due to support removal is thus equal to (0.69 -/- 0.54) divided by 0.54 = 28%.

Decrease in agricultural demand for gasoil
From [Annema, 1998] we take an own-price elasticity of – 0.2, leading to a projected decrease in demand of –0.2 times 28% = 5.6%. By way of sensitivity analysis, in the main text we also use a price elasticity figure of – 0.15, with parallel calculations (which are not therefore reproduced here).

Aggregate annual German gasoil consumption stands at 2 billion litres. In the absence of support to farmers, this demand would decrease by 5.6%, or in absolute terms 112 million litres.

Emission factors
To calculate the environmental effects of reduced demand for gasoil by the German agricultural sector, we need emission factors for that use. The following information was used to establish such factors for agricultural gasoil use.

Table 43 Calculation of emission factors for gasoil use in the Netherlands

	Total emissions from gasoil (million kilograms) (a)	Total gasoil consumption (million litres)[128] (b)	Emission factor (kilogram per litre) (c) = (a)/(b)
CO_2	2,300	864	2,661
NO_x	36.3	864	42
PM_{10}	3.6	864	4.2

Source: RIVM, 2000 (total emissions and total consumption)

[128] In the Netherlands gasoil consumption is reported in PJ. To convert this figure to consumption in litres, we took 1 kg gasoil to contain 42.7 MJ and the density of gasoil as 0.84 kg/l.

Environmental effects
Combining the projected decrease in gasoil consumption of 112 million litres and the emission factors of Table 43) yields the following estimated emissions reductions due to support removal.

CO_2: 301.5 ktonne
NO_x: 4.76 ktonne
PM_{10}: 0.47 ktonne

M The Netherlands - renewable energy and energy saving

M.1 Extra consideration

This case study differs from the others in not addressing a support measure anticipated to have a negative environmental impact. It has been appended to the study in order to investigate the effectiveness of support aimed at improving environmental quality.

M.2 Description of the support measure

The support measure considered in this annex is a tax deduction scheme for energy investments ("*Energie Investergsaftrek*", EIA)[129] introduced in the Netherlands at the beginning of 1997. The aim of the measure has been defined as follows [Senter, 2001]:

- to encourage energy saving by stimulating investments in energy-efficient equipment and in renewable energy;
- to improve the profitability of these investments.

In other words, the aim of the support measure is to improve environmental quality by providing an incentive to energy conservation and renewable energy use. Companies in the Netherlands investing in either of these areas can deduct part of their investment costs from their fiscal profit[130], providing the investments fulfil certain criteria in terms of energy performance.

The percentage of the investment costs that can be deducted varied, in 2000, from 40% to 52%. The higher the investment sum, the lower the percentage of investment costs that can be deducted from the fiscal profit. The scheme was introduced as an incentive for energy investments by small and medium sized enterprises. In 2001 the percentage was changed to 55% for all investments meeting the criteria.

The scheme applies to investments in various areas, each with their own criteria in terms of energy performance, viz.:

- buildings;
- machinery and processes;
- cogeneration plant;
- transport equipment;
- use of renewable energy.

There is no specific target group for this support measure. Any enterprise making appropriate investments and subject to payment of corporate taxes is eligible. The scheme is valid for investment sums from € 1,800 (NLG 3,900) up to € 94 million (NLG 208 million).

[129] It applies only to investments in energy saving and renewable energy. The specific measures eligible under this support scheme are detailed in a list that is regularly updated by the Dutch government.

[130] A similar measure has been introduced for non-profit organisations. This EINP had a budget of € 16 million in 2000.

In 2000 the estimated amount of support provided was € 100 million. This is the figure estimated by [Senter, 2001] from aggregate registered investments, given the prescribed tax deductions, average tax rates and possible later corrections. In 2000 the support amounted to roughly 15% of all announced investments[131].

M.3 Mechanisms

The aim of the support measure is to engender a switch from regular energy investments to investments in energy saving and renewable energy, by making the latter financially more attractive. This switch will in all likelihood lead to a reduction of emissions.

However, part of the support is provided to **free riders**. Free riders are parties that, even in absence of the support, would have invested *at the same time* in the *same energy-efficient alternative*. This implies that in the absence of the support measure, the same investment would have been profitable from the investor's point of view. The reductions can thus not be attributed to the support measure.

For some of the parties investing in energy saving and renewables, investments would have also been profitable in the absence of the support, but they were not aware of the scope for such investment. This positive effect is known as the **attention effect**.

Investments in energy saving lead to lower energy bills, but this may in turn lead to increased energy consumption, partly offsetting initial savings. This is known as the **rebound effect.**

Lower energy bills mean lower overall production costs, which may in turn lead to higher production, again partly offsetting the initial energy savings. This is known as the **Baumol effect**.

In the following section, the environmental effects of the support measure are estimated using these mechanisms.

[131] Total investments were € 1,486 million, the estimated support budget € 100 million.

M.4 Environmental impact

The environmental effects of this support measure are, a priori, expected to be positive, as the aim is to save energy and extend use of renewable sources.

M.4.1 Demarcation

We consider only the demand-side effects of the support, as its impact on the supply of technologies is highly dependent on dynamic effects on technology prices. These effects derive from learning effects and economies of scale, in turn dependent on the incentives provided for new technologies. It is only recently that empirical study of these interdependencies between supply and demand has started to draw the attention of researchers. It was beyond the scope of this case study to incorporate supply-side effects in the analysis. Supply-side dynamics are generally stronger when there is greater incentive for demand and the market for technologies is larger [see Ecofys, 2000].

Furthermore, we confine ourselves to two environmental effects: CO_2 and NO_x-emissions, the main emissions due to energy use.

M.4.2 Method

The method used to determine these environmental effects comprised the following steps:

1 Determine the energy savings achieved with technologies eligible for support compared to reference technologies.
2 Determine the number of *free riders* using the support.
3 Determine the number of parties for whom the *attention effect* of the support measure has prompted investment in energy saving or renewables.
4 Determine the *rebound effect*.
5 Determine the *Baumol effect*.
6 Determine the fossil energy savings that can be attributed to the support measure.
7 Determine the reduction of CO_2 and NO_x-emissions due to reduced fossil energy consumption.

M.4.3 Results

1) Gross energy savings due to support measure
In 2000 applications for the support were received for 109 different technologies [Senter, 2001]. To determine the amount of energy saved with each of these relative to an appropriate reference technology would require an extensive study that is beyond the scope of this project.

We therefore built on a sample survey reported in [Ecofys, 2000]. This survey covered the twenty technologies for which registered investment costs were highest. This boiled down to an analysis based on 63% of the total budget, representing 89% of the total energy savings associated with the measure as reported by [Senter, 1999].

The fossil energy savings calculated by Senter[132] as attributable to the support measure amount to 20,525 TJ. These energy savings are a mix of true energy saving and substitution of renewable for fossil energy.

2) Free rider effect
As explained above, part of these energy savings are due to so-called free riders. In the case of the EIA the percentage of free riders is estimated to be 52%[133]. This means that roughly half the calculated energy savings cannot be attributed to the support measure, because the investments would also have taken place in its absence[134].

3) Attention effect
Among these free riders are some parties who are not familiar with the specific technologies in question. The EIA then fulfils the role of supplier of information. This so-called attention effect has also been estimated in [Ecofys, 2000]. It appears that only 4% of the free riders were induced to invest by the EIA. For 40% this was certainly not the case and for the remaining 56% it cannot be determined whether the attention effect played a role.

As this attention effect has such a large bandwidth, we will not use it in analysing the environmental effects of the EIA. The greater the attention effect, the more energy savings (and thus environmental impact) are attributable to the support measure.

The number of free riders thus reduces the energy savings attributable to the EIA. Table 44 shows the energy savings per Euro investment with and without correction for the large percentage of free riders and for administrative costs. The latter make up about 6% of the total budget of the support measure[135] and include the following:
- the costs of the fiscal authority, to the extent that these are dedicated to implementing the support measure;
- the costs of a special authority (Senter) to administer, monitor and evaluate the support.

The costs were calculated differently for the two authorities. For the fiscal authority no specific information on the costs of EIA implementation was available. These costs therefore had to be estimated from the *ex ante* estimate of costs per application. Earlier research had led to an estimate of a little over € 100 per application, which in [Ecofys, 2000] is actualised using price indices. The figure cited in [Ecofys, 2000] is € 135 per application. Multiplying this figure by the number of applications leads to an estimate of 3% of the total support budget.

The special authority, Senter, does have detailed information available on the costs per EIA application. These figures were used in [Ecofys, 2000],

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132 Including only the respondents in the survey used in [Ecofys, 2000].

133 See [Ecofys, 2000].

134 We assume that these corporate budgetary savings will not lead to any additional investments in energy conservation. These savings can be used for increasing profits, providing better quality products and also for energy saving. Corporate spending on energy saving is generally only modest, however. [Dutch Statistical Office, 2001] reports that less than 4% of total corporate expenditure is dedicated to environmental investments. As a rule, only part of this small percentage will concern energy saving and we therefore assume this effect to be negligible.

135 Calculated in [Ecofys, 2000].

where it is concluded that the costs of this special authority are 3 - 4% of the total support budget.

Together, then, the costs of implementing the EIA can be estimated at 6% of the total budget [Ecofys, 2000]. These costs add to the direct costs of the support measure and should be interpreted as such. They reduce the cost-effectiveness of the support, as indicated in Table 44.

Table 44 Effectiveness of the EIA, with and without the effect of free riders and administrative costs

Energy savings in MJ per € support	
without free-rider effect	with free-rider effect and administrative costs
1,565 MJ/€	637 MJ/€

Source: Ecofys, 2000

The table shows that including the effect of free riders and administrative costs reduces the effectiveness of the support measure by some 60%.

We assume that the same downscaling can be applied to the energy saved in 2000. This implies that we assume that the percentages of free riders and administrative costs remained unchanged between 1998 and 2000.

[Senter, 2000] estimates the energy saved through the support in 2000 as 16,000 TJ. After correction for free riders and administrative costs, the energy savings attributable to the support measure amount to 6,500 TJ[136], a figure exclusive of the potentially high attention effect.

4) Rebound effect
There are two more effects that may lead to a downscaling of the a priori expected energy savings: the rebound effect and the Baumol effect. These are estimated in [CPB, 2000] based on the international literature.

[CPB, 2000] calculates the rebound effect for the EIA to be 0 - 20% of total energy savings. This implies that between 0 and 20% of the initial energy saving will disappear as efficiency measures make energy cheaper. Cheaper energy leads to higher energy use. For 2000 this implies a possible ‘rebound’ of up to 1,300 TJ of the original savings

5) Baumol effect
The Baumol effect is not estimated specifically for the EIA in [CPB, 2000]. For similar support measures it is calculated, though, and it is found to be very small. This effect will therefore not be included in our analysis.

6) Net fossil fuel savings due to support measure
The net energy savings attributable to the EIA in 2000 can then be calculated to be between 5,200 and 6,500 TJ.

136 (637/1,565) times 16,000 TJ.

7) Net environmental effect

To estimate the environmental effects associated with these fossil energy savings we need emission factors. We assume that the energy saved would otherwise have come from combined cycle generating plant, which is used as a reference technology *in the margin*. Emission factors per GJ fuel input are given in [RIVM, 2001]. These emission factors were converted to factors per GJ *output*, as this is the amount of energy saved. An efficiency of 55%[137] was taken for the combined cycle. The resulting emission factors are presented in the following table.

Table 45 Emission factors for combined cycle generating plant (reference technology)

Pollutant	Emission in gram per GJ output
CO_2	101,836
NO_x	49

Source: own calculations on the basis of RIVM figures.

This implies that the following environmental effects can be attributed to the support measure: reductions of between 530 and 660 ktonne CO_2 and between 255 and 320 tonne NO_x. If the full amount of support is allocated to these reduced CO_2-emissions, the effectiveness of the EIA can be calculated to be between € 150 and € 190 per tonne CO_2[138,139].

These cost effectiveness figures differ substantially from those presented by [Verbruggen et al., 2002]. This is because those authors discounted the support over the estimated lifetime of the different technologies. If we discount the total amount of support over 15 years at a discount rate of 10%[140] the cost effectiveness of the EIA is an estimated € 20 to € 25 per tonne CO_2. This is in the middle of the range presented by [Verbruggen et al., 2002], € 11.3 to € 34 per tonne $_{CO2}$.

These figures are still relatively high compared with the cost effectiveness of another recently introduced support measure to reduce CO_2-emissions, designed as a tender, to which companies can subscribe. The support is then directly linked to the predicted CO_2-reduction. The cost effectiveness of this measure varies, but is between € 4.9 and € 11.1[141] [Project office CO_2-reduction plan, 2000].

[Verbruggen et al., 2002] also make a comparison of cost effectiveness. The conclusion they draw is that the EIA should be considered as the third best alternative for reducing greenhouse gas emissions. The first best alterna-

137 This implies that 1 GJ input leads to 0.55 GJ output. This efficiency is used throughout Dutch policy reports.

138 Including the additional benefits of lower NO_x-emissions makes little difference to the cost-effectiveness. Measures to reduce NO_x in the Netherlands seldom cost more than € 5,000 per tonne reduced. If these benefits are valued at this level (these costs being avoided in the rest of society) the support that can be allocated to CO_2-reduction decreases to € 100 million minus € 5,000 times roughly 300 tonnes of NO_x reduced. The support allocated to CO_2-reduction thus decreases to € 98.5 million, hardly altering the cost-effectiveness of the support measure.

139 The cost effectiveness is calculated by dividing the total support (€ 100 million) by the reduced CO_2-emissions (530 - 660 ktonne).

140 These estimates of lifetime and discount rate are used in [Ecofys, 2000] as well.

141 Excluding the first series, which had a cost-effectiveness of € 24.1 per tonne CO_2.

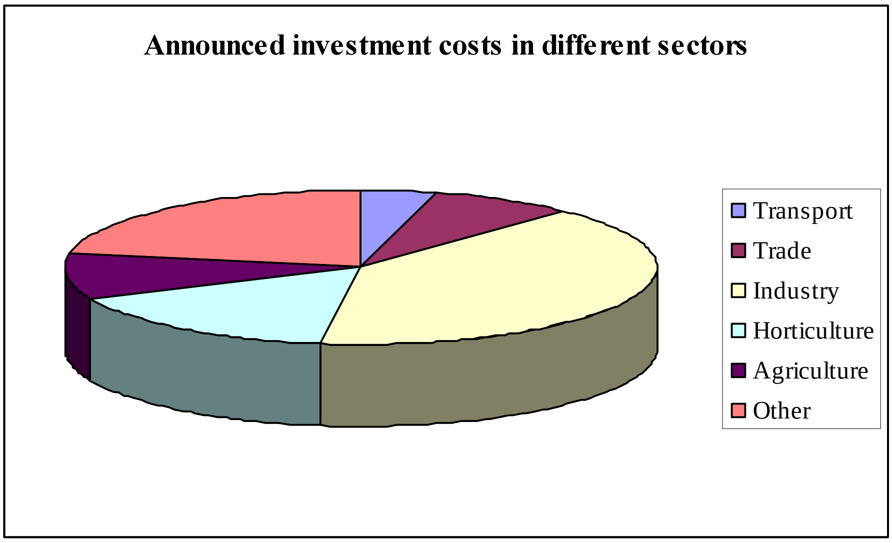
tives, emissions trading and emission charges, are more cost-effective, but can only be implemented with more international coordination in place. The second best alternative is described as support on the basis of emission reductions. Their recommendation is therefore to adjust the EIA towards a more tailor-made form of support in order to increase its cost effectiveness.

M.5 Economic effects

To calculate the economic effects of the support relative to the situation without it, the distribution of the support over various sectors must be examined. This provides insight into possible economic effects on the demand side for energy-efficient technologies.

From [Senter, 2000] we see that announced investment costs are spread over a wide range of categories; see Figure 4.

Figure 4 Announced investment costs in different sectors



The market structure between the different sectors will hardly change, as the support is spread fairly evenly over the sectors. If the support were removed, this would cause demand for energy-efficient technologies and investments in renewable energy to decrease and demand for regular energy investments to increase. The only economic effect on the demand side will then be that reduced benefits for free-riders.

On the supply side the most likely effect of support removal would be less implementation of energy efficiency measures. This will affect development of the energy-efficient technologies eligible for the EIA. That development work and the resulting process of adaptation are accelerated by two mechanisms:

– the support makes the technologies cheaper and therefore more attractive to potential investors;
– the support provides potential investors with better information, enlarging the potential market.

Quantitative analysis of the development effects of the support was not possible within the scope of the analysis, but it is obvious that removal of the support would, *ceteris paribus*, lead to slower development of energy-efficient technologies. This not only reduces the competitiveness of these technologies in the short run, but, given the existence of learning curves, especially in the long run. Learning curves for some energy-efficient technologies have been estimated in [OECD/IEA, 2000]. Supply-side dynamics are generally stronger when there is greater incentive for demand and the market for technologies is larger [see Ecofys, 2000].

On the supply side of the technologies eligible for support there may be employment effects. From the available data, however, it is not possible to calculate these.

The major economic effect that can be identified is the amount of support provided to companies that would have made the same investments in energy saving or renewable energy even in the absence of support. This puts unnecessary pressure on the government's budget, especially when compared to the limited environmental gains.

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M.6.1 Annex: Calculations

In this annex we provide the more extensive calculations on which the above analysis is based.

Effect of free riders and administrative costs on effectiveness of support
From [Ecofys, 2000] we have taken the following figure, providing insight into the effect of free riders and administrative costs on energy savings per euro support.

Table 46 Effectiveness of the EIA, with and without the effect of free riders and administrative costs

Energy saving in MJ per € support	
without free-rider effect and administrative costs	with free-rider effect and administrative costs
1,565 MJ/€	637 MJ/€

Source: Ecofys, 2000

This brings the effectiveness of the support down from 1,565 to 637 MJ/€, a decrease of roughly 60%.

[Senter, 2000] estimates the energy saved as a result of the support as 16,000 TJ. This estimate does not incorporate free riders and administrative costs. We therefore downscale the amount of energy saved by 60% in accordance with the above calculation.

The energy savings attributable to the EIA is then 40% times 16,000 TJ, i.e. 6,500 TJ.
These estimated savings do not incorporate the so-called Baumol effect (see main text), which may be as large as 20%. We therefore apply a correction for this effect to yield a minimum estimate of the energy savings attributable to the EIA. The amount of energy saved is thus equal to between 5,200 and 6,500 TJ.

Environmental effects
To establish the environmental effects of these energy savings, the emissions prevented must be calculated. We assume that the energy saved would otherwise have come from combined cycle generating plant, which is used as a reference technology *in the margin*.

The emission factors per GJ fuel input are given in [RIVM, 2001]. We convert these emission factors to emission factors per GJ *output* as this is the amount of energy saved. We use an efficiency of 55%[143] for the combined cycle. The resulting emission factors, both per GJ input and per GJ output, are presented in Table 47.

Table 47 Emission factors for combined cycle generating plant (reference technology)

Pollutant	Emission in gram per GJ input (a)	Efficiency of combined cycle (b)	Emission in gram per GJ output (c) = (a)/(b)
CO_2	56,000	55%	101,836
NO_x	27	55%	49

Source: RIVM, 2001 (emission in gram per GJ input), own calculations

The energy saved thus results in the following decrease of emissions:

CO_2:
- 5,200 TJ times 101.8 kilogram per GJ times 1,000 GJ/TJ = 529 ktonne
- 6,500 TJ times 101.8 kilogram per GJ times 1,000 GJ/TJ = 662 ktonne

NOx:
- 5,200 TJ times 49.1 gram per GJ times 1,000 GJ/TJ = 255 tonne
- 6,500 TJ times 49.1 gram per GJ times 1,000 GJ/TJ = 319 tonne

143 This implies that 1 GJ input leads to 0.55 GJ output. This efficiency is used throughout Dutch policy reports.