EUROPEAN COMMISSION DIRECTORATE GENERAL - ENVIRONMENT

STUDY ON INVESTMENT AND EMPLOYMENT RELATED TO EU POLICY ON AIR, WATER AND WASTE

FINAL REPORT

WRc Ref: EC 4739/M/11452-0
September 2000

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Report No.: EC 4739 Main

September 2000

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EXECUTIVE { TC "EXECUTIVE SUMMARY" }SUMMARY

Key Messages

- Europe suffers from a dual problem of the **simultaneous over use of natural resources and under use of human resources**. European environmental policies have a key role to play in resolving this paradox: by ensuring effective implementation of the environmental *acquis* to protect and enhance the natural environment and **capitalising on the resulting employment opportunities**.

- To facilitate this role requires a better understanding of the costs of policies, the employment opportunities and the expenditure-employment linkages. This report contributes to this understanding by providing **best order of magnitude estimates of the costs and the employment** associated with **ten major directives** in the areas of air, water and waste.

- Annual expenditures of **40 Billion Euro** per annum (0.5% of EU-15 GDP or 110 Euro per capita) have been estimated for the directives examined. Investments between 1990 and 2010 total **260 Billion Euro** with associated operating costs of **15 Billion Euro** per year at the height of implementation.

- These expenditures contribute to meeting a **wide range of environmental policy goals**, reducing **acidification** and **eutrophication**, protecting **drinking water** and improving **waste stream management**.

- Over and above these environmental benefits, however, the expenditures are estimated to provide **half a million job opportunities per annum** – equivalent to **3% of Europe's unemployed**.

- Comparative analysis of the costs and employment effects by Member State and directive yields a number of insights:

  - There is **no simple explanation of cost differences by Member State** but relatively high expenditures are seen in the developed parts of the EU, reflecting the extent of environmental pressures, opportunity costs, demand for environmental quality and a variety of country specific factors.

  - The pattern of job opportunities provided by the directives poorly matches the distribution of European unemployment: **areas where unemployment is highest tend to see the lowest level of linked employment opportunities**.

  - The expenditures identified are **a significant proportion of current eco-industry activities** – particularly in the air sector and for the lagging regions – highlighting the growth opportunities available in these areas.

Background

This report is the result of research undertaken by WRc (UK), Risø (Denmark) and Nilu (Norway) under contract to the European Commission Directorate General – Environment (B1/ETU/980051) between 1998 and 2000. The objectives of the research were to provide for adopted and in-the-pipeline EU environmental policy in the areas of air, water and waste, best order-of-magnitude estimates of the costs and employment linked to investments.

Europe suffers from a dual problem of the simultaneous over use of natural resources and under use of human resources and as a result environmental degradation and high unemployment go hand-in-hand. European environmental policy has a key role to play in resolving this paradox. Numerous recent studies have pointed to the positive association between environmental policy and employment yet despite this link there remain considerable gaps in the implementation of the European environmental *acquis*. Consequently, further action to ensure the implementation of the *acquis* can be considered to be one of the key supporting policies for addressing the resource paradox.

Facilitating such a role requires a better understanding of the costs of environmental policies, the employment opportunities and the expenditure-employment linkages. Directive and Member State specific factors contributing to differences in costs and employment need to be understood and policy relevant lessons learned.

The analytical approach and directives examined

The additional costs of Member State activities between 1990 and 2010 have been identified using a demand-side, microeconomic approach.

- It is a demand side approach as it looks at the implementation expenditures which give rise to demand for goods and services including labour and hence employment.

- It is a microeconomic approach as it looks at the immediate sectors affected without analysing the consequent economy-wide adjustment processes.

While necessarily giving only a partial perspective this approach offers considerable advantages in providing policy relevant detail on the links between the directives' costs and employment. The study focuses on the costs to Member States of achieving the objectives of the Directive relative to a common baseline, as opposed to the marginal costs of the Directive requirements relative to what the States would have done in the absence of the Directive. Employment linked to the expenditures has been estimated using an engineering analysis of the destination of expenditures and information on the relative unit labour costs in the EU-15 Member States. The ten directives examined were not chosen to be a representative sample of European environmental policy, but to reflect the broad spectrum of policies currently adopted and in the pipeline. The ten directives examined were:

Sulphur in Liquid Fuels Directive
National Emission Ceilings Directive
Large Combustion Plants Directive
Directive on VOC
Urban Waste Water Treatment
Drinking Water Directive
Nitrate Directive
Hazardous Waste Incineration
Packaging and Packaging Waste
End of Life Vehicles

Quality and availability of information

This research has sought to rely on existing sources of information. Although a range of information is available, there is little consistency and numerous gaps. In the absence of existing information on the costs and employment impacts, new estimates are provided here, utilising what information is available.

The available data varies substantially in volume and quality between sectors and directives.

- In the **air sector** there tends to be at least one pan-European estimate of costs together with a number of country specific or technology specific evaluations. The pan-European estimates tend to report very aggregated results requiring further assumptions to achieve the necessary breakdown by Member State or cost type. There is a tendency for cost evaluations to be overestimated because the models utilised focus on end-of-pipe controls, without recognising alternative, sometimes cheaper, options.

- There is generally more information available for the **water directives**, particularly the Urban Waste Water Treatment Directive, which has involved very high expenditures in most Member States. Information on the costs of the other water directives is more variable, with information limited to specific parameters for drinking water (lead, pesticides) and farming types for the Nitrate Directive (mainly the intensive livestock sector). Only a very partial estimate of costs is therefore possible in the case of these directives.

- For the **waste directives** available information is limited, focusing mainly on the costs of managing particular waste streams and as a result it has been necessary to produce new estimates of the costs for this study. Difficulties are encountered in using waste statistics because of differences in the classification systems of Member States and in defining a baseline over which the implementation of the directives takes place.

Across **all directives**, there is virtually no consistency in the reporting of cost data and as a result it is often difficult to compare estimates or disaggregate by Member State, cost driver or expenditure type. In particular, few evaluations treat operating costs satisfactorily, which introduces considerable uncertainty in the present analysis. This is particularly true where only investment costs are known as the use of engineering analysis impacts both upon overall costs and the resulting employment.

For those directives where there is limited information on the strategies adopted (or to be adopted in the case of in-the-pipeline policies) there is additional uncertainty about the impacts, given different options for implementation available to Member States. Further scenario analysis demonstrates that the choice of compliance strategy significantly impacts on costs and employment estimates:

- Labour intensive strategies are demonstrated to have a significant impact on the resulting employment - in the case of the Proposed Directive on End of Life Vehicles employment can vary by a factor of five between labour intensive and labour extensive approaches.
- Preventative strategies are often lower cost but, additionally, in the case of the Drinking Water Directive, may also involve a higher relative employment impact.

Due to the above mentioned uncertainties the estimates presented in this report should be interpreted cautiously and considered within the context in which they are presented.

The scale of expenditure and employment

It is estimated that investments of 260 Billion Euro between 1990 and 2010 are associated with the ten directives examined (Table I). Such expenditure is larger than the economies of all but the six largest of the EU-15 Member States. These investments are accompanied by additional operating costs of 15 Billion Euro per year bringing the annual expenditures (including an allowance for the investment expenditures) to 40 Billion Euro per annum (0.5% of EU-15 GDP or 110 Euro per capita). The expenditures create a demand for labour totalling half a million jobs – equivalent to 3% of Europe's unemployed.

Comparative analysis of the directives

The air sector directives are associated with capital expenditures of 64 Billion Euro with the National Emission Ceilings Directive accounting for over half of this total. With operating expenditures of 6 Billion Euro, this amounts to an annual expenditure of almost 13 Billion Euro per annum, representing 0.17% EU-15 GDP or 34 Euro per capita. Aside from the National Emissions Ceilings Directive, the Sulphur in Liquid Fuels and Large Combustion Plant Directives contribute significantly to costs, while the costs associated with the Directive on VOCs add very little to the total costs for the sector. Employment linked to the air directives amounts to 133 000 FTE (Full Time Equivalent Jobs) annually which represents approximately 1% of the EU-15 unemployed.

The water sector directives examined involve capital expenditure of more than double the air sector directives amounting to some 164 Billion Euro between 1990 and 2010. The vast majority of this (152 Billion Euro) arises through the Urban Waste Water Treatment Directive. Operating expenditures required for the exploitation of these investments add a further 3.5 Billion Euro at the height of implementation and contribute to an annualised cost (including the capital expenditures) of 20 Billion Euro/yr (54 Euro/capita/yr)). Employment linked to the water directives amounts to almost 180 000 FTE. The vast majority of this employment arises in relation to the Urban Waste Water Treatment Directive which itself is linked to a level of employment equivalent to around 1% of the EU-15 unemployed.

In the waste sector the estimated capital expenditure of 30 Billion Euro between 1990 and 2010 is almost exclusively attributable to the Packaging and Packaging Waste Directive. The other waste directives, for Hazardous Waste Incineration and End of Life Vehicles, represent just over 1.2 Billion Euro in capital expenditure. Operating expenditures amount to almost 5 Billion Euro contributing to an annual expenditure of 8 Billion Euro per annum. Such expenditures are around 0.1% of the EU-15 GDP and equivalent to around 20 Euro per capita. Employment linked to these expenditures represents around 120 000 FTE annually, representing some 0.8% of the total number of unemployed in the EU-15. Despite having a level of annual expenditure in the waste sector close to the level for the National Emissions Ceilings Directive, the employment impact is much higher due to the relative employment intensity of the waste sector expenditure (i.e. the importance of the return to labour in overall costs).

The directives examined are at different stages of their respective lifecycles, with some adopted, substantially revised or in the pipeline. The majority (63%) of the expenditures and employment have already occurred in the period 1990 to 2000. Post 2000 the air directives are of most significance, a position held by the water directives pre 2000.

Table I Investment and employment related to EU environmental policy (1990 to 2010) - key results by directive

	Investment (Capital Expenditure) (M Euro)	Operating Expenditure (M Euro)	Annual Expenditure (M Euro)	Annual expenditure as % of GDP	Annual expenditure per capita Euro	Annualised tangible employment (FTE) linked to the directives	Employment as % of EU-15 unemployment in 1999
The Air Sector Directives							
Sulphur in Liquid Fuels	10,000	500	1,500	0.02%	4	14,100	0.1%
National Emissions Ceilings	34,100	4,100	7,600	0.10%	20	78,200	0.5%
Large Combustion Plant	19,400	1,600	3,600	0.05%	10	37,900	0.3%
Volatile Organic Compounds	800	100	200	0.00%	0	1,700	0.0%
Sub total air	*64,400*	*6,300*	*12,800*	*0.17%*	*34*	*132,700*	*0.9%*
The Water Sector Directives							
Urban Wastewater Treatment	152,200	2,400	17,900	0.24%	48	152,400	1.0%
Drinking Water	12,100	500	1,700	0.02%	5	16,300	0.1%
Nitrate	-	600	600	0.01%	2	1,000	0.1%
Sub total water	*164,300*	*3,500*	*20,300*	*0.27%*	*54*	*178,700*	*1.2%*
The Waste Sector Directives							
Hazardous Waste Incineration	700	<100	100	0.00%	0	1,100	0.0%
Packaging and Packaging Waste	29,100	3,800	6,800	0.09%	18	97,400	0.7%
End of Life Vehicles	500	900	1,000	0.01%	3	18,900	0.1%
Sub-total Waste	*30,200*	*4,800*	*7,900*	*0.10%*	*21*	*117,400*	*0.8%*
ALL Directives/Sectors	258,874	14,596	41,000	0.54%	110	428,800	2.9%

Figures are rounded to the nearest 100 M Euro for expenditure (except per capita figures) and 100 FTE for employment. Figures may not sum due to rounding.

Table II Investment and Employment related to EU Environmental Policy - key results by Member State

Member State	Investment (Capital Expenditure) (M Euro)	Operating Expenditure (M Euro)	Annual Expenditure (M Euro)	Annual expenditure as % of GDP	Annual expenditure per capita (Euro)	Annualised tangible employment linked to the directives (FTE)	Employment as % of unemployment
Austria	12,900	300	1,600	0.77%	201	17,200	10%
Belgium	11,000	900	2,000	0.67%	198	19,800	6%
Denmark	2,700	200	500	1.03%	99	6,400	5%
Finland	3,500	200	500	1.44%	99	5,600	3%
France	27,300	1,700	4,500	0.12%	77	50,100	2%
Germany	93,000	4,200	13,700	0.07%	166	131,700	4%
Greece	4,500	400	800	1.98%	78	15,700	4%
Ireland	2,400	200	400	2.87%	116	5,100	5%
Italy	27,200	1,500	4,300	0.16%	74	38,500	2%
Luxembourg	400	<100	100	12.48%	172	700	12%
Netherlands	19,300	1,500	3,400	0.45%	221	31,500	12%
Portugal	4,200	200	700	1.74%	68	15,800	7%
Spain	17,300	1,200	3,000	0.33%	76	39,100	2%
Sweden	6,400	400	1,000	0.78%	114	10,400	3%
UK	26,900	1,700	4,400	0.16%	75	52,900	3%
EU-15	258,900	14,600	41,000	0.54%	110	440,400	3%

Figures are rounded to the nearest 100 M Euro for expenditure (except per capita figures) and 100 FTE for employment. Figures may not sum due to rounding.

The directives differ in terms of their environmental focus, each being associated with a specific problem. Nevertheless there are a number of overlaps, particularly for the air directives, which give rise to a potential double counting. In most cases this is not likely to be a significant problem with the possible exception of the overlap between part of the National Emissions Ceilings and Nitrate Directives both of which are concerned with farm manure management strategies.

The directives examined use a variety of approaches to environmental management. Most of the directives examined use technology or emissions standards but there are examples of quality standards (Sulphur in Liquid Fuels, Drinking Water Directive) and use standards (Nitrate Directive) with some Directives (Directive on VOC, Nitrate) using a combination of approaches.

Differences in the directives give rise to differences in the labour market responses to expenditures. The expenditure per employee varies between directives from 52 000 Euro for the Directive on End of Life Vehicles to 117 000 Euro for the Urban Waste Water Treatment Directive. Directive characteristics contribute to these differences because of the proportion of expenditure that goes directly to employees in sectors undertaking the expenditures and the unit labour costs in the sectors receiving expenditure. Differences also arise in the type of employment generated, with the waste directives giving rise to a higher proportion of permanent employment (given the importance of operating versus capital expenditures) relative to the water and air directives.

Comparative analysis by Member State

The highest per capita expenditures are seen in the most developed parts of the EU, reflecting the fact that this is where environmental pressures, opportunity costs and demand for environmental quality is greatest (Table II). The pattern of job opportunities provided by the directives does not match well the distribution of European unemployment. The areas where unemployment is highest also tend to see the lowest level of linked employment due to the generally lower expenditures on the directives and despite the lower labour costs. In most Member States the expenditures associated with the directives represent a significant proportion of current eco-industry expenditure – particularly in the air sector and for the lagging regions – pointing to the opportunities for the growth of these sectors.

There are wide variations in the cost patterns seen in individual Member States. The largest investment expenditure is seen in Germany, which accounts for 93 Billion Euro of the total 260 Billion Euro of capital expenditure. Three further countries, UK, France and Italy see investment expenditures over 20 Billion Euro. In most Member States the annualised expenditures represent a small but significant proportion of GDP, generally less than 1%. The expenditures account for more than 1% of GDP in several countries: Denmark, Finland, Greece, Ireland, Luxembourg and Portugal.

Annual expenditure per capita varies considerably between Member States. Austria, Belgium and the Netherlands have levels of per capita expenditure of almost double the EU-15 average (110 Euro/capita/yr), while a number of countries (France, Greece, Italy, Portugal Spain and the UK) have per capita expenditures at around three quarters or less of the EU-15 average. Even the lowest per capita expenditure in Portugal, however, is significant, amounting to 68 Euro/capita/yr.

As with expenditure per capita, there is considerable variation in the intensity of the employment linkages in each of the Member States. The employment linked to the directives represents over 10% of the total unemployed in Austria, Luxembourg and the Netherlands (as a result of high expenditures in conjunction with low unemployment). In three countries such employment represents around 2% of total unemployment (less than the EU-15 average of 3%). These countries (France, Italy and Spain) all have relatively low expenditures associated with the directives in conjunction with relatively high unemployment.

There is no simple explanation of the cost patterns faced by the different Member States. A number of countries consistently see low per capita costs across all sectors (UK, France, Italy and the Cohesion countries), while other countries see high costs for some directives and lower costs for others.

Much of the variation in the pattern of costs can be attributed to "volume" of environmental protection Member States must undertake to meet the objectives of the directive, although a number of country specific factors also play a role.

- In the air directives the energy strategies of the Member States plays an important role reducing costs in some countries because of the relatively high reliance on low emission fuels (e.g. gas, nuclear fuels).

- Differences in the concentration of affected economic sectors are an important factor in a number of directives. For the Sulphur in Liquid Fuels and National Emissions Ceilings Directives, for example, high costs are seen in the Netherlands and Belgium because of the highly developed oil refining and agricultural sectors in these countries.

- Differences in the sensitivity of the receiving environment can be important, for example for the Urban Waste Water Treatment and Nitrate Directives. In the Urban Waste Water Treatment Directive these differences lead to differences in the applicable standards, reducing the costs in those Member States where discharges do less damage.

- Differences in the compliance strategies adopted by Member States can be important, for example in the Drinking Water Directive, where the importance given to preventative versus remedial strategies reduces costs in a number of Member States.

- Differences in the opportunity cost of resources play a role, particularly where labour costs are an important component of overall costs (e.g. the proposed Directive on End of Life Vehicles), because of the large differences in labour costs between Member States.

Labour cost differences between Member States also give rise to different labour market responses to the expenditures. High unit labour costs tend to reduce the number of jobs linked to the directives. Differences between Member States as a result of different labour costs are, however, moderated by the fact that countries where labour costs are high also tend to see a relatively high proportion of sector expenditures going to labour.

Recommendations

- The considerable gaps in the available information mean that there is a need to collect and report more systematically on the unit costs of interventions.

- There is a need for a more complete analysis in the case of some of the directives covered in this report, particularly the Nitrate and Drinking Water Directives.

- There is a need to develop more coherent guidelines for developing and collecting cost information and to ensure different types of investment/operating expenditures are dealt with in a comparable and comprehensive manner.

- This report has presented an *ex-post* analysis of the costs of measures associated with the Directives. There is a further need for this type of analysis (of other directives) but also a need to develop *ex-ante* assessments to help in the development of new policies.

- Finally, it should be stressed that this study has used a micro-economic perspective to concentrate on the policy-relevant linkages between expenditure and employment. There is a further need for a macro-economic analysis to focus on the economy wide implications of expenditures.

GLOSSARY

Microeconomic	Focus on the effects of policies and activities in terms of how they effect specific firms, individuals, or governments.
Macroeconomic	Focus on the effects of policies and activities in terms of how they effect aggregated variables such as the national unemployment rate, total output etc.
Direct employment	Employment arising as a result of the first round of expenditure (either capital or operating) by the organisation undertaking the expenditure.
Indirect employment	Employment arising from the second and subsequent rounds of expenditure as organisations in receipt of first round expenditure subsequently spend the money received.
Tangible employment	Employment created in the first or second wave of expenditure.
Compensation to employees	The portion of expenditure in a sector received by employees
Economic sectors receiving expenditure	Energy – power production and supply. Capital goods – machinery and equipment providing services over a number of years. Intermediate goods – materials and consumables used in the production process. Construction – buildings and civil engineering. Services – design and waste disposal.
Capital costs/expenditure	Expenditure on goods and services providing an output over a number of periods (investments)
Operating costs/expenditure	Expenditure within periods for the exploitation of investments
Annual costs	Equivalent annual value of capital and operating expenditures

ABBREVIATIONS

Countries

A	Austria
B	Belgium
DK	Denmark
FIN	Finland
F	France
D	Germany
EL	Greece
IRL	Ireland
IT	Italy
L	Luxembourg
NL	Netherlands
P	Portugal
E	Spain
S	Sweden
UK	United Kingdom

Directives

SLFD	Sulphur in Liquid Fuels Directive
NECD	National Emissions Ceiling Directive
LCPD	Large Combustion Plants Directive
DVOC	Directive on Volatile Organic Compounds
UWWD	Urban Waste Water Treatment Directive
ADWD	(Amended) Drinking Water Directive
NITD	Nitrate Directive
HWID	Hazardous Waste Incineration Directive
PPWD	Packaging and Packaging Waste Directive
DELV	Proposed Directive on End of Life Vehicles

BAT	Best available technology
EAV	Equivalent annual value
ELV	End of life vehicle
FTE	Full time equivalent
LCP	Large combustion plant
MS	Member State
NPV	Net present value
PE	Population equivalent
WPZ	Water protection zone

AKNOWLEDGEMENTS

The team would like to extend their appreciation to the many individuals and organisations who provided assistance during this project. In particular great assistance was provided by the European Environment Agency and its Topic Centres on Air, Inland Waters and Waste. Particular thanks are extended to Mr Steinar Larssen (ETC/AQ, Kjeller, Norway), Dr Tim Lack (ETC/IW, Medmenham, UK) and Jens Brodersen (ETC/W, Copenhagen, Denmark). Special thanks are also accorded to Dr. Janusz Cofala, Dr. Zbigniew Klimont, Dr. Markus Amann and other staff of the Transboundary Air Pollution Project, International Institute for Applied Systems Analysis (IIASA) Laxenburg, Austria and to Mike Holland of AEA Technology, UK.

1. INTRODUCTION

1.1 Introduction

Following the European Commission call for tenders (Ref: B1/ETU/980051) WRc was selected to undertake research for a *Study on Investment and Employment Related to EU Policy on Air, Water and Waste*.

The objectives of the study were to provide for adopted and in-the-pipeline EU environmental policy in the areas of air, water and waste policy, best order of magnitude estimates of the costs (objective one) and employment linked to investments (objective two). The intention was for the study to lead to a clear view of the orders of magnitude of the costs involved, the main driving forces and the resulting employment impact. WRc assembled a team utilising the European Environment Agency's Topic Centres on Air Quality (ETC/AQ), Inland Water (ETC/IW) and Waste (ETC/W) through a consortium of WRc (UK), the Norwegian Institute for Air Research (Norway) and the Risø National Laboratory (Denmark).

1.2 Objectives

The recent communication on environment and employment summarised concisely the challenge in creating a sustainable Europe as:

"achieving a competitive economy combined with less environmental pollution, improved resource efficiency of energy and raw materials and higher employment rates" CEC (1997)

At the heart of this challenge is the need to design policies which recognise and respond to the so called "resources problem". Simply stated the resources problem involves the simultaneous over use of environmental resources and under use of human resources. The over use of environmental resources is characterised by the remaining problems of environmental degradation and continued pressure on environmental resources. The under use of human resources is characterised by continued high rates of unemployment in EU Member States (10% in the EU-15 overall - see Table 1.1).

Ways of addressing the resources problem in an integrated way clearly warrant detailed examination. In its White Paper "Growth, Competitiveness and Employment" (CEC 1993) the Commission has itself pointed to the need to analyse the ways in which economic growth could be secured in a sustainable manner and contribute to higher employment intensity and lower consumption of natural resources.

Table 1.1 Unemployment rate in EU-15 Member States (1998)

A	**B**	**DK**	**FIN**	**F**	**D**	**EL**	**IRL**
4.7%	9.5%	5.1%	11.4%	11.7%	9.4%	11.6%	7.8%
IT	**L**	**NL**	**P**	**E**	**S**	**UK**	**EU-15**
12.2%	2.8%	4.0%	5.1%	18.8%	8.3%	6.3%	10.0%

Source: Eurostat (1999)

In the context of EU policy in the area of air, water and waste what is important is the extent to which, and by what means, current, in the pipeline and future policies for the environment contribute to resolving the resource paradox. The OECD produced a comprehensive review of the linkages between environment and employment and outlined several factors which determine the net effect of policies (OECD 1997) (See Figure 1.1). Through an examination of macroeconomic studies into the environment and employment the overall conclusion was that environmental policies were having a small but positive impact on employment.

Figure 1.1 Major factors determining the employment effects of environmental policies

- **The level and sustainability of environmental expenditure** - how permanent is the environmental expenditure?
- **The economic context in which environmental measures are implemented** - state of the business cycle impacts on employment determining whether it is additional or just redistributive.
- **The level and the sectoral, regional and structural patterns of unemployment** - inability to target expenditures will limit the employment potential.
- **The competitive situation of human resources** - the skills must be available to meet the demands.
- **The direction of environmental policy strategies to be pursued** - prevention strategies will have different employment impacts than end-of-pipe or remediation.
- **The pattern of environmental spending** - impact of investment expenditure versus operational expenditure.
- **The type of environmental investment or spending** - add-on technologies versus clean technologies.
- **The means of financing and the impact on borrowing and taxes** - employment impact may be different depending on whether public or private sources of expenditure are used.
- **The significance of import leakage** - potential to export jobs in traded environmental goods.
- **The incidence of environmental measures** - competitiveness effects of unilaterally introduced environmental measures.
- **The competitive situation of the target industries** - how will industries respond to measures?

Source: Sprenger (1997)

Despite the apparent positive linkage between environmental policy and employment there are still considerable gaps in the implementation of the European environmental *acquis.* Consequently, further action to ensure the implementation of existing and in the pipeline legislation (together with locally effective application) can be considered to be one of the key supportive policies for addressing the resources problem.

1.3 Structure of report

Section 2 of this report outlines the principles of the adopted approach. Section 3 presents an overview of the approach to data collection and the information obtained. Section 4 presents the main results of the study at an aggregated level. A more detailed comparative analysis is presented in Section 5 (by Directive) and Section 6 (by Member State). Section 7

discusses some sensitivity/scenario analysis of a number of issues leading to uncertainty in the estimates provided.

Appendix 2 of this report presents a summary of the key results by directive (Appendix 2.1) and by Member State (Appendix 2.2). The report is accompanied by two Annexes that present the background material relevant to the production of the best estimates of costs (Annex 1) and employment (Annex 2).

1.4 References

CEC (1993) Growth, Competitiveness and Employment. White Paper, Brussels

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Eurostat (1999) Unemployment Rate in the EU-15 Member States.

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2. APPROACH

2.1 Introduction

This section details the principles of the approach adopted, focusing on the choice of analytical framework; the rationale for the choice of the directives analysed; the treatment of total and marginal impacts; treatment of uncertainty; analysis of cost information; and the method for assessing employment linkages.

2.2 Choice of analytical framework

Macroeconomic assessments, such as those reviewed by OECD (1997) and revealing the positive correlation between environmental policy and employment, have difficulty in demonstrating the mechanisms by which environmental policies impact on employment[1]. Other approaches aimed at looking at the environmental labour market have also been employed by researchers in the past but also fail to address sufficiently the link between environment and employment. Macroeconomic and labour market approaches tend to be good at counting environmental jobs but poor at explaining the relationships. Figure 2.1 summarises where the approach adopted for the current study fits in with other possible approaches.

Figure 2.1 Analytical frameworks available for the analysis of employment and environment interactions

Macroeconomic		**Microeconomic**		
Demand side	Equilibrium	Demand side	Supply side	Other
Behavioural and econometric models used to predict the impact of exogenous changes in expenditure.	Examination of long run adjustment processes to environmental policy changes where a new equilibrium is achieved in all markets following changes in demand, supply patterns	Use of input output data and engineering cost data to predict job requirements on the basis of environmental related expenditures (demand)	Identification of jobs in the environmental sector through surveys of businesses	Examination of jobs with specific environmental attributes/qualifications

Current approach: modified microeconomic demand side analysis:
Analysis restricted to the direct and first round indirect employment associated with specific expenditures related to environmental policies.

[1] Indeed a central assumption of many macroeconomic models is that labour markets are in equilibrium and hence there is no "unemployment".

To examine linkages and provide policy relevant detail, a microeconomic assessment framework is most appropriate. Such an approach has limitations but does provide a more detailed framework for assessing the employment linkages associated with different environmental policies and is of greater use in assessing ways in which employment considerations can be integrated into the design of environmental policies. One of the chief limitations is that the analysis is partial. It cannot account for all of the adjustment processes that will follow from changes in one sector of the economy and spill over into other sectors[2]. In order to concentrate on the direct effects such assumptions are absolutely necessary for a microeconomic analysis.

2.3 The directives considered

In order to understand linkages, a broad array of evidence is required from different sectors. For this purpose ten directives in the field of air, water and waste policy have been examined:

In the air sector:

- The Sulphur in Liquid Fuels Directive,
- The National Emissions Ceilings Directive,
- The Large Combustion Plant Directive,
- The Directive on Volatile Organic Compounds,

In the water sector:

- The Urban Waste Water Treatment Directive,
- The Drinking Water Directive,
- The Nitrate Directive

In the waste sector:

- The Directive on the Incineration of Hazardous Waste,
- The Packaging and Packaging Waste Directive,
- The Proposed Directive on End of Life Vehicles

These directives were partly chosen to provide a simpler analytical framework than some others which could have been examined and are not therefore considered to be

[2] As an example consider the implementation of an environmental measure such as improved waste water treatment which increases the production cost for industries discharging to the improved plants. This increased cost may be passed on by the dischargers in the form of higher prices and reducing demand for their products, with consequent further impacts.

representative of the universe of community environmental legislation. Nevertheless they do provide a broad spectrum of problems and policies.

2.4 Marginal impact of policies

A problem encountered when examining both the costs and tangible employment effects of environmental policies is in addressing the issue of marginal impacts. Traditionally, the identification of marginal or incremental impacts of policies receives considerable attention. The marginal impact is generally thought of as that additional activity Member States must undertake to comply with supranational policy (e.g. EU Directives) that they would otherwise not have undertaken (either at all or within a specific time frame).

Adopting such a perspective creates real difficulties, principally because of the phenomenon of joint costs and the difficulty of correctly describing the situation in which the policy in question is not adopted (i.e. the counterfactual case). Joint costs cause problems because by definition they are not additive. If we consider three different levels of policy formulation: national, international and EU, then a particular activity may lead to compliance with the objectives at each policy level.

A concrete example would be national policy for acceptable wastewater treatment, the North Sea Conference targets and the EU Urban Wastewater Treatment Directive. A particular investment programme may satisfy all policies simultaneously and a problem arises in answering the question *what are the costs of each separate element?*, *or what are the costs of the international obligations relative to what would have been done nationally?*

The accountancy profession has struggled with the problem of joint costs for many years and has developed a number of approaches, three of which are:

- fully distributed cost or activity based costing (involving detailed and systematic decomposition of costs),
- stand alone cost (articulation of the cost of producing each individual output in isolation),
- incremental cost (articulation of the cost of producing an additional output over and above a primary output).

Fully distributed cost (or activity based costing) involves the examination of all activities undertaken, the assignment of individual costs to specific cost drivers and a level of detail beyond the scope of the present study. Stand-alone and incremental cost approaches require the researcher to construct a hypothetical (counterfactual case) in which either one or more of the policies is not in place. Ultimately the separation of joint costs by such methods can only be as good as the characterisation of the actual and counterfactual cases. Such assessments are also easily manipulated because a counterfactual case is difficult to disprove and the results are often subjective. Returning to the example of the UWWT Directive it would be relatively easy to exaggerate the incremental costs of the Directive by constructing a counterfactual case in which national objectives for wastewater treatment are artificially lowered below what they would have been.

For the present study an alternative perspective has been adopted and one that recognises the overlapping nature of polices and objectives. The approach takes a baseline (in this case

1990 or the date at which the EU directives are required to be implemented) and looks at the costs of achieving the objectives of the directive *regardless of other initiatives.* Therefore in general, the costs articulated in this report are defined, where possible, as the "costs of achieving the objectives of the directive" and not as the "costs of the directive". As well as side-stepping the traditionally difficult issue of joint costs it is felt that this approach is more in line with EU policy which, in the end, is a negotiated outcome between Member States.

A remaining caveat relates to the situation in which national policies are more stringent or the objectives are set higher than the EU policy where an attempt has been made, where possible, to examine the costs of meeting the objectives of the directives only.

2.5 Treatment of cost information

A number of issues arise in considering the appropriate treatment of cost information. The purpose of the present analysis is to define the investment and operational cost implications of measures associated with the directives and from this to estimate the resulting level of linked employment. Cost data, however, are presented in a variety of formats, which can make the analysis difficult. Indeed an initiative has been launched which seeks to provide a more consistent approach to enumerating the costs of environmental activities (EEA 1999). Traditional issues encountered are:

- the use of different discount rates,
- the use of different price bases,
- the categorisation of costs.

The discount rate issue arises in using and manipulating source materials that are presented in terms of Net Present Values (NPVs) and Equivalent Annual Values (EAVs). The decomposition of such data into initial capital expenditures and ongoing operational expenditures generally requires knowledge of the life of the capital equipment, the discount rate employed by the original researchers and the time period over which the costs are summarised. In addition it is often necessary to know the nature of the relationship between capital and operating expenditures. Often NPVs and EAVs are presented in cost assessments without the necessary information to decompose into constituent parts in which case some assumptions need to be made, for example about the likely length of life of the capital equipment or the discount factor employed. These assumptions are illustrated clearly in the report where they are used.

The cost information is obviously presented for a variety of price bases. As a general rule the information in the Annexes are presented in the price levels of the original studies to facilitate an auditable data trail. For the main report, however, prices are in 1995 levels unless otherwise stated. The indices used to change price bases are taken from Eurostat (1999), with the Total Industry category used for operating expenditures and the Capital Goods Industry category used for capital expenditures.

A number of issues arise in the categorisation of costs. The main distinction of importance here is that between capital and operating expenditures. This distinction, however, is often not as clear-cut as it would first appear. Capital expenditures are by definition those that purchase assets which contribute services in more than the current period and are therefore

distinct from operating costs which purchase goods and services which are fully consumed in the period. Often, however, a definition of an annual cost will be employed which includes an allowance for financing and depreciation of capital investments. If the capital costs have been separately identified there is a tangible risk of double counting costs and hence employment if financing costs and depreciation charges are also included in the operating cost. Therefore as a general rule operating costs have been adjusted to exclude such costs and the relevant expenditure breakdowns have been re-based to concentrate on "pure operating costs only".

For the main report and in particular the comparative analysis of cost patterns by Member State, it has been necessary to annualise expenditure and employment results. This annualisation is based on the derivation of equivalent annual values for capital and operating expenditure streams. It is assumed that all capital items are amortised over a 20-year period. The annualised cost and employment impacts can then be compared for directives that have a different phasing of expenditure over the period of interest.

2.6 The estimation of employment linkages

As noted above a microeconomic framework focuses on the specific impacts of policies on different firms, economic sectors and populations. There remains, however, an issue regarding how far impacts are examined. Environmental policies have caused expenditure in many sectors and this expenditure can be linked to employment. Such expenditure however continues to circulate throughout the economy as it is in turn received and spent by many different economic agents. The focus of the present research, however, is on the tangible employment effects which are here defined as the employment in the industries undertaking the expenditure (capital and operating) and in the industries supplying the goods and services to the industries undertaking the expenditure.

Figure 2.2 illustrates the steps involved in estimating the tangible employment associated with the expenditure on implementing the directives.

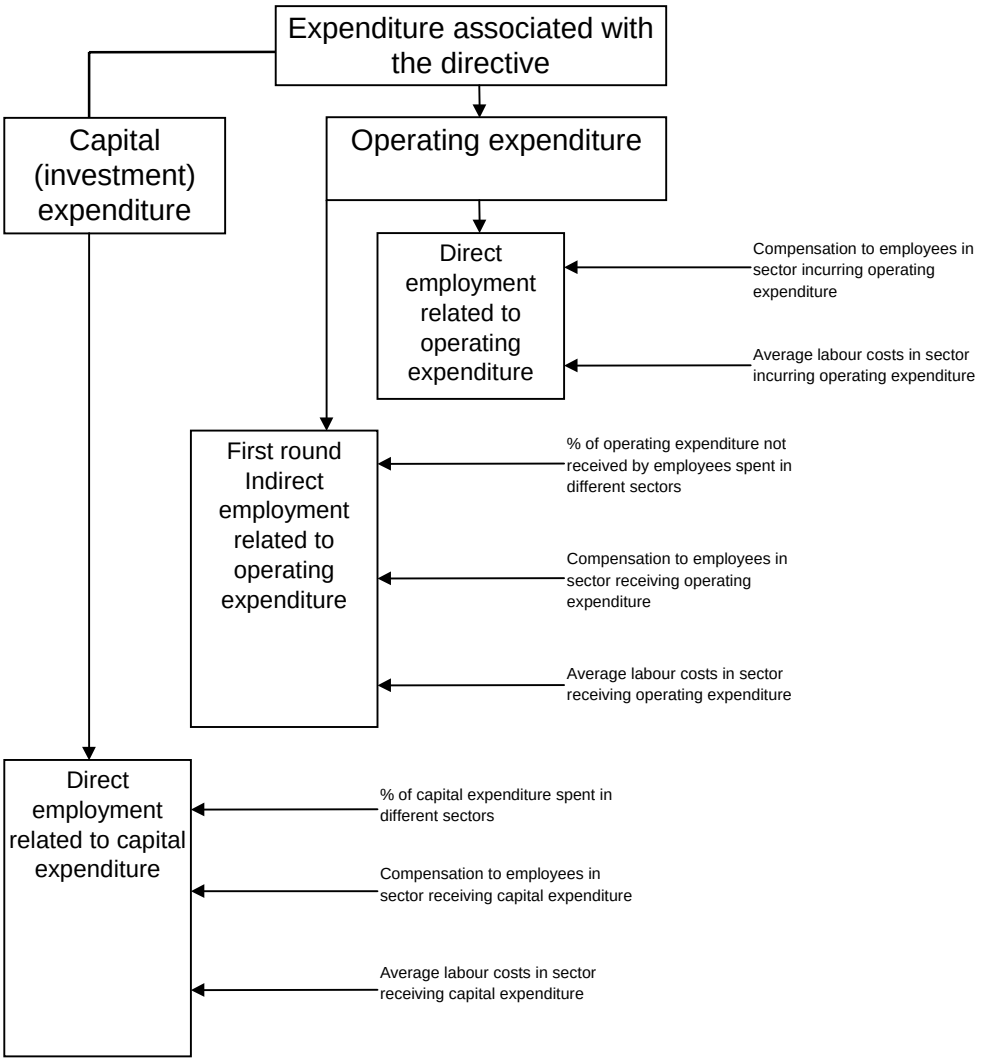
The principal elements of the methodology are the breakdown of expenditure into receiving sectors and each sector's respective labour costs. The former information is sometimes called an engineering analysis and is a common output of techno-economic studies concerned with pollution abatement technologies at least for operating expenditure.

The present study has attempted to build as far as possible on the methodology developed by Ecotec (1997). The Ecotec methodology contains engineering data for five "environmental domains":

- air pollution control,
- waste water treatment,
- waste management,
- contaminated land remediation,
- nature conservation.

The first three of these sectors obviously correspond well with the directives examined in terms of the air, water and waste sectors and have therefore been used as the point of departure for further analysis.

Figure 2.2 Employment calculation steps and data



In attempting build and improve on these estimates attention has been focused on the initial destination of expenditure. Other estimates (proportion of received expenditure in other industries which would be a compensation to employees) is less directive specific and it is assumed adequately captured by the original Ecotec figures[3].

[3] For example compensation to employees in the energy sector receiving expenditure associated with any of the directives is unlikely to be influenced by the nature of the directive itself.

For a number of directives limited additional information is required because there is a very close correspondence between the expenditures and the categories covered in Ecotec (1997). For other directives, notably, the Drinking Water Directive and the Nitrate Directive much additional information is required, as these sectors have not previously been examined in this context. To enable consistency the rules for allocating costs to categories developed in Ecotec (1997) have been followed (see Box 2.4, p21). This procedure is summarised in the Table 2.1.

Table 2.1 Categorisation of expenditure for the purposes of employment estimation

	Labour	Energy	Intermediate	Capital goods	Construction	Services
Capital expenditure						
Design						
Process equipment						
Construction						
Operating expenditure						
Materials on site						
Materials collection						
Maintenance						
Labour						
Energy						
Waste disposal						
Other services						

Table 2.2 Movement in labour costs for industry sectors (1992 - 1995)

	Energy		Intermediate goods industry		Capital goods industry		Construction Industry		Service Industry	
Austria	120%	e	123%		110%	e	109%	e	112%	e
Belgium	120%	e	114%	a	114%		114%		112%	e
Denmark	120%	e	117%		110%	e	109%	e	112%	e
Finland	120%	e	101%	a	110%	e	109%	e	112%	e
France	120%	e	113%		110%	e	109%	e	112%	e
Germany	111%		120%		121%		117%		112%	e
Greece	133%		117%		114%		109%	e	108%	
Ireland	120%	e	103%		103%		111%		112%	
Italy	120%	e	82%		110%	e	109%	e	112%	
Luxembourg	120%	e	116%		117%		118%		120%	e
Netherlands	120%	e	117%		117%		113%		112%	
Portugal	119%		106%		108%		110%		133%	
Spain	121%		95%		94%		96%		93%	
Sweden	120%	e	87%		110%	e	109%	e	112%	
UK	116%		102%		105%		97%		106%	

Note e = estimated value based on average of available estimates, a = 1994 data is the latest available. German data relate to Western states only. Intermediate goods are based on the general industry category, while capital goods are based on the Manufacturing category.

The labour costs used in the original Ecotec work were based on Eurostat (1996) which related to labour costs for 1992. Since the publication of this report these data have been updated to 1995 levels (Eurostat 1997). Labour costs in the different industry sectors have an important impact on the overall results and hence an understanding of the way in which they have changed in the period is important.

Table 2.2 indicates the change factors which have been applied to the original Ecotec (1997) labour costs, based on the updated Eurostat labour cost data.

In general an upward trend in labour costs has been witnessed in the period with 10%to 15% growth being the overall trend. Increasing labour costs are however not experienced in all countries and all industries with labour costs in Spain for example falling in all sectors with the exception of Energy.

2.7 Summary

This section has attempted to provide background on the approach used in this study. A demand-side, microeconomic approach has been adopted. It is demand side in that it looks at the directive implementation expenditures giving rise to the demand for goods and services including labour and hence employment. It is microeconomic in the sense that it looks at a limited number of sectors without analysing the consequent economy-wide adjustment processes. While necessarily giving a partial perspective this approach offers considerable advantages in providing policy relevant detail on the links between the directives' costs and employment.

The ten directives examined were not chosen to be a representative sample of European environmental policy, but to reflect a broad spectrum of policies currently adopted or in the pipeline. The approach has sought to identify the additional costs (capital and operating) of Member State actions to meet the objectives of the directives in the period 1990 to 2010. Employment linked to the expenditures has been estimated using an engineering analysis of the expenditures and information on the relative unit labour costs in the EU-15 states.

2.8 References

European Environment Agency (1999) Guidelines for defining and documenting data on the costs of possible environmental protection measures. EEA, Copenhagen.

OECD (1997) Environmental Policies and Employment, OECD, Paris

Ecotec (1997) An Estimate of Eco-Industries in the European Union 1994. A joint project of DGXI, EUROSTAT; report prepared for DGXI and Eurostat by ECOTEC Research and Consulting Ltd (United Kingdom) in association with BIPE Conseil (France) and IFO (Germany). Luxembourg, Office for Official Publications of the European Communities.

Eurostat (1999) Industrial producer price index. Eurostat, Luxembourg.

Eurostat (1996) Labour costs, principal results 1992. Eurostat, Luxembourg.

Eurostat (1997) Labour costs, updating 1993 to 1995. Eurostat, Luxembourg.

3. OVERVIEW OF DATA QUALITY AND AVAILABILITY

3.1 Introduction

This section summarises the approach to data collection and the quality and availability of information on the cost and employment linkages of EU policy on air, water and waste. A distinction can be drawn between the *quality* of the data in the studies utilised to produce cost estimates and the *validity* of the assumptions used in this study to transform the results into best estimates of cost by Member State (MS). These two aspects are inter-related to some extent as poor quality data (in the context of the present study) sometimes necessitates stronger assumptions to produce a cost estimate.

3.2 Approach to data collection

The approach of the study has been to rely primarily on existing sources of information. Where the coverage of this information, either in terms of cost drivers or countries affected has been insufficient, it has been necessary to resort to primary evaluations based on available data[4]. Information was collected for this study from a variety of sources including international organisations, the ministries and agencies of Member States concerned with these issues, from research institutes and from industry.

An iterative data collection approach has been applied with the following steps:

1. The Commission was asked to supply details of studies undertaken in a European context or known by them to have been undertaken, and productive routes of enquiry within EU institutions,

2. This list of information was supplemented by reports known by the study team members and their colleagues/institutes,

3. A unified list of existing materials were then distributed to the National Focal Points of the EEA with a request for additional national materials or suggestions for productive channels of enquiry,

4. A unified list was distributed to 300+ individuals known to be involved in the assessment of the costs of environmental policy drawn from databases assembled for other research and including a representatives from industry, ministries for environment and finance, statistical offices, research centres and private consulting organisations.

Information was requested in relation to national evaluations of costs as well as more micro-level assessments of costs of particular aspects of the directives.

[4] The term primary evaluation is used here to describe the situation in which existing data have been combined to produce an estimate of costs that is new, rather than collating, summarising and evaluating existing estimations.

In general a rather poor response to these requests was received. This is attributed to a number of factors:

1. many of the directives are quite old and have not been subject to critical cost evaluation which is a relatively recent concern by most Member States,

2. a reluctance to divulge sensitive information, and

3. a reluctance to disseminate information with a limited “shelf life” to current scrutiny.

A reason for non-response in the air sector may in addition be the fact that there are few national studies, the legislation being integrated with other supra-national environmental activities such as the United Nations Economic Commission for Europe Convention on Long Range Transport of Air Pollutants (UN ECE CLRTAP).

The availability of cost data for the different directives varies widely. Few country studies have been reported estimating the costs of the different directives and there is no legal requirement, except in the UK where it was introduced relatively recently, to estimate the costs and benefits of new legislation. There is also a requirement on the EU to produce cost estimates but these are not available for all directives as for some it was considered too difficult to produce cost estimates. However, where pan-EU studies are available these are often preferable as there is a consistency introduced through the use of a common methodology for all countries. This does not, however, mean that the results are reliable and in some circumstances such estimates are based on the extrapolation from national estimates which introduces a further level of uncertainty.

The availability and reliability of the cost data tends to be higher for those directives where the methods to implement the directive can be well defined. For instance, even though different standard processes (e.g. activated sludge or trickling filters) can be applied for the implementation of the UWWT Directive to comply with the requirement for the biological treatment of sewage, their costs do not vary substantially, at least not related to the accuracy of the global cost estimate required. In contrast many different approaches can be applied to implement the Nitrate Directive with the implementation being farm specific and, as a consequence, the available cost information tends to be at a micro level - related to individual actors and technologies. The waste directives have similar characteristics to the Nitrate Directive, there being much more concern about the costs of managing individual waste streams than in estimating the global costs of the different directives.

It is possible that there is more interest in assembling cost information at a Member State level for those directives which are publicly financed. However, it is also a question of access to the information, since costs assessments individually done by a large number of actors are more difficult to obtain.

The reliability of the cost data will also be influenced by the objective for producing the cost information. For instance if a country would like to negotiate an extended period for the implementation of a directive it may well try to over-estimate the costs. Similarly if the costs are prepared by industry the costs may be inflated to negotiate less stringent requirements.

3.3 Overview of information by sector and directive

Tables 3.1 to 3.3 summarise the available information in terms of two main aspects of quality – coverage of individual cost drivers and Member States. The tables also identify the main data treatment issues that may give rise to uncertainty in the cost estimates. A number of these issues are taken forward to more detailed scenario/sensitivity analysis in Section 7.

3.3.1 Air sector

The quality of the available data for the air sector directives is variable. Most studies relate to different aspects of the directives in question and although there is sufficient information to produce a best estimate that covers the main cost drivers, there are limits to comparability of individual studies. In the case of the DVOC a further problem is introduced in that the majority of the available information is too detailed to be useable in the present study – being related to micro level evaluations of specific technologies and specific plants.

The air sector studies tend to contain at least one pan-European study together with a number of single country studies. Frequently, the pan-European studies present only aggregated information at the EU-15 level requiring further assumptions for the apportionment to individual MS (particularly for the SLF and VOC directives). The degree to which this apportionment can reflect country specific circumstances depends to a large extent on the level of disaggregation of the pan-EU estimate. In the case of the SLFD and the DVOC this apportionment is based on the share of refinery capacity and the share of EU population. Significant variations in MS conditions are therefore missed.

Some differences between costs can be clearly attributed to different assumptions about the level of emissions (in two DVOC cost studies for France, for example, these vary by a factor of two). In other cases it is much more difficult to assess the reasons for the different cost estimates partly because of incomplete reporting of the relevant techno-economic data and partly because of the use of complex “black-box” optimization procedures which lack transparency – for example in setting emissions ceilings under the NECD.

Commonly for the air sector studies, there is a tendency to report costs in total annualised terms. For the purposes of the present study this means that further assumptions need to be made to break down these annualised costs into capital and operating cost streams. Typically, the original cost studies do not report the data necessary to achieve this breakdown (capital recovery factor, life time of capital equipment etc.) and this has necessitated the use of engineering data obtained either from the original researchers or from more general literature.

Table 3.1 Quality of data coverage and data treatment issues - Air sector

Directive	Available studies	Cost Driver coverage	Member State coverage	Data treatment issues introducing uncertainty
SLFD	5	**Medium -** The available studies relate to different components of the SLF Directives. CEC (1995) provides an aggregated EU-12 estimate of the costs of 98/70/EC. Cofala (1999) provides estimates of the costs of 93/12/EC+98/70/EC and 93/11/EC + 99/32/EC. ERM (1996) and Oudart (1997) relate to 99/32/EC. There are difficulties of comparing costs between studies given the reported data and the use of complex optimisation procedures. CONCAWE (1999) gives results for 98/70/EEC.	**Poor -** CEC (1995) is an aggregated EU-12 estimate. Cofala (1999) provides separate estimates for each EU-15 MS. ERM (1996) and Oudart (1997) are restricted to single MS (UK and France respectively). CEC (1995) does not include the costs of the late entry countries whose costs for 98/70 are therefore omitted from the analysis. Evidence suggests however that these costs would be small given their limited share of refinery capacity and relatively high starting points in relation to the objective of the Directive.	**Medium -** Best cost estimates based on apportionment of EU-12 estimates from CEC (1995) to individual MS (this accounts incompletely for variation in refinery types in each MS), and the extrapolation from Oudart's single country estimate for France to other MS. Decomposition of annual cost figures into capital and operating cost components is uncertain. As the Cofala (1999) estimates include the costs of the original Directive (93/12/EC), which is not the focus of this study they can only be used as a check on other estimates.
NECD	1	**Good** - Amman et al (1999) is a single but comprehensive study of the costs of the Directive.	**Good** - Costs are available for each individual EU-15 MS.	**Medium** - Decomposition of annualised total costs into capital and operating components on the basis of engineering estimates introduces some uncertainty.
LCPD	5	**Medium** - The available studies relate to different cost drivers of the Directive (to SO_2, NO_x and dust). Cesar and Klassen (1990) is restricted to SO_2, CEC (1996) relates to all cost drivers. CEC (1997) relates to all cost drivers and also covers the amendment to the Directive. Landrain and Hecq (1998) and Amann et al (1998) relate mainly to the amendment. Very limited data on dust means the cost of this parameter are not included in the present analysis.	**Medium** - Cesar and Klassen (1990) excludes the late entry countries (A, FIN, S). CEC (1996) and Landrain and Hecq are technology based assessments and provide no country estimates. CEC (1997) covers all MS for all cost drivers, while Amman et al (1998) covers all MS for the amendment only.	**Medium -** Costs of the original Directive are based on CEC (1997) and Amann et al (1999) for the revision. For CEC (1997) the NPV must be converted to an annualised cost (based on a capital recovery factor) and then split into capital and operating cost components based on engineering estimates. Amann et al (1999) gives only investment costs. Operating costs need to be estimated based on engineering assumptions.
DVOC	5	**Poor** - Large volume of information at a micro or technology scale which is too detailed for the present purposes. Usable studies tend to focus on different industrial sectors affected by the Directive. CEC (1997) is out of date since a change to the proposed Directive. ERM & Chemsystems (1997) exclude the pharmaceutical industry. Bouscaren et al (1994) is restricted to 7 industrial sectors.	**Poor** - CEC (1997) and CEC (1998) relate to the EU-15 in aggregate. DoE (1997), Bouscaren et al (1994) and ERM & Chemsystems (1996) are individual country studies covering only the UK and France.	**Poor** – Based on CEC (1998). Attribution of EU-15 total costs to individual MS is necessary and achieved on population shares, thereby ignoring structural differences between MS. Annualised costs need to be converted into capital and operating cost streams using engineering data.

Table 3.2 Quality of data coverage and data treatment issues - Water sector

Directive	Available studies	Cost Driver coverage	Member State coverage	Data treatment issues introducing uncertainty
UWWT	15	**Medium** - Different cost drivers are covered under the individual studies. The main deficiency is in terms of separately identifying the different cost elements. Particular problems arise in differentiating sludge treatment costs from wastewater treatment costs, industrial costs from municipal costs and the costs of meeting the different treatment goals (e.g. sensitive versus normal). Most studies sufficiently differentiate between treatment and collection of wastewater. Very few studies include an evaluation of the operating cost implications.	**Good** - number of almost compete multi-country studies (CEC (1998), EWWG (1997), WRc (1995), a number of more partial investigations (McCann (1994), Amber (1994) and individual country studies are available. Information for a number of countries (Greece and Italy) is partial or incomplete in the pan European studies. Other information is out of date and has had to be supplemented with more recent/accurate data.	**Good** - Based on CEC (1998) updated with more accurate/up to date assessments from individual countries (Italy, Denmark, Netherlands, Greece). Need to predict operating costs on the basis of investment costs introduces uncertainty into these estimates.
ADWD	12	**Poor** - Available studies focus on a limited number of cost drivers (parameters). Lead (WRc 1995), pesticides (Heinz et al 1995) and monitoring (LNEC 1995) costs are well covered. Severe limitations for other cost drivers (nitrate and problems associated with distribution systems (e.g. iron)). The estimated costs are a significant but partial estimate of the total costs of the Directive.	**Poor** - No comprehensive country coverage. Best coverage in terms of the lead parameters (WRc 1995) (but excludes late entry countries) and pesticides Heinz et al (1995) (but relates to costs in individual catchments in a limited number of MS). Patchwork of information available for other MS on individual parameters which have been used to check consistency.	**Medium** - For pesticides uncertainty is introduced by the need to extrapolate from catchment case studies undertaken in individual MS to MS level and then extrapolate to other MS (based on pesticide and water use patterns). For monitoring – need to extrapolate to MS from EU-15 wide unit monitoring costs based on water supplied.
NITD	11	**Medium** - Good coverage of livestock related costs but poor coverage of other farming types. Main difficulty associated with identifying costs of individual measures from packages of measures that are applied to particular agronomy situations.	**Poor** - Medium coverage of predominately mixed farming and intensive farming systems (D, UK, F, B, DK, NL) but poor coverage of Scandinavian and Mediterranean agricultures.	**Poor** - Costs tend to be at a mirco level – e.g. individual farms. Need to identify land areas affected by region and country. Method adopted for this recognises only two of three factors leading to impact (farm type and farming intensity) and ignores soil vulnerability.

Table 3.3 Quality of data coverage and data treatment issues - Waste sector

Directive	Available studies	Cost Driver coverage	Member State coverage	Data treatment issues introducing uncertainty
HWID	4	**Medium** – No evaluations of the costs of the Directive are presently available at either a EU or MS level. A number of sources of information on micro level costs are, however, available including CEC (1992) which relate to the costs of constructing and operating an incineration plant. CEC (1991) relates the unit costs of constructing a industrial (not hazardous) waste incineration plant. Hanemaaijer (1991) provides a further example of plant costs. All of these sources are old (1988 to 1991). KK/AAB (1999) provide a separate estimate of costs that is more up to date and provides a better breakdown of costs into the separate cost categories.	**Poor** - All studies relate to the costs of particular technologies and are not MS level evaluations. CEC (1991) and CEC (1992) are meant to be representative of the EU-15 but are not specific to hazardous waste. Other studies relate to specific MS: Hanemaaijer (1999) relates to Netherlands and KK/AAB (1999) relates to Denmark.	**Medium** - Primary evaluation using plant specific costs (based on KK/AAB (1999) together with data on the amount of hazardous waste incinerated presently. Different definitions and classification systems for hazardous waste introduce uncertainty. The plant costs used relate specifically to the situation in Denmark but are extrapolated to the EU-15. The international nature of the market for HWI equipment means that local variations in costs would not be large.
PPWD	6	**Medium** - Micro level unit costs available for main waste streams (paper, glass and plastics) and for incineration with energy recovery from CEC (1997). These differentiate between individual MS. Although dated (1994) these unit costs are pan European and provide relevant data on the cost breakdown and employment links. Costs can be compared to more recent data from Sofres (2000) and from the annual reports of European recycling organisations.	**Poor** - No evaluations at MS level. The CEC (1997) data, however, give data for the EU-12. No comparable information is available for the late entry countries. Comparative data by Sofres relate only to UK, Netherlands, France and Germany.	**Poor** - Primary evaluation based on CEC (1997) unit costs by MS in combination with data on waste arisings form ETC/W (2000). Unit costs for countries not covered by CEC (1997) are based on matching with countries where cost data is available (i.e. S and FIN = DK, A = D). The procedure for estimating costs produces highly theoretical estimates based on meeting the minimum targets in the cheapest manner possible regardless of the options actually chosen in the MS.
DELV	11	**Good** - FAR/ARN (1997), Glachant (1996) and Whitson (1995) cover all major cost drivers: plant investment and ELV dismantling and further processing. CEC (1997) and DTI (1998) exclude further processing. EEA (1997) relates only to investments at sites. GWU (1995) covers only dismantling and Danish EPA/DAG ignores investments.	**Poor** - CEC (1997) relates to EU-15 in aggregate but provides no breakdown by MS. All other studies relate to individual MS: France, Netherlands, Denmark, Germany and the UK.	**Good** - Primary evaluation based on unit costs derived from individual studies. These unit costs account for variations between MS because of the use of differential labour costs.

There is a strong tendency for the costs of controls in the air sector to be overestimated, particularly by analyses like those of IIASA/RAINS that are almost entirely restricted to consideration of end-of-pipe technologies. IIASA recognise this limitation of the important RAINS model very clearly, regarding costs estimated using it as upper bounds, though unfortunately this caveat is typically ignored in subsequent discussion. Alternative and cheaper options to those identified by RAINS are often available, but cannot be integrated into the model. An example affecting a number of directives would be switching from high sulphur coal to natural gas, which would require the use of energy systems models. In many cases, though not all, changes like this are made for purely commercial reasons (following liberalisation of energy markets) and any associated costs would not ascribed to environmental protection. A review of the tendency for ex-ante estimates of costs to overestimate the true costs was provided recently by the Stockholm Environment Institute (SEI, 1999). In view of this problem, part of the strategy used here for the selection of studies has been to take those that provide the more conservative estimate of costs, reducing the risk of overestimation.

3.3.2 Water

In the water sector there are generally more available studies, particularly for the UWWT Directive, which is perhaps not surprising given the very high cost implications for most MS. A fairly comprehensive estimate of the investment costs of the Directive is available in CEC (1998) due to the inclusion of investment data in the reporting requirements for the Directive. This report, however, has a number of deficiencies in the present context. Some of the data reported are of questionable quality and have had to be updated with more recent data (in the case of the Netherlands) or more accurate data (in the case of Denmark). In addition no estimate is available for Italy and only a partial estimate is available for Greece. Filling these gaps introduces some further uncertainty, as it is less clear that these new data are based on the same premises as the original submissions contained in CEC (1998). In most cases, however, there are additional data on which to validate the new information.

A major source of uncertainty arises in predicting operating expenditures. Regrettably, the CEC (1998) study and indeed most other evaluations of costs do not contain estimates of the operating costs that are associated with the new investments. This poses a similar problem to that encountered in the air sector where total costs (operating + capital) are known but the breakdown is not. In the case of the UWWT Directive, however, the situation is more uncertain as there is no upper bound on the level of operating expenditures that might be experienced. An estimate of the operating costs is made using a two-factor extrapolation procedure that recognizes two important factors:

- the degree to which investment in new capacity is new or is replacing existing investment (in which case there will be limited additional employment); and

- the level of treatment technology sophistication (as the more sophisticated the treatment technologies the higher are the operating cost requirements).

More limited information is available for the Drinking Water Directive. Available cost studies tend to focus on individual problem parameters, rather than the Directive taken as a whole. As a result it has not been possible to provide a comprehensive assessment of each of the individual cost drivers. Costs have been estimated for the pesticides and lead parameters and the additional monitoring requirements. This leaves a substantial gap in the information in

relation to problems with the distribution systems (e.g. iron) and other parameters (e.g. nitrate). In terms of country coverage there is a patchwork of data available and it is necessary to match expected costs in countries without cost information to those where cost data are available. This introduces particular uncertainty in the case of the pesticides parameters, where cost information is available only at a catchment scale requiring two stages of extrapolation to reach costs estimates for the EU-15. This is less of a problem for the lead parameter where fairly comprehensive data is available for the MS (although excluding the late entry countries).

Global estimates of the costs of the Nitrate Directive are available for a number of countries but are associated with a high degree of uncertainty. Most of the available cost information relates to micro-level evaluations of the costs potentially faced by different farming types. Much of this information appears to have been assembled in order to discuss the advantages and disadvantages of a possible tax on nitrogen and to compare the different forms such an economic instrument may take. This information tends to be incomplete both in terms of its cost driver and MS coverage. In terms of cost drivers there is relatively little information covering arable agricultures, with much more information on livestock. In addition each of the evaluations examined considers only a limited set of on-farm responses which may not be representative of the situation actually faced. In terms of MS coverage and following from the gaps for particular cost drivers, there is much more information available for those countries with intensive livestock sectors (Netherlands, Belgium and Denmark) and much less information on the predominantly mixed farming undertaken in UK, France and Germany. By contrast there is virtually no information in relation to Mediterranean and Scandinavian agricultures.

The availability of only micro-level cost evaluation data has required a primary evaluation of the costs. The approach taken recognizes a number of the key factors contributing to cost differences (type of farming and its intensity) but neglects a very important variable in terms of the vulnerability of soils to nitrate leaching and hence the area of land which would require measures.

3.3.3 Waste

In the waste sector there is a large amount of data available on the management of individual waste streams but very little information reporting the overall compliance costs for particular MS. As a result, all of the estimates of costs for the waste directives reported here are based on primary evaluations rather than summarising information available from previous studies. In each of the waste studies, therefore, an attempt has been made to estimate the costs of the directives using a unit cost in conjunction with a volume variable expressing the amount of environmental protection activity that has to be engaged in.

One of the principle difficulties of undertaking such an analysis is in obtaining consistent “volume” data for the different MS. Waste statistics collected from individual MS suffer from many problems of comparability because of the different classification systems operated by the MS (for example in terms of the definition of “hazardous” or “packaging waste”). This difficulty introduces problems of comparability between studies and between data of the different MS which introduce further uncertainty into the analysis.

In the HWI and PPW directives a further uncertainty is introduced in trying to define a suitable base period for the analysis. In the HWI Directive for example, a critical assumption relates to

the development of hazardous waste incineration capacity in Europe in the future. The Directive does not require a certain portion of hazardous waste to be incinerated but does set regulations for that part which is incinerated. In the absence of information on the development of incineration capacity it has therefore been assumed that no more hazardous waste is incinerated in the future than is done today.

In the case of the PPW Directive a lack of available information on the actual activities of MS in responding to the requirements of the Directive and the fact that many of the MS had already established such systems prior to the adoption of the Directive, has meant that the cost estimates produced here are highly theoretical in nature. They are based on the establishment of systems in MS to achieve the minimum targets in the least cost manner. This produces a set of waste management strategies that are not actually seen in practice in any MS because of their local circumstances and national objectives. Many of the MS for example go well beyond the requirements of the Directive and as a result adopt very different strategies to those that would be adopted to meet only the minimum targets. The approach of this study has been to estimate the costs of meeting the objectives of the Directive and to isolate these from the costs incurred in going beyond the objectives. Hence, although theoretical, the cost estimates produced here do accord with the adopted approach.

A further issue arising in the PPW Directive is the choice of unit cost data. The advantages of the unit cost data chosen (CEC 1997) (in terms of consistency and the appropriate breakdown of costs to facilitate the cost and employment estimation) are off-set by a number of disadvantages (the data is rather old relating to 1994 and some of the unit cost data no longer reflect market conditions in the MS (particularly for plastics)). An attempt has been made to resolve this issue by providing comparative data from more recent studies and from the market itself to give an indication of the validity or otherwise of the unit costs used.

For the ELV Directive, no European level estimates of the costs of the Directive have been produced. However, a number of MS level and micro-scale evaluations are available (France, Denmark, Netherlands). Typically, however, these studies have reported investment costs, together, with estimates of the labour (man-hour) requirements for processing ELVs. As a result it is necessary to reverse the employment calculations to estimate the operating costs on the basis of the labour requirements, the labour cost and the share of labour costs in operating expenditures.

3.4 Summary

This section has summarised the approach to data collection and the quality and availability of the data used. The approach has been to rely on existing sources of information, where possible, but the absence of cost information for a number of directives has required new estimates to be made in this report utilising what information is available.

Information was investigated from a wide range of sources but with a generally poor response. This is explained by a number of factors, including the age of some of the directives, the sensitivity of the information, its limited shelf-life and the sectors and number of actors affected.

The data received varies substantially in volume and quality between sectors and directives. In the air sector there tends to be at least one pan-European estimate of costs together with a number of country specific or technology specific evaluations. The pan European estimates

tend to report very aggregated results requiring further assumptions to achieve the necessary breakdown by Member State or cost type. There is a tendency for cost evaluations of air Directives to be overestimated because the models utilised focus on end-of-pipe controls, without recognising alternative, sometimes cheaper, options.

There is generally more information available for the water directives, particularly the UWWT Directive, which has involved very high expenditures in most MS. Information on the costs of the other water directives is more variable, with information limited to specific parameters for drinking water (lead, pesticides) and farming types for the Nitrate Directive (mainly the intensive livestock sector). Only a very partial estimate of costs is therefore possible in the case of these directives.

For the waste directives available information is limited, focusing mainly on the costs of managing particular waste streams and as a result it has been necessary to produce original estimates of the costs for this study. Difficulties are encountered in using waste statistics because of differences in the classification systems of MS and in defining a baseline over which the implementation of the directives takes place. In the case of the Packaging and Packaging Waste Directive, this results in a highly theoretical estimate of costs that does not reflect the actual situation faced in the MS.

In interpreting the information to be presented in the remaining sections the following points should be borne in mind:

- Across directives, there is virtually no consistency in the reporting of cost data and as a result it is often difficult to compare estimates or disaggregate by Member States, cost driver or expenditure type.

- Few evaluations treat operating costs satisfactorily, which introduces considerable uncertainty in the present analysis.

- For those Directives where there is limited information on the strategies adopted (or to be adopted in the case of in-the-pipeline policies) there is additional uncertainty about the impacts, given different options for implementation (e.g. labour intensive versus capital intensive options or preventative versus remedial options). These issues are investigated in more detail in Section 7.

As a result the estimates presented in this report should be interpreted cautiously and considered within the context in which they are presented.

3.5 References

For references to individual studies see the corresponding sections in Annex 1.

4. OVERVIEW OF KEY RESULTS

4.1 Introduction

This section summarises a number of key findings at an aggregated level:

- the overall scale of investment and employment related to the directives,
- the scale of expenditures in relation to the overall level of economic activity,
- the scale of expenditures in relation to the size of the eco-industries, and
- the scale of employment in relation to present levels of unemployment.

More detailed comparative analysis is provided in section 5 (by directive) and Section 6 (by Member State). Further detailed information on the individual directives is provided in Annex 1 (expenditures) and Annex 2 (employment).

4.2 The overall scale of investment and employment associated with the directives

Tables 4.1 and 4.2 present the key results by MS and directive.

The best order of magnitude estimate of the total capital expenditures associated with the directives is estimated to be 259 B Euro arising in the period 1990 to 2010. Such expenditure is larger than the economies of all but the six largest of the EU-15 MS. At the height of implementation of the directives additional operating expenditures of 14.5 B Euro are also estimated. In annualised terms these expenditures represent over 40 B Euro/yr or 0.5% of the EU-15 GDP. Taken across the EU-15 as a whole, this represents some 110 Euro/capita/yr of expenditure. The best order of magnitude estimate of tangible linked employment is 440 000 FTE/yr – approximately 3% of the total EU-15 unemployed.

The air sector directives are associated with capital expenditures of 64 B Euro with the NEC Directive accounting for over half of this total. With operating expenditures of 6 B Euro, this amounts to an annual expenditure of almost 13 B Euro per annum, representing 0.17% of GDP or 34 Euro per capita. Aside from the NEC Directive, the SLF and LCP Directives contribute significantly to costs, while the costs associated with the DVOC add very little to the total costs for the sector. Employment linked to the air directives amounts to 133 000 FTE annually which represents approximately 1% of the EU-15 unemployed.

The water sector directives examined involve capital expenditure of more than double the air sector directives amounting to some 164.3 B Euro between 1990 and 2010. The vast majority of this (152 B Euro) arises through the UWWT Directive. The investment costs for the water sector are underestimates given that the costs for the Drinking Water Directive include only a subset of the relevant parameters. Operating expenditures required for the exploitation of these investments add a further 3.5 B Euro at the height of implementation and contribute to an annualised cost (including the capital expenditures of 20 B Euro/yr (54 Euro/capita/yr)).

Table 4.1 Investment and employment related to EU environmental policy (1990 to 2010) - key results by directive

	Investment (Capital Expenditure) (M Euro)	Operating Expenditure (M Euro)	Annual Expenditure (M Euro)	Annual expenditure as % of GDP	Annual expenditure per capita Euro	Annualised tangible employment (FTE) linked to the directives	Employment as % of EU-15 unemployment
The Air Sector Directives							
Sulphur in Liquid Fuels	10,000	500	1,500	0.02%	4	14,100	0.1%
National Emissions Ceilings	34,100	4,100	7,600	0.10%	20	78,200	0.5%
Large Combustion Plant	19,400	1,600	3,600	0.05%	10	37,900	0.3%
Volatile Organic Compounds	800	100	200	0.00%	0	1,700	0.0%
Sub total air	*64,400*	*6,300*	*12,800*	*0.17%*	*34*	*132,700*	*0.9%*
The Water Sector Directives							
Urban Wastewater Treatment	152,200	2,400	17,900	0.24%	48	152,400	1.0%
Drinking Water	12,100	500	1,700	0.02%	5	16,300	0.1%
Nitrate	-	600	600	0.01%	2	1,000	0.1%
Sub total water	*164,300*	*3,500*	*20,300*	*0.27%*	*54*	*178,700*	*1.2%*
The Waste Sector Directives							
Hazardous Waste Incineration	700	<100	100	0.00%	0	1,100	0.0%
Packaging and Packaging Waste	29,100	3,800	6,800	0.09%	18	97,400	0.7%
End of Life Vehicles	500	900	1,000	0.01%	3	18,900	0.1%
Sub-total Waste	*30,200*	*4,800*	*7,900*	*0.10%*	*21*	*117,400*	*0.8%*
ALL Directives/Sectors	258,874	14,596	41,000	0.54%	110	428,800	2.9%

Figures are rounded to the nearest 100 M Euro for expenditure (except per capita figures) and 100 FTE for employment. Figures may not sum due to rounding.

Table 4.2 Investment and employment related to EU Environmental Policy - key results by Member State

Member State	Investment (Capital Expenditure) (M Euro)	Operating Expenditure (M Euro)	Annual Expenditure (M Euro)	Annual expenditure as % of GDP	Annual expenditure per capita (Euro)	Annualised tangible employment linked to the directives (FTE)	Employment as % of unemployment in 1999
Austria	12,900	300	1,600	0.77%	201	17,200	10%
Belgium	11,000	900	2,000	0.67%	198	19,800	6%
Denmark	2,700	200	500	1.03%	99	6,400	5%
Finland	3,500	200	500	1.44%	99	5,600	3%
France	27,300	1,700	4,500	0.12%	77	50,100	2%
Germany	93,000	4,200	13,700	0.07%	166	131,700	4%
Greece	4,500	400	800	1.98%	78	15,700	4%
Ireland	2,400	200	400	2.87%	116	5,100	5%
Italy	27,200	1,500	4,300	0.16%	74	38,500	2%
Luxembourg	400	<100	100	12.48%	172	700	12%
Netherlands	19,300	1,500	3,400	0.45%	221	31,500	12%
Portugal	4,200	200	700	1.74%	68	15,800	7%
Spain	17,300	1,200	3,000	0.33%	76	39,100	2%
Sweden	6,400	400	1,000	0.78%	114	10,400	3%
UK	26,900	1,700	4,400	0.16%	75	52,900	3%
EU-15	258,900	14,600	41,000	0.54%	110	440,400	3%

Figures are rounded to the nearest 100 M Euro for expenditure (except per capita figures) and 100 FTE for employment. Figures may not sum due to rounding.

Employment linked to the water directives amounts to almost 180 000 FTE. The vast majority of this employment arises in relation to the UWWT Directive which itself is linked to a level of employment equivalent to around 1% of the EU-15 unemployed.

In the waste sector the estimated capital expenditure of 30 B Euro between 1990 and 2010 is almost exclusively attributable to the PPW Directive. The other waste directives, for Hazardous Waste Incineration and End of Life Vehicles represent just over 1.2 B in capital expenditure. Operating expenditures amount to almost 5 B Euro contributing to an annual expenditure of 8 B Euro per annum. Such expenditures are around 0.1% of the EU-15 GDP and equivalent to around 20 Euro per capita. Employment linked to these expenditures represents around 120 000 FTE annually, representing some 0.8% of the total number of unemployed in the EU-15. Despite having a level of annual expenditure in the waste sector close to the level for the NEC Directive, the employment impact is much higher due to the relative employment intensity of the waste sector expenditure (i.e. the importance of the return to labour in overall costs).

There are wide variations in the costs seen in individual MS, as shown in Table 4.2. The largest investment expenditure is seen in Germany, which accounts for 93 B Euro of the total 259 B Euro of capital expenditure. Three further countries, UK, France and Italy see investment expenditures over 20 B Euro. In most MS the annualised expenditures represent a small but significant proportion of GDP, generally less than 1%. The expenditures account for more than 1% of GDP in several countries: Denmark, Finland, Greece, Ireland, Luxembourg and Portugal.

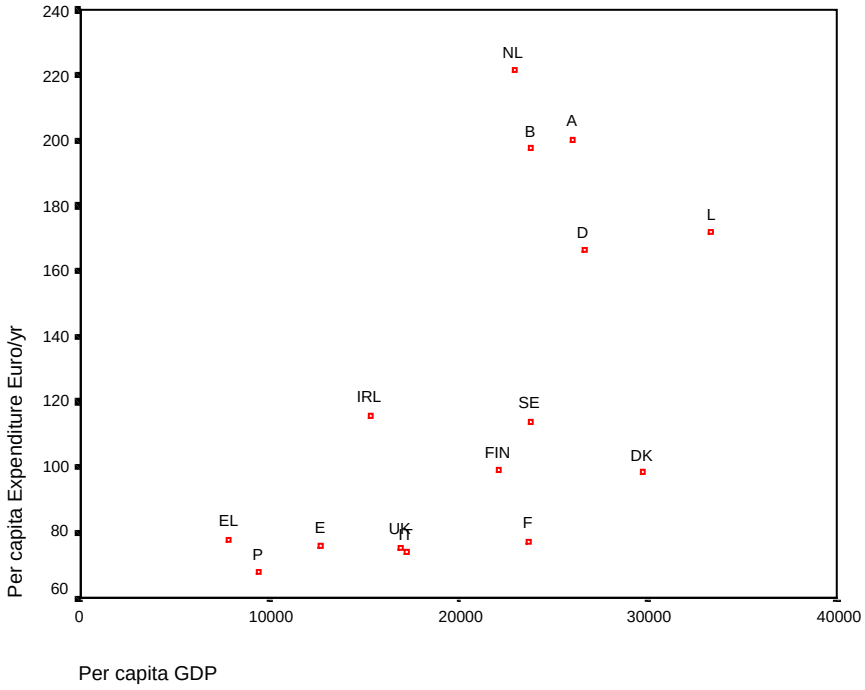
Annual expenditure per capita varies considerably between MS. Austria, Belgium and the Netherlands have levels of per capita expenditure of almost double the EU-15 average (110 Euro/capita/yr), while a number of countries (France, Greece, Italy, Portugal Spain and the UK have per capita expenditures at around three quarter or less of the EU-15 average. Even the lowest per capita expenditure in Portugal, however, is significant, amounting to 68 Euro/capita/yr.

As with expenditure per capita, there is considerable variation in the intensity of the employment linkages in each of the MS. The employment linked to the directives represents over 10% of the total unemployed in Austria, Luxembourg and the Netherlands (as a result of high expenditures in conjunction with low unemployment). In three countries such employment represents around 2% of total unemployment (less than the EU-15 average of 3%). These countries (France, Italy and Spain) all have relatively low expenditures associated with the directives in conjunction with relatively high unemployment.

4.3 The scale of expenditures in relation to economic activity

As noted above, there are significant differences in the scale of expenditures in relation to the MS level of economic activity. The following diagram illustrates the relationship between per capita costs and per capita GDP.

Figure 4.1 Relationship between per capita expenditure (Euro/yr) on the directives and per capita GDP (Euro/yr). 1995 Prices.



A discernible relationship between the per capita costs of the directives and the relative level of economic activity (per capita GDP) can be seen. This relationship suggests that implementation tends to be more expensive in the more developed relative to the less developed areas of the EU-15. Such a relationship is reflective of a number of factors:

- The more developed countries are also those where environmental pressures are most severe because of the relative intensity of economic activity and hence pressures on environmental resources.

- For two MS facing equally severe environmental problems implementation will be more costly in the more developed MS because of the higher opportunity costs, most notably labour.

- MS with a higher level of development will be associated with a higher demand for environmental quality and hence implement the directives more strictly than elsewhere, leading to relatively high costs.

The balance of these factors and their relative importance in explaining different cost patterns faced by MS will depend on the individual directives considered and is the subject of more detailed analysis in Section 6.

The scale of investments in relation to GDP also gives an insight into the level of affordability of the expenditures, since ignoring cross-frontier transfers such as the Cohesion Fund, the level of GDP in a MS has a major influence of the affordability of the improvement programmes. As noted above, expenditures tend to be lower in the Cohesion countries for a

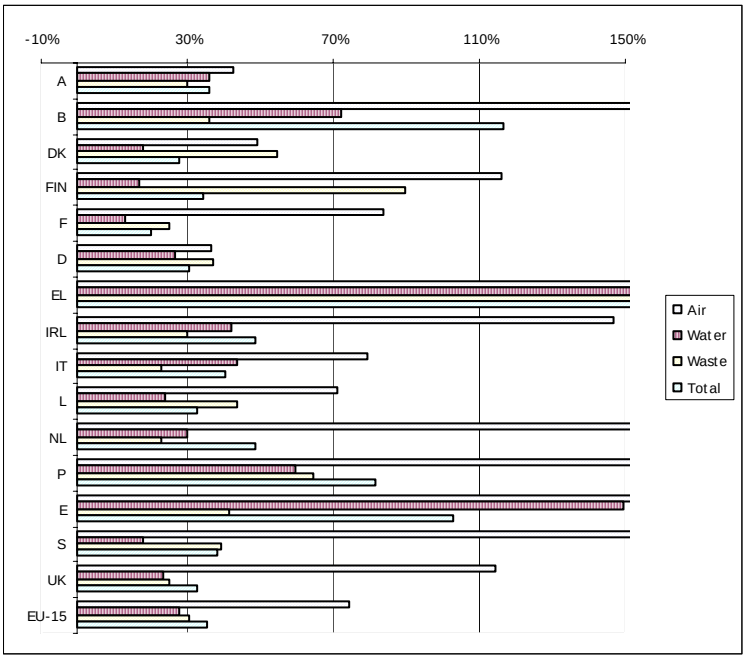
number of reasons. Despite this inter-regional transfers are still required for implementation. Cohesion issues are discussed in more detail in Section 6.4.

4.4 The scale of investments in relation to the size of the EU-15 eco-industries

The significance and impact of expenditures on meeting the objectives of directives also depends upon the infrastructure within MS for supplying the goods and services needed for implementation. The so-called eco-industries are developed to varying degrees in each of the MS and it is relevant therefore to analyse the scale of the expenditures estimated for the directives/sectors with the economic size of the eco-industries. This latter variable is taken from the work of Ecotec (1997) and relates to the year 1994. It should be borne in mind that the expenditure associated with the directives is calculated at the height of implementation, which for most directives will be sometime post 2000.

Figure 4.2 presents an analysis of the scale of expenditures associated with the directives in each of the sectors with the size of those eco-industry sectors in each MS.

Figure 4.2 Scale of expenditure in relation to the size of the eco-industries in MS



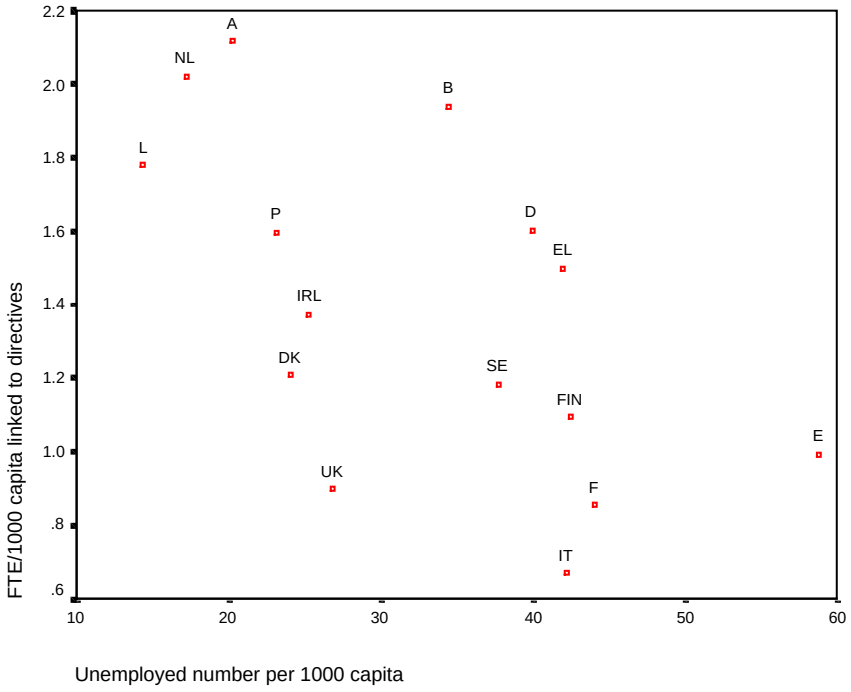
In most MS and for most sectors, the expenditure associated with the directives is a significant proportion of the current expenditure by the eco-industries. In the air sector in a number of countries, the expenditure associated with the directives is a high proportion of the air sector expenditure, sometimes outstripping it significantly (Belgium (400%), Sweden (195%)). Greece stands out as seeing by far the highest proportion of current eco-industry expenditure accounted for by the directives (almost 4 times the eco-industry expenditure in aggregate). This is most significant in the case of the air sector where the expenditure associated with the directives (500 M Euro/yr) is some 10 times the 1994 air eco-industry turnover (50 M Euro/yr).

Such findings point to the likely need for growth in eco-industries, particularly in some countries, given the scale of investments and additional operating costs still to come as a result of planned and proposed directives. An inability to grow the sectors in response to increased demands will inevitably lead to increased leakage both to other MS and markets external to the EU.

4.5 The scale of tangible linked employment in relation to unemployment

Exploiting the available synergies between environmental policy and employment in part relies on targeting employment opportunities associated with the directives to the areas of the EU-15 where unemployment rates are highest. An analysis of the relationship between the employment linked to the directives and the level of unemployment in the MS, however, suggests the opposite, as illustrated in Figure 4.3.

Figure 4.3 Relationship between employment linked to the directives and unemployment in the MS



Those MS where unemployment is relatively low (Luxembourg, Netherlands and Austria) also see a relatively large number of employment opportunities linked to the directives and a result of the higher expenditures. Conversely, MS where unemployment rates are high (Italy, France and Spain) see the lowest relative level of employment opportunities arising as a result of the directives analysed. This arises despite the fact, in Spain for example, that low labour costs tend to increase the relative number of jobs created per unit of environmental expenditure. This pattern reflects to some extent the fact, observed above, that the more developed areas of the EU-15 are also those where the environmental pressures are greatest and hence expenditures and employment highest (even allowing for higher labour costs).

4.6 Summary

This section has presented an overview of the main results of the study at an aggregated level. It is estimated that investments of 260 B Euro between 1990 and 2010 are associated with ten directives examined. Such expenditure is larger than the economies of all but the six largest of the EU-15 Member States. These investments are accompanied by additional operating costs of 15 M Euro per year bringing the annual expenditures (including an allowance for the investment expenditures) to 40 B Euro per annum (0.5% of EU-15 GDP or 110 Euro per capita). The expenditures create a demand for labour totalling half a million jobs – equivalent to 3% of Europe's unemployed.

The highest per capita expenditures are seen in the most developed parts of the EU, reflecting the fact that this is where environmental pressures, opportunity costs and demand for environmental quality is greatest. The pattern of job opportunities provided by the directives does not match well the distribution of European unemployment. The areas where unemployment is highest also tend to see the lowest level of employment due to the generally lower expenditures on the directives despite the lower labour costs. In most Member States the expenditures associated with the Directives represent a significant proportion of current eco-industry expenditure – particularly in the air sector and for the lagging regions – pointing to the opportunities for the growth of these areas.

4.7 References

Ecotec (1997) An Estimate of Eco-Industries in the European Union 1994. A joint project of DGXI, EUROSTAT; report prepared for DGXI and Eurostat by ECOTEC Research and Consulting Ltd (United Kingdom) in association with BIPE Conseil (France) and IFO (Germany). Luxembourg, Office for Official Publications of the European Communities.

5. COMPARATIVE ANALYSIS BY DIRECTIVE

5.1 Introduction

The aim of this chapter is to compare differences between directives and types of directives in terms of costs and also employment effects. A further aim of this chapter is in identifying the overlaps between directives and the likely impact these overlaps may have on the estimated cost and employment estimates.

Each directive gives rise to a cost and employment effect which depends on the specific characteristics of the directive. Differences exist in terms of:

- the status of the directive (adopted, in the pipeline etc.),
- the environmental domain and environmental pressures impacted,
- the regulated aspects and available measures,
- the sectors (economic and social) that are affected, and
- the type of employment generated.

These differences are examined in turn in the following sections.

5.2 Status of the directives

The directives that have been evaluated differ in terms of their current status. The directives currently in force have been adopted at different times and been subject to revisions at different stages of their life-cycle. Directives in the pipeline will take effect at different times and are subject to different levels of uncertainty regarding their actual outcome. It is relevant to examine therefore, the distribution of costs and employment in terms of adopted and in the pipeline directives and the time period over which expenditures and employment impacts are estimated to occur.

Several of the directives are yet to be implemented. The National Emissions Ceiling Directive and the Directive on End of Life vehicles are two examples. Several of the directives are quite old and much of the investment implications are largely complete (UWWTD, LCPD). Several of the directives have been or are to be substantially revised (ADWD, SLFD). The following table summarises an analysis of the costs and employment in relation to the status of the directives by characterising investment and employment as being pre and post 2000.

Table 5.1 Impact of the status of the directives on the balance between pre and post 2000 investment expenditure (B Euro) and employment (thousands)

Directive	Exp/Emp	Total	% post 2000	Comment
SLFD	Exp	10	75%	The SLF Directive was originally adopted in 1993. It has been the subject of two major revisions in 1998 and 1999. The focus of the cost assessment has been on the two revisions. The 1998 Directive set targets for 2000 and 2005 while the 1999 Directive set targets for 2000, 2008. The bulk of the expenditure and employment (c.75%) is associated with the revisions to the Directive are therefore likely to fall post 2000.
	Emp	82		
NECD	Exp	34	100%	The NEC Directive is scheduled to be adopted in 2000 and sets targets which must not be exceeded after 2010. As a result all of the expenditures will arise post 2000. It should be noted that a common position on the Directive, which alters the requirements, was agreed after the completion of analysis for this study.
	Emp	286		
LCPD	Exp	19	38%	The original Directive 88/609/EEC was adopted in 1988 and was revised in 1994 by 94/66/EC. The proposed revision COM (1998)415 would be adopted after 2000. The original directive scheduled targets in terms of three phases 1993, 1998 and 2003. The post 2000 costs, therefore have been estimated as one third of the costs of 88/609/EEC plus the costs of the proposed revision.
	Emp	168		
DVOC	Exp	1	100%	The Directive on VOC is at the proposal stage and sets targets to be met by 2007. As a result all of the costs are estimated to be undertaken post 2000.
	Emp	6		
UWWT	Exp	152	25%	The UWWT Directive was adopted in 1993 (91/271/EC) and revised in 1998 (98/15/EC), it sets targets for 2005. Analysis of the reporting by the individual MS reveals that around 25% of the capital expenditure is scheduled to be spent between 2000 and 2005.
	Emp	1 171		
ADWD	Exp	12	67%	The DWD was adopted in 1980 (80/778/EEC) and was updated in 1998 (98/83/EEC). Of the two parameters investigated the bulk of the capital expenditures for pesticides will arise pre 2000, with the bulk of the lead costs arising post 2000. The percentage of costs falling post 2000 is therefore estimated to be 67%.
	Emp	106		
NITD	Exp	n.a.	n.a.	Due to the manner in which costs have been identified for the Nitrate Directive it has not been possible to separately identify capital expenditures.
	Emp	n.a.		
HWID	Exp	0.7	0%	The Directive was adopted in 1994 (94/67/EEC) and from 1996 applied to all new plants. From 2000 the Directive applies also to all existing plants. As a result the bulk of the capital expenditures are assumed to arise pre 2000.
	Emp	6		
PPWD	Exp	29	0%	The Directive was adopted in 1994 (94/62/EEC) and set targets for 2001 (2005 for a number of countries given a derogation). As a result the bulk of the capital expenditures are assumed to arise pre 2000.
	Emp	256		
DELV	Exp	0.4	100%	The Directive is at proposal stage and hence the bulk of the costs will arise post 2000.
	Emp	4		

This analysis reveals that in aggregate the bulk of the expenditures associated with the directives have already been undertaken (63%). The high costs of the UWWT Directive and the fact that most expenditures were planned pre 2000 has a large weight in determining this result. Post 2000, this pattern of expenditure means that by far the most important directives in determining investment costs post 2000 are the remaining expenditures under the UWWT Directive and the expenditures required for the implementation of the NEC Directive. This latter directive makes up only 13% of the total costs between 1990 and 2010 but 35% of the costs post 2000. The relatively high remaining costs for the other air directives make the air sector in general the most important area of future costs and employment post 2000 – a position which the water directives hold for the period 1990 to 2000.

5.3 The environmental focus of the directives

Directives from three environmental domains were selected for this study: air water and waste. Each of the directives, however, is linked to specific environmental problems and there are overlaps between directives in this regard.

The following table summarises the environmental focus of each of the directives.

Table 5.2 Environmental focus of the directives examined

Key environmental problem areas	Progress	SLFD	NECD	LCPD	DVOC	UWWT	NITD	ADWD	HWID	PPWD	DELV
Climate change	☹										
Acidification	☹	O	O	O			◆				
Stratospheric ozone	😐										
Tropospheric ozone	☹		O		O						
Chemicals	😐								O		
Waste	☹								O	O	O
Bio-diversity	☹										
Inland waters	😐		◆			O	O	O			
Marine/coastal env.	☹		◆			O	O				
Soil degradation	☹										
Urban environment	😐										
Tech/natural hazards	☺										

Note: ☺ Assessment of progress in key European Environmental Themes 1993 to 1998 (Source: EEA (1998)). O - direct link ◆ - indirect link

As can be seen there is a considerable overlap in the objectives of the directives investigated not only in terms of directives within an environmental domain, but also between environmental domains.

The main intra-sector overlaps are associated with the air directives. In addition there are overlaps between the directives investigated and other air directives such as the Air Quality Daughter Directives. The specific overlaps for the air directives can be examined more closely in the following table.

Table 5.3 Links between the air directives considered in this study

	Acidification	Eutrophication	Ground level ozone	Human health
National Emission Ceilings Directive (NECD) [SO_2, NO_x, NH_3, VOCs]	X	X	X	(X)
Sulphur in Liquid Fuels Directive [SO_2]	X			(X)
Large Combustion Plant Directive [SO_2, NO_x, dust]	X	X	(X)	(X)
Solvents Directive [VOCs]			X	(X)
Air quality daughter directives:				
SO_2, NO_2, PM, lead	(X)	(X)	(X)	X
CO, benzene			(X)	X
Ozone			X	X

'X' denotes issues that were prime drivers, '(X)' denotes issues of secondary concern, in the development of the legislation.

The prime drivers for the development of the directives on national emission ceilings, large combustion plants and sulphur in liquid fuels, were concerns over acidification, eutrophication (in the form of excess nitrogen deposition) and ground level ozone (high levels of which can be formed through reaction in the lower atmosphere between VOCs and NO_x). For the Air Quality Daughter Directives the main driver was the protection of health. This was stimulated by research in the later 1980s and early 1990s that demonstrated that many air pollutants were linked with effects on health at much lower concentrations than previously recognised.

In a study such as this, there is a risk of double counting of some costs. So, for example, the costs of the Ozone Directive are covered by analysis of the NECD as it provides the mechanism for controlling the transboundary flux of ozone and its precursors. The costs of several other directives are also contained in IIASA's analysis of the NECD, requiring care in the selection of results from their paper.

Other intra-sectoral overlaps include that between the NITD and UWWT/ADWD. The UWWT is aimed at reducing the environmental impact of wastewaters on the environment, a principle result of which is eutrophication. The Nitrate Directive is aimed at safeguarding drinking water supplies from contamination by nitrate and also preventing eutrophication of waters receiving much of their nutrient load from diffuse (agricultural sources). As nitrate is also a parameter for the quality of drinking water there is an overlap also between the NITD and the ADWD.

EEA (1988) shows that the contribution from point and diffuse sources of nitrogen differs from catchment to catchment. However, in most catchments the contribution from diffuse sources dominates today (although it is it self sometimes overtaken by the natural background contributions). This would suggest a large degree of overlap between the Directives, however, as noted later the costs of the UWWT Directive are not based on reducing eutrophication itself but in meeting technology standards for given waste streams. Therefore regardless of the contribution made by agriculture in reducing eutrophication problems there would be no savings in terms of UWWT costs. There is a larger potential for overlap in terms of the ADWD and the Nitrate Directive. The response rate of aquifers to measures to control nitrogen on farm are not well known and can take many decades to have an impact on raw water quality – necessitating alternative drinking water treatment activities in the mean-time. However, as the costs of the nitrate parameter have not been included in the cost of the ADWD there is no double counting in the present estimates.

The main inter-sectoral overlaps are between the NEC and Nitrate Directive. The NEC Directive includes a substantial component of costs related to reducing ammonia emissions from agriculture. The ammonia is released from livestock farming (as a result of a number of processes including livestock housing, manure storage and application) and a variety of control measures are available many of which are strongly related to the measures required to control nitrate leaching to water bodies from farms:

- Stable adaptation (manure flushing),
- Covering manure storage areas,
- Cleaning of the stable air,
- Low ammonia applications such as the direct ploughing of manure,
- Change in the nitrogen content of manure.

Given the fact that the NEC Directive is still at proposal stage and the Nitrate Directive costs have been estimated on the basis on the nitrogen situation on farms in 1995, there is a large

potential for double counting costs. It is not presently possible to quantify the magnitude of such an overlap although it should be borne in mind in analysing the annual costs for the NEC Directive (approx. 3 B Euro) and the Nitrate Directive (0.6 B Euro) in particular for countries like the Netherlands where obligations under both directives are high and necessitate an integrated approach to ammonia and nitrogen management.

5.4 Regulated aspects and available measures

The directives differ considerably in terms of the regulated aspects and hence the measures available for compliance. The directives differ in the extent that they are based on the sensitivity of the affected environment and the flexibility they grant MS in adopting particular measures.

The following table characterises the directives according to a number of types.

Table 5.4 Directive typology

	SLFD	NECD	LCPD	DVOC	UWWT	ADWD	NITD	HWID	PPWD	DELV
Technology standards				✓	✓		✓	✓		
Emission standards		✓	✓	✓					(✓)	(✓)
Quality standards	✓					✓				
Use standards							✓			

The majority of directives are either based on technology/technique specification (BAT) or emission standards. The UWWT has, at its centre, the BAT approach where wastewater management technology (collection, treatment and disposal) is specified according to the size of the discharge and the sensitivity of the receiving waters. The same is true of the HWID although there is no differentiation with respect to the sensitivity of the receptors (e.g. population centres). The LCP directive uses emissions ceilings in two ways – national ceilings for existing plants and plant specific ceilings for new plants. The NEC directive, as its name implies, sets national emissions ceilings that are required to meet specific reduction targets on a national basis. The PPWD and DELV can be classified as emissions standards given that the emissions (disposal etc.) are defined by the recycling targets.

The SLF Directive and the ADWD are both examples of directives based on product quality standards. The SLF sets parameters for the composition of fuels while the ADWD sets quality parameters for drinking water.

Central to the Nitrate Directive is the adoption of codes of good agricultural practice that can be thought of as a farm management technique (technology) standard. A substantial component of the objectives of the Directive are aimed at improving the efficiency of farming through information campaigns. The Directive also involves a use standard in terms of the application of organic manure on farms.

Given the range of directive types it is pertinent to assess the extent to which the different standards give rise to differences in the availability and adoption of compliance measures. One hypothesis is that technology standards tend to confer limited options for compliance. This is certainly true of the UWWT Directive where essentially the same technologies are applied across the EU-15. It is also the case for the Hazardous Waste Incineration Directive where the main requirement (installing flue gas desulphurisation technology) is standardised.

A wider range of compliance options are available in the case of emissions standards where typically the studies examined have explored a range of options including switching/substitution, good housekeeping measures, end-of-pipe control and the introduction of clean technologies. Further flexibility is introduced into the emissions standards approach through the "bubble concept". This is seen in the DVOC where a wide range of costs of (between 60 M and 337 M Euro per annum (1996 prices, see Annex 1, Section 5, Table 5.3)) arise from alternative assumptions about the way in which the key pharmaceuticals sector deals with the directive, with the upper estimate based on an inflexible blanket emission limit on all release points, whereas the lower limit is calculated on the assumption that the sector as a whole would be given an emissions limit, allowing flexibility in identifying solutions.

A wide range of compliance measures are also available in the case of quality standards. In the case of the SLF Directive fuel switching and technology modifications are the main options. A form of switching is also a possible measure under the DWD (raw water source substitution) although the main alternatives are treatment and source protection an issue which is examined in more detail in Section 7.

5.5 Economic sectors affected

The directives differ in the types of economic sectors affected. Reflecting the variety of environmental problems addressed a large number of sectors are affected, as illustrated in the Table 5.5.

The energy sector is affected mainly by the air directives. In this regard, the NEC Directive is very different in that, in addition to energy, impacts also occur in general industry and the agricultural sectors. Power production is also indirectly affected by two of the waste directives given the energy recovery available in the HWI and PPW Directives. The main impacts of the Directive on VOCs is on general industry (printing, surface cleaning and coating etc.).

The main impact of the UWWT Directive is on the wastewater treatment industry, although industrial discharges are also impacted and there is an indirect impact on agriculture because of the sludge disposal requirements. The remaining water directives impact almost exclusively on single sectors (water supply and agriculture respectively).

For the waste directives the main impact is on the waste eco-industry but also general industry (in terms of producer responsibility for packaging waste and transport in the case of DELV).

Table 5.5 Economic sectors mainly affected by the directives

Sector	SLFD	NECD	LCPD	DVOC	UWWT	ADWD	NITD	HWID	PPWD	DELV
1 Energy										
Fuel Refining	✓		✓							
Power production	✓	✓	✓					(✓)	(✓)	
2 Transport		✓								✓
3 Industry		✓		✓						
General	✓		✓		✓			✓	✓	
Chemicals			✓							
4 Agriculture		✓			(✓)					
5 Eco-industries							✓			
Water					✓	✓				
Waste								✓	✓	✓

✓ - direct impact, (✓) indirect impact

5.6 Labour market response to directive characteristics

A more thorough investigation of the sectoral impact of the directives can be undertaken given an analysis of the destination of expenditures and resulting employment impact. Directive characteristics have important implications on the pattern of disbursement of expenditures and consequentially on the sectors seeing tangible employment impacts.

Table 5.6 summarises the salient characteristics of directives in terms of the sectors undertaking and receiving expenditures.

The employment impact of the directives gives rise to different employment impacts through two mechanisms:

1. Directives where a high proportion of expenditure is received directly by labour will give rise to a higher labour market response.

2. Directives where expenditure is received by relatively low cost sectors will give rise to a higher labour market response.

Tables 5.7 and 5.8 summarise the overall level of expenditure per FTE under the different directives, and the unit labour costs in each of the sectors receiving expenditures.

It should be noted at the outset that the labour market response (measured in terms of the expenditure per FTE) is also affected by country specific factors and not just differences in the characteristics of directives. A directive, for example, that has a large portion of its expenditure in a high unit labour cost country will have a relatively low labour market response regardless of the directive specific determinants of the employment impact.

Table 5.6 Disbursement of expenditures associated with the directives

Directive	Exp	Labour	Energy	Interm*	Capital	Cons*	Services
SLFD	Capital				85%	15%	
	Operating	15%	35%	45%			5%
NECD	Capital				85%	15%	
	Operating	15%	35%	45%			5%
LCPD	Capital				85%	15%	
	Operating	15%	35%	45%			5%
DVOC	Capital				85%	15%	
	Operating	15%	35%	45%			5%
UWWT	Capital				30%	60%	
	Operating	25%	20%	13%	13%		30%
ADWD	Capital				37%	53%	10%
	Operating	5%	8%	47%	40%		
NITD	Capital						
	Operating	15%		55%	30%		
HWID	Capital				85%	15%	
	Operating	21%	3%	5%	13%	58%	
PPWD	Capital				84%	16%	
	Operating	43%	14%	14%	14%		14%
DELV	Capital			33%	33%	33%	
	Operating	60%	10%	10%	10%		10%

Interm = intermediate goods, Cons = construction

Table 5.7 Summary of expenditure (K Euro) per FTE ratios for the directives

Air Directives	**SLFD**	**NECD**	**LCPD**	**DVOC**
Exp (K Euro) per FTE total	103	97	94	94
Water Directives	**UWWT**	**ADWD**	**NITD**	
Exp (K Euro) per FTE total	117	107	64	
Waste Directives	**HWID**	**PPWD**	**DELV**	
Exp (K Euro) per FTE total	96	70	52	

Table 5.8 Labour costs in the sectors receiving capital and operating expenditures Euro

	Energy	Interm	Capital	Cons	Services
EU -15 Average	47 674	29 266	36 464	28 263	33 766
Range minimum	P = 24 558	P = 10 852	EL = 18 921	P = 10 520	EL = 17 182
Range maximum	B = 65 592	D = 45 169	NL = 48 097	D = 40 289	D = 44 740

Interm = intermediate goods, Cons = construction

Not with standing this, a number of insights can be drawn from these tables. Firstly, the air directives which have a relatively low direct compensation to employees and where expenditures are received in relatively high labour cost sectors (capital goods and energy) generally have high expenditures per FTE. The converse is true in the waste sector where the direct compensation to employees is relatively high (very high in the case of the DELV = 60%) and expenditure in the low labour cost sectors is important (at least for the DELV). In the case of the HWID, expenditure per FTE is brought up by the high capital expenditure going to the capital goods sector, which (as it is based on standard air pollution control technologies – FGD) closely resembles the air sector directives.

For the water directives there are a range of outcomes. The low levels of expenditure per FTE in the Nitrate Directive largely arise from low incomes in the agricultural sector, the absence of significant capital expenditure and the importance of purchases from the relatively low labour cost intermediate goods sector.

Much of the expenditure in the ADWD is in low labour cost sectors (construction and intermediate goods) however, the cost per FTE is relatively high given the very low proportion of expenditure going directly to labour (5%).

In the UWWT Directive, relatively high energy costs have a role to play in determining the high expenditure levels per FTE. However, the main factor is actually country specific, in that the majority of expenditure (almost half) occurs in the highest labour cost country (Germany).

As can be seen from the table the variation in labour costs between countries within the same sector is significantly larger than the variation in labour costs between sectors in aggregate. Here Portugal/Greece and Germany/Netherlands offer the extreme conditions. This would suggest that country specific circumstances may be more important than directive characteristics in determining the labour market response to the environmental expenditures.

5.7 Type of employment generated

The characteristics of the directives have important implications for the types of employment generated. The principle mechanism through which the directives affect the type of employment generated is through the balance between capital and operating expenditures. In a simplified sense employment linked to operating expenditures can be characterised as permanent, while employment linked to capital expenditures can be considered more temporary in nature. This distinction is not perfect since the capital expenditures in question are not “one-off” in character but actually a sustained level of capital expenditure in investments which are continually replaced. Nevertheless expenditures on investments in plant facilities that arise largely as a single purchase of machinery and construction services are in a sense more temporary than the jobs created in operating and maintaining the new assets.

Given this distinction there are significant differences between directives in terms of the capital and operating split of expenditures and hence the permanence of the employment linked to these expenditures. The salient features of the directives in this regard are summarised in the following table.

Table 5.9 Features of directives and eco-industry expenditures affecting the characteristics of employment

Directive	Operating costs as % of total annualised costs	Comparison to eco-industry expenditures (Ecotec 1997)	Permanent (operating related) jobs as proportion of total jobs	Comparison to eco-industry employment (Ecotec 1997)
SLFD	33%		44%	
NECD	54%		63%	
LCPD	44%	53%	55%	36%
DVOC	53%		63%	
UWWD	13%		22%	
ADWD	29%	50%	33%	56%
NITD	n.a.		n.a.	
HWID	36%		46%	
PPWD	56%	80%	73%	90%
DELV	95%		98%	
All	36%	61%	49%	70%

Note: Permanent is equated to operating expenditure related

The importance of operating expenditures in total annual expenditures ranges from 13% for the UWWT Directive to 95% for the DELV (with an average of 36%). In general for the waste directives there is a higher proportion of expenditures accounted for by operating costs (a finding confirmed by the Ecotec work on the nature of eco-industry expenditure). As a result a much higher proportion of the annualised employment can be regarded as being permanent in nature. The results for the waste sector are generally below those revealed in Ecotec (1997). This is largely the result of the HWID, which has characteristics closer to the air directives than the more general waste directives.

In the water sector, operating expenditures account for a much smaller percentage of total expenditure. This results largely from the capital intensive nature of the investment involved (especially for the UWWT Directive). This result does not correlate well with the results of Ecotec (1997) which show a much higher proportion of expenditures accounted for by operations. This arises principally because the water eco-industry expenditure in general includes many support and administration staff that are not directly related to the investments considered. In the water sector, as a consequence a generally lower percentage of employment can be considered to be permanent.

In the air sector generally one half of the expenditures are operating costs and as a consequence the level of permanent relative to total employment is higher than the water sector but lower than the waste sector.

5.8 Summary

The section has compared differences between directives and types of directives in terms of costs and also employment effects. The directives examined vary considerably in a number of dimensions.

In terms of status, an analysis of the directives reveals that the majority (63%) of the expenditures and employment have already occurred in the period 1990 to 2000. Post 2000 the air directives are of most significance, a position held by the water directives pre 2000.

The directives differ in terms of their environmental focus, each being associated with a specific problem. Nevertheless there are a number of overlaps, particularly for the air directives, which give rise to a potential double counting. In most cases this is not likely to be a significant problem with the possible exception of the overlap between the NEC and Nitrate Directives both of which are intimately concerned with farm manure management strategies.

The directives examined offer of a variety of approaches to environmental management. Most of the directives examined use technology or emissions standards but there are examples of quality standards (SLFD, ADWD) and use standards (NITD) with some Directives (DVOC, NITD) using a combination of approaches.

Differences in the directives give rise to differences in the labour market responses to expenditures. The expenditure per employee varies between directives from 52 000 Euro for the DELV to 117 000 Euro for the UWWT Directive. Directive characteristics contribute to these differences because of the proportion of expenditure that goes directly to employees in sectors undertaking the expenditures and the unit labour costs in the sectors receiving expenditure. Differences also arise in the type of employment generated, with the waste directives giving rise to a higher proportion of permanent employment (given the importance of operating versus capital expenditures) relative to the water and air directives.

5.9 References

EEA (1998) Europe's environment: the second assessment. European Environment Agency, Copenhagen.

Ecotec (1997) An Estimate of Eco-Industries in the European Union 1994. A joint project of DGXI, EUROSTAT; report prepared for DGXI and Eurostat by ECOTEC Research and Consulting Ltd (United Kingdom) in association with BIPE Conseil (France) and IFO (Germany). Luxembourg, Office for Official Publications of the European Communities.

6. COMPARATIVE ANALYSIS BY MEMBER STATE

6.1 Introduction

This section presents a comparative analysis of the results of the study focussing on the differences by Member State. The individual directives examined give rise to different cost and employment effects in each of the MS. These differences will be strongly related to the "volume" of environmental protection activity a MS needs to undertake (i.e. the gap between the starting position of the MS and the objectives of the Directive). Other factors, however, may also be important in determining differences and similarities between MS and these factors may be related to the specific circumstances of the country itself (e.g. level of development, size, structure of economic activity) or the directive and its mode of implementation. In addition, the structure of the labour market will give rise to different employment effects in each of the MS, particularly with regard to relative labour costs. This chapter attempts to analyse these different impacts and the extent to which they facilitate an understanding of the differences between MS. Special attention is given to the impacts on cohesion countries given the mechanisms through which expenditure and employment related to the Directive may impact on the objectives of social and economic cohesion.

6.2 Analysis of the cost patterns faced by Member State

Hierarchical cluster analysis has been used to identify groups of countries facing similar per capita costs under each of the directives, using the equivalent annual value of the investment and operating costs faced by individual Member States. The results are summarised in Table 6.1 for all Directives and by sectors and in Table 6.2 (air sector), 6.3 (water sector), and 6.4 (waste sector).

6.2.1 All sectors

Table 6.1 summarises the pattern of expenditure faced by the MS for each of the sectors.

Table 6.1 Country clusters facing similar per capita expenditure requirements (cluster average Euro per capita) – directives and sectors

Directive	Low	Medium-low	Medium	Medium high	High
All	**74** P, I, UK, E, EL, F	**108** FIN, DK, S, IRL	**170** D, LU	**199** B, A	**224** NL
Air	**19** E,I, F, P	**26** DK, UK, IRL	**35** FIN, A	**49** D, EL, S, LU	**117** B, NL
Water	**34** EL, F, FIN, P, UK, S, I	**52** DK, E, B	**78** NL, IRL	**93** D, LU	**135** A
Waste	**10** EL, P, IRL	**13** I, UK, E	**20** B, LU	**26** FIN, S, F	**32** DK, A, D, NL

The shaded areas represent the location of the EU-15 average within the clusters.

The Netherlands sees by far the highest costs across all directives taken together. This arises mainly because of the high per capita costs seen in the air and waste sectors. Belgium, Austria, Germany and Luxembourg also feature as high cost countries. The costs for these countries range from 170 to 224 Euro/capita/year and can be compared to the EU-15 average of 108 which is seen in Finland, Denmark, Sweden and Ireland. The UK, France, the cohesion countries and Italy all see costs below the European average.

The pattern of costs seen across all the directives considered is incompletely paralleled in each of the sectors. In the air sector the costs in Belgium and the Netherlands tend to be the highest, with the cohesion countries, France and the UK seeing generally lower than average per capita costs. For the waste and water directives Netherlands remains a relatively high cost country while Belgium sees costs closer to the European average. The low cost countries, especially Spain, Portugal, UK, France and Italy, tend to be low cost countries for all directives. The two remaining cohesion countries (Greece and Ireland) tend to have low costs for most sectors, however, costs for Ireland are elevated in the water sector and Greece for the air sector.

The pattern of costs facing individual MS under each of the individual directives is considered in the following sections.

6.2.2 The air sector

Table 6.2 summarises the clustering of MS on the basis of per capita costs faced under the different air sector directives and in aggregate for all the air directives.

Table 6.2 Country clusters facing similar per capita expenditure requirements (cluster average Euro per capita) – air sector

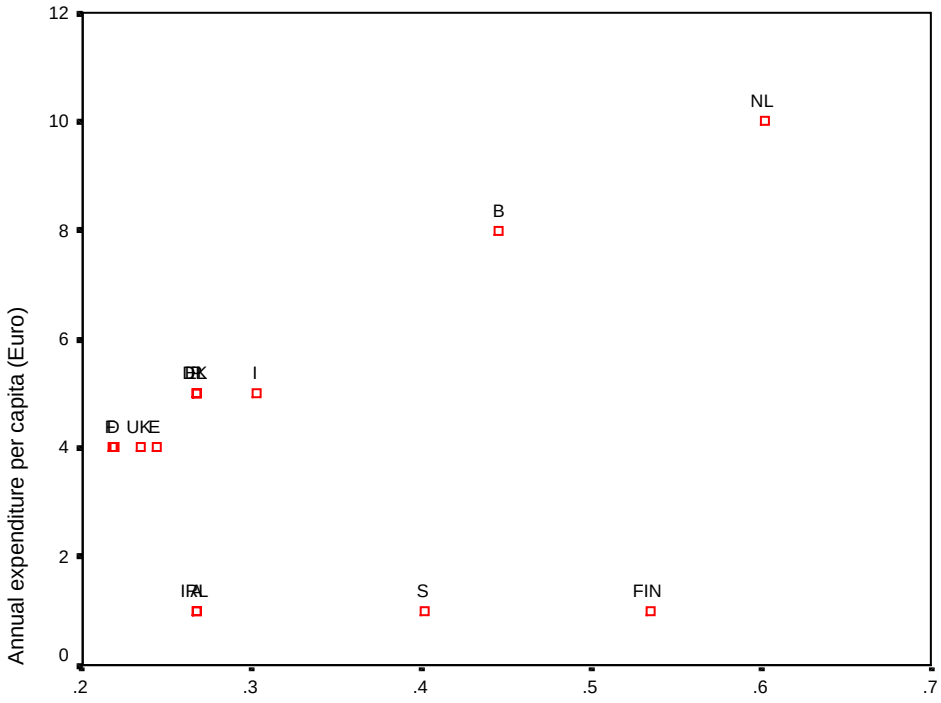
Directive	Low	Medium-low	Medium	Medium high	High
SLFD	**1** A, FIN, IRL,S, D	**4** UK, F, ES, I, DK, EL	**5** P	**8** B	**10** NL
NECD	**3** FIN, DK, ES, P, I	**20** A, F, IRL, UK, S, D, EL	**54** LU	**81** NL	**101** B
LCPD	**1** LU, F, UK	**10** B, I, ES, P, EL, IRL, D	**20** DK, A	**26** NL, S	**32** FIN
DVOC*			**1** ALL		
Air	**19** E,I, F, P	**26** DK, UK, IRL	**35** FIN, A	**49** D, EL, S, LU	**117** B, NL

The shaded areas represent the location of the EU-15 average within the clusters. * Costs are estimated on a population basis and hence per capita costs are equal across all countries

For the SLFD, across the EU, the average expenditure per capita associated with the Directive is estimated as 4 Euro/yr. The observed variation between countries is solely a function of national refinery capacity, as a result of the extrapolation method used. Figure 6.1 illustrates the relationship between MS population, refinery capacity and per capita costs.

Countries facing per capita costs similar to the EU average (4-5 Euro/capita/yr) include the UK, the Cohesion countries, Denmark and France. A group of countries faces low per capita expenditures, including the 1995 accession countries (Sweden, Austria and Finland[5]), Ireland, Luxembourg and Germany. Much higher costs can be seen in Belgium and the Netherlands. The high costs in these two countries arise from their disproportionate share of refinery capacity (15% of EU-15) relative to the their populations (7% of EU-15). In particular, costs in the Netherlands stand out, correlating with the role of the Netherlands as a major point for fuel import and distribution within Europe. Given the international nature of the oil trade the high cost/capita figures for some countries (e.g. the Netherlands) should not necessarily be regarded as an excessive burden on the population specifically in those countries as ultimate costs will be much more widely distributed.

Figure 6.1 Population weighted share of EU-15 refinery capacity and per capita annual costs under the SLF Directive[6]



For the NECD, again Belgium and the Netherlands are estimated to see significantly higher costs than the other MS (80 to 100 Euro/capita/yr compared to 20 for the EU-15). In addition Luxembourg also sees relatively high per capita costs. Significantly lower than average costs

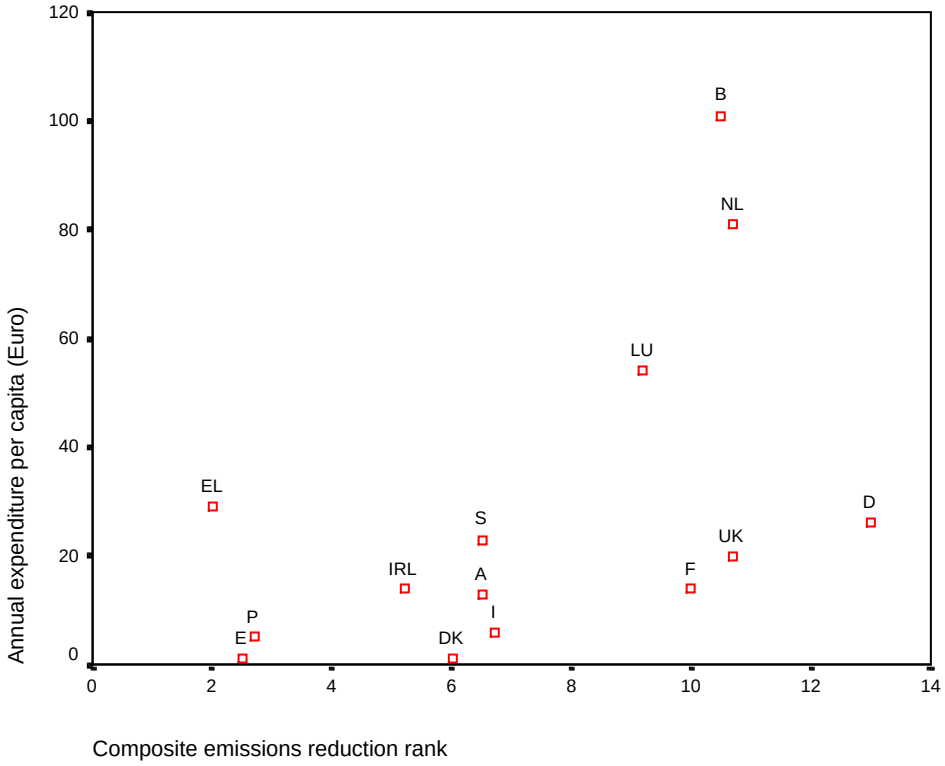
[5] The low per capita cost figures for these countries reflects that fact that the the analysis excludes the costs of the 1998 revision (98/70/EEC) which for other countries contributes around 75% of the total costs.

[6] Population weighted share of refinery capacity is defined as the MS % share of EU-15 refinery capacity per 1m population (see Annex 1 Table 2.14).

are seen in most of the cohesion countries (with the exception of Greece) and Finland and Denmark – an average of 3 Euro/capita/yr compared to 20 for the EU-15.

The main factor determining the pattern of costs faced by the MS is the calculated emissions reductions required of each of the MS. As there are four parameters (SO_2, VOC, NO_x and NH_3) and the required percentage emissions reductions and unit costs for each parameter may vary between MS, it is necessary to define a composite emissions reductions index to understand the pattern of costs. This rank index, together with the annual per capita costs faced under the Directive is shown in the following figure.

Figure 6.2 Composite emissions reduction rank[7] and annual costs faced under the NEC Directive



Belgium, Netherlands, Germany, UK and France see the highest emissions reductions (ranked over all parameters) although there are substantial differences between these countries in terms of the per capita costs faced. Two groups of countries stand out: Belgium and the Netherlands, where per capita costs are high and France, UK and Germany, where although emissions reductions are high, per capita costs are relatively low. This difference largely reflects the different unit costs of reducing a tonne of emissions of the various pollutants. The cost of reducing a tonne of NH_3 emissions is much higher than the cost of reducing a tonne of SO_2 emissions or NOx/VOC. As a result countries whose emissions

[7] Inverse of the estimated average rank for each MS in the EU-15 emissions reduction for the four NEC parameters.

reductions are high for NH_3 relative to other parameters (Belgium and the Netherlands) tend to face high per capita costs compared to other countries (Germany, UK and France) where the high emission reduction rank arises mainly from comparatively high emissions reduction for SO_2, NO_x and VOC.

For Belgium and Netherlands, therefore, the high costs under the SLF and NEC Directives are explained by different country specific factors but both reflecting highly developed industry sectors (agriculture for the NEC Directive and oil refining for the SLF Directive).

Other factors influencing the pattern of NEC costs by MS include:

- The starting position of countries – those countries that already insist on a high level of abatement, or which have agreed to stricter controls need to do less under the Directive than some other countries (Denmark and Finland).

- The RAINS model, on which the estimates are based, targets emissions abatement to protect the areas at greatest environmental risk. Using the example of acidification, the countries in the south of Europe (e.g. Spain, Portugal) need to do less in reducing SO_2, NH_3 and NOx emissions than those in the north (e.g. Belgium, UK) because of differences in the geology in the two areas.

- Effects of the non-linearities in ozone formation. Ozone forms through complex reactions in the atmosphere involving sunlight, NO_x and VOCs. In some locations typically close to the source of emissions, NO_x emissions tend to reduce ozone, whilst in areas further away NO_x tends to increase concentrations. The reason for this is that NO_x emissions are mainly in the form of NO, which consumes ozone, whilst further away NO_2 (formed through oxidation of NO) acts in favour of ozone formation.

For the LCP Directive, the Netherlands again remains among the high cost group of countries, (together with Sweden seeing an average cost of 26 Euro/capita/yr). In fact all of the Scandinavian countries and Austria face relatively high per capita costs under the LCP Directive. France and the UK face comparatively low per capita costs, while the Cohesion countries, Belgium and Germany face costs similar to the European average.

Many factors can be expected to influence the costs associated with the LCP Directive, these include:

- the number and size of plants that are planned to be built,

- the energy strategies of the Member States,

- the availability and relative costs of different types of fuel,

- the rate of replacement of existing plants, or

- the Member States plans for emission reductions that they have obligated themselves to (including the UNECE - negotiated protocols on sulphur and nitrogen emission reductions).

Differences in costs arise as a result of a number of factors that lead to large differences in per capita emissions and hence abatement requirements:

- extensive use of low emission fuels such as natural gas or nuclear power leading to low per capita costs in France,
- extent of liberalisation of energy markets leading to lower than average per capita costs in the UK,
- high sulphur content of available coal, lignite or oil leading to costs close to the EU average in some cohesion countries (e.g. Spain, Greece) despite a number of derogations,
- limited stock of facilities to which the Directive is relevant (e.g. Ireland),

For the VOC directive the method of extrapolation of MS costs (based on population size) does not permit any further analysis of the differences and similarities of per capita costs since these are identical.

Given the importance of the NEC Directive in terms of expenditures, and the relatively high expenditure in Belgium and Netherlands under this Directive, these countries also see high costs across the entire air sector directives in aggregate. These costs are three times as high as the EU-15 average (117 Euro/capita/yr compared to 35). In general the cohesion countries, UK and France tend to be consistently low or average cost countries. A different cost pattern is seen for the Scandinavian and late entry countries where costs may be relatively high under some air directives (i.e. LCPD) and low in others (i.e. NECD) as a result of country specific factors.

6.2.3 The water sector

Table 6.3 summarises the clustering of countries in terms of per capita expenditures associated with the water directives. Across all water directives Austria displays the highest per capita costs. This position is almost exclusively the result of the very high per capita costs seen for the UWWT Directive. The Netherlands and Germany feature more consistently as high cost countries.

Table 6.3 Country clusters facing similar per capita expenditure requirements (cluster average Euro per capita) – water sector

Directive	Low	Medium-low	Medium	Medium high	High
UWWT	**23** EL, UK, F	**39** P, IT, DK, FIN, S, E, B	**62** NL, IRL	**89** D, L	**133** A
ADWD	**1** DK	**2** A, D, EL, P, E	**5** N, L, IT	**8** UK, B, F	**12** IRL
NITD	**1** IRL, L, D, P, IT, F	**2** E, UK, EL	**6** B	**10** DK	**11** NL
Water	**23** EL	**38** FIN, F, P, S, UK, IT, DK, E	**67** B, NL, IRL	**93** D, L	**135** A

The shaded areas represent the location of the EU-15 average within the clusters.

For the UWWT Directive the main factor that would be expected to explain the variation in per capita costs (the per capita increase in wastewater infrastructure) actually explains very little

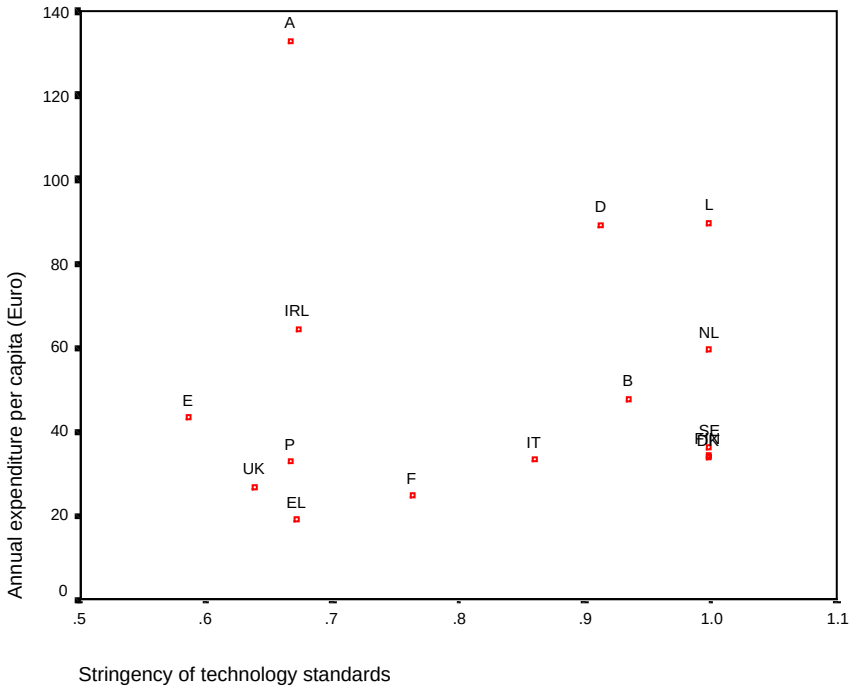
of the variation. Many countries seeing very high per capita infrastructure enhancements (Spain, Portugal and Greece) see lower or similar per capita costs to those of other countries seeing very little increase in treatment capacity.

A number of other factors, however, serve as better predictors of the cost patterns faced by individual Member States. These include:

- the relative stringency of the required technology standards given the sensitivity of the receiving environment in the respective MS, and
- differences in the starting positions of countries.

Figure 6.3 summarises the observed relationship between the stringency of technology standards and the annual per capita costs. A group of countries (Luxembourg, Germany and Netherlands) which face high technology standards (because of the sensitivity of receiving waters) also see relatively high per-capita costs. Spain, UK, and France all face lower than average stringency of treatment requirements and face lower than average per capita costs. However, there is also a group of countries where this relationship is not followed. In Ireland and Austria treatment stringency requirements are relatively low but per capita costs are high.

Figure 6.3 Relationship between per capita costs and the stringency of the technology standards[8] faced under the UWWT Directive



[8] Defined as the weighted average of discharges going to sensitive, normal and less sensitive areas and therefore requiring different treatment levels.

In Austria these costs (and to a lesser extent the high costs seen in Luxembourg) are largely explained by the very high per capita infrastructure rates. According to CEC (1997) in 2005 there will be 2.4 population equivalents per capita (for treatment and collection infrastructure) a rate which is almost twice the EU-15 average. This high rate of infrastructure provision is may be partly explained by over-design of the system and partly by the strength of industrial wastewaters (given limited differences in the discharge characteristics of household wastewater per capita).

Differences in the starting positions of countries responding to the requirements of the objectives of the Directive also appear to have an important impact on the cost differences faced by countries. One of the most important mechanisms is through the degree of retrofitting of investments. Measuring the degree of retrofit as the reciprocal of the proportion of new to existing capacity, a pattern emerges with two groups of countries (Austria, Germany and Luxembourg) where the degree of retrofit and costs are high and Greece, Italy, Spain and Portugal where the degree of retrofit and costs are low (see Figure 6.4).

Incorporating pollution clean-up through retrofitting tends to be more expensive than building it into new capacity for a number of reasons including the design constraints of existing capacity and the inability to optimise investment strategies given the degree of lock-in to historical system design. As illustrated in Figure 6.4 this appears to be a significant factor explaining the pattern of costs faced by individual MS.

For the Drinking Water Directive, the highest per capita costs arise in Ireland (12 Euro per capita), followed by the UK, Belgium and France (with an average of 8 Euro per capita). Denmark, Austria, Greece, Portugal and Spain all see costs below the EU-15 average, while Netherlands, Luxembourg and Italy all see costs close to the EU-15 average. It should be remembered, however, that the estimated costs cover only a limited set of cost drivers for the Directive (lead, pesticides and monitoring).

For the pesticide parameter, the costs are determined largely by the level of per capita water consumption, which varies between MS by a factor of 3 between Portugal (30 m^3/capita/annum) and Ireland (100 m^3/capita/annum). As the costs of the pesticide parameter have been developed on the basis of a limited number of country case studies (Austria, France, Germany, Italy and the UK), the cost pattern also reflects the choice made in matching countries where no information exists to those where cost data are available. As noted in Annex 1 the procedure for this extrapolation is based on a simple comparison of each country's relative consumption of pesticides (countries where there are no cost data (e.g. Spain) have been matched to countries with similar rates of pesticide consumption (Italy) where cost data are available). There is a tendency for higher per capita costs to be experienced in those MS (UK, Netherlands, Italy and France) where remedial strategies are important, relative to those where preventative strategies are more common (Austria, Germany) as illustrated in Table 6.4.

For the lead parameter, the costs are driven by the exposure to lead from the distribution system (which can be measured in terms of the number of connections to the distribution system that are made of lead). Exposure may also occur due to lead plumbing within homes, although there is a strong relation between the occurrence of lead in houses and lead being used as a material to connect houses to the distribution system.

Figure 6.4 Relationship between per capita costs and retrofitting for the UWWT

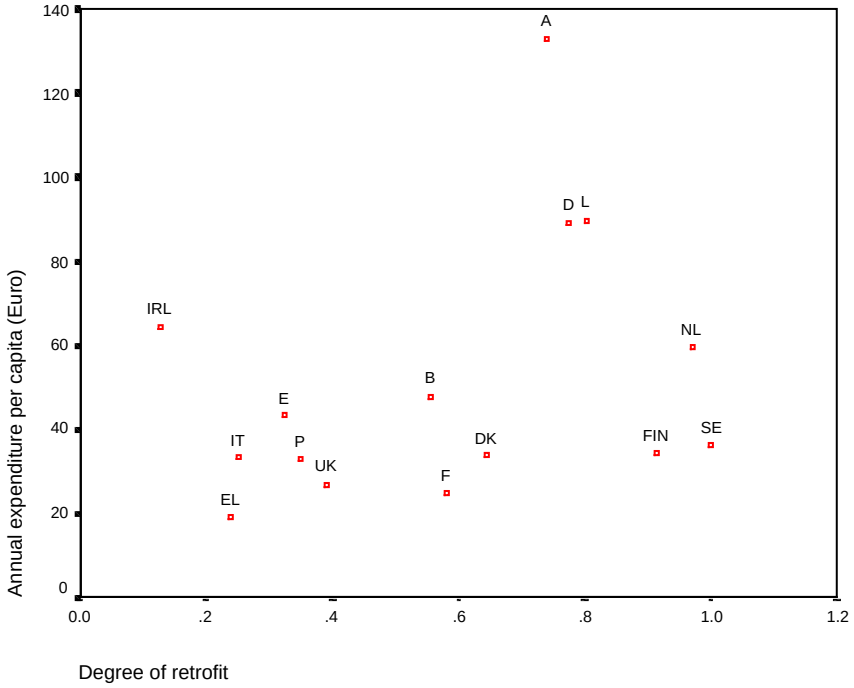


Table 6.4 Relationship between per capita costs and the degree of preventative action adopted.

MS	Degree of preventative action *	Cost Euro per capita
Germany	60%	1.4
Austria	67%	1.7
France	0%	2.1
UK	0%	2.6
Netherlands	8%	3.3
Italy	0%	4.1

* % of total catchment expenditures based on preventative measures (e.g. water protection zones)

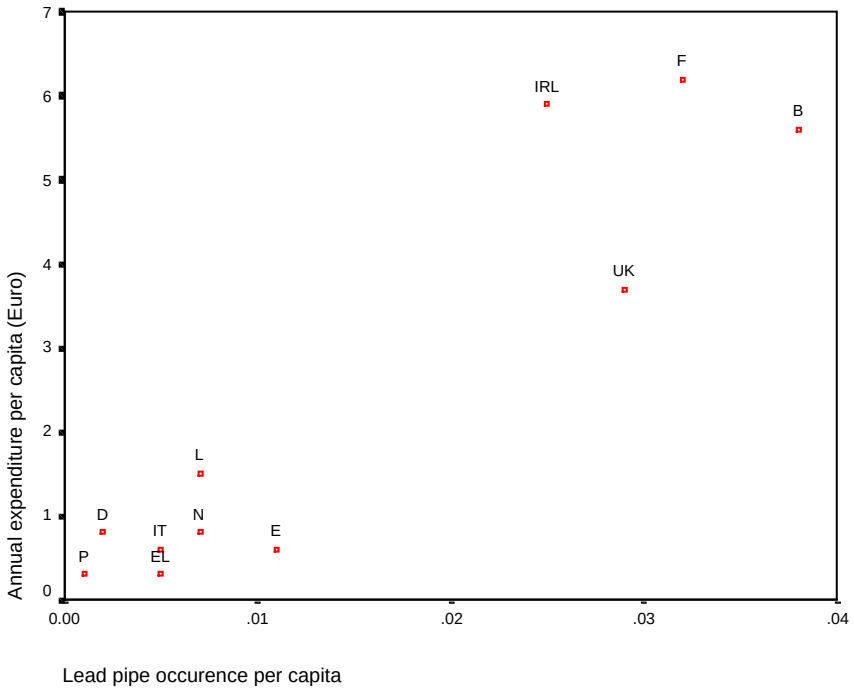
It is clear from Figure 6.5, that four countries (Belgium, France, UK and Ireland) stand out from the remaining countries because of relatively high per capita costs. All other MS have a relatively low number of lead connections per capita and low predicted expenditure as a result. For the high cost countries, the main factors responsible for the differences in results are country specific:

- the unit cost of pipe replacement which is highest in Ireland (2 000 Euro) and lowest in Belgium (825 Euro) based on data collected from the countries (WRc (1995)),

- the relative importance of treatment requirements. In Belgium, Ireland and especially France in addition to the pipe replacement costs, further costs are incurred in treating water to meet the Interim 25 μg/l standard. In the UK these costs are trivial given the high

percentage of supplies already treated in this way (75%). In France the high number of small supplies (<2 Ml/day) which deliver soft aggressive water exacerbates this cost.

Figure 6.5 Relationship between costs (EAV Euro per capita) for the lead parameter and the number of lead connections per capita



For the Nitrate Directive, above average costs are seen in Netherlands, Belgium and Denmark. There is a large difference between the costs experienced in these countries and those elsewhere. The lowest costs are seen in Ireland, Luxembourg, Germany, Portugal, Italy and France, with the UK, Spain and Greece, seeing costs closer to the EU average (2 Euro per capita). It should be noted, however, that these costs are based largely on meeting the application standard for animal manure and may not reflect the costs in mainly arable agricultures.

The procedure for estimating the cost of the Nitrate Directive features two related factors which aim to capture significant differences in costs and hence lead to variations in the pattern of per capita costs faced by the MS:

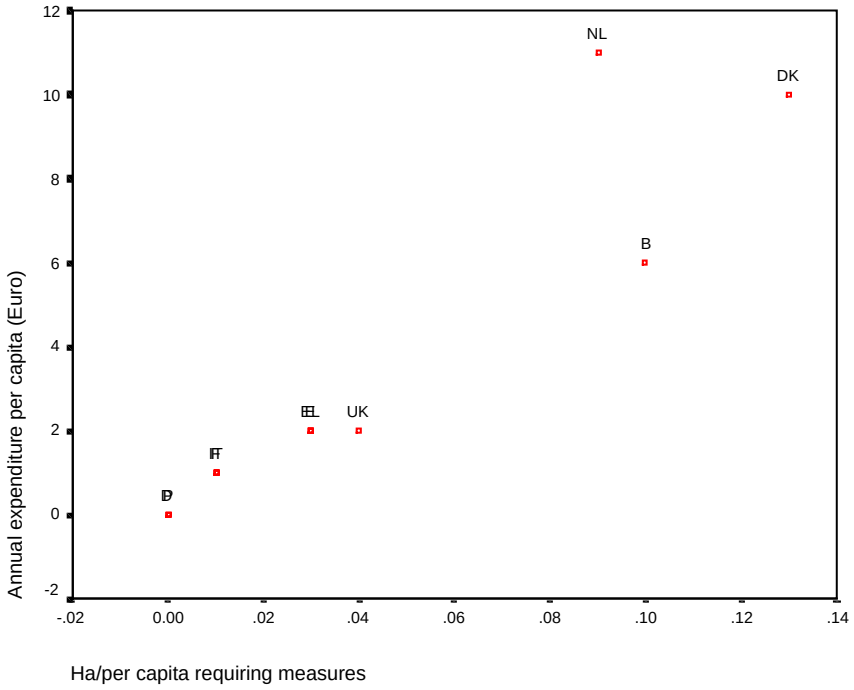
- the types of farming enterprises experiencing structural nitrogen surpluses – as different farming types will have different opportunities for achieving a more balanced use of nitrogen,

- the farm type specific costs of alleviating nitrogen surpluses.

The unit costs are developed from a micro level evaluation of the costs in particular MS. One of the key factors which would be expected to determine the costs faced in particular MS is the area of land which is predicted to require measures. As can be seen from Figure 6.6, there is a clear relationship between the estimated number of hectares per capita requiring

measures and the per capita costs faced. Netherlands, Belgium and Denmark stand out from the other MS both in terms of the land area requiring measures (generally greater than 0.1 ha/capita) and the per capita expenditure requirements.

Figure 6.6 Relationship between the cost (EAV Euro per capita) and the per capita land area requiring measures



There are, however, noticeable differences within this group of countries. In particular Netherlands and Belgium see quite similar areas of land per capita requiring measures but widely different per capita costs. This largely reflects the higher unit cost of measures assumed for the Netherlands, most importantly in the dairy sector where the costs per hectare used is 130 Euro compared to 45 Euro in Belgium. In turn this reflects the unique situation in the Netherlands where the area of affected land is relatively small but so intensively managed that unit costs are dramatically higher than elsewhere. For example, the net surplus for the average farm in the Netherlands was 388 kg N/ha in 1995 (Brouwer et al (1995)) more than double even the very high levels seen in Belgium.

The per capita costs experienced in the remaining high cost country, Denmark, are greater than those in Belgium but lower than those in the Netherlands. The lower per capita costs than the Netherlands, despite the higher relative land area requiring measures, arises as a result of the lower unit costs per area of land. The unit costs faced in Denmark are in fact the same as those seen in Belgium. The sector most affected in Denmark, however, is the granivore sector, leading on balance to generally higher costs. In Belgium, a much higher proportion of the land requiring measures is in the relatively low cost sectors – especially mixed farming where the opportunities to achieve a more balanced use of nitrogen are higher.

In the lower cost countries there is a much more stable relationship between per capita costs and the land area requiring measures. This arises mainly because they are assumed to face

quite similar unit costs per area of land. As a consequence the main factor explaining the different cost patterns is the share of different farming types in the total land area requiring measures. In Germany and Portugal the relationship between cost per capita and the per capita land area requiring measures is the same because in both areas only the granivore sectors are predicted to be affected.

Although a very similar relationship is seen in Italy and France this arises from different factors. In Italy the main sectors affected are dairy and drystock, while in France it is generally mixed farming and granivore enterprises. Similarly, Greece and Spain see a close similarity but again as a result of different factors, with drystock farming being the most affected sector in Greece but dairy and granivore enterprises being most affected in Spain. The UK, although within this low cost group of countries, sees a relatively high per capita land area requiring measures. The fact that costs are not consequentially higher is not because different (lower cost) farming types are affected but because unit costs of measures are lower (based on available UK data).

As noted above, across all directives, Austria faces the highest per capita costs (135 Euro/capita/yr) largely as a result of the UWWT Directive. The Netherlands, Germany, Belgium, Luxembourg and Ireland also feature consistently amongst the high costs countries for the different directives although with exceptions (e.g. Ireland is relatively high cost for the DWD and UWWT Directives but relatively low cost under the Nitrate Directive) as a result of country specific factors discussed above. In general the Cohesion countries, the UK and France tend to see the lowest per capita costs although here again Ireland presents a notable exception.

6.2.4 The waste sector

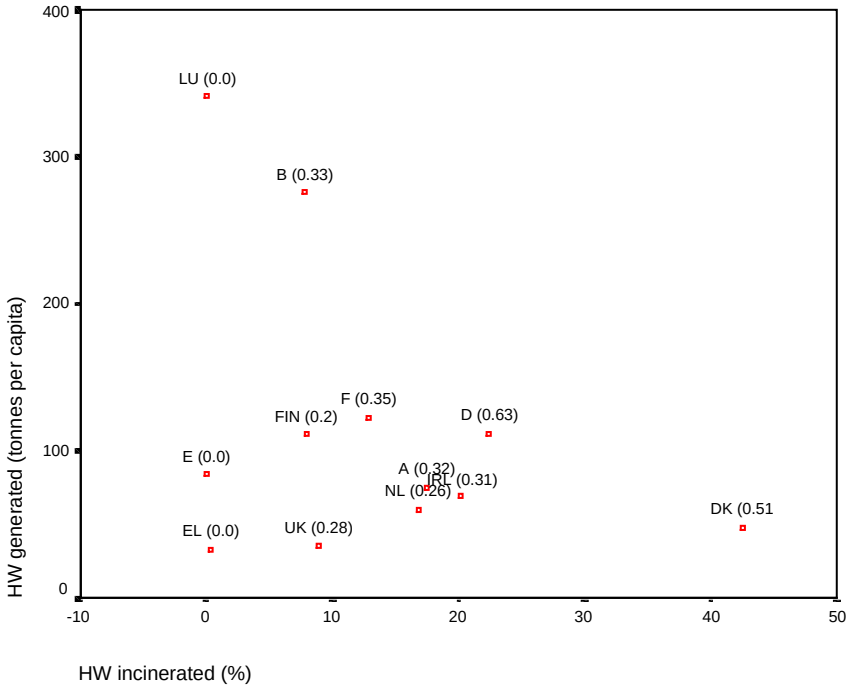
Table 6.5 Country clusters facing similar per capita expenditure requirements (cluster average Euro per capita) – waste sector

Directive	Low	Medium-low	Medium	Medium high	High
HWID	**0.0** EL, L, E, SE, UK	**0.1** IT	**0.3** FIN, NL, IRL, A, B, F	**0.5** P, DK	**0.6** D
PPWD	**10** EL, IRL, P, IT, UK, E	**18** B	**22** F, L	**27** SE, FIN, DK, A, D	**30** NL
DELV	**0** L	**1** EL, P, IRL, B, E, SE, FIN	**2** IT, UK, DK	**3** NL, A	**4** F, D
Waste	**10** EL, P, IRL	**13** IT, UK, E	**20** B, LU	**26** FIN, SE, F	**32** DK, A, D, NL

The shaded areas represent the location of the EU-15 average within the clusters.

For the HWID, the clustering of countries on the basis of their per capita expenditure requirements follows from the differences in per capita hazardous waste arisings and the present proportion of this waste which is incinerated (which is not assumed to alter as a result of the Directive), see Figure 6.7.

Figure 6.7 Relationship between hazardous waste generation, incineration and per capita costs (Euro)



Analysis of the data reveals two other classifications:

1. Those where the low rate of incineration mitigates against high costs resulting from high per capita waste arisings. This is most notable in the case of Luxembourg that has a very high rate of waste arisings but incinerates no waste and hence faces zero costs. It is also true to a lesser extent of Finland.

2. Those MS where high incineration rates push up costs which would be low given the low per capita hazardous waste arisings. This is most obvious in the case of Denmark that has comparatively low rates of hazardous waste production but has the highest incineration rate in the EU-15 (42%). It is also true of Ireland, Netherlands and Austria.

Germany, the country facing the highest per capita costs does so because of a high rate of waste arisings coupled with a higher than average propensity to incinerate hazardous waste. By contrast, the countries facing low per capita expenditures (e.g. UK, Spain and Greece) do so as a consequence of both low per capita generation and low rates of incineration.

The clustering of countries according to the HWID is incompletely paralleled in the case of the PPWD. Most of the low cost countries for the HWID are also low cost countries for the PPWD (Greece, Spain, UK), similarly, Denmark and Germany retain their positions among the higher cost countries. However, other country positions with respect to the two directives differ considerably given the directive under consideration. Examples include:

- Sweden, where that country's position under the HWID reflects largely the very low rate of hazardous waste generation (which at 16kg per capita is the lowest of the EU-15 and less than 1/5 the EU-15 rate of 84 kg/capita). By contrast the rates of recycling/recovery per

capita are close to the European average and unit costs are amongst the highest in Europe.

- Portugal, which experiences high costs under the HWID because of the large volume of waste generated relative to the EU, but low costs under the PPWD because of the low rates of per capita recycling recovery combined with low unit costs.

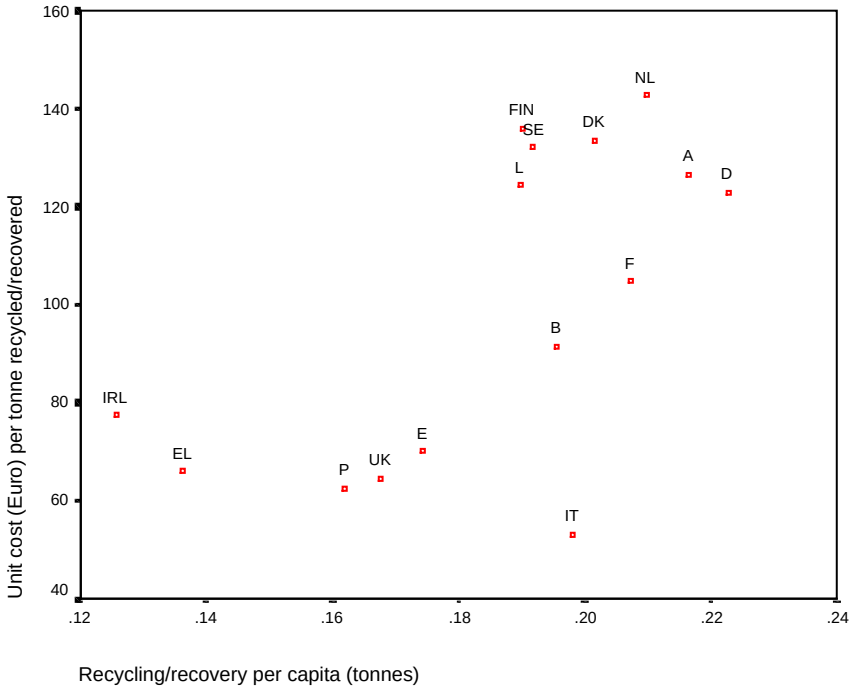
It should be noted that the per capita costs estimated for the PPW Directive are highly theoretical in nature (based on meeting the minimum requirements of the Directive in the cheapest manner available and ignoring local circumstances). The unit costs of waste management practices are based on a study undertaken in 1995 which have been overtaken in some circumstances (See Annex 1 Section 10 for a discussion of the validity of this data given more recent empirical evidence). Not with standing these difficulties the revealed pattern of MS clustering with respect to the PPWD can be attributed to a number of variables, most importantly:

- the costs (Euro/tonne) of different waste management options assumed for different Member States,

- the amount of packaging waste recycled or recovered per capita.

These relationships can be explored in the Figure 6.8, which illustrates the relationship between the unit costs per tonne of waste recycled/recovered and the rate of recycling/recovery per capita.

Figure 6.8 Unit costs (EAV Euro/tonne) and rates of waste recycling/recovery per capita under the PPWD



As illustrated in Figure 6.8 there is a general tendency for the costs per tonne to rise as the rate of recycling/recovery increases. Of the 15 MS, Belgium sees similar market characteristics to those of the EU-15 as a whole. A cluster of countries, Finland, Sweden and Luxembourg see similar rates of recycling/recovery but significantly higher costs per tonne of material and hence higher than average predicted expenditure requirements. The remaining high cost countries (Denmark, Netherlands, Austria, Germany and France) see both high unit costs and higher than average recycling/recovery rates.

There is a wide variation in the recycling/recovery rates seen in the low cost countries (Ireland, Greece, Portugal, UK, Spain and Italy). A contrast may be drawn between Ireland and Greece on the one hand, where recycling/recovery unit costs are relatively high but the rate of recycling/recovery is low and Italy where the reverse is true.

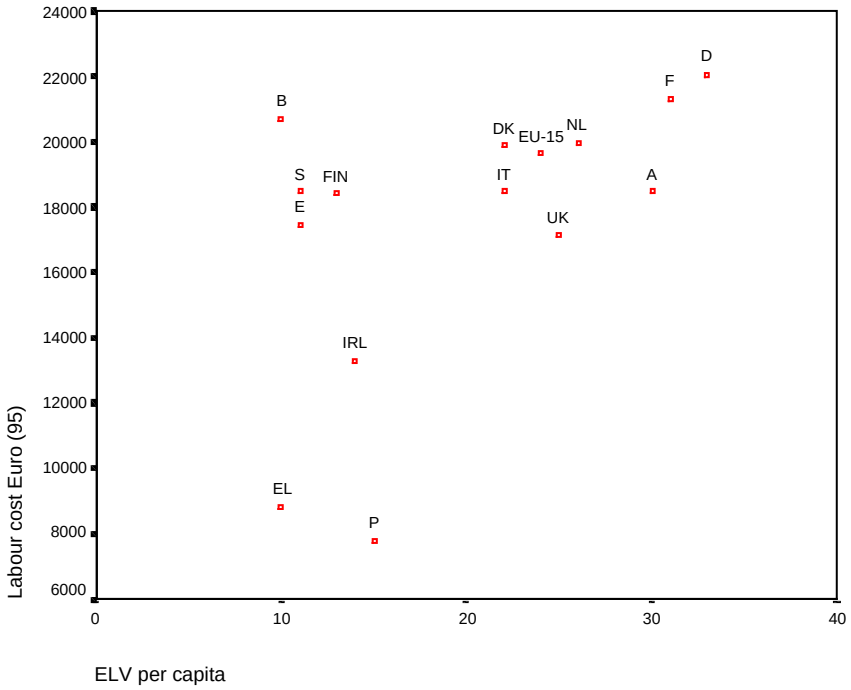
Clearly, therefore, the rates of recycling/recovery in a country are important determinants of the expenditure requirements being faced. Of similar importance, however, is the unit costs of the recycling/recovery undertaken as this differs significantly between MS.

The expenditure requirements for the proposed DELV reveal a similar pattern to those of the other waste directives, with Germany and Netherlands once more featuring in the high cost group and Greece, Ireland and Spain featuring in the low cost group.

The key cost driver under the proposed Directive is the rate at which ELVs are produced. In addition, labour costs play an important role in determining overall costs given the high proportion of labour costs in total expenditure. The relationship between these two variables is illustrated in Figure 6.9. Highest costs are seen in Germany and France, which shows the highest rates of ELV generation and highest labour costs. There is a large variation in the labour costs faced by the low cost countries revealing two further subgroups. In Belgium, Sweden, Finland and Spain, labour costs are relatively high but the low rates of ELV generation lead to low predicted per capita expenditure requirements. In Ireland and Portugal labour costs are lower but rates of ELV generation are higher leaving overall costs at the same magnitude as the other low cost countries.

Overall, there is a high level of consistency in the clustering of individual countries for the waste directives. Germany, Denmark, Austria and the Netherlands are all consistently high cost. Conversely Greece, Ireland, UK, Italy and Spain are consistently low cost. The PPWD, which is associated with much higher expenditure requirements, affects a number of countries disproportionately. Finland and Sweden for example, face relatively low expenditure requirements under DELV and HWID but higher costs under the PPWD and hence feature as relatively high cost countries in the waste directives in aggregate. Among the remaining countries, Belgium stands out as being consistently close the EU-15 average of expenditure requirements.

Figure 6.9 ELV generation per capita and labour costs (Euro)



The consistency of clustering of countries reflects to a limited extent the average labour costs faced by the countries. A high, significant correlation exists between labour costs and the expenditure requirements faced under all three directives. This relationship is strongest in the case of the proposed DELV, where labour costs constitute a high proportion of expenditures. Labour costs, however, are an incomplete explanation of the costs faced in different MS. An important factor explaining the pattern of costs faced by different MS is the relationship between the amount of waste generated and the level of treatment applied. Countries may face low expenditure requirements either because of a tendency to avoid the generation of waste in the first place (using upstream control measures such as waste minimisation, clean production technologies and consumption patterns) or through low rates of treatment of waste eventually produced. In the former case a county may apply more stringent treatment requirements and still remain low cost. In this regard there is an important difference between the HWID on the one hand and the PPWD and DELV on the other. The latter two directives specify targets for the treatment of the waste stream itself, whereas the former specifies only technological standards for the waste stream if it is treated in a certain way (incinerated).

6.3 Analysis of the labour market response in Member States

This section explores the relationship between the expenditures and the identified tangible employment effect. Given a level of expenditure related to a particular environmental policy goal different tangible employment effects may arise because of differences in the structure of the sectors undertaking and receiving the expenditures. This section reviews the available data to identify key similarities and differences between MS and the factors explaining these differences.

The labour market response to expenditures depends on two country specific factors[9]:

1. the level of compensation to employees (as a proportion of total expenditure) in the sectors undertaking and receiving expenditure,

2. the unit labour costs in the sectors undertaking expenditure.

These factors work in opposite directions, since all other things being equal the higher the compensation to employees in the sectors, the higher will be the resulting employment impact (and hence the lower the expenditure per employee). Conversely, the higher the unit labour cost the higher the expenditure per FTE, other things being equal.

Most MS that have high unit labour costs also have higher than average compensation to employees and visa versa. This has the effect of bringing the expenditure per FTE in each of the countries closer than they would be on the basis solely of differences in unit labour costs. In Austria, for example, unit labour costs are 13% higher than the EU-15 average but the level of compensation to employees is also 5% higher (see Table 6.6 illustrating the relationships for the UWWT Directive). As a result the expenditure per FTE in Austria is only 7% higher than the EU average.

Table 6.6 Relationship between compensation to employees, unit labour cost and labour market response to the UWWT Directive expenditures (differences by MS from EU-15 average)

	Expenditure and employment related to operations			Expenditure and employment related to investments		
Member State	Compensation to employees	Unit Labour cost	Expenditure per FTE	Compensation to employees	Unit Labour cost	Expenditure per FTE
Austria	**5%**	**13%**	**7%**	16%	12%	-3%
Belgium	4%	24%	20%	2%	11%	10%
Denmark	2%	12%	10%	18%	18%	0%
Finland	5%	10%	5%	14%	12%	-1%
France	0%	6%	7%	0%	6%	6%
Germany	3%	28%	24%	16%	32%	14%
Greece	-5%	-44%	-41%	-31%	-51%	-29%
Ireland	**-6%**	**-13%**	**-7%**	4%	3%	0%
Italy	-5%	7%	13%	-19%	13%	41%
Luxembourg	5%	10%	5%	17%	-6%	-19%
Netherlands	-5%	10%	16%	-9%	21%	34%
Portugal	-5%	-58%	-55%	-31%	-56%	-37%
Spain	4%	-4%	-8%	2%	-23%	-23%
Sweden	4%	8%	4%	4%	12%	9%
United Kingdom	-6%	-8%	-2%	-3%	-5%	-2%

[9] The nature of the Directive also has an impact on the labour market response, these factors, however are discussed in the comparative analysis of directives.

By contrast in Ireland the unit labour costs are 13% lower than the EU-15 average, but the compensation to employees is also lower (by 6%). As a result expenditure per FTE is not 13% lower but only 7% lower[10].

In terms of operating expenditures this relationship is true for all but three countries: Italy, Netherlands and Spain. In Italy and the Netherlands the compensation to employees is lower than the EU-15 average but unit labour costs are higher. The converse is true in Spain, where unit labour costs are lower but the compensation to employees is higher. A similar relationship is true for capital expenditures, with the addition that Luxembourg joins Italy and Netherlands as countries where unit labour costs are high but the compensation to employees is relatively low.

In general terms therefore, the labour market response in countries is governed by the relative wage rates (which tend to increase the level of expenditure per FTE associated with the directives). In most countries, however, higher unit labour costs also mean a high proportion of expenditure going to labour (which tends to decrease expenditure per FTE). As a result the level of expenditure per FTE tends to be closer between countries than a simple comparison of unit labour costs would suggest. The exceptions to this relationship are Italy, Netherlands, Spain and Luxembourg, where the relationship is such as to exaggerate the differences between countries.

6.4 Impact on social and economic cohesion

It is clear that there are large differences in the implementation costs of environment policies across Member States. A very general characterisation is that costs tend to be elevated in the Northern Member States because of the higher level of development and hence pressures. In addition, however, for a number of pressures, the assimilative capacity of the receiving environment is also considerably lower in northern countries and comparatively higher in the Cohesion countries. The final consideration, however, is the state of development of the countries environmental infrastructures at the time the directives are adopted. Despite generally lower pressures and a more assimilative environment, Cohesion countries tend to lack the environmental infrastructures seen in Northern Member States consequently increasing the scale of the investments required.

Cohesion is generally defined as being the convergence of a number of cohesion indicators (income, productivity, and opportunity) between a number of cohesion groups (MS, regions, sectors, social groups etc.). There are a number of obvious ways in which the directives examined here can interact with objectives for social and economic cohesion (WRc (forthcoming).

Differences in economic situation

At a Member State level, although expenditures tend to be lower in the Cohesion countries (for a combination of reasons) the use of inter-regional transfers such as the Cohesion Fund means that a greater proportion of expenditure will be additional (in that it is not simply

[10] It should be noted that the labour cost and percentage compensation to employees may be related in this way since a labour market able to negotiate a high return should also receive a relatively larger share of the money flows and visa versa.

replacing other productive expenditure which would have occurred anyway). This increases the likelihood that the potential income and employment opportunities associated with the directives will be translated into actual income and employment opportunities. In the case of the UWWT Directive for example 4 B Euro has been received in the Cohesion countries between 1993 and 1999. This represents around one quarter of the total investment in these countries, a proportion that will rise as further transfers occur between 2000 and 2005. Most of the Cohesion countries, however, will also see a large degree of leakage because of the presently small scale of the domestic wastewater eco-industries. As a result the cohesion impact of the expenditures is likely to be strongly positive, however, it could be improved further by encouraging supply side and import substitution for the main wastewater goods and services.

Differences in pressures

Differences in the pressures faced by MS may also lead to cohesion impacts. In the case of the Nitrate Directive, for example, the imposition of an application standard for nitrogen from animal manures is likely to increase costs and reduce agricultural incomes in countries with highly intensive livestock enterprises. The cohesion countries, due to their relatively more extensive agricultural systems are much less affected. Hence the application standard is likely to reduce agricultural incomes in the relatively productive northern agricultural regions leading to a form of negative cohesion as incomes are reduced closer to those prevailing in the Mediterranean agricultures.

At the same time, on farms where the environmental pressures are less intense their is evidence that the codes of good agricultural practice which are part of the directive can lead to substantial cost savings through better nitrogen management. Although nitrogen use efficiency could be improved throughout the community evidence suggests the largest gap is in the Mediterranean agricultural systems – where wide variations in the Nitrogen surpluses are in evidence for similar farming types. This is likely to have a positive impact on cohesion by improving the efficiency of European farming in general and making it more competitive on world markets and by enhancing efficiency most in the less developed regions.

Other impacts

The Directives examined are also likely to have more subtle interactions with cohesion objectives. Many of the directives have a direct impact on human health. Because of existing inequalities in the exposure to pollution reducing exposures through the measures associated with the Directives is likely to disproportionately benefit less advantaged groups. The Drinking Water Directive provides an example where a reduction in contamination from lead has a number of important effects on social and economic opportunity. Reduced exposure to lead improves the cognitive development of children, which in turn increases IQ, years of schooling, working wages and workforce participation, leading to higher lifetime earnings from a more productive population. While these impacts are likely to be beneficial in terms of general social and economic cohesion a further positive impact arises because of the inequitable pattern of exposure to other sources of lead and health inequalities generally. For a number of reasons high exposure tends to be associated with low incomes, disadvantaged social classes and poor living conditions. A reduction in the exposure from drinking water is likely therefore to have a disproportionate and positive effect these cohesion groups.

6.5 Summary

This section has presented a comparative analysis of the directives focusing on the differences and similarities between MS. There is no simple explanation of the cost patterns faced by the different MS. A number of countries consistently see low per capita costs across all sectors (UK, Spain, France, Italy and the Cohesion countries), while other countries see high costs for some directives and lower costs for others.

It would be expected that cost patterns would largely reflect the "volume" of environmental protection MS must undertake to meet the objectives of the directive. In general this is true, although a number of country specific factors also play a role.

- In the air directives the energy strategies of the MS play an important role reducing costs in some countries because of the relatively high reliance on low emission fuels (e.g. gas, nuclear fuels),

- Differences in the concentration of affected economic sectors is an important factor in a number of directives. In the SLF and NEC directives, for example, high costs are seen in the Netherlands and Belgium because of these countries highly developed oil refining and agricultural sectors.

- Differences in the sensitivity of the receiving environment can be important, for example in the UWWT and Nitrate Directives. In the UWWT Directive these differences lead to differences in the applicable standards, reducing the costs in those MS where discharges do less damage.

- Differences in the compliance strategies adopted by MS, for example in the DWD, where the importance given to preventative versus remedial strategies reduces costs in a number of MS.

- Differences in the opportunity cost of resources play a role, particularly where labour costs are an important component of overall costs (e.g. DELV), because of the large differences in labour costs between MS.

Labour cost differences between MS, also give rise to different labour market responses to the expenditures. High labour costs tend to reduce the number of jobs linked to the directives. Differences between MS as a result of different labour costs are, however, moderated by the fact that countries where labour costs are high also tend to see the largest proportion of sector expenditures going to labour.

In a comparative analysis by Member State special attention must be given to the interaction between the directives and the objectives for greater social and economic cohesion. Expenditure and employment in the cohesion countries is far more likely to give rise to additional economic opportunity because of the high proportion of expenditures financed through inter-regional transfers. Such positive cohesion however, is also likely to be accompanied by negative cohesion because of the relatively high pressures in Northern Member States relative to the South.

6.6 References

For references to individual studies see the corresponding sections of Annex 1.

WRc (forthcoming) Study on the Impact of EU Environment-Water Policy on Economic and Social Cohesion. Report prepared for EC DG Regional Policy. September 2000.

7. SCENARIO AND SENSITIVITY ANALYSIS

7.1 Introduction

This section discusses a number of cross-cutting issues that lead to uncertainties in the estimates of costs and employment:

- Incomplete data on operating and capital costs breakdowns, which is a problem for many of the directives examined.
- Uncertainty about the labour intensity of the compliance strategies chosen by MS,
- Uncertainty about the strategies chosen by MS particularly in terms of preventative versus remedial options.

Further sensitivity/scenario analysis is undertaken to understand the impact of these issues on the estimates of expenditure and employment.

7.2 Incomplete data on operating and capital costs

It is clear from this study that there is little standardisation nor any discernible trend in the way cost information is currently being presented in the type of evaluations reviewed - this being largely within the choice of the researchers producing the original studies. Examples of differences in practice include:

- the use of annualised costs (reflecting annualised capital expenditures together with operating expenditures),
- the use of net present values of future expenditure streams, or
- the reporting of capital and operating costs independently.

The presentation of cost information in alternative formats presents a number of problems in for the current study. As the employment implications of particular directives depend on the nature of the expenditures (i.e. whether they are capital or operating in nature) it is necessary to achieve a split of expenditures into these two streams. To achieve this split for a net present value (which includes capital and operating costs) it is necessary to know:

1. The life time of the expenditure streams (typically the life of the capital items),
2. The discount rate,
3. The relationship between operating and capital expenditure.

An example of the disaggregation procedure is given in Figure 7.1.

Figure 7.1 Disaggregation of summary cost figures

A net present value capital and operating costs of 1 M Euro can be broken down into capital and operating elements if it is known that:

- The npv is calculated over 20 years,
- The discount rate applied is 10%
- Annual operating expenditures are 5% of the total capital cost.

Assuming the capital cost occurs in the first year, the following equation for the present value (PV) of capital (C) and operating (O) costs can be established

$$PV = C + dO$$

Where d = the appropriate discount factor used to convert an annuity to a lump sum. In the case of 1 Euro for 20 years at 10% this is 9.4. Substituting with the parameter from the relationship between operating and capital expenditure $O = a * C$, then

$$PV = C + d(aC)$$

And therefore the capital expenditure component can be separated out as

$$C = \frac{PV}{1 + ad}$$

In which case Capital expenditures are 0.68 M Euro, with operating expenditures of 34 000 Euro.

Frequently, the information with which to disaggregate cost data in this way is not available in the original studies and as a result assumptions need to be made in order to estimate the capital and operating cost streams.

A scenario has been developed in order to understand and test the impact of such estimations. In the Directive on VOCs, costs are given as total annualised costs and engineering assumptions are used in order to predict capital and operating expenditures. The opex:capex ratio used is 15% (see Table 7.1) although it is recognised that there is a large variation in such ratios given specific technologies invested in. As the original figures are total annual costs (including capital and operating costs), the split between capital and operating expenditures is irrelevant to total costs (i.e. assuming a higher proportion of operating costs would increase operating costs and decrease capital costs leaving the costs in aggregate unchanged). However, the impact on employment is more complicated as operating expenditures give rise to a higher employment impact relative to the capital costs (employment related to opex includes indirect as well as direct employment whereas for employment related to capital expenditures only direct employment is regarded as tangible and therefore included).

In the case of a doubling of the opex:capex ratio, the present value of total costs remains unchanged. There is, however, an impact on employment as the increase in employment related to operating expenditures is not fully off-set by the decrease in employment related to capital expenditures. In this case the assumption regarding the opex:capex ratio has a significant impact on employment while leaving the overall expenditure implications unchanged.

Table 7.1 Scenario (1) related to engineering assumptions (opex:capex) ratios - impact on costs and employment of the Directive on VOCs

Case	Opex capex ratio	Costs (NPV) M Euro	Emp related to opex – total (direct and indirect)	Emp related to Capex	Total Annual employment
Original	15%	1 248	1088	6395	1488
Scenario (1)	30%	1 248	1404	4707	1699
% difference	100%	0%	29%	-26%	14%

Where opex:capex ratio does not affect total (capital and operating costs) because capital and operating expenditures are known

The above analysis is based on a situation in which the opex:capex ratio has no impact on the overall level of costs (because the original study figures included both capital and operating expenditures). In many situations however, only capital expenditures are known in which case alternative engineering assumptions about the opex:capex ratio will alter the overall level of costs involved. A further scenario has been developed to test the impact of alternative assumptions in this case. Table 7.2 summarises the results (based again on the Directive on VOCs, but assuming only capital expenditures are known from the original study).

Table 7.2 Scenario (2) related to engineering assumptions (opex:capex) ratios - impact on costs and employment of the Directive on VOCs

Case	Opex capex ratio	Costs (NPV) M Euro	Emp related to opex – total (direct and indirect)	Emp related to Capex	Total Annual employment
Original	15%	1 248	1088	6395	1488
Scenario (2)	30%	1 933	2176	6395	2576
% difference	100%	55%	100%	0%	73%

Where opex:capex ratio does affect total (capital and operating costs) because only capital expenditures are known

The doubling of the opex:capex ratio leads to a 55% increase in total (present value) costs. The impact on total annual employment, however, is magnified (+73%) because of the relative employment intensity of operating expenditures.

Clearly, therefore the absence of sufficient information on the capital and operating costs streams of the directives can have an important implication in terms of employment (where total annual costs are known and total costs and employment (where only capital costs are known). The implication of this finding should be borne in mind particularly for the air sector Directives (where in all cases engineering assumptions are required to break down total annualised costs into capital and operating streams) and Drinking Water and Urban Waste Water Directives where there is only very partial information on operating costs. These

conclusions are generally less relevant to the waste directives because cost estimates are built up from estimates of the unit costs of the investment and operating activities themselves.

7.3 Choice of compliance strategies – labour intensive/extensive

For a number of the directives studied, particularly those in the pipeline, there is presently only limited information on the actual strategies which will be adopted for compliance in the MS. Often there is a choice to be made between labour intensive and extensive strategies for meeting environmental objectives, which will have important implications for the estimated cost and employment effects. Clearly more labour intensive strategies will generate a higher volume of jobs per unit of expenditure. To understand this issue a scenario/case study has been developed for the Directive on ELVs, examining different labour intensive/extensive strategies.

The cost of the Directive on ELVs is mainly operating costs with relatively little expenditure required to upgrade dismantling operations. In this context a labour intensive strategy would imply a fairly complete dismantling of vehicles relying upon a large degree of manual separation and possible re-use of dismantled parts.

Whiston (1995) provides some information on a plant dismantling BMWs in UK, however, as he mentions "complete dismantling, manual separation has not been a widely accepted alternative". The plant totally strips the car and about 85% is recycled or salvaged for resale, but the amount varies according to the condition of the car, its age and the state of components. Likewise the time required for dismantling varies according to the amount of components dismantled for re-use. For example "a dashboard may be removed in two minutes with a crowbar, but if it is to be reused it may take up to 40 minutes to unscrew and preserve intact". With a team of four individuals the time required for disassembly varies between 2 and 7 hours with an average of about 4 hours per vehicle, that is about 16 man-hours per ELV. Based on 9 million ELVs in Europe this implies about 100,000 man-years of employment in dismantling.

In addition to dismantling, the plants undertake sales of recovered parts, storage and administrative activities. With a staff of 16 persons the plant handles 550 vehicles/yr. Of the employed, only five are actively involved in the disassembly of vehicles, the others undertake sales of recovered parts, storage and administrative activities. With 9 million ELVs in Europe this amounts to about 250,000 employed, however this is only economically justifiable for ELVs that contain a high proportion of valuable recovered parts. For poor quality ELVs re-sale and some administrative staff are dispensable and the disassembly of the ELVs will be faster as parts are not preserved intact.

In a labour intensive scenario with 9 million ELVs the employment effect is evaluated to vary between 50 000 and 250 000 man-years depending on the proportion of the ELVs that are preserved intact for re-use and re-sale. However, it should be kept in mind that total disassembly of ELVs is economically justifiable only if disassembled parts have economic value and may be sold for re-use. That is, from an economic point of view, parts are either disassembled carefully and sold for re-use, which require administrative employees or parts should not be carefully disassembled.

At the other end of the scale a capital-intensive option is being developed by Mercedes Benz in co-operation with Voest-Alpine. After drainage and an initial disassembly of the engine and

hazardous components the "metallurgical recycling" technology is employed, based on the direct melting of ELVs in a melt-reactor where the separation of ferrous metals occurs. The organic materials are incinerated to produce heat and to increase the carbon content of the steel fraction. The main feature of the technology is the possibility of eliminating the dismantling and shredding phases, however the technology is still at the development stage. Investment requirements are relatively high, but no specific figures on the amounts required have been identified.

Clearly, therefore, there would appear to be considerable impact on employment of adopting alternative labour intensive strategies - in the case of ELVs the employment can vary by a factor of 5 depending on the nature of the strategy adopted. In terms of other Directives this issue is of most relevance to those directives where a large proportion of the estimated expenditure is yet to be undertaken (SLFD, NECD, DVOC and ADWD see Table 5.1) but will also depend upon the extent to which labour extensive strategies are available. This in turn is likely to be greatest in those directives that do not employ technology standards and which involve flexibility in meeting environmental targets (see Section 5.4).

7.4 Choice of compliance strategies – preventative/remedial

An issue, which has arisen in the context of a number of directives, is the role of preventative versus remedial measures in achieving environmental objectives and their respective cost and employment implications. Examples include:

- The use of low sulphur fuels or low sulphur alternatives (e.g. gas) to achieve compliance with the SLF targets as opposed to end-of-pipe treatment,
- The avoidance of hazardous waste as an alternative to treatment (incineration),
- the use of water protection zones to achieve drinking water quality targets (e.g. for pesticides) versus treating the extracted water.

It has been demonstrated in a number of studies that preventative strategies can be more cost effective than remedial strategies (Heinz et al (1995)) for achieving pesticide water quality objectives. A similar result is given in a recent study for Austria (WWF (1997)) which examined the costs of a number of strategies to reduce nitrate in groundwater. Table 7.3 summarises the results.

Table 7.3 Costs of different strategies to reduce nitrate in groundwater

Scenario	Cost	Unit
(1) Co-operation between water and agriculture	130,712	Euro/yr
(2) Dilution with low nitrate water	944,033	Euro/yr
(3) Source substitution (deeper well) - investment	2,251,156	Euro
(4) Nitrate treatment		
Investment	3,630,897	Euro
Operating	254,163	Euro/yr

Source: WWF (1997)

The lower cost of preventative strategies would at first sight suggest lower employment generating potential although the actual outcome will very much depend upon case specific circumstances.

On the basis of WRc experience in analysing the cost implications of preventative versus remedial strategies to achieve water quality targets the following scenario/case study has been developed to explore the respective cost and employment implications. The data have been extracted from a study undertaken by WRc at a catchment scale in the UK. Typically scenarios analysed in addition to a business as usual case are:

- the installation of a water protection zone - based on defining an area within a catchment to achieve a quality goal,
- a total ban on pesticides within a catchment - regardless of whether they give rise to problems in water,
- selective restrictions on the timing and application of pesticides - based on the actual problems encountered,
- investment in water treatment facilities

Typically, it is found that while a total ban on pesticides imposes large costs, the relative costs of selective restrictions on usage, protection zones and remedial (treatment) strategies are more competitive, with the preventative strategies often being lower cost. Table 7.4 summarises results for a UK catchment with the labour cost component explicitly identified.

Table 7.4 Costs of alternative preventative strategies for pesticide control Euro (1995)

	Scenario		
	Ban	**Restricted use**	**WPZ**
Agriculture			
Operating costs			
Regular labour	-150969	-3087	294
Machinery/repairs/fuel	142884	-882	-2058
Subtotal	-8085	-3969	-1764
Capital costs			
Machinery purchases	464520	0	0
Non-agriculture			
Labour costs	369,638	-	-
Other costs	862,488	2,437	237
Total	1,232,126	2,437	237
Monitoring and enforcement			
Staff costs	38,698	66,995	31,715
Other costs	79,583	475,663	76,434
Total	**1,806,842**	**541,126**	**106,622**
Total expenditure on labour	257,367	63,908	32,009
Total other expenditure	1,549,475	477,218	74,613
Total	1,806,842	541,126	106,622

Costs are identified for pesticide users (agricultural and non agricultural) in addition to the costs of monitoring and enforcement. Under the total ban scenario labour costs decline substantially because of changes in cropping patterns and livestock which require less labour. There is however a large compensating increase in expenditure because of the adoption of mechanical methods for weed control.

For non-agricultural users substantial costs are incurred through the adoption of alternative practices. Additional costs can be particularly high for maintaining road and railway verges and for some amenity uses (e.g. golf courses). Other costs are incurred by utilities (gas, water and telecoms). In general much of this additional work would be subcontracted but on balance it would be expected that labour costs would be a substantial component of the extra costs. In this example, the compensation to employees is set at 40%. Monitoring and enforcement costs also need to be evaluated. Typically this will involve field inspection, soil analysis and monitoring of water.

Costs under the restricted use and water protection zone strategies tend to be much lower because the need to invest in costly alternative weed control machinery for farms and labour intensive alternatives for non agricultural users is avoided. Monitoring costs under the restricted use scenario however, increase substantially because of the need to undertake widespread soil analysis.

On the basis of these costs, assuming an average labour cost of 30,000 Euro and that 1/3 of non staff costs are received as compensation to labour in the sectors receiving the expenditure, it is possible to estimate the additional labour requirements of the different strategies.

The pesticide ban, being associated with the largest increase in expenditure also generates the largest level of linked employment - 26 FTE/yr. Restricted pesticide usage by comparison is estimated to be linked to employment of approximately 7 FTE/yr. As with the total ban the majority of employment is indirect (as a result of non-labour expenditures being received in other sectors). The water protection zone is associated with the lowest level of additional employment 2 FTE/yr. The cost per FTE/yr varies between 70,000 Euro for the total ban to 60,000 Euro per FTE/yr for the water protection zone.

These costs and labour requirements of preventative measures can be contrasted to the costs and employment linked to additional investments in treatment capacity. In the above example this would involve additional capital expenditure for the water companies of some 1.5 M Euro and additional operating costs of 200,000 Euro per annum (assuming the installation of granular activated carbon). Using the engineering analysis developed in Annex 2 of the report, the operational employment directly and indirectly linked to these expenditures would be approximately 2 FTE/yr. The additional capital expenditure would generate approximately 15 FTE man-years which translates to less than 1 FTE man year over the 20 or so years of productive life of the assets. By comparison to the expenditure per FTE/yr under the preventative measures, the costs of the additional FTE/yr is higher for the remedial strategy ranging from 100,000 per FTE/yr for the employment related to operating expenditures to 110,000 per FTE/yr for the employment related to capital expenditure.

On balance this scenario illustrates the fact that in addition to being lower cost, remedial strategies can have a higher employment impact (per unit of expenditure) than remedial strategies. Very high labour demands can be created by the most restrictive strategies as

agricultural and non-agricultural users are forced to adopt more costly (and in the case of non agricultural, use labour intensive) alternative strategies.

In terms of other Directives this issue is of most relevance to those directives where a large proportion of the estimated expenditure is yet to be undertaken (SLFD, NECD, DVOC and ADWD see Table 5.1) but will also depend upon the extent to which preventative strategies are available. This in turn is likely to be greatest in those directives that do not employ technology standards and which involve flexibility in meeting environmental targets (see Section 5.4).

7.5 Summary

This section has attempted to explore some cross cutting issues related to the uncertainty associated with the estimation of cost and employment effects undertaken in this study.

A particular difficulty is introduced by different ways in which cost data is presented in studies for the costs of particular directives. There are a number of alternative presentational forms and for some it is difficult to achieve a disaggregation into expenditure types which have differential impacts on employment. Engineering assumptions are therefore required which introduce a further degree of uncertainty. This is particularly true where only investment costs are known as the use of engineering analysis impacts both upon costs and the resulting employment.

For a number of in-the-pipeline directives there is uncertainty with regard to the choice of compliance strategies. Two issues have been examined in this regard: the impact of the choice of labour intensive versus labour extensive strategies and the impact of the choice of preventative versus remedial strategies. Labour extensive strategies are demonstrated to have a significant impact on the resulting employment – which in the case of the DELV can vary by a factor of five between labour intensive and labour extensive approaches.

The choice of preventative strategies also has an important impact. A number of studies have demonstrated the potential cost savings of preventative strategies, the scenario examined here, suggests preventative measures may also have a higher relative employment impact.

7.6 References

Heinz et al (1995) economic efficiency calculations in conjunction with the Drinking Water Directive. Part 3: the parameter for pesticides and related products. Report prepared for the European Commission.

Whitson (1995) Employment considerations and consequences pertinent to automobile disposal and recycling. An EU perspective, SPRU.

WWF (1997) Kosten der grundwasser-verschmutzung. Studies 30 Wein August 1997