Employment Effects of Waste Management Policies

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prepared for

European Commission, Directorate-General Environment

by

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Executive Summary

1. Background

The drive to create a more sustainable Europe has required governments, business and individuals alike to examine the environmental and social impacts of current and proposed activities and to balance these impacts against goals such as economic growth, low inflation and full employment. The potential economic consequences of socially and environmentally driven regulations should also be examined, including the changes in costs faced by business and consumers, the wider economic effects and any shifts in employment patterns.

Within the field of waste management, there has been considerable debate on the employment effects that may occur from shifts in policy. It has been argued that recycling and other waste management activities create employment, and in particular may provide initial routes into employment for the socially excluded or the low skilled. At the same time, the increased cost of waste management may lead to the loss of (potentially higher quality) jobs in other sectors of the economy. This study has been commissioned in response to the debate, to examine how the employment effects of waste management policies can better be taken into account. Its key objectives are:

- to critically evaluate and complete existing information on employment activities related to waste management policies;
- to look at the issue of opportunity costs in terms of reduced job levels in other economic sectors; and
- to identify ways in which employment effects can usefully be integrated into evaluating policy instruments in the field of waste management.

To assist in meeting these objectives, the study included three case studies. These examined the impacts of changes in waste management policy on the chemicals industry, the impacts of introducing the directive on waste electrical and electronic equipment and the impacts of Regulation (EEC)259/93 on the secondary metals industry.

2. Approaches for Assessing Employment and Wider Effects

To understand how employment effects can be better taken into account when evaluating policies, it is necessary to recognise the different levels at which impacts may arise. Policies that influence waste management practices can have both positive and negative direct effects. Expenditure on waste management generates direct employment in carrying out waste management activities. This employment may arise either in specialised waste management firms or in companies in other sectors. Such expenditure may also have direct negative effects for waste generators. For individual companies, higher waste management costs could potentially increase prices, reduce market share, lower output and potentially reduce employment. The negative effect for an individual firm, though, may be offset by gains in market share for other companies.

Indirect effects result from changes in direct employment and can also be either positive or negative. If direct employment increases, then there is a 'multiplier' effect because those people directly employed spend their salaries on goods and services. This can create additional employment in the sectors supplying those goods and services (or reduce employment if direct employment decreases). However, if increased expenditure on waste management means that there is less expenditure in other sectors, then jobs in those sectors may be lost. This is known as a 'crowding-out' effect.

The interaction between the direct and indirect effects changes the structure and composition of the overall demand for labour in the economy. This is termed the net macroeconomic effect and needs to be understood in order to evaluate the impact of waste management policies on total employment. Whether there is a net increase or reduction in aggregate employment depends upon two key factors. Firstly, whether waste management activities are more labour intensive than other activities, so that expenditure on waste management results in more jobs than equivalent expenditure elsewhere. Secondly, whether waste management expenditure feeds through into higher product prices and lower real wages, which may affect labour supply.

The current basis for policy appraisal is cost-benefit analysis (CBA) which usually focuses on the sectors that will be directly impacted by a policy. As a result, the analysis may fail to capture significant indirect effects on other sectors of the economy. In addition, the theory underlying CBA assumes that no social costs arise from unemployment. For these reasons, there may be a need to supplement any CBA with information on either employment effects or wider macroeconomic effects. Potential approaches include:

- supply side approaches: using data on the supply of labour, for example the number of tonnes of waste per job for a particular type of treatment, to determine direct employment effects ;
- demand side approaches: using data on jobs per unit of expenditure, to estimate direct and first order indirect employment effects, but not overall net effects; and
- macroeconomic modelling approaches: modelling the interactions between direct and indirect employment effects to determine the impact that changes in a sector's supply and demand for goods and services will have on employment and the wider economy.

Each type of approach has advantages and disadvantages. These include the scope of the indirect impacts taken into account, the accuracy of results and the complexity of model specification. It should be noted though that the supply and demand side approaches only cover employment effects that are directly (or indirectly via multipliers) linked to the measure under consideration. They cannot be used to answer questions as to what the effect of a particular measure is on the overall (macroeconomic) level of employment. This question can only be answered using macroeconomic modelling approaches, even though the results of such models are subject to significant uncertainty. These issues are explored through an examination of supply-side data on waste management-related employment and then through the case studies.

3. Waste Management-Related Employment Activities

Statistical data collected at the European level provides poor quality information on waste management-related employment because:

- the classifications used exclude a wide range of waste related activities; and
- few countries submit regular, up-to-date information.

Specialised studies, whether they are country-, waste stream-, or activity-specific, can be used to provide more information. However, differences in approaches and definitions can lead to wide-ranges and incompatibility in the data generated.

Taking account of the range of data available from both these sources, **the probable level of employment in the EU in organisations for which waste management is a primary activity totals around 200,000 to 400,000. This represents approximately 0.2-0.4% of total EU employment**. There is also waste-related employment in other sectors, though numbers of jobs are small compared to the specialised waste management sector (possibly another 3000 to 12000 jobs). Discussions with industry indicate that there is a tendency for increased out-sourcing of waste management to specialist companies.

Information on the nature of waste management employment is limited and appears somewhat contradictory. Some studies indicate that jobs are of a higher quality in waste management than in some other environment-sector activities. Other data indicate that waste management jobs are mainly low-skilled and low-paid. The poorest quality jobs appear to be in collection and transport, manual sorting and composting. Higher-quality jobs are associated with the more technology-intensive, specialised activities.

Data on trends in employment in waste management are ambiguous. Industry experts indicate that there is a general trend towards fewer, but higher quality, jobs arising from productivity increases as processing technologies improve. The trend for lower employment per tonne of waste may, however, be compensated by a growth in absolute waste quantities and potentially by increasing levels of control over waste disposal.

4. The Chemicals Sector

There are approximately 36,000 chemical companies within the EU, employing a total of around 1.7 million people. The industry is expanding, with a 25% increase in production in real terms between 1990 and 1998, but employment has reduced by 14% over the same period due to efficiency improvements and outsourcing. During the 1990s, a number of waste management policies were adopted at EU level with potential impacts on the chemicals industry. Over this period, waste-related investment accounted for between 1% and 5.4% of total chemical industry investment, and remained fairly constant whilst other investment reduced. Waste-related operating costs range from 0.2-1.7% of net sales; a level that is unlikely to have had a significant impact on profits.

There are an estimated 5,700 to 11,300 waste-related jobs within the European chemical industry. There is little evidence that waste management measures have increased the numbers of such jobs; the trend-towards out-sourcing may even have reduced them. Any such reduction may have been compensated, though, by increased investment and employment in the waste management sector. Only limited information is available on investment by the waste management sector in relation to chemical industry waste, but up to 5,000 jobs may have been created in hazardous waste management.

Macroeconomic modelling using the Cambridge Econometrics E3ME model indicates a fall in total employment of 18,000 jobs across the EU over the period from 2000 to 2005 arising from the impact of waste management costs on prices and the EU share of world markets. This estimate, less than 0.01% of the EU total, excludes any jobs created in hazardous waste management and is also subject to uncertainties in the data.

5. Waste Electrical and Electronic Equipment

Whilst EU Directives on Waste Electrical and Electronic Equipment (WEEE) are still at the proposal stage, broadly similar legislation concerning WEEE has already been implemented in the Netherlands. The Netherlands legislation allows manufacturers and importers to fulfil their responsibility for collection and re-processing of WEEE either individually or collectively; almost all have signed up to one of two collective schemes.

The available data on the Netherlands indicates that WEEE-related operating costs account for well below 0.5% of turnover for electrical and electronics companies. As the costs of the scheme are re-charged to consumers in the form of a levy on prices of new products, they are therefore unlikely to have a significant impact on profitability. Investment costs for the electrical and electronics industry are minimal. Because of the way the collective schemes are organised, the majority of the investment has been made by the transport and recycling firms contracted by the schemes

Data on the employment effects of the WEEE legislation are limited; in the Netherlands, the consensus is that few, if any, jobs have been created other than a small number in local authorities. Additional employment in administration of the collective schemes has been kept to a minimum to reduce costs. Meanwhile, the organisation of the collective schemes has resulted in significant consolidation in the recycling sector with the displacement of small organisations, including social welfare organisations. The loss of jobs in these small organisations has probably been offset by increases in employment in the larger firms to deal with additional throughput of WEEE.

The E3ME model was used to model the macroeconomic implications of adopting WEEE legislation across the EU, based on the type of approach taken in the Netherlands. The policy is predicted to increase direct employment across the EU by roughly 2,900 jobs after five years. A further 2,000 plus indirect jobs are predicted to result from multiplier effects. There would also be net increases in GDP across Europe as a whole. Again, these figures should be viewed with some degree of caution due to data uncertainties and model assumptions.

6. Secondary Metals Industry

The non-ferrous secondary metals recycling industry employs a workforce of approximately 100,000 people in 15,000 enterprises. Statistics show that 40% of non-ferrous metal produced in the EU is currently based on recycled materials, and this proportion is increasing. Council Regulation (EEC)259/93 on the supervision and control of shipments of wastes within, into and out of the European Union implements the Basel Convention but has a much broader scope. The level of control imposed on waste depends on the intended treatment, its destination and its position within three lists that distinguish waste according to its degree of hazard (green/amber/red lists). Exports of amber and red listed wastes outside the OECD are banned. Most non-ferrous scrap metals traded internationally are green listed, but some are amber listed.

The Regulation may have both positive and negative impacts on employment in the industry. It has been suggested that many companies have had to hire at least one extra person in order to deal with the extra administration and legal aspects that have arisen from the Regulation, indicating over 6,000 additional jobs. However, the extra burden of administration and delays in trade due to additional notification procedures may have contributed to contract failures restricted trade with some countries.

The E3ME model was used to assess the effects of a theoretical situation, where there is no international trade in amber-listed metals (in reality there is only a ban on trade to non-OECD countries). The model suggests that an initial gain of over 6,000 jobs will change to a loss of nearly 2,000 jobs in total EU employment five years later. The effects on GDP are negative in each of the five years, with the greatest impact on occurring in year two with a predicted decrease in GDP of €390 million (0.006%). Due to the nature of the assumed situation, the data uncertainties and inherent model assumptions, these results should also be viewed with caution. The effects of waste legislation may be masked or seem overstated by market developments which are unrelated to regulation.

7. Integration of Employment and Wider Effects into Appraisals

A simple comparative assessment was made of how well the estimates generated through the E3ME econometric model might compare to those derived through the application of a supply-side and demand-side analysis. Table 1 provides a summary of the predicted job numbers under each of the three approaches.

Table 1: Comparison of Predicted Employment and GDP Effects in EU 15

Case Study	Supply-Side	Demand-Side	Macroeconomic	
	Direct Employment Only	Direct and First Round Indirect Employment	Total Employment	GDP (€ million)
Chemicals Industry	5,700 -11,300	18,774	-18,000	-660
WEEE Directive	1,500 to 2,000	14,150	5,600	145
Metals Recycling Industry	6,250	5,020	-1,700	-368

The differences between the various predictions are considerable. The supply-side and demand-side figures reflect only direct and first order indirect employment creation. They do not consider the negative macroeconomic effects that arise from reduced investment/expenditure on other goods and services. Only by expanding the analysis to the macroeconomic level can the influence of changes in output or price increases, changes in investment and changes in consumer spending be addressed.

This comparison then raises questions as to when the various approaches might be the most appropriate as a means of supplementing the results provided by CBAs. Our conclusion is that for those policies which are likely to have only small impacts on the prices faced in the directly regulated markets, use of the simpler methods for estimating changes in direct and indirect employment should be sufficient. It should be made clear though that these methods are only partial analyses which can only give an idea about effects directly linked to a measure but do not give a full picture of net employment effects on a macroeconomic level. However, where a policy will have significant compliance cost implications for one or more sectors of the economy, then use of the more sophisticated macroeconomic modelling approaches may be important for supplementing CBA results. This latter scenario is one that is likely to arise often in the context of waste management, and understanding the impact of a policy on the linkages between different sectors may be essential to understanding the overall employment and economic effects. This should not hide the fact that due to the high complexity of macroeconomic issues, results of such studies should be viewed with a certain degree of caution.

It must be emphasised that none of these approaches alone will provide decision makers with an indication of whether or not the benefits of a proposed policy would outweigh the costs. To achieve this, the outputs of such analyses would need to be presented as part of a comprehensive CBA.

8. Conclusions

A key finding of the study is that the relationship between waste management policies and employment is more complex than the ongoing debate might indicate. Although waste management policies may increase demand for waste management services, this does not necessarily result in additional jobs. Instead, technology substitution for labour, increased productivity and consolidation in the waste management sector may severely constrain job creation. There is also some evidence that these factors could reduce employment opportunities for the socially-excluded in waste management.

The three case studies indicate that the impact of waste management policies on the competitive position of the sectors they regulate has been limited to date. Waste management accounts for a small proportion of total expenditure and companies subject to regulation naturally act to minimise the costs of compliance. Some companies also seem to have gained efficiency benefits through focusing on waste minimisation.

Overall, the study demonstrates that waste management measures are likely to have only a small effect, either positive or negative, on employment. The detailed way in which a policy is implemented and complied with is most likely to determine the direction and scale of the effect, and this is often the hardest to predict. The most significant effects may arise outside the directly-regulated sector, making the use of approaches that take account of indirect effects particularly important.

Abbreviations

CBA	-	Cost-benefit analysis
CEA	-	Cost-effectiveness analysis
GE	-	General equilibrium model
FTE	-	Full time equivalent
GDP	-	Gross domestic product
I-O	-	Input-output model
MSW	-	Municipal solid waste
NVMP	-	The Association of Metal Producers
PACE	-	Pollution abatement cost estimates
WEEE	-	Waste electrical and electronic equipment

CONTENTS

1. INTRODUCTION

1.1 The Policy Context

The move towards creating a sustainable Europe has required governments, business and individuals alike to consider their impacts on both the environment and society more generally. Not only do the environmental and social impacts of actions need to be taken into account, they also should be balanced against economic goals such as continued economic growth, low inflation and full employment. In recent years, employment in particular has become a priority in the work of European institutions.

Our understanding of the linkages that exist between economic growth and socially and environmentally driven activities has improved over the past few years. There is wider recognition of the potential consequences of environmental regulations, including not only changes to the costs faced by business and consumers but also the wider economic effects, such as shifts in employment patterns.

The key problem for policy-makers is that traditional cost-benefit analysis (CBA) based appraisals may fail to address the full range of likely impacts. This is particularly relevant for employment. CBA typically treats labour as a valuable resource, with the market price of labour acting as an indicator of its value. Therefore, when a policy measure increases the amount of labour used by a firm to perform its activities this is considered as a social cost within a CBA, as the labour used to implement the policy is now no longer available for other productive purposes. In essence, there is an opportunity cost to using labour, and this is captured by the CBA.

This approach makes perfect sense in a situation where labour is relatively mobile and flexible, and where employees are free to move from one job to another at the market wage. However, it is less acceptable where the policy causes changes in the demand for labour that affect categories of workers who would normally be unemployed (as a result of structural unemployment). In such cases, traditional CBA will understate the benefits of a policy that raises the net demand for labour, and some adjustment to the analysis should be considered.

1.2 The Links Between Employment and Waste Management

Along with a range of other organisations, the European Commission has, on various occasions, examined the links between environmental and employment policies to exploit possible cross-benefits. This includes a Communication on Environment and Employment – Building a Sustainable Europe (COM/97/0592). From these documents, a number of hypotheses on the links between employment and waste management have emerged. These include:

- well designed environmental policies can offer opportunities to create positive effects on employment;

- in the field of waste management, employment benefits may be particularly significant due to the high labour-intensity of processes for collection, sorting and recycling of wastes;

- employment in waste management is often unskilled and low paid, with poorer quality jobs in waste replacing higher quality jobs elsewhere;

- such jobs, though, may provide an initial route back into employment for the socially-excluded;

- there are significantly higher risks associated with certain waste-related occupations, such as hand-sorting, and such activities should not be encouraged;

- waste management measures can give rise to a range of costs and related impacts, including impacts on the competitive position of industry, which can in turn affect employment levels;

- advanced technologies and waste minimisation measures may be encouraged through the implementation of high standards for waste treatment, these can have significant business benefits.

1.3 Objectives of the Study

The aim of this study is to provide additional information to the Environment Directorate-General on the employment impacts of waste management policies. The objectives, as set out in the Technical Annex to the terms of reference, are to:

- critically evaluate and complete existing information on employment activities related to waste management;

- look at the issue of opportunity costs in terms of reduced job levels in other economic sectors; and

- identify ways in which employment effects can usefully be integrated into evaluating policy instruments in the field of waste management.

1.4 Approach

The study involved the following analytical steps:

- review of available data on waste management and employment;
- analysis of job types within waste-related employment[1];

[1] Due to the commissioning of a study by DG Enterprise, which placed greater emphasis on the quality of jobs in the environmental sector, this issue is not considered in depth in this report. For further information see AK Wien (2000).

- determination of the opportunity cost impacts of waste management and evaluation of the macroeconomic effects on employment across the EU through the use of case studies.

In this context, opportunity costs refer to the benefits, or gains, that individual companies or industry sectors may have to forego as a result of having to invest in waste management rather than some other aspect of production. At a sectoral level, expenditure on waste management may reduce the level of growth that a sector is able to achieve as the money is diverted from investments that could increase output or reduce costs, for example. At the macroeconomic level, this may result in reduced economic growth across the economy as a whole, or simply result in shifts in relative growth rates between different sectors (for example, increasing growth in the waste management sector compared to manufacturing).

These changes in investment (which act as changes in demand for the goods and services produced by different sectors) may also result in the net creation or loss of employment. This in turn may have an impact on the demand for different goods and services, as levels of employment affect levels of consumption. This pattern may repeat itself for several iterations.

In some cases, such sectoral and macroeconomic effects may be minimal and will be captured by the traditional cost-benefit analyses used in the appraisal of environmental policies. In other cases, a cost-benefit analysis will be insufficient, as it will fail to capture the significant economic impacts occurring in sectors other than those which will be directly affected by the change in policy. Because waste management policies are often cited as examples of the latter case, the failure to account for such wider effects may result in policies being adopted which do not produce net economic benefits.

In order to determine the degree to which opportunity costs might be arising and how the wider economic and employment impacts of waste management policies could best be integrated into policy appraisal, three case-studies were selected for detailed examination. These were:

- **Chemicals industry**: an examination of the cost implications of waste management policies for the chemicals sector;

- **Producer responsibility: waste electrical and electronic equipment**: this policy-based case study assesses the implications for the electrical and electronics industry of producer responsibility, focusing on the Netherlands decree on brown and white goods, implemented in 1999; and

- **Non-ferrous metals recycling industry**: a sector-based case study examining the implications of waste shipment regulations on the non-ferrous metals recycling industry.

The outputs of the desk based case study work was fed into an econometrics-based macroeconomic model, the E3ME model, to evaluate the net employment and wider economic impacts of the policies for the EU economy as a whole. Based on this analysis of the impact of waste management policies in macroeconomic terms, the study then focused on how best to incorporate such predictions into policy appraisals. This involved an analysis of the current approaches for valuing employment (ranging from qualitative to monetary) to determine the relative merits of different approaches as ways of supplementing the cost-benefit analyses that normally form the basis for such appraisals.

1.5 Organisation of the Report

The remainder of this report sets out the key findings of the study:

- Section 2 reviews the approaches available for addressing employment and wider economic issues in policy appraisals;

- Section 3 presents an analysis of available statistics and other data sources on waste management-related employment (referred to in Section 2 as supply-side information);

- Sections 4 to 6 consider the three case studies and the predicted net employment and net economic effects of the waste management policies, using the E3ME model;

- Section 7 draws conclusions on the appropriateness of the different approaches for estimating employment and wider economic effects; and

- Section 8 provides a summary of the conclusions drawn from the study.

The main report is supplemented by additional data and detailed discussion in the Annexes. This includes a more in-depth consideration of the various approaches for assessing employment and wider economic effects (Annex 1) and details of key assumptions underlying the E3ME econometric model (Annex 2). Additional, relevant data on employment in the waste sector is given in Annex 3. Finally, more detailed discussions of the case study findings are presented in Annexes 4 to 6.

2. APPROACHES FOR ASSESSING EMPLOYMENT AND WIDER EFFECTS

2.1 Introduction

One of the key aims of this study is to identify ways in which the net employment and wider macroeconomic effects of waste management policies can be incorporated into policy appraisals. A number of different approaches could be adopted to do this, ranging from the use of current waste-related employment and economic growth statistics to the application of sophisticated predictive modelling techniques. However, the appropriateness of adopting the different approaches varies, depending on the nature of the waste management policies in question.

This section provides an overview of the available approaches, highlighting what they cover and some of the key advantages and drawbacks in the context of waste management. The starting point for this review is an examination of how these issues are treated in cost-benefit analysis (CBA) which acts as the basis for most policy appraisals. A more detailed discussion of the approaches is presented in Annex 1.

2.2 Treatment of Employment and Wider Economic Effects in CBA

2.2.1 CBA and Employment

The theory underlying the application of CBA (and CEA) is that of neo-classical welfare economics[2]. Essentially, this theory assumes that there are no social costs or benefits associated with changes in employment because such changes only represent transfers of activity within a sector, or within the economy more generally.

The result of this assumption is that changes in employment are not taken into account in CBAs. In reality of course, the above assumptions do not hold for many economies. Instead, structural unemployment exists and labour is not fully mobile. As a result, the introduction of a new policy may create new employment opportunities and not simply result in individuals transferring from one job to another. When a net gain in jobs occurs across the economy, real social benefits will arise from a policy's introduction. Such gains are only likely to arise, however, when a policy is likely to affect either the supply of, or demand for, the goods and services produced by one or more sectors.

One approach that could be adopted to account for employment effects is to incorporate estimates of the economic value of changes in employment into the estimated costs or benefits. This would require first estimating the number of jobs that would be created or lost by introducing a policy and then multiplying this by the economic value associated with each job. Theoretically speaking, this economic value is defined in terms of the net income gained from the new job, plus any improvements in quality of life, minus the value of any lost leisure time. Because

2 See also OECD (1992) for a discussion on the theory and practical application of CBA.

deriving estimates for each of these factors may be difficult, wage rates are often used as a proxy for this value. In order to correctly reflect economic value, the wage rate used for this purpose should reflect the opportunity costs of labour. In economies where social policy subsidises certain types of labour, market wage rates may not equate to the opportunity costs of labour[3]. However, within the EU there is considerable mobility of labour and relatively low levels of structural unemployment, so the market wage rate is likely to act as a reasonable approximation of the opportunity cost of labour (i.e. it will reflect the value of output foregone if the labour was engaged in other productive activities).

Thus, wage rates can provide a measure of the economic value of the changes in employment arising from the changes in waste management policy. However, it must be recognised that direct changes in labour costs should be captured by a CBA in any event. Changes in labour costs will form one aspect of estimated changes in costs to producers of complying with a new policy. In other words, they will be included in estimates of any investment in capital equipment required and in changes in operating costs arising from use of the new equipment. As a result, adding a further sum to estimated compliance costs to reflect changes in employment will result in double counting for any direct employment changes and for some indirect changes. This problem will be compounded if separate estimates are also prepared on the wider economic effects (indirect and induced) stemming from changes in demand and supply relationships (see Section 2.2.2).

The alternative is to measure and present data on changes in employment in terms of the number of jobs created or lost. Such changes, whether positive or negative, can be estimated using a number of different approaches. For the purposes of this study, these have been grouped into three categories (based on OECD, 1997):

- **Supply-side approaches**: these rely on the use of current employment data, for example, tonnage of waste treated per full-time job equivalent, to estimate the number of jobs to be created by a change in policy;

- **Demand-side approaches**: these predict the number of jobs that will be created (or lost) as a result of new investment or an increase (or decrease) in demand for the goods and services provided by a particular sector (e.g. the waste management sector); and

- **Macroeconomic approaches**: these estimate the net changes in employment that will occur as a result of changes in both demand and supply relationships.

Table 2.1, overleaf, gives an overview of the approaches in each category. Each of the above approaches can be used to develop estimates of the number of jobs that may be directly created or lost as a result of a change in waste management policies. An example of such direct effects would be the creation of jobs in the recycling sector and the loss of jobs in landfill and other forms of disposal as a result of a policy setting increased recycling targets.

3 For example, this may be the case in a developing country context.

Table 2.1: Approaches to Assessing Employment and Wider Economic Effects

Approach	Scope of Analysis	Methodology	Data Sources
Expanded CBA	Wider effects but variable, depending on the positive identification of linkages	Analysis of microeconomic data; partial equilibrium analysis	Survey data and statistics
Supply-side Approaches	Direct positive or negative employment effects	Analysis of microeconomic data and job losses surveys	Survey data
Demand-side Approaches	Direct positive employment effects	Calculation of manpower per unit of expenditure	Statistics on jobs per unit of expenditure
	Direct and indirect positive employment effects	Input-output and multiplier based calculations using changes in final demand	Statistics on environmental expenditures and input-output tables
	Direct and indirect positive or negative economic growth effects	Analysis of microeconomic data, investment and growth surveys	Survey data
Econometric and Macroeconomi c models	Net employment and GDP effects of environmental expenditures	Behaviour equations used to link changes in expenditure to changes in inter-sectoral supply and demand	Econometric models and input-output equations
Computable general equilibrium models	Net employment and GDP effects of environmental measures	Modelling of long-run changes in supply and demand equations until all markets reach equilibrium	Detailed data on inter-sectoral linkages, including input-output data

Source: Based on OECD, 1997 (pg 22).

However, the impact of creating or losing a net number of jobs may go beyond the direct gains or losses. As a previously unemployed person takes a new job, his expenditure on a range of goods and services increases, with this in turn leading to an increase in demand for those goods and services. This increase in demand may, in some cases, be significant enough to lead to the creation of other new jobs, which in turn will lead to further increases in expenditure and, hence, which may lead to a further round of job creation. The first round of jobs created through increased demand are referred to as indirect employment, while the subsequent rounds are induced employment.

2.2.2 CBA and Wider Economic Effects

In addition to generating direct, indirect and induced employment effects, waste management policies can also result in indirect and induced economic effects across the economy as a whole. When a waste management policy has significant impacts on the costs of producing a particular good by one sector, then this may affect the demand for substitute and complementary goods and services produced by other sectors. When the change in demand for the substitute or complementary goods and services is accompanied by a price change, then this may lead to indirect effects on producers and consumers of the substitute or complementary good. These indirect effects may then have an impact on the behaviour of producers and consumers, leading to further changes in demand and potentially a further round of induced effects. Such effects may be either positive or negative.

Because most CBAs focus on the sectors that are directly affected by the introduction of a new policy, they will not capture any impacts arising from shifts in demand and hence changes in the prices faced in other sectors[4]. In many cases, this failure to consider the impacts of a measure on related markets will not be significant, as the impacts themselves will be small in magnitude compared to the costs incurred by the directly affected sector. However, in other cases, it may result in a significant miscalculation of the net economic effects of introducing a new policy. In particular, the more difficult it is to substitute the regulated good or service with another good or service, the greater may be the costs arising to producers and consumers in the related markets, and in secondary markets.

These indirect and induced effects may be either negative or positive in nature, depending on the supply and demand relationships that are affected by the new policy. As a result, a policy leading to significant direct compliance costs for one sector may generate net gains for the economy, as a whole as a result of changes in spending and hence the demand for different goods and services. Equally, it may create net losses to the economy, for example, as a result of investment being diverted from measures that would increase output or productivity.

The picture is therefore complex within the context of waste management. In many cases, the traditional CBA approach of focusing on the directly affected sectors will be sufficient to capture the economic effects arising from the introduction of a new policy. However, the more sophisticated demand-side or macroeconomic approaches may be needed in other cases to gain a fuller understanding of the net economic effects to other sectors and the economy as a whole.

For this reason, the relative advantages and disadvantages of the approaches described in Table 2.1 are examined in more detail below.

2.3 Extension of the Partial Equilibrium Framework of CBA

One approach to dealing with the failure of CBA to account for wider economic effects is to extend the boundaries of the analysis so that it covers all of the related markets likely to be affected by the policy. Each of these markets would then be examined individually to determine any changes in costs to producers and consumers stemming from changes in the directly affected sector. Any estimated changes can then be added to those calculated for the directly affected sector.

The advantage of this approach is that it ensures that any estimates of direct and indirect effects are soundly based in economic theory and are consistent with those generated for the directly affected sector. It may also help retain a focus to the

4 Also referred to as related markets - see Annex 1 for a more detailed discussion on why such indirect and induced effects occur.

appraisal, enabling any estimated indirect effects to be accounted for within the CBA itself.

The disadvantage is that it may be difficult to properly scope the range of markets that may be affected by a change in policy. In addition, this type of approach will not be able to capture the impacts which any net changes in employment may give rise, either in terms of indirect and induced employment effects or the changes in spending and, hence, demand to which any net change in employment may lead.

2.4 Supply-Side Approaches

Approaches falling under this heading use data on the number of people currently employed in various waste management activities (i.e. the supply of labour) to generate estimates of the number of jobs that might be created or lost from shifts in activities. The types of data presented in Section 3 are essentially supply-side data. For example, the data include figures for the volume of waste treated per employee for different activities, which would allow the impacts on total waste related employment of a change in policy to be predicted.

Many issues arise though in the adoption of this type of approach, including:

- the a lack of reliable data on the level of employment generated per unit of waste for many of the activities (discussed in Section 3);

- difficulties in capturing indirect employment effects and a failure to capture induced effects; and

- new policies may be implemented in a different manner than previous policies, meaning that data for existing levels of employment are invalid (as in the WEEE case study presented in Section 5).

The use of supply-side data may, however, be useful in providing order-of-magnitude estimates of the direct employment effects arising from a change in waste management policy, where the use of more sophisticated methods is constrained.

2.5 Demand-Side Approaches

2.5.1 Overview

Three different types of demand-side approach can be identified from the literature:

- input-output models for predicting total net direct and indirect output and employment effects;

- multipliers for predicting the number of direct, indirect and induced jobs created as a result of new expenditure. Related to these are manpower to expenditure ratios for estimating the number of direct and indirect jobs created; and

- econometric analyses for estimating the impacts that expenditure on compliance costs has had on sector and economic productivity and employment.

2.5.2 Input-Output Models

Input-output (I-O) models provide a systematic description of the interdependencies that exist between sectors in the economy. These models indicate, for any one sector, how much input from other sectors (and in what proportions) is required to produce a unit of output. For example, the production of chemicals requires a range of inputs such as energy, raw materials, engineering equipment, as well as waste disposal, transport and other services. In turn, the production of energy, raw materials, engineering equipment, etc. will require a number of inputs, including chemicals.

Because I-O models map these interrelationships, they can be used to examine how changes in the total output of one sector (or in household consumption or government expenditure) is likely to impact on the demand for inputs from other sectors. In addition, the basic set of input and output tables that provide the core to such models can be expanded to include both labour and the production of waste by-products, to enable the impacts of policies on these two aspects to be examined.

I-O models can be used to compare two distinct states of the economy; pre- and post-policy implementation. The difference between the two 'states' represents the net economic effect (expressed in terms of a change in output) of implementing the waste management policy in question. These estimated net economic effects could then be added to estimates of the compliance costs falling on the regulated sectors for inclusion in a CBA-based analysis. This would allow the wider economic effects to be taken into account in comparing the total (net) costs and benefits of a proposed waste management policy.

The use of I-O models may be important to understanding the full economic implications of a policy when it is likely to affect not only supply and demand in the directly affected sectors but also in related markets, as they can provide information on impacts at both the sectoral and macroeconomic level (Fankhauser & McCoy, 1995). However, their application for the purposes of inclusion in a CBA should be undertaken with care, as they ignore any changes in demand that may occur as a result of price effects (including changes in relative prices), and may not be flexible enough to take into account changes in production relationships (for example as a result of technology changes). The result is that they may miscalculate the net employment and economic effects stemming from a policy change.

2.5.3 Multiplier-Based Approaches

Multipliers essentially provide a measure of the extent to which a change in direct output or direct employment will result in additional changes in output or employment, through further rounds of spending (i.e. indirect and induced effects). For example, it has been estimated that every €1 increase demand results in a total increase in output of €1.1 in France (OECD, 1997). The output multiplier in this case is 1.1.

Multipliers are often derived through the manipulation of input-output tables, with the aim of providing an alternative means of capturing the (positive) direct, indirect and induced effects of changes in final demand for particular goods and services (Abelson, 1996). In practice, they can be defined at different levels. For example, they can be developed so as to capture only direct and indirect effects. Or, they can be developed to also include induced effects, thereby providing a more comprehensive picture of net economic or employment effects. Within the context of waste management, multipliers that capture induced effects are likely to yield better estimates of net economic effects or changes in employment. This is because they will take into account changes arising from activities such as the sub-contracting or contracting-out of services; key characteristics of the waste management sector.

Although multipliers can be used to provide 'order of magnitude' estimates of the growth in output or income resulting from the expenditures required to comply with a change in new policy, their use warrants some care. Multipliers assume that all additional spending is new spending (rather than transfers from one set of goods and services to another) and, therefore, acts as a net addition to real output. Where expenditure is not new but a transfer, then multipliers will overestimate effects on both output and employment.

Furthermore, multipliers will change in value as a result of shifts in technology. For example, a waste management policy encouraging end-of-life recovery might result in changes to products so that they require fewer inputs during production and less processing prior to re-use. In this case, the application of old-technology based multipliers will lead to incorrect estimates of total output and employment effects.

2.5.4 Manpower to Expenditure Ratios

Related to the use of input-output based multipliers is the use of manpower to expenditure ratios (which are effectively the same but more crudely derived). These ratios provide an indication of the number of direct and indirect jobs created as a result of the new expenditure (capital and operating) required by a policy.

The argument underlying the use of this approach is that it provides a good reflection of the more tangible employment impacts arising from a policy, and does not confuse these effects with several rounds of downstream effects. As a result, these ratios result in a better indication of the actual relationships between different environmental policies and employment and avoid reliance on assumptions concerning market equilibrium and full employment common to the macroeconomic modelling approaches. Such ratios are developed in two recent studies undertaken for the Commission on the numbers of jobs created by changes in environmental policy (WRc, 1999 and Heady *et al,* 2000).

However, manpower to expenditure ratios suffer from the same disadvantages as input-output based multipliers. They fail to capture induced demand effects and ignore any price-related adjustments that may occur more as a result of changes in demand and supply relationships. In addition, they assume that expenditure leads to new jobs, rather than transfers in activity. As a result, they may result in either significant over- or under-estimates of employment effects.

2.5.5 Change in Productivity Estimates

The final form of demand side analysis is the use of econometric analysis to examine the impacts that environmental regulations have had on both sectoral and economy-wide productivity. A number of studies has been undertaken in the US on this issue, with the aim of determining whether environmental regulations essential 'crowd out' investment on more growth generating activity, thereby reducing the productivity of those affected. The research has had two different purposes. The first is to determine the degree to which compliance costs estimates capture the full costs incurred by companies in meeting environmental requirements. The second is to provide estimates of the sum of the direct and indirect costs to the economy as whole arising from the need to divert expenditure towards meeting environmental requirements.

Although most of the research carried out on this issue has found that the effects have been minimal[5], such analyses again focus only on the impacts of direct changes in demand. They do not take into account the full interrelationships that exist within an economy. As a result, they do not recognise that increased investment in environmental goods and services may offset some of the estimated decreases in productivity experienced by the regulated sectors.

2.6 Macroeconomic Modelling Approaches

2.6.1 Overview

Only the macroeconomic modelling approaches recognise that the implementation of waste policies by individual companies affects their behaviour as both 'buyers' and 'sellers', in turn affecting interactions at inter- and intra-sectoral levels. As a result, they are the only approaches that are able to predict the full net effects generated by a change in waste policy.

Two different types of models can be used for analysing effects at the macroeconomic level. These are:

- econometric models; and
- general equilibrium (GE) models.

2.6.2 Econometric Models

Econometric models may be either macroeconomic or sectoral in coverage and are essentially applicable to analysing short to medium term policy impacts. They are all highly complex, involving numerous equations and time lags to allow for a dynamic analysis. Examples of such models include HERMES and the E3ME model used in this study.

5 See for example OECD (1997) and Worldwatch Institute (2000).

The models are generally based upon an input-output based accounting framework to which behavioural data are added (OECD, 1997). As with input-output models, changes in final demand are taken as the starting point but are then linked to production or input demand functions that incorporate capital, energy, labour and intermediate goods. Through these functions and the associated impacts on demand, prices and real wages, new supply and demand relationships (equilibria) are reached for the various sectors. Once these new relationships have been calculated, changes in output and employment can be determined at a sectoral and macroeconomic level.

One of the key advantages of this type of model is that they are developed to reflect actual behaviour, drawing upon historic data for these purposes. In addition, although they start from a demand perspective, they do take into account the likely effects that changes in demand will have on prices and on the substitution of one input of production for others (e.g. labour for energy). There are, however, drawbacks to their use when compared to general equilibrium models, including:

- the short forecasting time-frame over which they are considered appropriate (generally between five and seven years in order to ensure that the underlying assumptions reflect changes in the structure of the economy);

- their reliance on measures such as changes in gross domestic product (GDP) as a proxy for economic costs;

- the use of fixed production relationships that may not take into account recent technical innovations and associated changes in market structure; and

- because they are governed mainly by demand rather than supply considerations, they may be unable to reflect the full extent of impacts on unemployment.

2.6.3 General Equilibrium Models

In contrast to the econometric models (which are driven by changes in aggregate demand), GE models are driven by changes in price. They consider both supply and demand interactions and are capable of dealing with longer planning horizons. As a result, analysts can examine long-term movements in economic variables (i.e. GDP and employment) as an economy moves towards a new equilibrium. In addition, they are more compatible with CBA, as welfare is explicitly accounted for by assuming that individuals maximise their utility (or satisfaction) for a given level of income.

The models are based on the concept underlying I-O models, but the system is completed by including all relationships needed to represent the related flows within the economy. Within these models, production in each sector is a function of input prices and the output price, while consumption becomes a function of income and prices, with prices determined by the model. Computable GE models can be used to compare two distinct states of the economy; pre-policy versus post-policy, with the difference between the two 'states' representing the net (economic) effects of implementing the policy in question.

The inherent complexity of CGE models means that the amount of time and effort required to collect the basic data, and build a suitable model, is often prohibitive. As a result, no model can actually include all possible markets, with many markets often aggregated together and other simplifications made to create a useable and practical model. As a result, models are generally tailored to particular needs and functional forms are chosen with an eye to reducing the number of elasticity-related parameters that must be estimated. This usually means that most CGE models have an I-O model core that defines production relationships in terms of intermediate inputs, and the only flexibility in production is usually some substitution between capital and labour as inputs.

In addition, most CGE models start from the assumption that there is no unemployment, i.e. the labour market is in equilibrium. Consequently, any change in employment is a result of voluntary decisions on the part of the workforce. This aspect of CGE models causes studies to reach different conclusions regarding the impact on employment of implementing environmental policies, and subsequently leads the OECD (1997) to advise that the results of studies using such models should be considered with reservations.

2.7 Non-Monetary Assessment Approaches

In contrast to the use of quantitative, economics-based approaches for examining the impacts of waste management policies on employment and the economy more generally, it is often suggested that more qualitative approaches are applied. For example, a qualitative assessment could describe impacts in terms of:

- number of long-term full-time job equivalents;
- number of jobs by occupational skill category;
- change in employment relative to regional or national average rates;
- the quality of the job created (e.g. taking into account associated health risks); and
- the average wage rates associated with the jobs created.

Such assessments could be based on the recommendations that exist in a range of appraisal guidelines concerning the assessment of equity and distributional issues[6] (see for example Ontario Ministry of Environment & Energy, 1996 and US EPA, 1999). Alternatively, an approach based on the use of simple '+' and ' -' scores could be adopted to provide an indication of the direction and significance of likely effects. A further approach has been suggested by the Worldwatch Institute (2000) based on consideration of the life-cycle effects of a proposed policy (see Annex 1 for an example), although such approaches may need to be expanded to ensure that they reflect indirect and induced economic and employment effects.

6 Where equity relates to ‘fairness’ and distribution to the share of costs or benefits to sub-populations within society arising from the introduction of a policy.

3. WASTE MANAGEMENT-RELATED EMPLOYMENT ACTIVITIES

3.1 Introduction

3.1.1 Waste Management and the Environment Sector in Europe

A range of studies has been carried out on the environment industry and the waste management sector in Europe, attempting to define the scope and size of the industry, levels of employment, prospects for growth and the impact of environmental policies. A range of statistical data is also gathered at European and national level. The key findings of these sources are outlined in Annex 3.

A considerable degree of uncertainty exists over the current size of the EU environment industry, owing to limited data availability, variations in definitions of the sector and possible differences in the bases used by different Member States for recording environmental expenditure. An estimate of €110 billion for turnover in the EU environment industry was derived by ECOTEC (1997) from three estimates, which ranged from €105.9 – €133 billion.

Within the environment industry, the turnover of waste management activities is estimated at approximately €44 billion, with operating expenditure accounting for 80% of this (€35.2 billion) and capital expenditure 20% or €8.8 billion (ECOTEC 1999). The waste management industry encompasses many different organisations, ranging from specialist multi-national companies to small-scale social enterprises, with significant public sector (mainly local government) involvement. The sector is in a state of flux, with consolidation in some areas (e.g. municipal waste collection in the UK) but a large number of small companies remaining.

3.1.2 Quality of Data on Waste-Related Employment

Drawing conclusions on the level and quality of employment related to waste management is hampered by the poor quality of the statistical data available. Particular problems arise from the classifications used, which tend to cover businesses where waste management is a primary activity but exclude companies where waste management is a subsidiary activity and, potentially, some waste management activities in the public sector (see Annex 3 for a fuller explanation and list of waste management activities). Specialised studies, whether they are country-, waste stream- or activity-specific, can be used to provide more information. However, differences in approaches and definitions can lead to wide-ranging and incompatible data.

Sections 3.2 and 3.3 examine the level and nature of employment in the waste management sector respectively, while 3.4 looks at the overall balance of employment effects due to waste legislation.

3.2 Levels of Employment

3.2.1 Overall Employment

Table 3.1 summarises the available statistics on employment in the environment industry and the waste management sector. There is reasonable consistency between OECD (1997) and ECOTEC (1997) on the overall level of employment in the environment industry in Europe, totalling somewhere between one and three million. This amounts to between 0.4% and 1.2% of overall employment.

Because of the definitional and statistical difficulties noted above, it is likely that official statistics under-estimate the level of employment in waste management by a considerable margin. All of the studies of waste management employment summarised in Annex 3 give higher numbers than Eurostat's figures for employment in the three main NACE[6] categories, with the multiple ranging from 1.2 (for Sweden) to seven for the UK. The Association of Cities for Recycling (1999) derives a figure for total employment in waste management of 3 – 3.5 million, which is significantly higher than estimates from other sources and is at the upper boundary of ECOTEC's estimate of total environment industry employment.

Taking account of the range of data within the statistics and studies on waste management, **the probable level of employment in organisations for which waste management is a primary activity totals around 200,000 to 400,000**. This represents 20-40% of total employment in the environment sector and, therefore, approximately 0.1-0.4% of total employment. In addition to companies where waste management is a primary activity, there is also waste related employment in non-specialised companies in other sectors. Indications are, though, that this employment is small compared to the specialised waste management businesses (maybe another 3,000 to 12,000 jobs). Data on waste management expenditure by industry, together with industry expertise, indicates that there is a tendency for companies to outsource waste management to specialist companies, reducing the need for in-house employment. Under these circumstances, employment related to waste management in industry should, in theory, be included in the main NACE categories.

3.2.2 Employment in Recycling

A number of the studies reviewed in Annex 3 provide information on the employment content of specific waste management activities. Three sources give data on levels of employment in recycling. The Association of Cities for Recycling (1999) gives a figure of 300,000, equivalent to 10-11% of total waste management employment. Statistics Sweden (1999) and Profeta (1996) indicate that 21% and 20% of waste management jobs are in recycling for Sweden and France respectively.

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[6] NACE is a system of statistical classification, used for assessing economic activity and competitiveness. The three main NACE categories which cover data relating to waste management are 37 (recycling), 51.57 (wholesale of waste or scrap) and 90 (sewage and refuse disposal, sanitation and similar activities). For further explanation see Annex 3.

Table 3.1: Overview of Statistical Employment Data

	Europe	AU 1993	BE	DK 1990	FI 1990	FR 1992	DE 1994	GE	IR	IT 1990	LU	NL 1997	PO 1997	SW 1998	UK 1992
Employment in the Environment Industry	1.7 million - 3.5 million [1]	20,000[2]		22,900[2]	15,000[2]	249,000[2]	421,600[2]			9,600[2]		92,000[3]	3,600[4]	95,000[5]	141,700[2]
% of Total Employment		0.57[2]		0.86[2]	0.6[2]	1.12[2]	1.2[2]			0.5[2]		1.3[3]		2.5[5]	0.55[2]
Employment in Core Industries[6]		9,000[2]		3,700[2]	-	139,000[2]	165,600[2]			-		24,000[3]	3,000[4]	9,228[5]	103,200[2]
Employment in Main NACE Classes[7]	79028 (1996)	11,990 (1995)	4,841 (1997)	5,388 (1995)	1,062 (1997)	21,901 (1997)	22,761 (1997)		145 (1997)	10,947 (1996)	256 (1996)	5,048 (1995)	3,909 (1997)	13,410 (1995)	9,318 (1997)
Employees in Waste Management	3-3.5 million [8]		12,770[8] (1996)	35,033[9]		102,000[10]	45,000[10] (1990)					39,000[3]	2,600[4]	17,321[5]	65,000[11] (1996)
Employees in Recycling	300,000 [8] (1998)					26,000[10] (1990)						5,700[3]	680[4]	4,707[5]	
Employment in Social Enterprises (1998) [12]	35,000	80	2,100	2,318[13]	2,318[13]	4,000	8,130	50	500	2,500	100	4,000	400	3,864[13]	3,000-5,000

Sources: [1]ECOTEC 1997, [2]OECD 1997, [3]Statistics Netherlands 2000, [4]Instituto Nacional de Estatistica do Portugal, [5]Statistics Sweden 1999,
[6] The core industries are considered to contain 100% environmental industry, mainly waste treatment, wastewater and recycling. The core industries are the NACE code headings 25.12, 37, 51.57 and 90.
[7]Eurostat Structural Business Statistics, [8]Association of Cities for Recycling 1999, [9]Statistics Denmark 1999, [10]Profeta 1996, [11]DTI 1997, [12]CWESAR 1999
[13] Data in source is given as 8,500 for Scandinavia, so figure has been divided between Denmark, Finland, Sweden relative to total population.

Information on the breakdown of employment in municipal waste recycling for the UK is given by Waste Watch (1999). This indicates that 41% of recycling jobs are in collection and sorting, with 56% in reprocessing. Community sector jobs account for the remaining 3%. This study also notes that the relationship between increased recycling tonnage and increased employment is not directly proportional. Job creation will also be affected by factors such as the efficiency of the processes and the changes made to accommodate the increased tonnage (Waste Watch, 1999).

3.2.3 Employment in Social Enterprises

Although they are often present in the form of scattered associations and are poorly structured, social enterprises may be significant in some areas for the level of employment they generate, their employment of the socially-excluded and the tonnage of waste that they handle. In the UK, for example, the Community Recycling Network has over 250 member organisations, the majority of which run weekly kerbside collection schemes, covering 4.1 million households (20% of the UK). Employment in these organisations in 1999 comprised 1,000 full time and 660 part time staff (Waste Watch, 1999).

An assessment of the numbers of jobs associated with social enterprises carrying out recycling was undertaken by CWESAR (1999); its findings are summarised Annex 3. The study's total estimate of around 35,000 jobs appears reasonably consistent with the Association of Cities for Recycling's total of 300,000 recycling jobs, which would imply that just over 10% of recycling jobs are in social enterprises. The numbers look high, however, compared to the Eurostat data on recycling employment. They imply that 13% of French recycling jobs and 45% of Swedish recycling jobs are in social enterprises. The authors of the CWESAR report note that their work was carried out rapidly with limited resources, and that it is based on discussions with key players in the sector and their own knowledge rather than statistical sampling. Nevertheless, it does appear to indicate that social enterprises may make a significant contribution to employment in recycling.

3.2.4 Links Between Employment Levels and Waste Volumes

A range of studies provides information on the job content of specific waste management activities, in terms of numbers of jobs per volume of waste or the volume of waste associated with a single job.

The level of employment in waste management, in terms of tonnes of waste per job, appears to vary significantly between different activities. Although there are some inconsistencies in the data, there is general agreement that the most labour-intensive activities (<500 tonnes of waste per job) are manual sorting, some separate collection processes and waste and scrap wholesale. The least labour intensive activities (over 1,000 tonnes of waste per job) are landfill, incineration and composting together with most forms of collection. Recycling and reprocessing fall in between these two extremes, depending upon the materials involved and the processes used. Because of these differences, the impacts of waste management policies on employment levels will be highly dependent on the methods used to implement the policies.

3.3 Nature of Employment

3.3.1 Job Quality

Information on the nature of waste management employment is limited. The poorest-quality jobs appear to be in collection and transport, manual sorting and composting, with landfill also towards the lower end of the spectrum. Higher-quality jobs are associated with the more technology-intensive, specialised activities. One factor not covered by the studies in Austria and Sweden is the contribution of waste management to employment of the socially-excluded. This has long been claimed as a benefit, particularly of recycling jobs, but little evidence has been produced. Perhaps, though, the importance of social enterprises in recycling is one indicator that such an effect is occurring. Further information on the quality of employment in waste management can be found in Annex 3 and AK Wien (2000).

3.3.2 Salaries

Some of the studies reviewed in Annex 3, for example Fritz *et al.* (1997), conclude that waste management jobs are less well paid than the average. Experts within the UK waste industry, by contrast, indicated that salaries in the industry were generally above average. Statistics Sweden (1998) found that salaries were reasonably in line with the labour market average, but varied by activity and gender. Eurostat data suggest that labour costs per employee are somewhat higher for NACE category 37.10 (metal recycling) than for the other categories, although in France costs are highest for the wholesale of waste and scrap. On average, labour costs in recycling decreased over the period 1995-1997, although this varies between countries. Austria (for NACE 37.10), Belgium, Denmark and Luxembourg saw reductions whilst the UK and Sweden saw cost increases. It is not clear whether these changes are specific to recycling or follow overall labour market changes. Industry experts believe that overall labour costs for the sector will reduce over time, as more processes are mechanised. Mechanisation, however, is likely to replace the most unskilled and thus lowest-paying jobs, so that average labour costs per employee may increase.

3.4 Impacts of Waste Management Policies on Employment

3.4.1 Trends in Employment Over Time

The OECD (1996) considered the role of the environment industry in creating jobs, and data presented suggest that there has been a positive effect with the growth of the industry. However, it is recognised that there are also job losses, with the overall employment change being the sum of jobs created by the growing environmental goods and services industry and those either created or destroyed by the impacts of environmental regulation on other industries. The aggregate direct and indirect benefits and costs, gains and losses due to the impacts of regulation proved difficult to model.

Data on trends in employment in waste management are ambiguous. Industry experts indicate that there is a general trend towards reduced but higher quality employment, in the course of productivity increases as processing technologies become more sophisticated. This trend for lower employment per tonne of waste may, however, be compensated by a growth in absolute waste quantities and potentially by increasing levels of control over waste disposal. Unfortunately, the limited nature of the data makes interpretation of trends over time difficult.

3.4.2 Impacts of Specific Policies

A number of the studies reviewed in Annex 3 have attempted to model the impacts of particular waste management policies upon employment. The demand-side approach taken by WRc (1999) in evaluating the impacts of EU environmental policies was based on manpower per unit expenditure. As noted in Section 2, it was restricted to the direct and first round indirect employment created as a result of specific expenditures related to environmental policies. The policies studied included the Hazardous Waste Incineration Directive, Packaging and Packaging Waste Directive and the Directive on End-of-Life Vehicles.

The overall conclusion of this report was that environmental policies have a small but positive impact on employment. Waste management policies tend to be more labour intensive than air or water directives, and the relative level of expenditure per Full Time Equivalent (FTE) is lower. WRc highlight that there is often a choice available between strategies to reach the same environmental goals, and these may have variable labour intensities associated with them. An assessment, made in the case of the Directive on End of Life Vehicles, demonstrated that employment can vary by a factor of five depending on the strategy used.

Such studies provide very specific data on the employment effects of specific environmental policies, and recognise that waste management policies may have both net positive and negative effects on employment, both within the waste management sector and total employment.

4. THE CHEMICALS SECTOR

4.1 Background

4.1.1 The Policy Context

During the 1990s, several waste management policies were adopted at the EU level that have potential impacts on the chemical industry. These include:

- measures concerning disposal methods, such as the Directive on Hazardous Waste Incineration and the recently-adopted Landfill Directive;
- measures concerning the definition of wastes, such as the Hazardous Waste Directive;
- regulations concerning transport of waste;
- industry-specific directives, such as the Directive on Waste from Titanium Dioxide Manufacture; and
- producer-responsibility measures, such as the Packaging Directive.

In addition to waste-specific measures, policies to reduce air and water pollution have led to an increase in solid waste volumes in the form of residues from wastewater treatment and end-of-pipe air pollution control. This case study examines the potential macroeconomic implications of these measures (with Annex 4 providing a more detailed account).

4.1.2 The Business Context

There are approximately 36,000 chemical companies within the EU, with a turnover in 1998 of €402 billion. The industry is expanding, with a 25% increase in production in real terms between 1990 and 1998 (CEFIC, 1999). The industry employs a total of around 1.7 million people who tend to be better qualified and more highly trained than average, which is reflected in above-average salaries. Employment within the sector has reduced significantly, with approximately 14% fewer employees in 1998 than in 1990. As well as increased efficiency, this reduction has been achieved through outsourcing of non-core functions, including some aspects of waste management.

4.2 Data Analysis

This case study looks at current waste management costs to the chemical industry in general, rather than those related to any specific policies. Data on specific waste management costs for the chemical industry are limited and there is considerable variation in costs between companies. In general, though, costs have remained reasonably stable during the 1990s or even reduced slightly in some cases. Waste-related investment costs are in the range of 1-5% of total investment costs, whilst waste-related operating costs range from 0.2-1.7% of net sales.

Little information is available on waste-related employment in the chemical industry. Waste and other environment-related activities tend to be carried out by operational staff as an integrated part of their duties. Data from three companies indicate that environment or environment, health and safety (EHS) jobs may account for 1-2% of employment in the chemical industry. If this percentage were repeated across the sector, it would indicate a total of 17,000 to 34,000 environment-related jobs. If waste-related jobs accounted for a third of the total, in proportion to waste management's share of operating expenditure, there might be 5,700-11,300 waste-related jobs within the European chemical industry.

Trends in the numbers of jobs are difficult to discern. In general, discussion with companies indicates that there has been a slight reduction in the number of full-time environment-related jobs, as environmental protection is integrated into mainstream operations. Full-time environmental jobs are also reducing in line with the general reduction in employment in the chemicals industry.

4.3 Impacts of Waste Management Measures on the Chemical Industry

Whilst the operational costs of waste management to the chemical industry are not negligible in absolute terms, it appears unlikely that the costs in themselves have had a significant impact on profitability.

Waste-related investment by the chemical industry is equivalent to €249 million to €1,347 million in 1999. Waste-related investment has remained stable throughout the 1990s, whilst overall investment dipped significantly during the mid-1990s and only exceeded 1990 levels in 1997. This suggests that waste-related investment costs may have displaced some production-related investment (i.e. the crowding out effect leading to possible opportunity costs as discussed in Section 2).

It has not been possible, within the scope of this study, to compare waste management costs for the European chemical industry with costs elsewhere. However, the average growth rate of the European chemical industry compares favourably with that of the USA and Japan, suggesting that waste management policies have not had an adverse effect overall on the competitive position of the European chemicals industry.

Industry representatives indicate that environmental costs (including waste management costs) may be a contributing factor to the general trend towards re-location of bulk chemical processes outside Europe. Other factors, such as labour and energy costs and proximity to markets, may however be at least equally significant.

It seems unlikely that the increase in operational costs due to waste management has had a significant effect on the overall level of employment in the chemical industry. During the 1990s, waste-related operational costs remained stable or even decreased whilst employment fell significantly. The industry itself indicates that the rise in unit labour costs during the 1990s was the key reason for reductions in the number of jobs. It is difficult to estimate the potential impacts of any displacement of production-related investment by waste-related investment, as no data are available on the relative numbers of jobs associated with different types of investment.

There also appears to be little evidence that waste management measures have increased waste-related jobs in the chemical industry. The trend towards out-sourcing of waste management may even have reduced the number of waste-related jobs within the sector. Even where significant investment has been made on in-house waste management facilities, these tend not to be labour-intensive due to a high degree of automation.

The tendency for increased out-sourcing of waste management might be expected to result in increased investment, and potentially employment, in the waste management sector. Unfortunately, only limited data are available on investment and employment by the waste management sector in relation to services to the chemical industry. The hazardous waste management organisation in Finland, Ekokem, employed 189 people in 1999 to treat 1.1 million tonnes of waste. If a similar level of employment applies to treatment of all hazardous wastes, then the external employment associated with treatment of chemical industry wastes could total around 5,000 jobs.

4.4 Application of the E3ME Model

Cambridge Econometrics' E3ME model (described in Annex 2) was used to examine the impact of the chemical industry's current level of waste management expenditure on both employment and GDP. The aim is to determine the net effects of industry's current annual expenditure of €804 million on waste management.

In applying the E3ME model, it is assumed that waste management policies have led to the chemical industry spending the equivalent of 0.8% of its net sales on waste management. The model treats these extra costs as being passed on in higher prices, depending on the competitive position of the industry in different Member States. The extra costs will lead to higher prices and a loss in the European share of world markets. The model has assumed that crowding out of investment is not taking place, since waste management is generally integrated into production process and investments are likely to have improved product qualities. Instead, the extra investment implied by waste management regulations is assumed to lead to extra output and jobs in the investment industries (i.e. providers of waste management related goods and services), with multiplier effects throughout the EU economies. No extra direct employment in the chemicals sector or in chemicals waste management is assumed.

The most important findings of the analysis are that the current level of costs will lead to a less than 0.01% reduction in gross domestic product (GDP) by the end of the five year period, as a result of increased prices being passed on to private domestic consumption and exports. The increase in consumer prices leads to reductions in household consumption and hence GDP. The increase in export prices leads to a fall in exports to countries outside the EU and hence GDP. The increase in prices also makes imports more price-competitive and so increases European imports. However, the fall in consumers' expenditure reduces imports, offsetting these increases, resulting in the net effect being negligible. A fall in employment of less than 0.01% is also predicted.

The impacts of the waste management costs and investment vary considerably across the Member States; some countries experience a net gain in employment, while others experience significant losses. Most notable of those experiencing losses are the UK and France, which by 2005 are predicted as losing 10,000 jobs between them. The pattern is generally one of an increase in employment followed by decreases, with the number of jobs lost by the end of the five year period estimated at around 17,000. The first-year increase in employment is a short-term effect arising from the initial fall in real labour costs across industries. This is the effect of the lag between rises in chemicals costs and, therefore, prices more generally and the consequent rise in wage rates. The effect is particularly noticeable for the UK, which according to the model has a more responsive labour market with more employment generated for a fall in real wage rates compared to most other EU economies.

These estimated losses in jobs are likely to be over-predictions as they take no account of the potential creation of additional jobs in hazardous waste management. Based on an assumption that every 10 direct jobs leads to 6 indirect and induced jobs (which has been found by the E3ME model to generally be the case for the manufacturing sector), this implies some 8,000 jobs in total may have been created in hazardous waste management and indirectly in those sectors supplying this activity. These indirect and induced jobs would offset the losses stemming from the initial rise in prices.

The percentage change in GDP also varies by country. The UK is expected to experience relatively significant losses, as are Greece and Sweden. In contrast, a number of countries, including France, realise small gains. GDP across the EU as a whole is reduced by 0.008% (equivalent to €600 million) by the fifth year of the modelling period (2005) as a result of higher prices and loss in exports. There is a confounding factor in that the model is unable to take into account the extra competitiveness effects of regulations. In addition, the eco-efficiency gains that have been achieved within the industry may not be adequately accounted for. These combined effects may, therefore, counteract the predicted reductions in GDP and employment. The predicted losses in GDP would also be reduced if account was taken of the potential jobs created in hazardous waste management and the indirect and induced employment effects stemming from these.

5. WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT

5.1 Background

5.1.1 The Policy Context

The main objectives of the Directive on Waste Electrical and Electronic Equipment (WEEE) are to prevent waste by increasing re-use, recycling and other forms of recovery and to improve the performance of all operators in the life cycle of electrical and electronic equipment, particularly WEEE treatment. The main measures used to achieve these objectives are set out in Box 5.1.

Box 5.1: Main Measures of the Draft Directive on Waste Electrical and Electronic Equipment
• Separate collection of WEEE, free of charge to households, and provision for collection of non-household WEEE; • Targets for separate collection of WEEE from private households; • Provision for treatment of WEEE to specified standards, at permitted establishments; • Provision for recovery of WEEE, to meet specified rates for overall recovery, reuse and recycling of components, materials and substances; • Provision of appropriate information and marking of equipment; and • Financing of the system primarily by producers, either individually or collectively.

Whilst the EU Directive is still at the proposal stage, legislation concerning WEEE has already been adopted and implemented in the Netherlands. The Decree on the Disposal of White and Brown Goods came into force from 1 June 1998 and was fully implemented from 1 January 2000. The Decree imposes similar requirements to those in the proposed EU Directive; it may therefore provide a useful indication of the potential impacts of the proposed Directive. Annex 5 provides a more detailed account of this case study.

5.1.2 The Business Context

In the EU, there are over 100,000 small and medium sized enterprises involved in the manufacture and supply of electrical and electronic equipment. The sector, though, is dominated by a small number of large companies that typically account for 80% of turnover and employment. Total employment is estimated at around 1.4 million. Manufacturers are located primarily in Germany, the UK, France, Italy, the Netherlands and Sweden. In the Netherlands, there are around 600 manufacturers, most of which are very small companies. However, the majority of goods are imported and there are estimated to be several thousand importers. As in the overall EU situation, a small number of manufacturers or importers (30 for white goods and 33 for brown goods) cover 85% to 90% of the market.

5.2 Data Analysis

Clearly, no actual data on the costs of the proposed EU Directive on WEEE are yet available. Estimates of the potential costs, though, have been prepared by the European Commission, by industry organisations and by national governments including the UK Government. There is considerable variation between these estimates, depending upon the underlying assumptions. Data on the impacts of the Netherlands Decree on the Disposal of Brown and White Goods are available from the Netherlands Government, local authorities, industry and the two collective organisations implementing industry responsibilities for take-back.

Only limited investment is thought to have been required by the Netherlands Decree. Known investment costs total approximately €7 million. This represents an initial outlay of €114- €209 /tonne of waste (depending on whether the volume of waste collected is taken as the 1999 actual level or the expected long-term level). Further investment may not be required for 10 or 15 years, though, depending on the lifetime of the assets. The operating costs have been reduced considerably below the predicted level through the use of collective schemes, reducing the number of recycling facilities and taking advantage of existing transport routes and networks.

No detailed data have been collected on the employment impacts of the Decree; however, they are thought to be minimal. One of the key effects has been the consolidation of the recycling industry for WEEE. Jobs may therefore have been lost in smaller organisations, including social welfare organisations, although this may have been offset by increased employment in the large organisations to handle the additional throughput of waste. A small number of additional jobs (perhaps 90 to 100) is also thought to have been created in local authorities, in separating out usable goods for sale on the second-hand market. The number of additional jobs in administering the scheme (fewer than 10) has been kept to a minimum to reduce costs.

5.3 Impacts of WEEE Policy Measures

The impacts of the EU Directive on employment in the electrical and electronics industry are likely to be minimal. The UK Government predicts that one day per year will be required by each manufacturer/importer in compiling relevant information to be provided to treatment facilities. This is in line with experience in the Netherlands. Some additional employment may be generated through product innovation, to reduce the generation of waste and to enhance the potential for recycling and re-use. This is most likely to occur when the costs to manufacturers of implementing WEEE policy are linked to the amount of waste associated with their products and the ease with which they can be recycled. The collective scheme in the Netherlands does not encourage innovation because a single levy is applicable to each type of product, regardless of individual product design. It is not thought, therefore, to have led to significant product innovation or associated employment increases.

WEEE policy has the potential for greater impacts on investment and employment in the waste management and transport sectors. The UK Government has estimated that implementation of the Directive in the UK could create of 500 to 600 jobs. This is equivalent to 1 to 1.25 jobs per thousand tonnes of WEEE collected, compared with up to 1.6 jobs per thousand tonnes of WEEE in the Netherlands in the long term, and would imply creation of 1,500 to 2,000 jobs across the EU.

Table 5.1 compares the actual operating costs of the Netherlands Decree and the estimated costs of the proposed EU Directive with the turnover of the electrical and electronics industry at Netherlands and EU level.

Table 5.1: Comparison of WEEE Operating Costs with Turnover (in € million)

	Operating Costs of WEEE Policy	**Turnover of Electrical and Electronics Sector**	**Operating Costs as % of Turnover**
Netherlands: actual costs, 1999	15.3	7,110	0.22 %
Netherlands: 'normal situation'	18.9	7,110	0.27 %
EU: Commission low estimate[1]	500.0	175,000	0.29%
EU: Commission high estimate[1]	900.0	175,000	0.51%
EU: Industry estimate[2]	7,500.0	175,000	4.29%

Sources:
1. Commission of the European Communities (2000**): Proposal for a Directive on Waste Electrical and Electronic Equipment**, Brussels, CEC (COM (2000) 347).
2. Orgalime (2000): **Detailed Position of Orgalime's Electrical and Electronic Liaison Committee in Co-operation with the European Sector Committees, Brussels, Orgalime.**

In most cases, the impacts of WEEE operating costs appear likely to be minimal as they account for well below 1% of turnover. The operating costs of the Decree in the Netherlands have been minimised through the use of a collective scheme. Provided that implementation of the WEEE Directive allows for similar economies of scale, it appears unlikely that WEEE policy will have a significant impact upon profitability.

Analysis by the European Commission indicates that the proposed WEEE Directive could increase the prices of electrical and electronic goods by an average of 1%, with increases of 2-3% for certain products such as refrigerators, televisions and other monitors. Under the Netherlands' schemes, the cost-recovery levies charged on most white goods are around 1-2% of prices but can be up to 5% for some refrigerators and freezers. Research for the Netherlands Government indicates that these increases are unlikely to lead to long-term sales changes.

One other potential effect of WEEE legislation could be the substitution of new electrical and electronic goods components by components recovered from recycled goods. At present in the Netherlands, processing of WEEE primarily takes the form of materials recycling (e.g. metals recovery) rather than component recovery, so that no such substitution effects arise.

5.4 Application of the E3ME Model

The E3ME model was used to examine the macroeconomic implications arising from increase in consumer product prices with the adoption of WEEE legislation across the EU. The modelling assumes that the direct effects of the legislation estimated for the Netherlands would be similar for all other Member States. There would be some small extra direct employment by the waste recycling industry resulting from an increase in the purchase of waste recycling services by the electrical and electronics industries, leading to higher costs of their products and extra output of waste-related services. There would also be more investment in recycling equipment. The overall picture is one of increases in employment and investment, increasing EU GDP and indirect employment.

The increases in costs and prices have negative effects on GDP via reductions in consumers' expenditures and exports, but these are generally smaller than the positive effects. The cost-inflation effects are modelled to outweigh the direct employment and investment effects only in Member States that have had a tendency to high wage inflation (e.g. Greece and Spain). However, the advent of the single currency may well mean that these countries will experience a change in behaviour implying smaller inflationary responses. In this case, the loss in GDP from the policy will be overstated.

The policy is predicted as yielding increases in employment, with a total gain in direct employment across the EU of roughly 2,800 jobs relative to the base year at the end of the five year simulation period. The effects are in direct proportion to the data provided for the Netherlands, hence the largest economies (Germany, France, UK, Italy) account for around 70% of the total, owing to their higher consumption of electrical goods. Net changes in total employment are generally small, but positive, across the Member States. They do, however, illustrate the potential importance of accounting for the indirect and induced effects when considering the employment implications of a policy. Added to the direct job gains are a further 2,000 plus jobs resulting from multiplier effects. In other words, for almost every three direct jobs created, two additional indirect/induced jobs are created.

This increase in employment is accompanied by slight increases in GDP in most Member States. The gains would peak in 2002 at an estimated increase in GDP of 0.021% (€163 million), but by the end of the five year period the increase in GDP is slightly reduced at roughly 0.016% (€145 million). The countries benefiting most from increases in GDP would be Germany, followed by France.

6. THE NON-FERROUS METALS RECYCLING INDUSTRY

6.1 Background

6.1.1 The Policy Context

The non-ferrous metals recycling industry is affected by both the Waste Framework Directive and Council Regulation (EEC) 259/93 on the supervision and control of shipments of wastes within, into and out of the European Union. The case study focuses on the latter legislation due to better data availability. Council Regulation (EEC) 259/93 on the supervision and control of shipments of wastes within, into and out of the European Union implements the Basel Convention on the Transboundary Movements of Hazardous Wastes and their Disposal, but is much broader in scope, extending control to all wastes (except radioactive waste).

The Regulation controls the shipment of waste based on a system of notification between the exporting/importing and transit countries. The level of control is variable depending on the proposed treatment of the waste, its destination and its assignment to one of three lists according to the degree of hazard of the waste (red, amber or green lists) (TN Sofres, 2000). Exports of red and amber listed wastes are banned outside the OECD. Most non-ferrous scrap metals traded internationally are green listed (non-hazardous), but some are amber listed. None currently appear on the red list (most hazardous). It is, therefore, the amber procedures for waste for recovery that are the most important. These require the notification of the competent authorities in the countries of dispatch, transit and destination, any of which may request additional information and documentation. These authorities then have a period of 30 days in which to object to the shipment. If no objection is lodged after 30 days the shipment may be effected; however, the consent expires within a year of that date. Annex 6 provides a more detailed account of the case study.

6.1.2 The Business Context

The ferrous and non-ferrous recycling industries are the two most widely and longest established recycling sectors, with the non-ferrous secondary metals recycling industry employing a workforce of approximately 100,000 people in 1995. It is estimated to consist of approximately 15,000 enterprises of which 10% are large, 30% medium and 60% small (IPTS, 1997).

Exisiting statistics show that 40% of non-ferrous metal produced in the EU is currently produced from recycled materials, and this proportion is increasing. Clubb (1997) reports that the value of the non-ferrous recycling industry is approximately €4.2 billion, with 3.5 million tonnes traded within the EU, 441,000 tonnes exported outside the EU and 880,000 tonnes imported to the EU. Price and transport costs are usually the determining factors in whether scrap is sold domestically or is exported, and the EU scrap industry relies heavily on exports for economic viability when the domestic market is depressed.

6.2 Data Analysis

There is no single source of reliable and comprehensive data on the recycling of non-ferrous metals, and data therefore have to be extracted from a number of sources. Countries such as France, Germany and Italy dominate the EU non-ferrous metals recycling industry, both in terms of number of enterprises and level of employment. The average number of employees per enterprise varies between Member States but in no country is it more than 20, with an EU average of six, suggesting that the majority of non-ferrous metal recycling is undertaken by small businesses. Eurostat data show that on average 31 tonnes of metal are recycled per job, which compares to the figure of 44 tonnes/job given by the Association of Cities for Recycling (1999).

The export market for non-ferrous secondary metal is considerable, accounting for 2.4 million tonnes within the EU (€2.3 billion), and 700,000 tonnes (€657 million) to non-EU countries in 1998. Between 1995 and 1998, the volume of trade within the EU decreased, while exports out of the EU increased. There are significant variations, however, by both country and by metal, with very few trends noticeable. Although there has been an overall increase in both intra- and extra-EU aluminium exports, this has not occurred in all countries. Likewise, the overall decrease in exports of metal ash and residues has not been experienced by all countries, with Austria and the Netherlands both significantly increasing their exports. Exports in general have fluctuated over the 1995 to 1998 period, as has the price per tonne of metals. Again there is no clear trend between these two factors.

In general, the volume and value of green listed metal scrap is much greater then that of amber listed. However, for Greece, Spain and Sweden, amber listed metal ash and residues accounts for more than 50% of their total exports of non-ferrous secondary metals.

6.3 Impacts of Waste Management Policies on the Non-Ferrous Metals Recycling Industry

Regulation (EEC) 259/93 may impact both positively and negatively on employment in the non-ferrous metals recycling industry. A study by TN Sofres (2000) attempts to quantify the costs associated with this legislation to the non-ferrous industry, but concludes that the costs are extremely variable across companies. Estimates of the compliance costs incurred by the Italian non-ferrous metals recycling sector in implementing Decree 22/97 suggest that costs approximate to 0.5% - 1.0% of turnover. TN Sofres (2000) estimates the additional costs associated with Regulation (EEC) 259/93 range from 0.0016% to 1.3%. It has also been suggested that many companies have had to hire at least one extra person in order to deal with the extra administration and legal aspects that have arisen from the Regulation. This was the case in Italy. If similar costs to those arising in Italy were incurred due to the implementation of Regulation (EEC) 259/93, then this would result in 40% (10% large and 30% medium sized companies) of the total 15,616 companies having to employ one extra person, creating over additional 6,000 jobs.

However, the restrictions to trade in non-ferrous metal scrap may also have a negative effect on employment. The extra burden of administration, variation in requirements for information, and delays in trade due to additional notification procedures have caused contract failures and have deterred some companies from trading with certain countries. The main costs are reported as hidden costs in terms of losses of margins; but notification fees and administration costs are also significant, with administration fees varying greatly between countries (Clubb, 1997).

It should be remembered that the Regulation has the advantages of reducing illegal shipments and treatment practices through better control and of protecting developing countries from importing waste that they cannot handle properly. However, the ban on trade with non-OECD in (red and) amber listed wastes also has obvious effects on the industry, although the extent of this is not clear from the data available. Current exports of amber listed metals have a value of approximately €400 million, including both intra- and extra-EU trade, but there has been a noticeable decline in the volume of trade within the EU between 1995 and 1999. Therefore, such restrictions may have wider implications than at first thought, owing to the fact that the EU scrap industry relies heavily on exports for economic viability when the domestic market is depressed. However, other, unrelated market developments may conceal the effects of waste management measures, or make them seem larger than they are in reality.

6.4 Application of the E3ME Model

As for the other case studies, the E3ME model was used to predict the total net employment and GDP effects associated with the impact that Regulation (EEC) 259/93 has had on the export of secondary non-ferrous metals. The modelling assumes a theoretical situation where there is no international trade in amber listed non-ferrous metals. In practice, only exports to non-OECD countries are forbidden. This assumption was made on the basis that it was not possible to ascertain from the available data the proportion of exports going to non-OECD countries before the ban was implemented. The data, as discussed in Section 6.3, also shows a decrease in trade in amber listed metals within the EU, which may have been caused by extra administration costs and delays. Hence, the results of the model present a worst case scenario.

The assumption was made in modelling the Regulation to treat the policy effects as if they were taking place in a closed system (in other words to assume that the metal was not exported, but simply ended up sitting in stockpiles). It was not possible to model a more dynamic system involving delayed sales. From the information on the size of export markets, it was possible to infer the number of job losses through not being able to trade in amber-listed metals. The job losses were added to the direct gains created by the additional administrative and legal requirements to work out the overall net employment effect and the consequent impact on GDP by Member State.

In all but two countries the model indicates that the Regulation has led to an increase in direct employment. These direct job gains reflect the need for companies to hire in additional legal and administrative assistance in order to deal with the additional burdens in these two areas stemming from the change in legislation. The number of additional direct jobs remains fairly constant over the five year period, with them predicted at roughly 6,150 by the end of the modelling period. Owing to predicted losses in GDP, the pattern for total employment for the EU moves from being positive in the first two years following implementation of the Regulation to being negative in year five, although the magnitude of the net losses (at 1,700 jobs) is small.

The losses in GDP are negative in each of the five years, however, due to the fact that the non-ferrous metals recycling industry is a highly integrated sector, with considerable demand and supply linkages to other sectors of the economy. Thus, impacts on this sector have significant knock-on effects for other sectors (through impacts on demand and supply relationships). The greatest impact on GDP occurs in year two at a predicted decrease in GDP of 0.006%, with GDP down by 0.005% by year five. However, these are likely to be over-estimates of the effects of the Regulation given that the impact may be more one of delaying export rather than preventing it.

7. INTEGRATION OF EMPLOYMENT AND WIDER ECONOMIC EFFECTS INTO CBA

7.1 Introduction

As discussed in Section 2, no social costs are normally associated with unemployment as part of the preparation of a CBA. This stems from assumptions that the economy is effectively fully employed (with only transitional employment occurring), that labour is mobile and thus any measured unemployment is the result of the need to match a changing demand for labour to a changing supply.

These assumptions rarely hold, however, for most EU countries, indicating that there may be employment related costs and benefits arising from changes in policy. One approach that could be adopted in doing this is to incorporate economic estimates of the social effects associated with changes in employment. This requires first estimating the number of jobs that would be created or lost by introducing a policy and then multiplying this by the economic value of each job. Theoretically speaking, this economic value is defined in terms of the net income gained from the new job, plus any improvements in quality of life, minus the value of any lost leisure time. In practice, wage rates are often used as a proxy measure for this value (with the market wage rate assumed to reflect the shadow wage rate in developed economies).

However, care is required in incorporating such welfare measures into CBA on top of estimates of changes in compliance costs (which are used as proxy for economic losses). Such compliance cost estimates will already include the wage component of any new capital or operating requirements. As a result, adding further sums to compliance costs to reflect changes in employment will result in double counting for any direct employment changes and, potentially, for some indirect changes. This problem will be compounded if separate estimates are also prepared on the wider economic effects (indirect and induced) stemming from changes in demand and supply relationships.

This, together with the case study findings, suggests that in the context of waste management, there is likely to be value in supplementing traditional CBAs by the use of additional assessments of employment and economic effects. In order to examine the degree to which the different approaches discussed in Section 2 can assist in this process, a simple analysis is presented below that compares the types of results that would be produced through each approach.

7.2 Supply-Side Analysis

As discussed in Section 2 (and Annex 1) adopting a supply-side approach generally involves the use of existing data on the number of jobs per unit of activity to predict the impacts which a change in policy will have on employment. Table 7.1 provides a summary of the relationships that various researchers have found between tonnes of

Table 7.1: Job Content of Waste Management Activities*			
Activity	**Jobs per 100 000 tonnes**	**Tonnes per Job**	**Source**
Collection-Packaging	466	214	Cottica and Kaulard (1995)
Reprocessing	162	617	Murray (1998)
Recycling	241	415	Based on Murray (1998)
Landfill	8 - 12	7 885 - 15 246	Cottica and Kaulard (1995)
Incineration	19 - 37	2 692 - 5 397	Cottica and Kaulard (1995)
Aluminium	-	28 - 933	From Murray (1998)
Ferrous Metals	-	162 - 2 102	From Murray (1998)
* See Annex 3 for further discussion of these figures			

waste processed per direct job created. As can be seen from the table, the figures vary considerably across the different waste management activities.

How well would these figures predict the levels of direct employment quoted in each of the case studies? In the Chemicals Industry case study, a ratio of 5,820 tonnes of hazardous waste per job was estimated from the data provided for one country's main handling facility. This figure corresponds well to the figures given in Table 7.1 for incineration - one of the main disposal routes for such wastes. However, the data presented in the table also suggest that changes in regulation, such as the Landfill Directive which will prevent the co-disposal of wastes, may lead to increases in the number of jobs, owing to a shift from a high tonne/job ratio to a lower tonne/job ratio (because incineration is more labour intensive than landfill).

For the WEEE case study, estimates of the direct number of jobs created through the introduction of the Directive suggested that 1 to 1.25 jobs would be created in reprocessing activities per thousand tonnes of waste. This is significantly lower than the figure quoted above, suggesting that use of the data provided in Table 7.1 would lead to an over-estimate of direct job creation by almost 60%. This difference is likely to be owing to variations in the way in which past policies have been implemented compared to WEEE, and to economies of scale that are occurring in the move from smaller to larger operations under WEEE (this includes the potential substitution of technology for labour).

Research on Regulation 259/93/EEC and the non-ferrous metals recycling sector estimated that some 6,250 high income, direct jobs in the sector will be created owing to the need for new legal and administrative expertise. Against these gains, however, are any direct losses stemming from a reduction in exports. Under the hypothetical case study scenario, export of roughly 730,000 tonnes of amber listed metals to non-OECD countries ceases to take place. Based on statistics for the industry indicating a ratio of 31 tonnes of recycled metals per job, this suggests that some 23,000 jobs would be lost. The net effect in terms of predicted changes in direct employment would, thus, be the loss of around 17,000 jobs using this type of data.

These simple comparisons imply that use of standard tonne per job ratios may lead to incorrect estimates of the direct employment arising from changes in waste policy. This is in addition to the fact that they provide only a partial analysis, because they fail to account for any indirect and induced effects. As the case studies show, such effects may be significant and may lead to net total effects that run contrary to consideration of the direct effects alone.

The use of these types of ratios should not be discounted completely, however. They may be valuable in providing a quick understanding of the degree to which shifts in waste management activities would lead to net changes in employment. They may also assist in informing discussions on policies that would lead to 'more of the same', assuming this would not be accompanied by economies of scale or technology shifts.

7.3 Demand-Side Analysis

Demand-side approaches assume that a policy leads to a change in demand, which in turn then leads to changes in employment and output. Three key approaches were identified: input-output models, multipliers and the use of econometric analyses.

Because of their widespread use, multipliers in the form of manpower to expenditure ratios are applied to the case studies to examine how well these correspond to the estimates generated through the case study analysis. The ratios calculated by the study undertaken by WRc (1999) for the Commission are used for this purpose. This study found average ratios of expenditure to employment as follows for three waste related policies (see also Annex 1 for more detail):

- one FTE (first order indirect) job created per €115,700 capital expenditure; and
- one FTE (direct and first order indirect) job created per €53,000 operating expenditure.

The sum of these two ratios provides the total employment associated with expenditure on waste management. The results of applying these ratios to the estimated capital and operating costs associated with the three policies considered in this study are presented in Table 7.2.

Table 7.2: Application of 'Standard' Manpower to Expenditure Ratios

Case Study	Expenditure (M Euro)		Employment Related to Capital Expenditure	Employment Related to Operating Expenditure
	Capital	Operating	Total FTEs	Total FTEs
Chemicals Industry	249	804	2 152	16 622
WEEE Directive	N/A	750	N/A	14 150
Non-Ferrous Metals Recycling Industry	N/A	266	N/A	5 020

For the Chemicals Industry, the results indicate a total of 18,774 direct and first order indirect jobs. If the assumed figure of around 5,000 direct jobs involved in treatment of hazardous waste is correct, the above results suggest that for every one person directly employed in chemical industry waste management, another 2.5 are indirectly employed in providing related services. This compares with a multiplier generally used for the manufacturing sector (in the E3ME model) of 10 direct jobs leading to six indirect jobs. The latter figure, however, takes into any negative impacts arising from account wage and price effects, while also including induced employment.

For the WEEE case study, it has been predicted that 1 to 1.25 direct jobs will be created per thousand tonnes of WEEE collected, with this implying the creation of 1,500 to 2,000 direct jobs across the EU as a whole. This differs considerably from the estimates given in Table 7.2 of over 14,000 direct and indirect jobs being created. The implied ratio of direct to indirect jobs in this case is roughly 1:7 - significantly different to the figures calculated above for the chemical industry.

The estimate of 6,200 direct jobs being created in the Non-Ferrous Metals Recycling Industry as a result of Regulation (EEC)/259/93 is considerably higher than the figure given in Table 7.2, especially as the latter includes both direct and indirect jobs. This difference arises because this type of demand-side approach neglects the fact that a policy may lead to more than just increases in compliance costs. Again, the manner in which a policy is implemented may be crucial to assessing the resulting changes in output and hence direct employment, particularly where there may be effects on market structure and the need for individuals with specialist skills.

From the above and the discussion presented in Section 2, it can be concluded that the use of these types of multipliers is best confined to those cases where: a) it can be argued that the policy will lead to an increase in demand, rather than transfers; b) compliance with the policy will mainly involve capital and operating expenditure, rather than more subtle changes in current practice; and c) there is a desire to focus on the more direct additional effects of a policy, rather than the net effects (which may include negative impacts).

7.4 Macroeconomic Analysis

As noted above, macroeconomic analysis (as carried out using an econometric model such as E3ME or a GE model) involves a more complex analysis of the interractions that are likely to occur within an economy. This type of analysis takes into account the implications of both changes in demand and prices, and the effects which these have on consumption, wages and relative input and output mixes. It therefore is able to capture both the negative and positive effects that a policy may generate, including direct, indirect and induced economic and employment effects.

The degree to which it may be important to capture such wider effects is illustrated by Table 7.3. By expanding the analysis to the macroeconomic level, the potential negative net effects of changes in investment patterns on net employment levels and GDP are also incorporated into the analysis. Only for the WEEE case study is the net effect at a macroeconomic level considered to be positive; even in this case, the net

Table 7.3: Comparison of Predicted Employment and GDP Effects in EU 15				
Case Study	**Supply-Side**	**Demand-Side**	**Macroeconomic**	
	Direct Employment Only	**Direct and First Round Indirect Employment**	**Total Employment**	**GDP (€ million)**
Chemicals Industry	5,000	18,774	-18,000	-660
WEEE Directive	1,500 to 2,000	14,150	5,600	145
Non-Ferrous Metals Recycling Industry	6,250	5,020	-1,700	-368

employment gains predicted by the macroeconomic modelling exercise are lower than those predicted using the manpower to expenditure ratios as described above.

Although a number of simplifying assumptions were made in the macroeconomic modelling undertaken for the case studies, the above comparisons highlight the potential importance of expanding the scope of an analysis to incorporate the full rounds of indirect and induced effects. This is likely to be particularly important for those waste management policies that will: a) result in significant cost increases to one particular sector; b) impact on the costs faced by a number of different sectors; or c) result in significant costs to the waste management industry itself, which will then be passed on through increased prices to other sectors.

However, it should be noted that the application of these more sophisticated macroeconomic models is complex. In addition, as for the other approaches, the results may also be confounded by a number of factors related to the modelling. In this regard, it is important that the influence that key model uncertainties (surrounding the data underlying the model, assumptions concerning full employment, behavioural assumptions and model specification) are likely to have on the predicted changes in GDP and employment are understood.

7.5 Implications for Integration of Results into CBA-Based Appraisals

Table 7.4 pulls together the conclusions drawn above and from the discussion presented in Section 2 on the factors affecting the appropriateness of each of the above approaches. Essentially, the conclusions are that when a policy would result in only minor changes or shifts in waste management activity, such as an increase in the scale of existing levels of recycling, then the use of the less complex supply, demand and qualitative approaches may be appropriate. However, these approaches can only provide data on the direct effects (or indirect via multipliers) of the policy in question. This information may be enough for many appraisals, but cannot answer questions concerning the impact of the policy at a macroeconomic level.

When a policy would impact on the prices faced by non-target sectors, then the macroeconomic approaches will be more appropriate. Only these approaches will provide an indication of the total net effects of a policy. Both econometric models and GE models provide a means of calculating these net effects, although the assumptions underlying these and their appropriateness in terms of the period of likely impacts differs.

Table 7.4: Coverage and Appropriateness of Alternative Assessment Approaches as Supplements to CBA

Type of Approach		Scope of Effects	Direction of Effects (+ or -)	Compliance Requirements	Time Period and Technology	Consistency with CBA
Supply-side Approach		Direct employment effects only	Measures additional jobs	Only reliable when policy is either an increase in the level of activity or a shift in activity, with implementation based on current practice	Will miscalculate when technology shifts or economies of scale may occur; best as short-term indicators	Indicates change in employment in terms of number of jobs created so does not lead to double counting
Demand-side Approach	Input-Output Models	Direct, indirect and induced employment and output effects	Provides a measure of net changes in jobs or output	Able to examine changes in demand (expenditure)	Most reliable for short-term effects as rely on fixed assumptions concerning technology/production	Does not take into account responses to changes in price; partially consistent
	Multipliers	Direct, indirect and induced employment and output effects possible	Measures additional jobs or output	Appropriate where compliance involves main capital or operating expenditure	Most reliable for short-term effects	Assumes all expenditure results in new demand; takes no account of possible transfers
	Manpower to Expenditure Ratios	Direct and indirect employment effects only	Measures additional jobs created	Appropriate where compliance involves mainly capital or operating expenditure	Most reliable for short-term effects	Assumes all expenditure results in new demand; takes no account of possible transfers
Macro-economic Models	Econometric Models	Direct, indirect and induced employment and GDP effects	Positive and negative effects into estimates of net change	Can examine changes in investment or changes in employment	Most appropriate for short-term; may require adaptation to account for technology shifts	Uses measures such as GDP as a proxy for economic value
	General Equilibrium Models	Direct, indirect and induced employment and GDP effects	Positive and negative effects into estimates of net change	Can examine changes in investment and in employment; models may labour market is in equilibrium	Most appropriate for long-term; may require adaptation to account for technology shifts	Uses measures of economic change that are consistent with CBA
Qualitative Assessments		Can capture direct and indirect employment effects	Positive and negative effects can be indicated	Type of compliance required not a constraining factor	Only really appropriate for indicating short-term effects	Can be designed to be consistent with principles underlying CBA

8. SUMMARY AND CONCLUSIONS

8.1 Introduction

The objectives of this study were to:

- critically evaluate and complete existing information on employment activities related to waste management;

- look at the issue of opportunity costs in terms of reduced job levels in other economic sectors; and

- identify ways in which employment effects can usefully be integrated into evaluating policy instruments in the field of waste management.

Below we set out our conclusions in relation to each of these objectives, and also more generally on the links between employment and waste management.

8.2 Information on Employment Activities in Relation to Waste Management

8.2.1 Sources of Information

Information on employment activities related to waste management can be found in two main sources. These are statistical employment data, collected at European and national level and specific, one-off studies of particular aspects of waste-management related employment. Currently, statistical data collected at the European level provide limited and poor quality information on employment in waste management. This is because:

- the classifications used exclude a wide range of waste related activities; and
- few countries appear to submit regular, up-to-date information that is publicly-accessible (in some cases the data are specified as confidential).

Particular problems arise from the classifications used, which tend to focus on businesses where waste management is the primary activity and exclude waste-related jobs in other sectors. The statistics also fail to separate solid waste management from wastewater management activities. The fact that the waste management sector includes large numbers of small organisations, including social organisations, makes collection of accurate statistics particularly problematic.

Specialised one-off studies, whether they are country-, waste stream-, or activity-specific, can provide additional information. However differences in approaches and definitions, as well as the variations in time-scale, can lead to wide variations and incompatibility in the data generated.

8.2.2 Levels of Employment

Taking account of the range of data available from both statistical sources and specialist studies, **the probable number of jobs in the EU in organisations for which waste management is a primary activity lies between 200,000 and 400,000. This represents approximately 0.2-0.4% of total employment**. (This compares to the turnover of the waste management sector which, at approximately €44 billion in 1997, is around 0.6% of EU gross domestic product). In addition to companies where waste management is a primary activity, there are also waste-related jobs in companies in other sectors. The indications are that such employment is limited (possibly another 3,000 to 12,000 jobs). Discussion with industry indicates that there is an increasing tendency for companies to out-source waste management to specialist companies.

Data on trends in employment in waste management are ambiguous. Industry experts indicate that there is a general trend towards reduced but higher quality employment, as processing technologies become more sophisticated and productivity increases. This trend for lower employment per tonne of waste may, however, be compensated by a growth in absolute waste quantities and potentially by increasing levels of control over waste disposal. Unfortunately, a lack of data makes interpretation of trends over time difficult.

Neither the statistical data nor the specialist studies indicate a consistent relationship between volumes of waste and numbers of jobs. However, there seems general agreement that the most labour-intensive activities are manual sorting, some separate collection processes and waste and scrap wholesale. The least labour-intensive activities are landfill, incineration and composting, together with most forms of collection.

8.3 Opportunity Costs in Other Economic Sectors

8.3.1 Opportunity Costs for the Chemicals Sector

During the 1990s, a number of waste management policies were adopted at EU level with potential impacts on the chemicals industry. Over this period, waste-related investment accounted for between 1% and 5.4% of total investment, and remained fairly constant whilst other investment reduced. Waste-related operating costs range from 0.2-1.7% of net sales. This level is unlikely to have had a significant impact on profits or on employment (which reduced significantly owing to productivity improvements).

There are an estimated 5,700 to 11,300 waste-related jobs within the European chemical industry. There is little evidence that waste management measures have increased the numbers of such jobs; the trend-towards out-sourcing may even have reduced the numbers employed. This reduction may have been compensated by increased investment and employment in the waste management sector. Based on the limited information available around 5,000 jobs may have been created in hazardous waste management.

Based solely on consideration of the industry's expenditure on waste-related goods and services, the E3ME model calculates the change in employment and GDP that would arise if all of this expenditure were met through increases in prices for chemical goods. The calculated change is a drop in total employment of 18,000 jobs across the EU over the period from 2000 to 2005, with this representing less than 0.01% of the EU total; GDP is also predicted as falling by less than 0.01%. These figures should be viewed with some caution; they exclude jobs created in hazardous waste management and potential eco-efficiency gains.

8.3.1 Opportunity Costs of Policies on Waste Electrical and Electronic Equipment

Whilst EU Directives on Waste Electrical and Electronic Equipment (WEEE) are still at the proposal stage, broadly similar legislation concerning WEEE has already been implemented in the Netherlands. The Netherlands legislation allows industry to fulfil its responsibility for collection and re-processing of WEEE either individually or collectively; in practice, almost all companies have signed up to collective schemes. The available data on the Netherlands indicates that WEEE-related operating costs account for well below 0.5% of turnover for electrical and electronics companies. As the costs of the scheme are re-charged to consumers in the form of a levy on prices of new products, they are unlikely to have a significant impact on profitability. Investment costs for the electrical and electronics industry are minimal. Because of the way the collective schemes are organised, the majority of the investment costs have been born by the transport and recycling firms contracted by the schemes.

Data on the employment effects of the Netherlands legislation are limited. The consensus is that few, if any, jobs have been created, other than a small number in local authorities. Additional employment in administration of the collective schemes has been minimised to reduce costs. Meanwhile, the organisation of the collective schemes has resulted in significant consolidation in the recycling sector, with the displacement of small organisations, including social welfare organisations. The loss of jobs in these small organisations has probably been offset by increases in employment in the larger firms to deal with additional throughput of WEEE.

The E3ME model was used to model the macroeconomic implications arising from adoption of WEEE legislation across the EU, based on the approach taken in the Netherlands. The policy is predicted to increase employment, with a total gain across the EU of roughly 2,900 direct jobs after five years. Added to this are a further 2,000 plus jobs resulting from multiplier effects. There would also be net increases in GDP across Europe as a whole. Again, these figures should be viewed with some degree of caution due to data uncertainties and model assumptions.

8.3.3 Opportunity Costs in the Secondary Metals Industry

Under Council Regulation (EEC)259/93 on the supervision and control of shipments of wastes, the level of control imposed depends on the intended treatment, its destination and its inclusion on three lists that distinguish waste according to its degree of hazard (green/amber/red lists). Exports of amber and red listed wastes outside the OECD are banned, whilst green listed wastes are subject to different controls. Most non-ferrous scrap metals traded internationally are green listed, but some are amber listed.

The Regulation may have both positive and negative impacts on employment. It has been suggested that many secondary metals companies have hired additional staff to deal with the extra administration and legal issues arising from the Regulation, potentially generating over 6,000 additional jobs. However, the extra burden of administration and delays in trade due to additional notification procedures may have contributed to contract failures and deterred some companies from trades with certain countries.

Modelling using E3ME of a hypothetical situation, where there is no international trade in amber-listed metals suggests that an initial gain of over 6,000 jobs will change to a loss of nearly 2,000 jobs in total EU employment five years later. (In reality there is only a ban on trade to non-OECD countries). Impacts on GDP are negative in each of the five years, with the greatest impact occurring in year two (a predicted decrease of €390 million). Given the non-realistic basis for the modelling, as well as the data uncertainties, these results should also be viewed with caution. In addition, the effects of waste legislation may be masked or seem overstated by market developments unrelated to regulation.

8.3.4 Overall Conclusions

The three case studies suggest that waste management policies, in the three sectors studied, have so far had limited direct effects on total employment. Few additional waste-related jobs appear to have been created in either of the three sectors and the impact of waste management measures on operating costs seems unlikely to have had a significant effect on overall employment in the sectors.

The macroeconomic modelling has indicated that, for each of the three sectors studied, the impact of increases in waste-related expenditure has resulted in additional indirect and induced impacts on employment and GDP. For the chemicals and metals sectors, these result in an overall loss of jobs and a reduction in GDP through increased product prices and reduced world market share. For WEEE, the overall impact is a minor increase in jobs and GDP.

8.4 Integration of Employment and Wider Effects into Appraisals

8.4.1 Comparison of the Estimates Generated through Different Approaches

In order to assess how employment and other wider effects might be incorporated into appraisals of waste management policies, a simple assessment was undertaken to highlight the differences in estimated employment and GDP effects that might arise through the use of the supply-side, demand-side and macroeconomic analysis. As expected, the differences between the predictions are considerable. The supply-side and demand-side figures reflect only direct and first order indirect employment creation. They do not consider the negative macroeconomic effects that arise from reduced investment/expenditure on other goods and services. Only by expanding the analysis to the macroeconomic level can the influence of changes in output or price increases, changes in investment and changes in consumer spending be added into the analysis.

This comparison raises questions as to the appropriateness of the different approaches in different decision contexts. Our general conclusion is that for some waste policies a CBA alone will be sufficient to capturing the total economic effects, and that this can then be supplemented using the simpler supply- and demand-side methods to provide an indication of direct (and indirect multiplier) employment effects. However, given that waste management forms an integral part of the costs of productions faced by most sectors in the economy, a policy that would lead to significant changes in waste related activities or costs and, thus, have impacts at the macroeconomic level will require a more sophisticated analysis of total employment and GDP effects. This is likely to be best achieved through the use of macroeconomic models, such as the E3ME model, which can reflect changes in both supply and demand relationships within the economy. The employment effects can then be presented alongside the CBA results; similarly the GDP effects could be presented alongside or integrated into the CBA results.

8.5 Links Between Employment and Waste Management

A key finding is that the relationship between waste management policies and employment is more complex than the simple hypotheses outlined in Section 1 would imply. Although waste management policies may increase demand for waste management services, this does not necessarily result in additional jobs. Instead, technology substitution for labour, increased productivity and consolidation in the waste management sector may severely constrain job creation. Unfortunately, data on trends in waste-related employment are inadequate to determine the net effect.

Certain waste management jobs, especially in manual sorting for recycling, are clearly of poor quality but may provide a route into employment for the socially-excluded. Experience with WEEE policy in the Netherlands, though, indicates that waste management organisations focussed on the socially excluded may be forced out by industry consolidation even as the level of recycling increases. Evidence from other studies (for example AK Wien, 2000) also indicates that such jobs may not be socially sustainable because of factors such as their increased health and safety risks.

The three case studies indicate that the impact of waste management policies on the competitive position of the sectors they regulate has been limited to date. Companies subject to regulation naturally act to minimise the costs of compliance and there appears to be a very limited effect on profitability or employment. Some companies also appear to have achieved significant efficiency benefits by focusing on waste minimisation.

Overall, therefore, the study demonstrates that waste management measures are likely to have only a small effect, positive or negative, on employment and the economy more generally. The detailed manner in which a policy is implemented is most likely to determine the direction and scale of the effect, and this is often the hardest aspect to predict.

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ANNEXES 1 TO 6

CONTENTS - ANNEXES

Abbreviations

CBA	-	Cost-benefit analysis
CEA	-	Cost-effectiveness analysis
GE	-	General equilibrium model
FTE	-	Full time equivalent
GDP	-	Gross domestic product
I-O	-	Input-output model
MSW	-	Municipal solid waste
NVMP	-	The Association of Metal Producers
PACE	-	Pollution abatement cost estimates
WEEE	-	Waste electrical and electronic equipment

A1.1 APPROACHES FOR ASSESSING EMPLOYMENT AND WIDER ECONOMIC EFFECTS

A1.1 Introduction

There is a range of approaches that could be adopted for incorporating data on the employment and wider macroeconomic effects of a proposed policy into regulatory appraisals. These vary from reliance on current waste and economic growth statistics to the application of sophisticated predictive modelling techniques. However, the appropriateness of adopting the different approaches varies, depending on the nature of the waste management policies in question and the availability of data.

This annex provides a more detailed review of the available approaches, highlighting both their advantages and drawbacks. This review starts with the treatment of such effects within CBA, and then examines the use of the alternative supply- and demand-side approaches.

A1.2 Economic Efficiency and Wider Economic Effects

A1.2.1 Efficiency and Employment Effects

The theory underlying the application of CBA (and CEA) is that of neo-classical welfare economics[1]. As part of the theoretical underpinnings to such analyses, it is assumed that no social costs arise as a result of unemployment. The reasons for this relate to assumptions that:

- the economy is effectively fully employed;
- any measured unemployment is the result of the need to match changing demand for labour to a changing supply;
- because of the need to match skills with changes in demand, there will be periods when individuals can anticipate that they will be out of work as they move from job to job; and
- such periods are reflected in employment contracts and in unemployment benefits, there is no cost to society from the existence of a pool of unemployed workers.

In reality of course, many economies are far from conforming to the definitions of a well-functioning and stable economy at full employment. In addition, employment contracts and unemployment benefits may not fully reflect social costs. As a result, examination of employment effects may be important when a policy is likely to result in significant changes in demand for the services produced by either one or a number of sectors. Where significant changes in sectoral demand would result, there may also be net increases or decreases in employment across the economy as a whole. For

1 See also OECD (1992) for further discussion on the theory and practical application of CBA.

example, where a policy results in increases in demand for more labour intensive goods and services, new jobs may be created in order to meet production requirements.

When a policy creates a job, it has a benefit to society to the extent that the person employed would otherwise not have been employed (with the reverse being the case if with the loss of a job). The benefits of employment, therefore, are equal to the social costs of unemployment avoided as a result of a policy. The magnitude of these benefits will depend primarily on:

- the period that the person will be employed;
- what state support is offered during any period of unemployment; and
- what opportunities are available for informal activities that generate income or cash in kind.

In addition, unemployment is known to lead to health problems, which have to be considered as part of the social cost.

To estimate benefits, figures are required on the number of jobs that would be created or lost by introducing a policy. This should include measure of the direct, indirect and induced effects if the total change in employment is to be accounted for. Once these figures are available, it is possible to place a monetary value on them. Theoretically speaking, the economic benefit, or welfare gain, arising from an additional job is defined as:

- the gain in net income as a result of the new job, after allowing for any unemployment benefit, informal employment, work-related expenses, etc., minus

- the value of the additional time that the person has at his or her disposal as a result of being unemployed, which is lost as a result of being employed, plus

- the value of any health related consequences of being unemployed that are no longer incurred.

Because deriving estimates for each of these factors may be difficult, wage rates are often used as a proxy for this value. In order to correctly reflect welfare gains, the wage rate used for this purpose should reflect the opportunity costs of labour. In economies where social policy subsidises certain types of labour, market wage rates may not equate to the opportunity costs of labour[2]. However, within the EU there is considerable mobility of labour and relatively low levels of structural unemployment, so the market wage rate is likely to act as a reasonable approximation of the opportunity cost of labour (i.e. it will reflect the value of output foregone if the labour was engaged in other productive activities). Thus, in the context of this study, market-clearing wage rates can act as a measure of the welfare gains or losses caused by changes in employment arising from the changes in waste management policy.

2 For example, this may be the case in a developing country context.

However, it must be recognised that direct changes in labour costs should be captured by a CBA in any event. Such changes will form one aspect of the estimated costs to producers and consumers of complying with a new policy. In other words, they will be included in estimates of any the capital and operating expenditure required to meet the requirements of a change in policy. As a result, adding a further sum to the estimated compliance costs to reflect changes in employment will result in double counting for any direct employment changes and for those indirect changes stemming from compliance related expenditure. This problem will be compounded if separate estimates are also prepared on the wider economic effects (indirect and induced) stemming from changes in demand and supply relationships (see Section 2.2.2).

The alternative is to measure and present data on changes in employment in terms of the number of jobs created or lost. Such changes, whether positive or negative, can be estimated using a number of different approaches. For the purposes of this study, these have been grouped into three categories (based on OECD, 1997):

- **Supply-side approaches**: these rely on the use of current employment data, for example tonnage of waste treated per full-time job equivalent, to estimate the number of jobs to be created by a change in policy;

- **Demand-side approaches**: these predict the number of jobs that will be created as a reult of a new investment or increase in demand for the goods and services provided by a particular section (e.g. the waste management sector); and

- **Macroeconomic approaches** (econometric and general equilibrium models): these estimate the net changes in employment that will occur as a result of changes in both demand and supply relationships.

All three types of approach can provide estimates of the direct effects on employment of a proposed policy. This may relate to the creation of new jobs in the waste management sector or in other sectors that must add staff to meet new requirements. It may also relate to the direct loss of jobs, where waste management shifts from one type of activity to another (e.g. landfill to waste recovery). In the latter case, the loss of jobs in one activity may be offset by gains in employment in another activity. Thus, waste management policies can have wither net positive or net negative direct effects.

However, the impact of creating a net number of new jobs may go beyond the direct gains to those taking those jobs. As a previously unemployed person takes a new job, his expenditure on other goods and services increases, with this in turn leading to an increase in demand for those goods and services, and so on. The result may be the indirect creation of jobs, which can in turn result in changes in consumption, with these induced changes in consumption commonly referred to as the multiplier effect[3].

3 It should be noted that the multiplier effect is based on the assumption that there is a shortfall of demand in the economy, thus implying that current macroeconomic policy is incorrect. If macroeconomic policy was to correct to shortfall, then no multiplier effect would be observed as a result of changes in environmental (or other sector) policies. Instead, environmental policies would result only in the transfer of activities between sectors and not the net creation or loss of demand and

Of note in this regard is the potential importance of the creation of large numbers of fairly low wage jobs as a result of changes in waste management policies. Because those on lower wages spend a higher proportion on their income (the marginal propensity to consume) that those in higher earning occupations, increasing the number of lower wage jobs available can lead to relatively higher levels of spending throughout the economy.

Thus, a policy may lead to a series of net changes in employment, where these may include direct employment, indirect (first order) employment or induced employment. As indicated in Table A1.1, the different approaches can capture the indirect and induced employment effects to varying degrees.

Table A1.1: Approaches to Assessing Employment and Wider Economic Effects

Approach	Scope of Analysis	Methodology	Data Sources
Expanded CBA	Wider effects but variable, depending on the positive identification of linkages	Analysis of microeconomic data; partial equilibrium analysis	Survey data and statistics
Supply-side Approaches	Direct positive or negative employment effects	Analysis of microeconomic data and job losses surveys	Survey data
	Direct and indirect positive or negative economic growth effects	Analysis of microeconomic data, investment and growth surveys	Survey data
Demand-side Approaches	Direct positive employment effects	Calculation of manpower per unit of expenditure	Statistics on jobs per unit of expenditure
	Direct and indirect positive employment effects	Input-output and multiplier based calculations using changes in final demand	Statistics on environmental expenditures and input-output tables
Econometric Models	Net employment and GDP effects of environmental expenditures	Behaviour equations used to link changes in expenditure to changes in inter-sectoral supply and demand	Econometric models and input-output equations
Computable General Equilibrium Models	Net employment and GDP effects of environmental measures	Modelling of long-run changes in supply and demand equations until all markets reach equilibrium	Detailed data on inter-sectoral linkages, including input-output data

Source: Based on OECD, 1997 (pg 22)

A1.2.2 Efficiency and Indirect Effects on Related Markets

In addition to having net employment effects, waste management policies can also have wider economic effects. When a waste management policy has significant impacts on the costs of production faced by one sector, then this may also effect the

hence employment. The implication of this is that such shortfalls in demand would be better corrected through changes in macroeconomic policy than through environmental or other policies.

demand for the goods and services produced by one or more other sectors. Such shifts in demand can have a significant affect on the prices faced by consumers in these other sectors, which in turn can have an impact on the supply and demand relationships across the economy more generally.

Box A1.1 illustrates why such impacts may arise. In this example, it is assumed that the introduction of a new policy on hazardous waste management increases the costs of consuming a good, say a chemical that acts as an input to production. In response, demand for the primary chemical decreases and demand for a non-hazardous substitute increases. The market for this non-hazardous substitute is a related market, and as demand shifts outward for this substitute, the price which producers are able to charge also increases. This increase in price leads to a transfer in welfare from consumers of the substitute to producers, but overall there is a net loss in welfare.

The degree to which such losses in welfare are significant and, thus, will need to be taken into account in a policy appraisal will depend on the magnitude of the price changes in the related markets. These in turn will depend on the nature of the supply and demand functions underlying those related markets. The easier it is to substitute one good for another (i.e. the more elastic are the supply curves in the related markets), the less importance that needs to be placed on consideration of related markets. The less easy it is to substitute one good for another, the more important consideration of price effects and, hence, wider economic impacts will be[4].

What are the implications of the above analysis on the need to examine the wider economic effects of waste management policies. Because CBA is a partial equilibrium analysis, it assumes that prices in related markets are unaffected. Use of CBA to estimate the welfare effects of a policy is, therefore, appropriate in those cases where a policy would affect a good which has ready substitutes (in such cases, changes in supply and demand in the primary market will capture the majority of any changes in welfare). In such cases, prices in the related market(s) should not be significantly affected by the change in policy. As a result, focusing on the directly affected sector and, perhaps, one or two key related sectors should provide a good estimate of the total welfare effects arising from the policy.

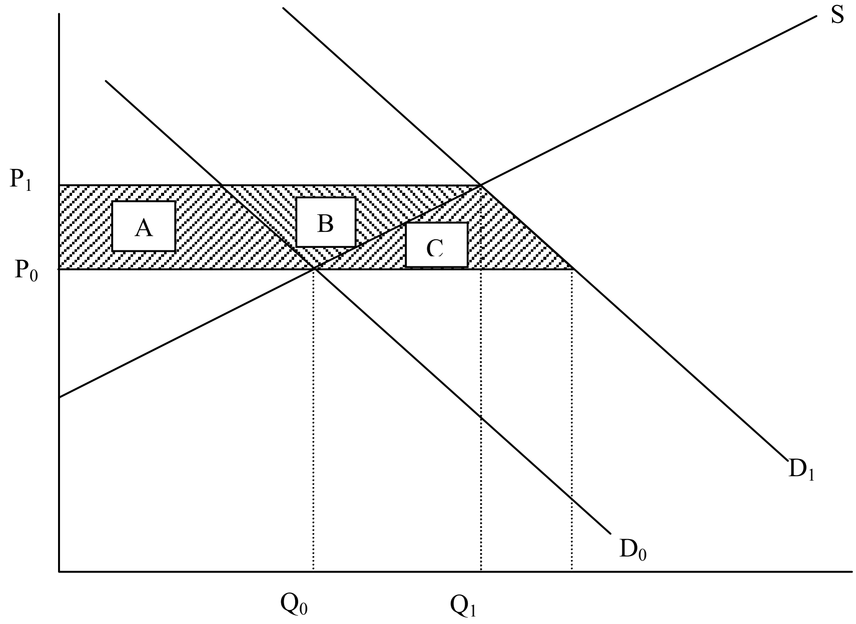
However, the greater the expected impact on prices in related markets, the more important it is likely to be to apply one of the more sophisticated modelling approaches listed in Table A1.1, and in particular either econometric or general equilibrium models. Indeed, waste management is often highlighted as a key environmental policy area requiring such analyses for the full economic effects of a proposed policy to be understood (Fankhauser & McCoy, 1995). The argument is that unless the negative impacts which such policies may have on the demand for goods in other market sectors are understood, the benefits of such policies may be considerably overestimated.

4 For further discussion as to when it is important to go beyond the directly affected markets in an environmental policy context, see Arnold (1995, pg 84).

Box A1.1: The Impact of Regulation on other Markets

Consider a policy that is aimed at reducing the quantities of hazardous waste produced by a particular industry sector. Assume that a regulation is introduced that means additional procedures are required in the handling and treatment of a specific hazardous substance. The companies affected by this regulation are able to switch instead to a substitute substance that produces less hazardous waste and, hence, reduces costs and improves environmental requirements.

The substitute is sold in what is called a related market, in that demand for this good is related to demand for the regulated substance. When the supply curve for the substitute good is not perfectly elastic, then an increase in demand for the substitute will lead to an increase in the price (as indicated below). This increase in price is inconsistent with the demand curve developed for the regulated substance which assumed a constant price for the substitute (the assumption of *ceteris paribus* underlying partial equilibrium analysis.) As the prices in the related market changes, this causes a shift in the position and (potentially) shape of the damand curve for this market. When such changes in damand occur, there will be welfare effects (transfers from demanders to producers).



Consider the demand and supply curves in this related market. As the supply curve for the substitute is not perfectly elastic, price rises when demand increases. The post-regulation demand curve for the substitute is D_1. This is the demand curve that is used to measure the welfare effects arising from the higher price being charged in this market as a result of the increased costs of using the regulated substance. In this case, demanders of the substitute substance lose areas A, B and C and producers gain B and C. The net social cost of this induced price increase is measured by area C.

The implications of this analysis are that where markets that are undisturbed by any regulation – in the sence that their demand and supply curves do not shift – then consideration of related markets is not necessary and a partial equilibrium approach will capture all welfare effects. Where related markets are affected by a change in another market – in the sense that their demands (or supplies) shift in response to price changes in the primary market – then the impacts on these markets must also be examined if the total welfare effects are to be calculated. The easier it is to substitute one good or service for another (i.e. the more elastic the supply curve), the less important consideration of related markets is likely to be.

Source: Adapted from Arnold, 1995

The above discussion implies that in order to determine whether the total effects of a policy are positive or negative, then consideration of indirect and induced economic effects may be important for waste management policies when the following hold:

- the waste management policy affects a highly integrated good or service (widely demanded by most other sectors with the economy), meaning that increases in costs arising from this policy to the waste sector may affect the costs of production experienced by other sectors where these are passed on to 'users' of the waste management services;

- however, waste management costs would need to comprise a significant proportion of the manufacturing costs faced by the 'user' sectors so that the increases affected the supply curves for these markets and the prices in related markets; and

- where the change in policy has no technology forcing or 'market consolidation effects' on either the waste management industry or those sectors calling upon the waste management services affected by the policy.

With regard to the above rules, it should be recognised that failure to adopt an approach which will take such impacts into account when they are significant may result in a considerable miscalculation of a policy's net economic effect. At the simplest level, it may fail to take into account the types of indirect welfare losses illustrated in Box A1.1. It may also lead to the failure to identify cases where investment in waste management might forestall other, more growth-generating investment. Such 'crowding-out' of investment (and hence the creation of new employment opportunities) has led to numerous claims by industry and others that environmental policies are damaging economic growth and employment; although the research carried out on this question reaches varying conclusions [see for example Morgenstern, Pizer & Shih (2000) with regard to jobs versus the environment and Gray & Shadbegian (1994) with regard to productivity effects].

The picture then is complex within the context of waste management. In many cases, the traditional boundary adopted in CBAs of focusing on the directly affected sectors and perhaps one or two indirectly affected (or related) markets will be sufficient. However, the more sophisticated demand-side approaches or macroeconomic modelling approaches may be needed in other cases to gain a better understanding of the likely impacts on other sectors of the economy.

For this reason, the characteristics of the different approaches listed in Table A1.1 are described in more detail below.

A1.3 Extension of the Partial Equilibrium Framework of CBA

When the CBA of a policy is based on appropriate measures of the opportunity costs arising from its introduction, then the estimated net present value of a policy should include all direct costs and benefits. As noted above, however, this focus on directly affected markets may fail to take into account significant welfare effects arising in other related markets.

One approach to rectifying this situation is to extend the CBA to cover all of the related markets that may experience significant changes in supply and demand relationships (USEPA, 1999). This would involve determining the changes in demand that would occur in these relating markets and calculating the corresponding changes in welfare. The estimated change in welfare (whether positive or negative) would then be added to those estimated for the directly affected sectors to derive estimates of the total economic costs of the policy.

Firstly, it should be noted that this type of approach will not address employment issues, only impacts on related markets. In addition, prior to gaining information on all of the related markets with regard to their underlying supply and demand relationships, it may be difficult to set the boundaries for the analysis. It may be particularly hard to specify the boundaries where a waste management policy may result in significant shifts in activity. This suggests that specifying what should be examined is likely to be problematic for those commissioning the CBA. Indeed, earlier work (RPA, 1999) has highlighted the difficulties faced by those preparing CBAs in accounting for the full range of direct costs and benefits (where these include environmental and health effects).

A1.4 Supply-Side Approaches

As noted in Section 3 and discussed further in Annex 3, a range of data is collected from industry on the number of people employed in various waste management activities. This includes data on the volume of waste processed per employee for a variety of different waste management activities.

Use of this data to predict the number of jobs that will be created or lost owing to a change of policy forms the first of the so-called supply-side estimation approaches. It is termed a supply-side approach because it is using actual data on the existing supply of labour to meet a given demand. So for example, assume that a policy would shift waste management from a landfill-based approach to a recycling-based approach. The net change in employment would then be calculated by comparing the relative employment per unit of waste data for landfill versus recycling for the volume of waste affected. Say that existing data suggest that one job is created for every 1,000 tonnes of waste going to landfill, while 1.5 jobs are created for every 1,000 tonnes going to recycling. If the policy were to affect 10,000 tonnes of waste, then the recycling policy would be estimated to result in the creation of five new jobs based on current data.

The key difficulties in adopting such approaches are:

- a lack of reliable data as to current levels of direct waste related employment upon which to base any predictions;

- definitional problems as to who is included in current statistics, as different definitions are adopted in different countries;

- related to the above two points, there are problems in moving from direct to indirect employment as the latter is captured by the data even less often; and

- the need to adjust the data to reflect differences between past policies and the manner in which new policies are likely to be implemented, given that such differences can have a significant effect on employment levels.

The waste-related employment data presented in Section 3 of this document could essentially provide the basis for undertaking a supply-side analysis of the impact of past regulations (*ex post)* and of proposed changes in policy (*ex ante*) on employment in the various waste management activities. However, the discussion notes the significant definitional and boundary problems involved in trying to estimate the number of jobs connected with different waste management 'supply' services. Aside from these problems, such data - based as it is on previous policies and responses to them - may also be a poor predictor of how those supplying waste services may respond to future regulations. Technological innovation and changes in market structures (e.g. consolidation in the recycling industry) are key factors affecting the predictive ability of past data.

It should also be noted that this type of approach cannot capture any of the induced employment effects arising from job creation, nor will capture any negative indirect effects arising from the losses of jobs as a result from changes in activities.

The use of supply-side data may, however, provide rough order-of-magnitude estimates of the direct employment effects arising from a change in waste management policy. Where the use of more sophisticated methods is constrained, this may be better than no data on the likely effects.

A1.5 Demand-Side Approaches

A1.5.1 Overview

With regard to the demand-side approaches, three different forms of demand-side analysis for calculating direct and indirect economic and employment effects can be identified:

- approaches based on the use of input-output models to predict direct and indirect output and employment effects.

- approaches based on the use of multipliers, ranging from the use of engineering based manpower requirements per unit of expenditure ratios, or income and employment multipliers (derived from input-output tables); and

- approaches based on the use of econometric analysis to predict the changes in productivity caused by environmental regulations 'crowding out' other expenditure.

These three forms of analysis are discussed further below. This discussion starts with the use of input-output models, then proceeds to the use of multipliers derived from such models, followed by a discussion on the use of manpower to expenditure ratios. Finally, a brief overview is provided on the use of econometric analysis to predict the negative effects which environmental regulations have had on industry and hence economic productivity.

A1.5.2 Input-Output Models

The key purpose of input-output (I-O) models is to provide a systematic description of the interdependencies that exist between sectors in the economy and, by so doing, to enable recording of the transactions that take place between different sectors. For example, the production of electrical goods requires a range of other inputs, such as energy, raw materials, chemicals, engineering equipment, as well as transport and other services required for distribution of the goods to consumers. In turn, the production of energy, raw materials, engineering equipment, etc. require a number of inputs including electrical goods.

I-O models map these flows of between sectors and indicate, for any one sector, how much input from other sectors (and in what proportions) is required to produce a unit of output. As a result, they can be used to examine how changes in the total output of one sector (or in household consumption or government expenditure) is likely to impact on the demand for inputs from other sectors (including labour).

Since their first development, I-O models have been used to address not only economic linkages but also economic-employment linkages. The primary purpose of economic-employment models is to examine how a policy which will affect either the level or structure of demand (for a given set of goods or final demand for the economy as a whole) will affect the demand for labour. They enable both changes in the direct and indirect demand for labour to be predicted.

It is relatively straightforward to expand an I-O model to incorporate employment, as it is simply treated as primary inputs. For example, once final sectoral output has been determined, these figures can be translated into employment. This is based on developing a matrix reflecting industry-occupation relationships and corresponding employment/output coefficients from data on manpower requirements, man-hours, and productivity within each sector (OECD, 1997).

Also of relevance to waste management policy development is that I-O models can be used to assess both the direct and indirect effect of controlling waste by-products from economic activities. This is done by incorporating waste products (including emissions or discharges to the environment) into the model. In the waste management context, the first step would be to work out the contributions (direct and indirect) of each sector to waste arisings. Then through manipulating different sectoral output levels, one would predict the structural adjustments necessary to meet reductions in arising, such as a 30% cut in hazardous waste streams. An example of how such an approach was applied to analysing alternative strategies for reducing carbon dioxide emissions is given in Proops *et al* (1993 - as described in Frankhauser & McCoy, 1995).

I-O models obviously provide a means of examining the employment implications of adopting alternative waste management policies. Their use as a supplement to a CBA based regulatory appraisal is appropriate when:

- a policy would be likely to affect not only supply and demand in the directly affected sectors but also in related markets; in addition, the expected changes in prices in the related markets would need to be significant. Note that waste management policies are often cited as key examples of where these conditions are likely to be met (Frankhauser & McCoy, 1995); and

- where a detailed analysis of impacts at a sectoral level is desired (as opposed to less detailed macroeconomic indicators of change).

I-O models can be used to compare two distinct states of the economy; pre-policy intervention versus post-policy intervention. The difference between the two 'states' represents the net economic effect (expressed in terms of a change in output) of implementing the waste management (or other) policy in question. These estimated net economic effects could then be added to estimates of the compliance costs falling on the target sectors for inclusion in an expanded CBA-based framework. This would allow the wider economic effects to be taken into account in comparing the total costs and benefits of a proposed waste management policy.

While I-O models provide a useful means of describing the interconnected nature supply and demand relationships across an economy, they have a number of shortcomings. Most of these stem directly from the need to contain a large range of production information at the sectoral level. Key shortcomings (see also: OECD, 1997; and Hufschmidt, 1990):

- there is no ability within these models to determine how demand for a sector's output may respond to changes in price;

- no flexibility in production is allowed for, as fixed relationships are assumed concerning the inputs required to produce a given unit of output; this raises further problems in economic-employment and economic-environment models, as fixed coefficients do not accurately describe real production relationships and enable substitution effects (e.g. the substitution of labour for other inputs as relative prices change) to be taken into account. The use of fixed relationships also implies that marginal outputs in an industry require the same proportional mix of inputs as does the average unit of output; and

- owing to the fact that the models fail to take into the impacts of changes in relative prices on the demand for the various factors of production (labour, energy, raw materials, etc.), they ignore several relevant channels of indirect employment effects. These include effects stemming from price and wage adjustments, induced consumption effects of the incremental employment (i.e. the multiplier effects), and induced investment or accelerator effects.

A1.5.3 Multiplier-Based Approaches

Multipliers are essentially numbers which provide a measure of the degree to which a change in direct output or direct employment will result in additional changes in output or employment, through further rounds of spending. For example, employment multipliers reflect the following process:

- the introduction of a new policy, results in expenditure and, hence, new jobs;
- a previously unemployed person taking one of the new jobs will now increase his/her own expenditure on other goods and services (housing, food, clothing, etc.);
- this increased expenditure on (and hence demand for) housing, food and clothing creates additional new jobs in these sectors, resulting in further increases in income and expenditure and, thus, another round of additional new jobs; and so forth until the additional income is too small to lead to sufficient increase in demand to lead to further new jobs being created.

It is important to note that multipliers are often derived through the manipulation of input-output tables, with the aim of providing an alternative means of capturing the (positive) direct, indirect and induced effects of changes in final demand for particular goods and services (Abelson, 1996). They can provide, therefore, an indication of how a waste management policy, involving new expenditure and/or new jobs, is likely to impact on output or employment across the whole economy.

Output and income multipliers provide a measure of the change in total output and income that will result for some change in expenditure (e.g. spending on the capital costs of new technologies) or in direct income (e.g. the introduction of an economic instrument such as product taxes or subsidies). Employment multipliers provide a measure of the change in employment that will result from changes in direct employment levels. Box A1.2, overleaf, provides a more detailed explanation of how multipliers operate.

In practice, multipliers at different levels to account for varying degrees of indirect effects and induced effects. For example, with regard to output multipliers[5]:

- Type I multipliers provide a measure of the sum of the direct and indirect (first order) effects on the change in output resulting from a unit increase in final demand; while

5 There are also Type III multipliers, which are a modified form of the Type II multiplier. They are modified with the aim of minimising any potential over-estimation of effects that may occur by assuming linear relationships, for example between consumption and income.

- Type II multipliers take into account the changes in consumption generated by higher personal incomes that will result from the increases in direct and indirect output; they, therefore, provide a measure of the sum of direct, indirect and induced (e.g. second and third order) output changes resulting from a unit increase in final demand.

Within the context of waste management, the use of a Type II multiplier instead of a Type I may be important. This is because the Type II multiplier, by accounting for direct, indirect and induced effects, will take into account changes arising from activities such as the sub-contracting or contracting-out of services. In addition, Type II multiplier are better able to capture the effects of increased specialisation over time, which may be ignored by Type I multipliers. Because waste management is characterised by both sub-contracting and the specialisation of services, both of these factors may be important when assessing the introduction of a new waste management policy. As a result, the use of Type I multipliers which only cover direct and indirect (first order) effects may incorrectly calculate the end impacts.

Box A1.2: Multipliers and the Marginal Propensity to Consume

Multipliers operate as follows, assuming a standard consumption function represented by[6]:

$$C = \overline{C} + cY$$

If it is then assumed that a waste management policy results in an increased demand for new technology, this then translates to an increase in investment or autonomous expenditure (denoted by $\Delta\bar{A}$). Production has to expand to meet this increase in demand with output then also expanding by $\Delta\bar{A}$. The increase in production gives rise to an equivalent increase in income which, in turn, results in secondary expenditures equal to $c\Delta\bar{A}$.

Production again expands to meet the increase in spending. The corresponding increase in production, and then income, is $c\Delta\bar{A}$. This gives rise to a further round of secondary spending equal to the marginal propensity to consume times the increase in income, in other words:

$$c(c\Delta\overline{A}) = c^2\Delta\overline{A}$$

Since the marginal propensity to consume is less than 1, the term c^2 is less than c. Secondary expenditures in round three are therefore less than in round two.

The total change in income for successive rounds of increased secondary spending is given by:

$$\Delta AD = \Delta\overline{A} + c\Delta\overline{A} + c^2\Delta\overline{A} + c^3\Delta\overline{A} + ... = (1 + c + c^2 + c^3 + ...)\Delta\overline{A}$$

As c is less than 1, the total value is a decreasing geometric series, the sum of which is equal to:

$$\Delta AD = \Delta\overline{A}(1 - c)^{-1} = \Delta Y$$

Therefore, the cumulative change in aggregate output is equal to a multiple of the increase in autonomous spending. The multiple, $(1\text{-}c)^{-1}$, is the multiplier[7], the size of which is directly proportional to the size of the marginal propensity to consume.

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6 Lower case *c* is the marginal propensity to consume and *Y* is output. The marginal propensity to consume is the increase in consumption per unit increase in income.

Although multipliers provide 'order of magnitude' estimates of the growth in output or income resulting from the capital expenditures stemming from a new policy, they tend not to be included in CBAs[8]. The argument for not including output/income multiplier effects is that induced or secondary benefits are generally viewed as transfers within an economy rather than net additions to the productivity or income of that economy (Abelson, 1996). This argument for ignoring induced effects is based on the presumption that resources are essentially fully employed, and any unemployed resources are completely mobile and are distributed evenly throughout the economy.9 If resources are fully employed (or completely mobile and evenly distributed), then the effect of the multiplier is cancelled out as all additional demand must be met by imports. In such cases, there are no secondary economic benefits.

Because the above conditions do not generally hold, however, secondary benefits may occur which reflect more than just transfers within the economy. As a result, examination of multiplier effects may be important. Inclusion of such effects warrants some care, though, as it unlikely that all additional spending will be new and hence a net addition to real output. This indicates that where expenditure is not new, multipliers will overestimate effects on both output and employment.

This is because they ignore any impacts stemming from possible reductions in supply and demand which may occur as a result of a given sector (or consumers more generally) having to fund the expenditure required by the policy. As a result, they do not provide an indication of the net effect of the changes that may filter through the economy as a result of the introduction of a new regulation. Such net effects can only be captured through the use of macroeconomic modelling techniques.

In addition multipliers will change in value as a result of shifts in technology. So, for example, where a waste management policy would lead to such shifts (with end-of-life recovery perhaps being examples of policies leading to such shifts), the application of old-technology based multipliers will lead to incorrect estimates of either total output or total employment effects.

A1.5.4 Manpower to Expenditure Ratios

Related to the Type I multipliers discussed above is the use of manpower to expenditure ratios to predict increases in direct and indirect employment as a result of the new expenditure required by a policy. These are presented separately here as they are generally derived using less disaggregated data than those that are based on formal input-output tables.

In relation to environmental policies, these ratios are generally developed as follows:

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7 It is also possible to express the multiplier in terms of the marginal propensity to save, i.e. 1/*s*.

8 In the above example, the effects of taxes and imports have been ignored. These serve to lessen the increases in demand for domestic output induced by secondary increases in income, and thereby lower the multiplier.

9 It will be recalled from earlier in this discussion, the mobility of labour was cited as one of the underpinning reasons for employment not being taken into account in cost-benefit analyses.

- identifying the types of actions that will be taken in order to implement a new policy (e.g. adoption of pollution abatement equipment or construction of a recycling facility);

- developing engineering estimates of the capital and operating expenditure required;

- linking these estimates to the sectors that would supply goods and services required by the capital and operating expenditure; and

- combining data on the number jobs created per unit of expenditure in each of the sectors supply the goods and services with the levels of expenditure required to determine the number of new jobs created by the policy.

Two recent examples of the use of this type of approach to examine the number of jobs created by changes in environmental policy are given by WRc (1999) and Heady *et al* (2000). The most relevant of these, as it examines waste management policies is the work undertaken by WRc for DG Environment. Manpower to expenditure ratios were used in this study to predict:

- the direct employment stemming from the increased labour requirements associated with operating expenditure (whether stemming from the introduction of new plant or other increased manpower requirements);

- the (first order) indirect employment arising in the industry sectors meeting new capital requirements (where these included the capital goods, construction and service sectors); and

- the (first order) indirect employment stemming from operating expenditure on maintenance, energy, materials and other non-labour from capital expenditure (where new jobs would be crated and operating expenditure.

The argument underlying the use of this approach is that it provides a good reflection of the more tangible employment impacts arising from a policy, and does not confuse these effects with several rounds of downstream effects (i.e. the use of a Type II multiplier). As a result, these ratios result in a better indication of the actual relationships between different environmental policies and employment (and in so doing avoid reliance on assumptions concerning market equilibrium and full employment common to the macroeconomic modelling approaches); the results are outputs that are more policy relevant. The authors accept, however, that the approach has limitations in that the analysis is only partial.

The approach involved the adoption of an engineering analysis building upon the methodology developed by ECOTEC (1997), which categorises the recipients of capital expenditure and operating expenditure for five different types of environmental policies/projects. The recipients were broken into six categories: labour, energy, intermediate goods, capital goods, construction and services. The outputs are a series of relationships indicating the percentage of expenditure that is likely to be spent on the services provided by the different sectors when undertaking different environment-based measures.

The analysis found that for waste the relative expenditure per full time equivalent (FTE) job is lower than for other policy related to air and water. It also highlighted the influence that the strategy adopted for implementing a policy can have to employment creation, with a case study on End of Life Vehicles suggesting that employment effects can vary by a factor of five depending on the nature of the strategy used.

Table A1.2 provides a summary of the expenditure to employment relationships found for the three waste related policies examined by the study. Of note from the table are the capital and operating expenditure to employment ratios implied by the study findings. For example, one FTE job is created indirectly through roughly €115,000 expenditure on capital requirements, with this apparently varying only to small a degree when moving to other environmental policy areas. The picture is more complex with regard to operating expenditure; the average figure of roughly €53,000 for the three waste management policies covers both direct and indirect employment created. From a more detailed review of the findings, however, it can be seen that the direct employment costs are roughly €30,000 per FTE, with expenditure per indirect FTE job created more in line with the figure quoted above for capital expenditures.

Table A1.2: Manpower to Expenditure Ratios for Selected EC Policies

Directive	Expenditure (M Euro - 1995 prices)		Employment related to Capital Expenditure		Employment related to Operating Expenditure	
	Capital	Operating	Total FTEs	Expenditure per FTE[3]	Total FTEs	Expenditure per FTE[3]
Hazardous Waste Incineration[1]	695	40	5 800	119 830	510	78 430
Packaging Waste Directive[2]	28 630	3 820	265 550	107 810	72 020	53 030
End of Life Vehicles	0	880	0	0	17 460	50 460
Total Waste Policies	30 790	4 700	266 050	115 730	90 330	53 310
Total All Policies	260 265	14 690	2 212 925	117 610	218 250	67 310

Source: WRc, 1999

1 Based on the assumption that no new hazardous waste incinerators are built and that the pollution abatement equipment needs to be replaced in all existing facilities.

2 Based on the assumption that all Member States just fulfil the minimum targets at the lowest possible costs. This is a theoretical calculation that does not reflect the empirically found costs of implementing schemes in Member States.

3 The figures for the individual policies were calculated by RPA based on the figures given for total waste and all policies within the various WRc reports.

How good an indicator are such figures as to the real employment impacts of these waste management policies? Firstly, the accuracy of the above figures will depend upon the accuracy and robustness of the assumptions underlying the development of the capital and operating cost requirements. More importantly for the purposes of this study, this modified multiplier-based approach fails to capture induced demand effects, including multiplier effects stemming from increased employment and wage incomes and any accelerator effects resulting from increased investment. This failure to include second order effects may result in either significant over- or under-estimates of employment effects.

In addition, the criticisms noted above with regard to the more formal input-output table based multipliers, also apply to the use of these ratios. In particular, they assume that the expenditure leads to new jobs (as opposed to shifts in employment) and they fail to recognise that expenditure on waste management may result in shifts in spending and income (thus affecting supply and demand relationships in other markets), which may significantly decrease the estimated gains.

A1.5.5 Change in Productivity Estimates

The final form of demand-side analysis is the use of econometric analyses to dervise estimate of the impacts that environmental regulations have had on the productivity of individual industry sectors and, thus, indirectly on the economy more generally. Much of the research concerning this issue has been undertaken in the US in response to business claims that environmental policy damages competitiveness, leading to indirect impacts on economic growth across the economy as a whole. The line of argument is that the compliance costs arising from environmental regulations lead to a lack of investment and, therefore, a reduction in productivity. As a result, there is a loss in both the productivity of and employment by companies in the regulated sector. These losses in productivity and employment then leads to further reductions in investment and consumer spending, which in turn lead to a reduced demand for the goods produced by other sectors and, hence, in economic growth in general.

The research carried out on this issue has reached varying conclusions, although most has concluded that the effects have been minimal[10].

The premise of most of this research has been that estimates of environmental expenditure costs alone are under-predictors of the true costs to companies of environmental regulations. The true economic costs of regulation will vary from compliance costs figures as a result of (Morgenstern *et al*, 1997):

- the adoption of cost-saving innovations (a positive effect in contrast to those that follow);
- changes in operating flexibility;
- the crowding-out of non-environmental investments; and/or
- discouraging investment in new equipment as a result of differential performance requirements for new versus existing plant.

10 See for example OECD (1997) and Worldwatch Institute (2000), Robinson (1995), Gray & Shadbegian (1994) and Morgenstern *et al*, 2000.

The estimation approaches that have been adopted to predict the magnitude of indirect and induced economic effects have generally been based on the use of compliance cost estimates (or Pollution Abatement Cost Estimates - PACE), which are generated through industry surveys or through review of CBAs prepared as part of the regulatory approvals process. Econometric analysis is then used to derive an indication of the relationship between environmental expenditure and total costs, based on industry production function data. The studies themselves produce widely varying results. At the high end is a calculated relationship of $1 in environmental expenditures leading to $12 increase in total compliance costs (Joshi *et al*, 1997), while the low end suggest a relationship closer to $1:$1.13 (Morgenstern *et al*, 1997)[11].

The purpose of such studies varies. Some are aimed at providing a means for more accurately predicting the direct compliance costs implications to industry of implementing new environmental regulations. They therefore address questions related to the potential opportunity costs faced by a particular company or industry sector arising from new regulations. Other of the studies, such as that undertaken by Robinson (1995), are aimed at identifying the sum of direct and indirect costs (as measured by a loss in productivity) to the economy more generally.

However, it should be recognised that these analyses focus on the changes in input demand and hence productivity resulting from investment in compliance costs rather than other factors of production. They do not recognise the full interrelationships that exist within an economy, for example, that investment in pollution abatement (including waste management) increases the demand for the goods and services provided by the environment industry, which may offset decreases in the productivity of the economy.

A1.6 Macroeconomic Modelling Approaches

A1.6.1 Overview

Macroeconomic modelling recognises that the implementation of new regulations by individual companies affects their behaviour as ‘buyers’ and ‘sellers’, which in turn affects their interactions at inter- and intra-sectoral levels. They contrast to I-O models, which often forms the starting point for such models, as they provide more sophisticated representations of the supply and demand relationships within an economy, allowing for price and substitution effects to take place. They also vary from a CBA-based (partial equilibirum) approach in that they model the impacts of a policy intervention in terms of its impacts on the economy as a whole (general equilibrium).

To illustrate the difference between a CBA-based appraisal and the use of a macroeconomic model, assume a tax is imposed on waste disposed to landfill. It is likely that the imposition of such a tax will have impacts beyond the waste disposal industry. Firstly, the increase in waste disposal costs will affect the production costs

[11] See also Gray & Shadbegian (1993), Robinson (1995) and Porter & Van der Lindhe (1995).

and, hence, supply curves (shifting them upwards) of the markets relying on landfill for the disposal of residuals. As prices in these markets rise, demand for their goods and services will fall, inducing a second round of effects on the demand for waste disposal. As demand for substitute goods rises (with the demand curves shifting out and upwards) production inputs will be reallocated across the economy, with this also affecting the earnings attributable to different factors of production (e.g. labour, capital, etc.). Finally, since different actors in the economy may not have the same marginal propensity to save/consume, the pattern of relative demand for different goods and services may change. These changes will result in a new set of consumption levels and product prices, which, in turn, will directly affect the rate of productive capital formation, technological innovation, labour supply, and the economy's dynamic growth path.

When the increase in waste disposal costs would lead to significant impacts on the prices faced by consumers in other sectors, partial equilibrium calculations of the costs and benefits of the tax will give a very poor approximation of the overall impacts of the tax policy[12]. The assumption of *ceteris paribus*, which underlies the use of a partial equilibrium approach such as those adopted in conventional CBAs (and CEAs) becomes invalid (Mishan, 1994). Thus, when a policy induces price changes in related markets (non-marginal price changes), macroeconomic models, because they explicitly model the interactions between markets, give a relatively more accurate picture of the overall impact of a policy.

Two different types of models can be used for analysing effects at the macroeconomic level. These are:

- econometric models which are essentially aimed at predicting macroeconomic performance in relation to a number of key variables such as growth, inflation and unemployment rates; and

- general equilibrium (GE) models that are more concerned with the use of resources and ensuring that they are allocated to generate the highest possible level of output.

A1.6.2 Econometric Models

The first category of macroeconomic model is that of the econometric models, where this includes the EC's model HERMES and the E3ME model used in this study. Econometric models may be either macroeconomic or sectoral in coverage and are essentially applicable to analysing short to medium term policy impacts. They are all highly complex, involving numerous equations and time lags to allow for a dynamic analysis.

The models are generally based upon an accounting framework to which behavioural data are added (OECD, 1997). As with input-output models, changes in final demand

12 It will be recalled from the discussion given above that the more inelastic the supply functions are in the related markets, the more important it is likely to be that a general equilibrium analysis is undertaken rather than a partial equilibrium analysis.

are taken as the starting point but they are then linked to production or input demand functions that incorporate capital, energy, labour and intermediate goods. Through these functions and the associated impacts on demand, prices and real wages, new equilibria are reached for the various sectors. Once these equilibria have been calculated, changes in output and employment can be determined at a sectoral and macroeconomic level.

The main drawbacks commonly noted in the literature surrounding these types of models with regard to the assessment of waste management policies are:

- the forecasting time frame for most models is generally limited to between five and seven years (in order to ensure that the underlying assumptions reflect changes in the structure of the economy). This may be too short a time period for examining the full effects of certain waste management policies as it may not allow for fundamental structural and relative price changes to captured in the end predictions;

- these models do not include any explicit welfare functions to explain individuals' behaviour and thus allow for non-optimal solutions to be found in terms of welfare maximisation;

- because the models do not specifically model changes in welfare (as do CBA or GE models), they rely instead use measures such as changes in gross domestic product (GDP) as a proxy. Such measures of change would therefore need to be combined with a CBA to determine whether a proposed policy would deliver net economic benefits;

- these models assume fixed production relationships that are developed on the basis of time series data. Where a policy would alter these relationships, for example as a result of technical innovation, then the estimated effects will be incorrect (Frankhauser & McCoy, 1995); and

- because of their structure, they are governed mainly by demand rather than supply considerations and, as a result, the model design may set limits to any predicted impacts on unemployment rates; and

- they are commonly criticised for being overly sensitive to assumptions set out in their underlying equations, with uncertainty on key equations resulting in uncertainty over the analysis results.

One of the main advantages of these models is that they are good at providing predictions of big macroeconomic numbers, such as changes in employment. In addition, as they are based on historical, empirical data, they are often more accurate than GE models. In this regard, it important to note that (in contrast to many of the general equilibrium (GE) models) several of the econometric models currently in use (such as the E3ME model which is described in more detail in Annex 2) allow for unemployment and do not assume perfect competition; they also allow for non-linearities between input demand and productivity.

A1.6.3 General Equilibrium Models

In contrast to the econometric models (which are driven by changes in aggregate demand), GE models are driven by changes in price. These models consider both supply and demand interactions (in contrast to the econometric models which focus more on demand), and are capable of dealing with longer planning horizons. As a result, analysts can examine the long-term movements in economic variables as an economy moves towards a new equilibrium. An equilibrium in the economy is achieved at the set of prices that equate supply and demand in every market, with this set of prices being referred to as market-clearing prices. In addition, welfare is explicitly accounted for by assuming that individuals maximise their utility (or satisfaction) for a given level of income.

These models are based on the concepts underlying I-O models, but the system is completed by including all of the relationships needed to represent the entire circular flow of the economy. Choices are then determined within the model (endogenous to it) by allowing some relationships to take a flexible functional form to enable individuals' to adopt optimal responses to changes in prices. Thus, production in each sector becomes a function of input prices and output prices, consumption becomes a function of income and prices, and those prices are determined by the model. The model is then solved to find the level of prices, consumption, and production such that the quantity supplied is equal to the quantity demanded in all markets.

Applied, or computable, GE models are the most sophisticated type of GE models and are capable of quantifying the direct and indirect effects of environmental policies on the structure of the economy and product mix, economic growth, the allocation of resources and the distribution of income. Although there are many examples of CGE models, Zerbe & Dively (1994) suggest that the best 'thought-out' models will have the following elements:

- a description of the utility functions and budget constraints of each household in the economy;
- a description of the production functions of each company in the economy;
- the government's budget constraint;
- a description of the resource constraints of the economy; and
- assumptions relating to the behaviour of households and companies in the economy.

There are also variations in how a CGE analysis is conducted, although most analyses involve the following basic steps (Gramlich, 1990):

1) the baseline, or pre-policy change world is represented by a system of empirical equations describing demand and supply in all relevant markets. This model is subsequently solved, usually by computer, to yield a pre-policy vector of production and consumption prices;

2) the proposed policy change is then modelled by shifting the supply and demand curves appropriately;

3) the model is re-solved, yielding a new vector of production and consumption prices; and

4) finally, the overall net benefit/cost of the proposed policy is determined by examining the difference pre- and post-policy vectors of prices.

Various applied CGE models have been used to assess the implementation of environmental policies, with the results concerning the impacts on employment and GDP indicating in general positive impacts. This is illustrated by the studies reported in the OECD (1985) report on the 'Macroeconomic Impact of Environmental Expenditure', and several more recent studies (described in OECD, 1997). The types of results generated through these analyses for a range of countries are presented in Table A1.3.

Table A1.3: Estimated Macroeconomic Impacts for Various Environmental Investments

Country	Policy	Period	GDP	Unemployment
Netherlands	Doubling annual environmental expenditure	1979-87	-0.3 to 0.6%	+10 000 to -6 000
Norway	Increases in private sector environmental expenditure	1974-83	+0.1 to 0.9%	-25 000 (fall in unemployment)
USA	Additional Federal expenditure	1970-87	-0.7%	-0.4% (fall in unemployment
Belgium Germany France UK	Doubling of environmental investment with policy coordination across four countries	5 years	+0.06 +1.21 +0.90 +0.96	- 18 300 -106 000 - 66 000 -103 000

Source: OECD, 1997

As indicated, CGE models compare two distinct states of the economy; pre-policy versus post-policy. The difference between the two 'states' represents the net (economic) effects of implementing the policy in question on the economy, which can be used to supplement the outputs of a CBA as part of decision making. The estimated net effects will, however, relate only to the (compliance) costs of implementing an environmental policy, and will not account for any social or environmental benefits that remain external (outside) the market.

CGE models give an indication of what should happen in response to a policy or other economic change, assuming that the economy in question conforms to the assumptions of the model. As a result, some commentators take the view that these models are too abstract for the real world, arguing instead for use of more traditional partial equilibrium approaches that take a set of observations relating to what is actually happening.

The inherent complexity of CGE models means that the amount of time and effort required to collect the basic data, and build a suitable model, is often prohibitive. As a result, no model can actually include all possible markets. In practice, many markets are aggregated together and other simplifications are made to create a useable and practical model. As a result, models are generally tailored to particular needs and functional forms are chosen with an eye to reducing the number of elasticity-related parameters that must be estimated. This usually means that most CGE models have an I-O model core that defines production relationships in terms of intermediate inputs, and the only flexibility in production is usually some substitution between capital and labour as inputs.

In addition, most CGE models start from the assumption that there is no unemployment, i.e. the labour market is in equilibrium. Consequently, any change in employment levels is a result of voluntary decisions on the part of the workforce. This aspect of CGE models causes studies to reach different conclusions regarding the impact on employment of implementing environmental policies, and subsequently leads the OECD (1997) to advise that the results of studies using models should be considered with reservations.

A1.7 Non-Monetary Assessment Approaches

The previous sections detailed the quantitative, economics-based approaches for examining the impacts of waste management policies on employment and the economy more generally. It is important to stress that employment and indirect economic impacts can also be assessed using more qualitative/semi-quantitative approaches. For example, impacts could be assessed in terms of:

- number of long-term full-time job equivalents;
- number of jobs by occupational skill category;
- change in employment relative to regional or national average rates;
- the quality of the job created (e.g. taking into account associated health risks); and
- the average wage rates associated with the jobs created.

In addition, one could always define a range of lower level, more specific indicators depending on the nature of the proposed measures under consideration and their likely impacts (for example drawing on social sustainability indicators). Whatever indicators are selected, it will be important to ensure that they are capable of distinguishing between alternative policy proposals in terms of the end impacts.

What types of approaches could provide the basis for such assessments? In many policy appraisals, employment and wider economic effects are considered together with equity and distributional issues[13]. This is the case, for example, in the US and Canada [see for example Ontario Ministry of Environment & Energy (1996) and US EPA (1999) for further details of the specific requirements of these countries]. The types of issues taken into account in these assessments will generally relate to a range of considerations in addition to employment, such as:

[13] Where equity relates to 'fairness' and distribution to the share of costs or benefits to sub-populations within society arising from the introduction of a policy.

- impacts on vulnerable or other particular groups within society;
- impacts on income distribution;
- impacts on industry, taking into account size, age of plant, etc.;
- creation of barriers to entry into a market sector; and
- impacts on price inflation across the economy.

Formal equity analysis has both a descriptive and a normative component. The descriptive component will generally include describing the populations that will be affected (where these effects are significant enough to matter) and the degree to which costs and benefits are likely to be shifted between groups. The more quantitative (normative) component involves directly incorporating such effects into aggregate measures of option performance. This requires that costs and benefits falling on each group are quantified and then weighted, with the latter reflecting the importance that should be placed on the impacts incurred by different sections of society. Although such weights can be derived through the use of utility theory and other approaches, a number of problems arises in so doing (see Little & Mirrlees (1974) and Ableson (1996) for further discussion). As a result, the direct incorporation of utility weights into economic appraisals is rarely undertaken. There are, however, examples of the use of 'distributional weighting' systems as part of CBAs concerning land use issues and project and policy proposals in developing countries, where equity issues can be of prime importance. For most developed countries, however, the use of this type of approach is not as common, with such information being provided through supplemental analyses.

Instead, a simplified version of equity analysis is sometimes adopted. This again involves describing the likely impacts across different end points and for different groups or populations of concern. Once it is known what end points are of concern and for what sub-populations, simple scoring methods can be used to indicate the likely direction of impact. An example of a simple 'trend analysis' for increased recycling is given in Table A1.4, covering not only employment and indirect effects but also other considerations.

Assuming that these end impacts are of equal importance (an assumption which is unlikely to hold in reality), the above table suggests that there would be net benefits in terms of the wider effects of the proposed waste management policies. However, the value in applying this type of approach is not in being able to add up the numbers of '+' and ' -' scores. It is in setting out the impacts of concern and systematically defining what they might be. Through this type of process alone, without any further quantification, decision makers will be provided with valuable information to set alongside the results of any CBA.

Alternatively, an approach based on consideration of the life-cycle effects of the policy could be adopted. Table A1.5 sets out an example summary table (based on Worldwatch Institute, 2000) concerning the employment implications of policies similar to the WEEE and End of Life Vehicles Directives. A complementary table could be developed to reflect the likely indirect and induced economic impacts.

Table A1.4: Example of a Simple Approach to Assessing Wider Effects of Increased Recycling		
Type of Impact	**Gain or Loss**	**Comment**
Prices of end products	-	Prices to consumers may increase
Impacts on manufacturing sector	-	Price increases may affect demand, but key concern surrounds the ability of smaller companies to absorb cost increases in order to remain competitive
Reduction in materials costs to other sectors	+	Recycled goods acting as lower cost inputs to other production processes
Impacts on exports	0	No impacts likely
Unskilled Employment	++	Waste recycling will lead to gain in direct and indirect employment although some rationalisation of current operations expected; some concern over quality of jobs
Specialist Employment	+	Product re-design, etc. will lead to gains in indirect employment
Total	++	Overall judgement is that there will be a net gain

Table A1.5: Example Summary Table of Employment Implications of Durable, Repairable and Upgradable Products		
Product-Life-Cycle Stage	**Observation**	**Employment Effect**
Design and engineering	Intense redesign of products and production processes required	Positive
Energy and materials inputs	Fewer products, therefore fewer raw materials inputs needed but more robust materials required	Negative
Manufacturing/assembly	Fewer products, but production more attentive to durability and quality and likely to be produced in smaller batch mode	Mixed
Distribution/transportation	Fewer products shipped to end consumer but increased local circulation from users to repair shops, recyclers and back to consumers	Mixed
Maintenance	Revitalising almost abandoned functions; labour intensive	Positive
Re-manufaturing	Currently limited; labour intensive	Positive
Upgrading	Currently limited; labour intensive	Positive
Consulting/performance contracting	Advisce on maximizing product utility and extending product-life; guidance on substituting services for goods	Positive
Disposal at end of life-cycle/ reuse and recylcing	Fewer products to be disposed of; but greater recycling plus disassembly of parts and components for reuse; more labour-intensive than landfilling and incineration	Positive
Source: Worldwatch Institute, 2000		

A2. THE E3ME MODEL USED IN THE CASE STUDY ANALYSIS

A2.1 Overview of the Model

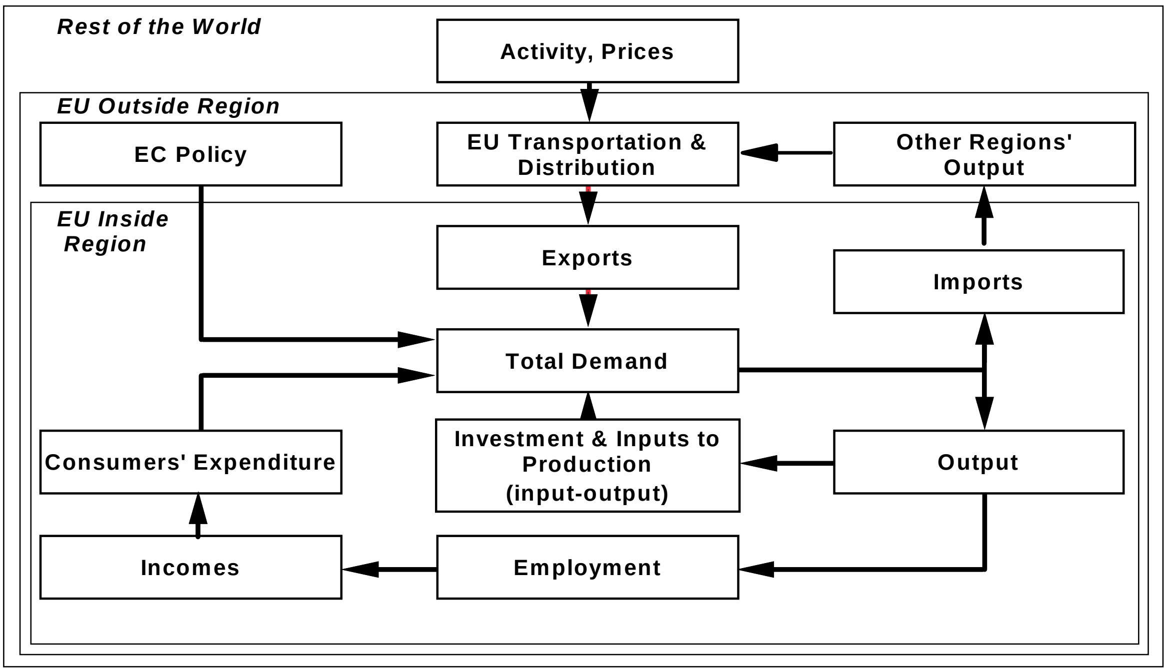
The E3ME model has been used in the case study analyses (see Sections 4 to 6) to examine the impacts that the various waste management policies have had on employment and gross domestic product (GDP). It is an econometric model that incorporates input-output tables to provide its accounting framework, with a series of behavioural relationships then used to model responses to changes in demand and prices.

In order to estimate the total value of the direct and indirect economic impacts of a policy on output (as measured by GDP) and on employment, the following types of impacts were fed into the model for each of the case studies:

- changes in direct sectoral employment and associated average wage rates;
- capital investment requirements and associated operating costs; and
- data on changes in final demand at a sectoral level.

Figure 2.1 provides a flow chart representation of the some of the key interactions allowed for in the model. Given the changes predicted for each of the case studies, estimates were generated on changes in total employment (covering direct, indirect and induced) employment, as well as in GDP for the economy as a whole. The impacts on GDP stem from any changes in income generated by changes in employment, resulting in an increase/decrease in consumer expenditure, which are predicted as leading to further rounds of increases/decreases in demand. These in turn may lead to increases/decreases in import demand, with this and all of the other interactions simulated until a new stable solution is reached across the EU.

Figure A2.1: Interactions within the E3ME Model



A2.2 The Model Assumptions and Their Implications for Case Studies

The E3ME is a model is based on historical data for the EU, which in some case may have been estimated. This is a strength in that the behaviour represented in the model is based on statistical analysis of past behaviour of industries and consumer over the years, with the data covering the period from 1970 to 1995. However, the model is used to give projections of what might happen in the future. In most areas of economic life, behaviour in the past is a good guide to behaviour in the future; in some areas though there may be evidence of a change in underlying relationships. In many cases, such changes can be included in the model projection by introducing special assumptions. This is done for new infrastructure projects, such as investments in transport links. Similarly, new technologies are introduced by changing the input-output coefficients. Other changes in behaviour may be more far-reaching and less amenable to simple adjustments.

One area where substantial changes are expected is that of price formation in the single European market, following reductions in trade barriers and the moves towards a single monetary area. Economies, such as Greece, Italy and Spain, where inflation has been significantly higher than in the rest of the EU have switched from national currencies to the euro. As a result, it is no longer possible for their currencies to be devalued to compensate for high domestic inflation. This change may lower the expected inflation rate and, hence, actual inflation following an inflationary shock, such as an increase in costs as a result of an environmental regulation or tax.

Aside from changes to behavioural relationships, which can be altered to a limited extent through changes to the input-output coefficients, there are factors that the model takes as given, known exogenous variables. These fall into a variety of categories, such as demography (population, working population), monetary policy (interest rates, exchange rates), and fiscal policy (direct and indirect tax rates). No attempt was made to alter the profile of these assumptions in the policy scenarios adopted for the case studies. So, for example, the €/$ exchange rate is the same in all model runs. In reality, these factors will change. A policy that induces greater inflationary pressure will be met by tighter monetary policy, which in turn can affect the exchange rate. On the whole, however, the view has been taken that the relatively small changes to the macro aggregates of employment and output brought about by the waste policy measures are unlikely to have brought about changes in macroeconomic policy.

Another point concerning the uncertainties surrounding the model projections is related to the econometric nature of the E3ME model. In any exercise such as this, a variety of sources of uncertainty exist:

- data: historical time series data may be estimated, incurring measurement errors;
- parameters: the values used in the equations are point estimates, in that they are the mean value from a larger distribution of possible values;
- assumptions: errors could be made in exogenous forecasts, as mentioned above; and

- model: results are presented on the assumption that the model is correctly specified with appropriate functional forms.

Data uncertainty seems inherent in this process, as much of the series required are not directly observable and, therefore, need to be estimated. Parameter uncertainty will also be present, and is a particular problem when underlying relationships are believed to have changed, perhaps through a new era of price stability brought about by the introduction of the euro and the independence of the new ECB. Model uncertainty is present whatever the model type, whether econometric, general equilibrium, etc.

It is sometimes possible to convey the degree of uncertainty surrounding a model projection by adding in what are called 'confidence limits', which represent the range of uncertainty in the projections to a certain degree, say 95%. The interpretation is that one is 95% confident that the projection will lie between the upper and lower boundaries, with the point forecast usually lying somewhere in the middle. There are two caveats to this approach. Firstly, the confidence limits only take account of the parameter uncertainty and, thus, still assume that the model is correctly specified, assumptions are accurate, and the data do not suffer from measurement errors. Secondly, in a model as complex and large as E3ME, it is simply not feasible to identify the uncertainty element in the model parameters.

In spite of this, there is a number of ways of conveying uncertainty in results, the most common of which is through sensitivity and scenario analysis. Sensitivity involves running the model with singular changes, e.g. to a particular parameter, to test the size of the reaction. Scenario analysis, as undertaken in this study, aims to build up a more complete set of changes to check whether the results conform to prior expectations. More could be done in this area, for example by altering the magnitude of the various waste policy changes to gage whether the effects on output and employment were proportional, but this is beyond the remit of the current study.

A3. ANALYSIS OF DATA ON EMPLOYMENT ACTIVITIES RELATED TO WASTE MANAGEMENT

A3.1 Existing Studies on the Environment and Employment

A3.1.1 The Literature Review

In order to identify literature relevant to this study, a number of sources have been consulted. An extensive Internet search was undertaken, covering sites such as the OECD, European Commission, Eurostat, the European Topic Centre on Waste, national statistics offices, national environment agencies and government departments. Contact was made with a number of associations and companies, which provided additional publications as well as information on employment within the waste management industry based on their experience.

The major studies reviewed generally fall into one of four categories:

- the environment industry, both internationally and nationally;
- waste management;
- studies looking specifically at the impacts of directives and policies; and
- studies which focus on specific waste activities.

A3.1.2 Environment Industry Studies – International

A number of studies have looked at the environment industry in general with regards to employment, number of enterprises, turnover and so on. These include studies by the OECD (1996) and by ECOTEC (1999). The OECD study describes the status of the environment industry in the main OECD countries and examines the prospects for growth, related to market developments and environmental policies. The ECOTEC report was prepared for the European Commission, DGXI, to provide an analysis of current export activity by the EU eco-industry, the employment effects of this export activity, future export opportunities and to develop appropriate policy recommendations for promoting EU eco-industry exports and employment in the future.

OECD (1996) discusses the main obstacles in analysing the environment industry, which are in part due to the complexity of definition but also due to the lack of information in some newer areas. The first problem is the heterogeneous nature of the industry, and the goods and services produced, making data collection complicated and comparisons difficult. Secondly, many producers of environmental equipment and services have a low degree specialisation in these products, and are therefore classified under another line of business. Thirdly, there are problems in agreeing the boundaries of the industry.

OECD (1996) also considers the role of the environment industry in creating jobs, and data presented suggests that there has been a positive effect with the growth of the industry. However, it is recognised that there are also job losses, with the overall employment change being the sum of two different effects, those jobs created by the growing environmental goods and services industry, and those either created or destroyed by the impacts of environmental regulation on other industries. The aggregate direct and indirect benefits and costs, gains and losses due to the impacts of regulation have proved difficult to model.

The wide ranging definitions and data for the environment industry as a whole provide little more than an indication of waste management employment. According to OECD (1996) the environment industry accounts for no more than 1% of the total employment in any country, and waste management produces 20-30% of the overall European environment industry output.

A3.1.3 Environment Industry Studies – National

Three national studies have been identified, two covering Sweden and one focusing on Austria. The Swedish studies aimed to identify enterprises where environmental production is the principal activity, rather than measuring total environment production. The Austrian work concentrated first on providing quantitative measures of employment, and secondly on the quality of environmental employment, with an emphasis on waste management.

These reports provide more specific information on the waste management sector of the environmental industry, and provide a breakdown of employment in terms of age, sex, education and related factors. Both Austrian and Swedish research shows that conditions may be below average. There is a low concentration of qualifications, and subsequently lower incomes. The risks of accidents and ill health are potentially significant, but there is insufficient research to evaluate these risks fully.

A3.1.4 Waste Management Studies

Several studies focused specifically on the waste management sector. The Coopers & Lybrand (1996) study aims to identify the combination of Municipal Solid Waste (MSW) treatment methods which would minimise the total net economic costs of MSW management. The key findings from the study are that, as expected, the unit costs of collection are significantly higher in rural areas than urban areas. The costs of semi-automatic sorting/processing are two and a half times those of manual processing. However, the costs of reprocessing vary significantly between materials.

In comparison, Cottica & Kaulard (1995), attempted to model the choice of municipal waste management options for a hypothetical European medium-sized city based on research in four countries (France, Germany, Italy and the UK). The costs and benefits of selecting 'green' waste management solutions as opposed to baseline management (good quality waste management, but with no particular emphasis on recycling) were estimated for each town. The study found that increasing recycling within municipal waste management has a strong and positive effect on employment, but incurs higher capital costs.

A3.1.5 Studies of Waste Management Directives and Policies

Three key studies have been identified:

- WRc (1999) considered the investment and employment impacts of EU environmental policies. This included the Hazardous Waste Incineration Directive, Packaging and Packaging Waste Directive and Directive on End of Live Vehicles;

- Whiston (1995) looked specifically at employment associated with the requirements for increased recycling and improved disposal of the materials and components in the context of the End of Life Vehicles Directive. The prime focus was on the employment consequences of different technological and organisational options;

- Quirion & Glachant (1996) reviewed the employment potential of contaminated site remediation policies in the Netherlands, Germany and France.

The overall conclusion of the WRc report was that environmental policies are having a small but positive impact on employment. The authors highlight that alternative strategies to reach the same environmental goals may have variable labour intensities associated with them. An assessment, made in the case of the Directive on End of Life Vehicles, has demonstrated that employment can vary by a factor of five depending on the nature of the strategy used.

Whiston similarly emphasises that, as the End of Life Vehicles Directive specifies targets rather than techniques, there are a number of ways in which manufacturers could meet the requirements, and hence there is a range of employment scenarios. The employment effects may not be similar in each Member State, as some countries may specialise in particular processes, depending on the existing expertise and infrastructure. There may be a reduction in employment if current dismantling processes are rationalised as a result of increased recycling.

Quirion & Glachant concluded that, as each contaminated site is different as regards its geographical features, the available technical options and their related costs and employment may differ significantly. There may also be a negative employment effect in the polluting firms, due to the increasing requirements (and associated costs) to decontaminate sites. Site remediation also requires a rather skilled workforce and is, therefore, not likely to provide employment for those with few qualifications.

A3.1.6 Studies on Specific Waste Activities

The majority of the reports considering specific waste streams and employment tend to focus on household waste and recycling. They focus on the job creation opportunities in recycling, but give no consideration to the quality of such work. Although they recognise that job replacement may occur if recycling is increased, there is no attempt to evaluate the extent of this. Estimates of employment levels connected with recycling are therefore gross estimates and no account is taken of opportunity costs.

A3.2 Availability and Applicability of Waste-Related Employment Statistics

A3.2.1 Sources Consulted

European-wide data on employment in environmental industries, as well as in other sectors, are collated as part of Eurostat's Structural Business Statistics. There are two key problems with these data:

- a mis-match between the NACE codes used for classification of industry sectors and the structure of the waste management industry; and
- incomplete data, even within the relevant NACE codes.

In order to address the issue of definitional mis-match, we also reviewed statistics on waste-related data at the national level to identify countries where a more detailed breakdown of the environment sector was used. To address the problem of data incompleteness, we sought European-wide data on waste streams within individual countries from the Eurostat MILIEU database, the European Topic Centre on Waste and the European Environment Agency, in order to combine this with data from the waste studies on the numbers of jobs created per tonne of waste.

A3.2.2 Definitional Issues

The main NACE codes covering the waste management sector are:

- 37: recycling of refuse or waste;
- 51.57: wholesale of waste or scrap; and
- 90: sewage and refuse disposal, sanitation and similar activities.

These definitions pose problems of both over-estimation and under-estimation in evaluating waste-related employment.

The potential for over-estimation arises because NACE 90 includes employment in sewage, sanitation and amenity activities such as street cleaning as well as waste management. At national level, the Sweden and Denmark have developed a further breakdown of NACE 90 to separate out waste management from sewage disposal and sanitation. The Swedish approach also separates out street cleaning.

The potential for under-estimation arises because the NACE codes cover only specialised producers, who carry out waste management as a principal activity. They exclude other producers, for whom waste management is a subsidiary activity, general government activities and social enterprises as well as manufacturers and suppliers of equipment and services to the waste management industry.

A3.2.3 Data Completeness

Although data on waste-related employment are available for all 15 EU member States, its completeness varies significantly. Information on NACE 90 activities, in particular, is very sparse. Certain countries have classified some data, including employment figures, as confidential so that its availability to researchers is very limited.

The year of the most recent data available also varies between countries although, with the exception of NACE 90, there is generally information available between 1995 and 1997. The most recent NACE 90 data are for 1995, and in some cases 1994.

A3.3 Employment in Waste Management

A3.3.1 The Waste Management Industry in Europe

Estimates of the overall size of the environment sector in Europe at the end of the twentieth century range from \$100 – 200 billion, with around \$25 billion of this coming from Eastern Europe and the newly-industrialised states. Waste management is thought to account for 20-30% of this expenditure (OECD, 1996). Eurostat's MILIEU database identifies expenditure on waste management in seven EU member States totalling €1.3 billion in the mid-1990s.

The waste management industry encompasses many different organisations, ranging from specialist multi-national companies to small-scale social enterprises, with significant public sector (mainly local government) involvement. The sector is in a state of flux, with consolidation in some areas (e.g. municipal waste collection in the UK) but a large number of small companies remaining. Eurostat data indicates a total number of enterprises of between 15,000 – 26,000, having an average size of below 25 employees. Table A3.1 summarises data on the size of enterprises. According to the OECD (1992), companies supplying waste management equipment tend to be larger than those in waste management operation.

The waste management industry undertakes a wide range of activities. The balance between activities varies between countries in line with differences in waste management regulations and practices. The proportion of municipal waste going to landfill varies from almost 100% (Finland, Ireland) to 20% or below (Denmark, Netherlands). The proportion of municipal waste recycled ranges from near zero (Spain, Greece) to nearly 50% (Luxembourg). At the same time, the volume of municipal waste arisings per capita ranges from below 300kg/year in Ireland to over 400 kg/year in Germany.

As well as companies directly involved in waste management operations, it involves companies providing equipment and services to the industry including design and consultancy. The focus of the remainder of this section is on direct employment.

Table A3.1: Number of Waste Management Enterprises in Europe

NACE	**37**			**37.1**			**37.2**			**51.57**					**90**			**Total**		
Year	**1997**	**1996**	**1995**	**1997**	**1996**	**1995**	**1997**	**1996**	**1995**	**1997**	**1996**	**1995**	**1994**	**1993**	**1995**	**1994**	**1993**	**1997**	**1996**	**1995**
Austria	81	106	91	47	67	59	34	39	32	141	189	190						*303*	*401*	*372*
Belgium																				
Denmark	32	32	28	21	21	18	11	11	10			637		805	372			*64*	*64*	*1,065*
Finland	103	58	83	84	45	68	19	13	15	419	387	368						*625*	*503*	*534*
France	4,307	4,374		2,705	2,721		1,602	1,653		132	128					1,237	1,125	*8,746*	*8,876*	
Germany	110	102	82	44	42	33	66	60	49	1,720	1,717	1,892						*1,940*	*1,921*	*2,056*
Greece		2	2		2	2		0	0										*4*	*4*
Ireland	12	8		7	5		5	3		c	0	36						*24*	*16*	*36*
Italy		1,939	1,679		1,252	1,083		687	596		3,784	3,390							*7,662*	*6,721*
Luxembourg		17	16		c	4		C	12		c								*17*	*32*
Netherlands		130	95		35	25		95	70	1,075	925	1,071		1,461				*1,075*	*1,185*	*1,261*
Portugal	73	88		31	40		42	48		632	666							*778*	*842*	
Spain	130	130	135	37	29	24	93	101	111							1,776		*260*	*260*	*270*
Sweden		87	55		56	32		31	23		831	805	812	766		618	568		*1,005*	*915*
UK	922	760	72	480	430	44	442	330	28		2,376	2,281			1,180			*1,844*	*3,896*	*3,605*
Total	*5,770*	*7,833*	*2,338*	*3,456*	*4,745*	*1,392*	*2,314*	*3,071*	*946*	*4,119*	*11,003*	*10,670*	*812*	*3,032*	*1,552*	*3,631*	*1,693*	*15,659*	*26,652*	*16,871*

Source: EUROSTAT Structural Business Statistics Database (numbers in italics are calculated from other Eurostat data), c = confidential

A3.3.2 Overall Level of Employment

Table A3.2 summarises available statistics on the overall level of employment in the waste management industry within Europe. There is reasonable consistency between OECD (1997) and ECOTEC (1997) on the overall level of employment in the environment industry in Europe, totalling somewhere between one and three million. This amounts to between 0.4% and 1.2% of overall employment, although data collected by Statistics Sweden (1999) using a different definition of the environment industry gives a proportion of 2.5%.

Both OECD and Statistics Sweden define the ‘core’ environmental industries as comprising waste and wastewater treatment and recycling. This accords closely to Eurostat’s NACE categories 90, 37 and 51.57. However, there are significant differences in the employment numbers given by the OECD/Statistics Sweden and those contained within the Eurostat database. These variations are particularly striking for the UK, where a Eurostat total of 9,318 contrasts with a figure of 103,200 from the OECD. The OECD figure for core industry employment in the UK also comprises a much higher proportion of total employment in the environment industry (73%) than for other countries, where the proportion ranges from below 20% (Sweden, Denmark) to around 50% (Austria, France).

A number of the studies reviewed in Section A3.1 also give data on employment levels in waste management. The Association of Cities for Recycling (1999) derives a figure for total employment in waste management of 3 – 3.5 million, which is significantly higher than estimates from other sources and is at the upper boundary of ECOTEC’s estimate of total environment industry employment. All of the studies of waste management employment, however, give higher numbers than Eurostat’s figures for employment in the three main NACE categories, with the multiple ranging from 1.2 (for Sweden) to seven for the UK.

Three sources also give data on levels of employment in recycling. The Association of Cities for Recycling (1999) gives a figure of 300,000 which is 10-11% of total waste management employment. Statistics Sweden (1999) and Profeta (1996) indicate that 27% and 25% of waste management jobs are in recycling for Sweden and France respectively.

As well as showing the diversity of estimates of employment in the waste management industry, these data indicate that Eurostat data on the three main NACE categories do appear more likely to under-estimate than over-estimate the level of employment in waste management. Whilst the Association of Cities for Recyling’s figure of 3 – 3.5 million appears very high in comparison to other sources, it appears likely that the Eurostat data may underestimate total employment in waste management by two to five times.

If this is correct, then the **total number of jobs in waste management in Europe could be in the region of 200,000 to 400,000**. Waste management would then probably comprise between 20% and 40% of overall employment in the environment

Table A3.2: Overview of Statistical Employment Data

	Europe	**AU 1993**	**BE**	**DK 1990**	**FI 1990**	**FR 1992**	**DE 1994**	**GE**	**IR**	**IT 1990**	**LU**	**NL 1997**	**PO 1997**	**SW 1998**	**UK 1992**
Employment in the Environment Industry	1.7 million - 3.5 million [1]	20,000[2]		22,900[2]	15,000[2]	249,000[2]	421,600[2]			9,600[2]		92,000[3]	3,600[4]	95,000[5]	141,700[2]
% of Total Employment		0.57[2]		0.86[2]	0.6[2]	1.12[2]	1.2[2]			0.5[2]		1.3[3]		2.5[5]	0.55[2]
Employment in Core Industries[6]		9,000[2]		3,700[2]	-	139,000[2]	165,600[2]			-		24,000[3]	3,000[4]	9,228[5]	103,200[2]
Employment in Main NACE Classes[7]	79,028 (1996)	11,990 (1995)	4,841 (1997)	5,388 (1995)	1,062 (1997)	21,901 (1997)	22,761 (1997)		145 (1997)	10,947 (1996)	256 (1996)	5,048 (1995)	3,909 (1997)	13,410 (1995)	9,318 (1997)
Employees in Waste Management	3-3.5 million [8]		12,770[8] (1996)	35,033[9]		102,000[10]	45,000[10] (1990)					39,000[3]	2,600[4]	17,321[5]	65,000[11] (1996)
Employees in Recycling	300,000 [8] (1998)					26,000[10] (1990)						57,00[3]	680[4]	4,707[5]	
Employment in Social Enterprises (1998) [12]	35,000	80	2,100	2,318[13]	2,318[13]	4,000	8,130	50	500	2,500	100	4,000	400	3,864[13]	3,000-5,000

Sources: [1]ECOTEC 1997, [2]OECD 1997, [3]Statistics Netherlands 2000, [4]Instituto Nacional de Estatistica do Portugal, [5]Statistics Sweden 1999,
[6] The core industries are considered to contain 100% environmental industry, mainly waste treatment, wastewater and recycling. The core industries are the NACE code headings 25.12, 37, 51.57 and 90.
[7]Eurostat Structural Business Statistics, [8]Association of Cities for Recycling 1999, [9]Statistics Denmark 1999, [10]Profeta 1996, [11]DTI 1997, [12]CWESAR 1999
[13] Data in source is given as 8,500 for Scandinavia, so figure has been divided between Denmark, Finland, Sweden relative to total population.

sector. This figure accords reasonably well with the OECD finding that waste management accounts for 20-30% of total environmental expenditure in Europe.

A3.3.3 Employment in Main NACE Categories

Table A3.3 summarises information from Eurostat on employment levels in the three main NACE categories relevant to waste management, categories 37, 51.57 and 90. It can be seen that data for category 90, covering waste and wastewater disposal, are particularly sparse. For countries where data on category 90 employment are available, this category represents two-thirds or more of total employment in the three categories. Absence of data on category 90, therefore, is likely to lead to significant under-estimation of total waste management employment.

Distribution of employment between categories 37 (recycling) and 51.57 (wholesale of waste and scrap) varies amongst countries. In some cases employment in 51.57 is significantly higher than in 37, in other cases the position is reversed. This may be due to differences in the structure of the recycling industry or definitional differences. The year with the most complete data, 1996, gives a total employment in category 37 of around 50,000 whilst employment in category 51.57 is nearly 34,000.

Even added together, these figures are far lower than the 300,000 total for jobs in recycling derived by the Association of Cities for Recycling (see Table A3.4). The figure of around 21,000 recycling-related jobs for France, however, compares reasonably well with the 26,000 figure identified by Profeta. Similarly, the total of categories 37 and 51.57 for Sweden, nearly 3,000, compare reasonably with the figure of 4,707 from Statistics Sweden.

It seems possible, therefore, that Eurostat data on employment in recycling are more reliable than those on employment in waste and wastewater treatment. Unfortunately, though, waste treatment jobs are likely to be considerably more numerous than those in recycling. This means that the least accurate data are those covering the largest category of employment.

Table A3.3: Number of Employees by the Main Waste Management NACE Categories

NACE	**37**			**37.1**			**37.2**			**51.57**			**90**		
Year	**1997**	**1996**	**1995**	**1997**	**1996**	**1995**	**1997**	**1996**	**1995**	**1997**	**1996**	**1995**	**1995**	**1994**	**1993**
Austria	c	1,017	*716*	418		494	c		*222*	1,440		1,668	*9,606*		
Belgium	4,009	3,306	3,267	1,221	979	937	2,788	2,327	2,330	832	733	768			
Denmark	*412*	354	389	*270*	*242*[1]	*258*[1]	*142*	*127*[1]	*143*[1]			1,508	3,491		
Finland	261	136	196	216	110	157	45	26	39	801	751	817			
France	21,572	20,887		11,778	11,934		9,794	8,953		329	244			37,535	34,758
Germany	6,971	7,299	6,508	3,213	3,479	2,977	3,758	3,819	3,531	*15,790*	*16,157*	*18,125*			
Greece		c	c		c	c		0	0						
Ireland	c	c		145	c		c	c		c	0	64			
Italy		4,386	5,238		1,783	2,937		2,603	2,301		6,561	6,130			
Luxembourg		256	246		c	c		c	c		c				
Netherlands			738			171			567	5,037	4,841	4,310			
Portugal	816	728		379	389		437	339		2,277	1,666				
Spain	1,383	1,336	1,639	346	292	302	1,037	1,044	1,337						
Sweden		577	428		416	313		161	115		2,461	2,395		5,349	5,123
UK	9,318	7,657	3,749	5,246	4,627	2,348	4,073	3,030	1,401						
Total	*44,742*	*47,939*	*23,114*	*23,232*	*24,251*	*10,894*	*22,074*	*22,429*	*11,764*	*26,506*	*33,414*	*35,785*	*13,097*	*42,884*	*39,881*

Source: EUROSTAT Structural Business Statistics Database (numbers in italics are calculated from other Eurostat data), c = confidential. [1] These figures have been calculated using the figure for number of employees per enterprise for the overall 37 category, and therefore slightly overestimate the employees in 371 & 372

A3.3.4 Employment in Social Enterprises

Section A3.2.2 noted that one potential source of under-estimation of employment numbers in the Eurostat data was the exclusion of social enterprises. An assessment of the numbers of jobs associated with social enterprises carrying out recycling was undertaken by CWESAR (1999); its findings are summarised in Table A3.4.

Table A3.4: Numbers of Recycling Jobs in Social Enterprises

Country	**Numbers of Jobs (minimum assessment)**
Austria	80
Belgium	2,100
France	4,000
Germany	8,130
Greece	50
Ireland	500
Italy	2,500
Luxembourg	100
Netherlands	4,000
Portugal	400
Scandinavia	8,500
Spain	1,500
United Kingdom	3,000 – 5,000
Total	**34,860 – 36,860**

Source: CWESAR, 1999

The study's total of around 35,000 jobs appears reasonably consistent with the Association of Cities for Recycling's total of 300,000 recycling jobs, where it would imply that just over 10% of recycling jobs are in social enterprises. This compares with Waste Watch (1999) findings that 3% of UK recycling jobs are in the community sector.

The numbers look high, however, compared to the Eurostat data on recycling employment. They would imply that 15% of French recycling jobs and over 80% of Swedish recycling jobs were in social enterprises. The authors of the CWESAR report note that their work was carried out rapidly with limited resources, and is based on discussions with key players in the sector and their own knowledge rather than statistical sampling. Nevertheless, it does appear to indicate that social enterprises may make a significant contribution to employment in recycling.

A3.3.5 Employment in Public Authorities

Waste-related operational employment in public authorities is covered by the three main waste-related NACE categories. Within Eurostat data, no distinction is made between public and private sector employment in waste management operations. However, regulatory activities involving measurement and control, as defined by SERIEE, are not covered by the three main categories. There is no specific NACE code which distinguishes regulatory activities related to waste management, but the Eurostat MILIEU database does include information on waste-related employment within public administration for selected countries.

There is significant variation between countries in the numbers of employees reported, ranging from zero for Denmark and below 500 for Finland to over 18,000 in Austria and nearly 55,000 in Germany. The numbers show no consistency with data on employment in the three main NACE categories; for example the number of waste-related public sector jobs in Germany is more than twice the number of jobs in the main NACE categories.

There is no clear pattern, either, to the distribution of jobs between different levels of public administration, although, in general, there are fewer jobs in central and state government than in general government or local government. This is not unexpected, given the different governmental structures in different countries and different allocation of responsibilities for waste management.

The only conclusion that can be drawn from these data is that numbers of waste-related jobs in public administration, encompassing both operational and regulatory roles vary significantly between countries, probably reflecting differences in government structure as well as the organisation of waste management.

A3.3.6 Employment in Specific Activities

A number of the studies reviewed in Section A3.1 provide information on the employment content of specific waste management activities in terms of the proportion of total waste management employment they represent or in tonnes of waste per job.

Statistics Sweden (1999) provides a breakdown of Swedish waste management employment by activity, shown in Table A3.5. The highest percentage of employment is in collection, sorting and reloading of non-hazardous waste, at 59%, with wholesale of waste and scrap (NACE 51.57) at half of this. All other activities account for less than 5% of total waste management employment.

Table A3.5: Breakdown of Swedish Waste Management Employees by Activity		
Activity	**Number of Employees**	**% of Total for Waste Management**
Recycling of metal waste and scrap	468	4.7
Recycling of non-metal waste and scrap	116	1.2
Wholesale of waste and scrap	2,853	28.4
Collection, sorting and reloading of non-hazardous waste	5,922	59.0
Composting and digestion of non-hazardous waste	4	0.04
Deposit on landfills of non-hazardous wastes	107	1.1
Receiving, reloading and intermediate storage of hazardous waste	268	2.7
Treatment and permanent storage of hazardous waste	127	1.3
Other waste management	173	1.7
Total	10,038	100
Source: Statistics Sweden, 1998		

Information on the breakdown of employment in municipal waste recycling for the UK is given by Waste Watch (1999). This indicates a total of 41% of employment in collection and sorting, with 56% in reprocessing. Community sector jobs account for the remaining 3%.

A range of studies provide information on the job content of specific waste management activities in terms of numbers of jobs per volume of waste or the volume of waste associated with a single job. Table A3.6 compares the findings of the Cottica & Kaulard (1995) study with work carried out in the USA.

Table A3.6: Job Content of Waste Management Activities			
Activity	**Jobs per 100,000 Tonnes**	**Tonnes per Job**	**Source**
Mixed Collection -UK	86-157	637-1,165	Cottica & Kaulard 1995
Mixed Collection - FR	140-157	637-713	Cottica & Kaulard 1995
Mixed Collection - DE	102-157	637-982	Cottica & Kaulard 1995
Mixed Collection - IT	44-60	1,664-2,253	Cottica & Kaulard 1995
Collecting & sorting	79	1,266	Murray 1998
Separate Collection - Glass	36-53	1,892-2,746	Cottica & Kaulard 1995
Separate Collection - Paper	26-42	2,337-2,613	Cottica & Kaulard 1995
Separate Collection - Packaging	466	214	Cottica & Kaulard 1995
Separate Collection - Organic	472	212	Cottica & Kaulard 1995
Sorting Facility	261	383	Cottica & Kaulard 1995
Compost Plant	34	2917	Cottica & Kaulard 1995
Central composting	20 - 30	5,000 – 3,333	Murray 1998
Reprocessing	162	617	Murray 1998
Recycling	241	415	Murray 1998
Recycling	40 - 50	2,500 – 2,000	Murray 1998
Landfill	4 - 6	25,000 – 16,667	Murray 1998
Landfill	8-12	7,885 – 15,246	Cottica & Kaulard 1995
Incineration	10 - 29	10,000 – 3,448	Murray 1998
Incineration	19-37	2,692-5,397	Cottica & Kaulard 1995

The variation in job content for recycling of different materials is discussed in a range of studies, summarised in Table A3.7. The only conclusion that can be drawn from these data is that the job content of recycling different materials is poorly characterised at present. Even for materials where recycling is well-established, for example ferrous metals, there appears to be little consensus about the level of jobs.

Table A3.7: Job Content for Recycling of Specific Materials from Different Sources (tonnes per job per annum)

Material	ACR 1999	NRF 1998	ILSR 1999	LPWAP 1997	COM (463) 1998
Paper/card	500	530	296	486	228
Plastics	583	149	26	214	35
Aluminium	44	933			28
Ferrous metals	700	2,102	162	1,667	290
Glass	493	3,207	138	500	253
Textiles	210		83	100	39
Wood			317		
Asphalt/concrete			2,400		
Vehicle batteries			24		
Rubber			69		
Composting			3,000		

A3.3.7 Employment Outside the Waste Management Sector

Waste-related employment in management outside the waste management sector is by definition excluded from the three main NACE categories. Waste-related employment in these sectors can include:

- waste management activities, such as collection and storage of waste prior to its collection by a specialist waste management organisation, on-site treatment and disposal; and

- prevention of pollution through adoption of clean technologies or use of adapted products.

Limited information on labour inputs into waste management by industry is contained within Eurostat's MILIEU database. Data are only available for the Netherlands and Austria; they indicate a total of 650 – 700 jobs in each country. This compares with 12,000 and 5,000 NACE main category jobs respectively, with industry sector jobs accounting for 6-12% of the total. The distribution of jobs between sectors is quite different for each country. This may partly be due to differences in industry structure, but definitional differences may also be involved.

Discussions with industry experts indicate that an increasing number of large companies contract out their waste management activities to specialist organisations. In the UK, this has been part of a general move to 'contractorisation' with non-core activities ranging from energy supply through to waste and wastewater treatment now carried out by specialist organisations under contract. Under these circumstances, employment related to waste management in industry would generally be included under NACE codes 90 and 37.

A3.3.8 Growth in Employment

The Eurostat Structural Business Statistics include information on the annual rate of growth in employment in NACE categories 37, 51.57 and 90. Unfortunately, the limited nature of the data (particularly for NACE 90) makes interpretation of trends difficult, with large swings between years making it difficult to discern trends. Whilst some countries appear to have experienced significant growth in recycling employment in both years, for example the UK, others such as Italy have seen more modest growth or even a reduction in employment.

A3.4 Nature of Jobs and Employee Characteristics

A3.4.1 Full-Time and Part Time Employment

Eurostat Structural Business Statistics contain only limited information on working hours in waste management, for the NACE categories 37 and 5157, covering recycling. No data are available on working hours for NACE category 90. For the countries where data are available, part-time workers generally comprise less than 10% of the total workforce. This figure was exceeded only for category 51.57 in the Netherlands, in 1995 and 1996.

A3.4.2 Salaries

Some of the studies reviewed in Section A3.1 of the report, for example Fritz *et al*, conclude that waste management jobs are of poorer quality and less well paid than the average. Experts within the UK waste industry, by contrast, indicated that salaries in the industry were generally above average. Statistics Sweden (1998), found that salaries were reasonably in line with the labour market average, but varied by activity and gender, as shown in Table A3.8.

Table A3.8: Employee Annual Income (100 SEK) by Activity, Gender and Sector 1995				
Activity	**Women**		**Men**	
	Govt	**Private**	**Govt**	**Private**
Recycling of metal waste and scrap	0	1,679	0	2,233
Recycling of non-metal waste and scrap	0	2,071	0	2,207
Wholesale of waste and scrap	2,004	1,431	1,535	1,711
Collection, sorting and reloading of non-hazardous waste	1,599	1,698	1,969	2,032
Composting and digestion of non-hazardous waste	0	1,181	0	1,606
Deposit on landfills of non-hazardous wastes	1,796	0	1,777	1,601
Other waste management	1,575	1,700	2,497	2,412
Receiving, reloading and intermediate storage of hazardous waste	0	2,115	0	1,995
Treatment and permanent storage of hazardous waste	1,506	1,709	2,230	1,872
Core Industries[1]	1,645	1,618	2,008	1,923
Total Labour Market	1,597	1,473	2,151	2,028

Source: Statistics Sweden 1998. [1]The core industries are considered to contain 100% environmental industry, mainly waste treatment, wastewater and recycling. The core industries are NACE headings 25.12, 37, 51.57, and 90.

The table shows that salaries for women in waste management were generally near to or above the labour market average, except for private sector employment in waste and scrap wholesale (NACE category 51.57) and composting. For men, a wider range of waste management jobs had salaries below the labour market average. The lowest paid jobs were wholesale of waste and scrap, composting and landfill of non-hazardous waste. In the private sector, hazardous waste operations also paid below the labour market average. With some exceptions, salaries for women were below those for men.

The Eurostat Structural Business Statistics Database contains no information on waste management salaries, but it does give information on labour costs per employee for NACE categories 37 and 51.57, covering recycling activities. These are shown in Table A3.9. There are, of course, significant variations in labour costs between countries, due to factors such as general labour market conditions and social costs. Generally, labour costs appear to be somewhat higher for NACE category 37.1 (metal recycling) than for the other categories, although in France costs are highest for wholesale of waste and scrap

The data appear to indicate that, on average, labour costs in recycling decreased over the period 1995-1997, although this varies between countries. Austria (for category 37.1), Belgium, Denmark and Luxembourg saw reductions whilst the UK and Sweden

Table A3.9: Labour cost per employee ('000 €)												
NACE	**37**			**37.1**			**37.2**			**51.57**		
Year	**1997**	**1996**	**1995**	**1997**	**1996**	**1995**	**1997**	**1996**	**1995**	**1997**	**1996**	**1995**
Austria	c		c	29.62		35.96	c		c	32.06		27.90
Belgium	28.58	29.50	32.04	31.44	32.35	34.07	27.32	28.30	31.22	25.05	24.18	29.10
Denmark		32.52	43.89		c	c		c	c			
Finland	31.04	31.61	30.69	32.31	33.01	31.05	24.92	25.66	29.26	27.14	28.51	27.17
France	28.00	27.90		29.00	29.40		25.00	25.91		31.00		
Germany	32.61	32.01	32.21	32.75	31.50	31.42	32.49	32.48	32.88			
Greece		c	c		c	c						
Ireland	c	c		21.99			c	c				
Italy		20.00	20.00		20.00	20.00		30.00	20.00		20.00	20.00
Luxembourg		26.72	28.11		c	c		c	c		c	
Netherlands			37.01			33.43			38.10	26.00	19.00	27.19
Portugal	11.30	10.11		14.02	11.85		8.93	8.12		7.60	7.69	
Spain	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00			
Sweden		36.23	32.62		38.14	34.01		31.30	28.81		31.94	28.33
UK	23.00	20.57	20.00	24.00	21.33	21.45	20.00	19.39	17.56			
Average	24.93	26.11	29.66	26.13	26.40	29.04	22.67	24.57	27.23	24.81	21.89	26.62
Source: : EUROSTAT Structural Business Statistics Database (numbers in italics are calculated from other Eurostat data), c = confidential												

saw cost increases. It is not clear whether these changes are characteristic to recycling or follow overall labour market changes. Industry experts believe that overall labour costs for the sector will reduce over time, as more processes are mechanised. Mechanisation, however, is likely to replace the most unskilled and thus lowest-paying jobs, so that average labour costs per employee may increase.

A3.4.3 Skills and Educational Level

Information on the skill levels of waste management jobs in Austria and France is given by Fritz *et al* (1997) and Profeta (1996) respectively.

In Austria, the proportion of unskilled jobs in waste management is very high. More than three quarters of jobs in collection and transport, sorting, utilisation and handling of waste are unskilled. Amongst operational activities, only in maintenance does the proportion of skilled workers exceed the proportion of those who are unskilled. In France, the situation is quite different, with similar proportions of skilled and unskilled workers in waste collection and disposal and more skilled than unskilled workers in recycling. Experts in the UK waste management industry have indicated that the situation in the UK is similar to that in France.

In Austria a number of apprentices are identified, particularly in maintenance. None are identified in France. According to Eurostat's Structural Business Statistics, there are also apprentices in the recycling sector in Ireland and Italy. The lack of apprentices may reflect differences in approaches to training in different countries, for example, a preference for extended full-time education combined with other forms of on-the-job training. On the other hand, it may indicate that training is a low priority in waste management.

In Austria, the lowest levels of education are found amongst employees in waste sorting, where a significant proportion of employees (14%) have not even completed compulsory schooling. The highest levels of education are found, not surprisingly, in consultancy and in administration/management. The Swedish data indicate that employees in landfill have the lowest educational levels and those in hazardous waste management have the highest. All waste management activities have a lower proportion of highly-educated employees and a higher proportion of those with only compulsory schooling than the labour market as a whole.

A3.4.4 Health and Safety Issues

In the literature reviewed, there is little evaluation of the relative health and safety impacts of employment in waste management. Fritz *et al* (1997) concludes that, although the risks may be considerable, there is insufficient evidence to prove this conclusively.

Jonsson (1997) claims that numerous investigations have shown that workers who handle wastes are exposed to bioaerosols and also experience ergonomic problems at a level well above the average. Increased recycling, resulting in a greater need to separate wastes, will result in a greater number of workers being exposed to these risks.

Research in Denmark (Malmros, 1997) found that, in a sorting facility where waste was sorted both manually and mechanically, 10 out of the 20 employees registered cases of occupational illness. These illnesses were primarily bronchial and were associated with microbial activity arising from contamination of the material being sorted with food residues.

There is little information at present, however, to evaluate how widespread such risks are in the waste management sector.

A4. THE CHEMICALS SECTOR

A4.1 Background

A4.1.1 The Policy Context

During the 1990s, a number of waste management policies have been developed at the EU level that have potential impacts on the chemical industry and these are summarised in Table A4.1.

Table A4.1: Key Waste Management Measures Affecting the Chemical Industry

Measure	Main Provisions	Potential Impacts
Waste Framework Directive (75/442/EEC amended by 91/156/EEC)	Constitutes the basic framework for waste legislation	The definition of waste entails the application of waste legislation, leading to associated costs
Wastes from the Titanium Dioxide Industry (82/883/EC)	Limits disposal routes for titanium dioxide industry wastes	Increased investment costs in modified processes and waste treatment, increased operating costs
Hazardous Waste Directive (91/689/EC)	Definition of hazardous wastes, requirements for record-keeping	Increased costs for disposal of wastes defined as hazardous
Supervision and Control of Shipments of Waste (259/93)	Implementation of the Basel Convention	Possible constraints on waste disposal and recycling options
Hazardous Waste Incineration Directive (94/67/EC)	Control of emissions from hazardous waste incinerators	Increased investment and operating costs for incinerators
Packaging Directive (94/62/EC)	Requirements for recovery and recycling of packaging materials	Increased costs for certain speciality chemical sectors
Directive on PCBs and PCTs (96/59/EC)	Controls on the disposal of PCBs and PCTs	Increased treatment facility investment and operating costs
Landfill Directive (1999/31/EC)	Bans on landfill of some wastes, tighter controls on landfills	Increased disposal costs and investment in on-site landfills

In addition to these waste-specific measures, policies to reduce air and water pollution have led to an increase in solid waste volumes in the form of residues from wastewater treatment and end-of-pipe air pollution control.

A4.1.2 The Business Context

There are approximately 36,000 chemical companies within the EU. The industry is expanding, with a 25% increase in production in real terms between 1990 and 1998 (CEFIC, 1999). The industry has grown at an average rate of 2.7% per year since 1988, compared with an average of 1.7% for manufacturing as a whole. The turnover of the industry in 1998 was approximately €402 billion, second only in turnover to the US chemical industry at €407 billion. The chemical industry operates across the EU, with the highest percentage of total turnover in Germany (24%), France (18%), the UK (12%) and Italy (11%).

The chemical industry employs a total of around 1.7 million staff, or 7% of the total manufacturing workforce. Employees within the industry tend to be better qualified and more highly trained than average, which is reflected in above-average salaries. In the UK for example, chemical industry employee earnings are 22% higher than in manufacturing generally (CIA, 1999).

However, employment within the sector has reduced significantly, with approximately 14% fewer employees in 1998 than in 1990, so that unit labour costs have actually reduced by 4% over the period. As well as increased efficiency, this reduction has been achieved through increased outsourcing of non-core functions such as IT, logistics and support services (including some aspects of waste management). As with other manufacturing sectors, every 10 manufacturing jobs is thought to support six in other sectors.

A4.1.3 Potential for Impacts on Employment

There are a number of ways in which waste management policy might affect employment, both within the chemical industry and in other sectors:

- increased waste management operating costs may affect the profitability of the sector, leading to reduced growth rates and/or a more rapid reduction in employment levels;
- increased requirements for investment in waste management may divert funds from other investments, leading to reduced growth rates and hence more rapid reduction in employment levels;
- increased waste-related operating and investment costs may reduce the competitiveness of the European chemical industry, resulting in a shift of jobs outside Europe;
- tighter waste management controls may lead to increased numbers of waste management jobs within the chemical industry;
- tighter waste management controls may encourage innovation and higher levels of recycling in the sector, leading to improved profitability and potential new markets, which could increase (or at least reduce the rate of decrease of) employment; and
- outsourcing of waste management may lead to increased investment and employment in the waste management sector, but potentially at lower salaries and in lower quality jobs.

These impacts are likely to be increased if the costs of waste management comprise a significant proportion of total costs for the sector. The chemicals industry is one of the highest-spending sectors on solid waste management, according to a 1997 survey of environmental expenditure in the UK (ECOTEC, 1997).

A4.2 Data Analysis

A4.2.1 Data Availability and Reliability

Although data on specific waste management costs are limited, information on the overall costs of environmental protection measures for the chemical industry is available from a range of sources. These include trade associations, government surveys and the environmental performance reports that are published by an increasing number of major chemical companies. In some cases, the data cover total expenditure on environment, health and safety measures (which the chemical industry tends to manage in an integrated manner).

There are a number of acknowledged shortcomings with this information. The most significant of these is that data tend to focus on end-of-pipe environmental protection measures and ignore the increasing integration of environmental protection into process operations. The environment-related share of integrated investments cannot be determined from accounting systems and thus has to be evaluated subjectively. Some research has also indicated that data on environmental expenditure significantly under-estimates environment-related labour costs (Bartolomeo, 1999). This is because the number of staff working solely on environment-related tasks is low; environment-related activities are generally carried out as only part of a job. This makes it difficult to determine with any precision the proportion of staff time spent on environmental tasks.

Relatively few published sources provide a breakdown of environmental expenditure into different media, to enable spending on solid waste management to be identified. This is partly because of the interactions between expenditure on different media. For example, an incinerator may be designed to handle solid, liquid and gaseous wastes so that determining the proportion of costs attributable to each type is very difficult. Similarly, an effluent treatment plant may generate solid residues; should the costs associated with disposal of these residues be allocated to solid waste or to water treatment? We were, however, able to access data on waste-related costs from a number of the companies that account for environmental costs for management purposes and/or for publication in environmental reports. These sources, together with limited survey data, provide a range for the proportion of environmental costs allocated to waste management.

A further problem arising with data on both environmental expenditure overall and waste management expenditure concerns definitions. Companies differ in the scope of data included as environmental expenditure; there are particular difficulties in relation to on-site treatment and recycling of materials. CEFIC, the European confederation of chemical industries, has issued guidance to members on environmental reporting but environment-related costs are an optional parameter only and no detailed guidance is given on definitions. For the purposes of this report, we have assumed that the definitional differences do not have a significant impact on reported costs.

A4.2.2 Environmental Protection Costs in the Chemical Industry

In order to assess the likely costs associated with waste management, we first examined the overall costs of environmental protection for the chemical industry. Table A4.2 presents the most recent data available from a number of sources. In general, the sources refer to data from the year prior to the publication date.

Table A4.2: Environmental Protection Costs for the Chemical Industry

Type of Cost	Investment Costs	Operating Costs	Overall Costs	Source
Total health, safety and environment costs, EU			3-4% of sales	CEFIC, 1999
Environmental expenditure, UK	11% of total capital spending	5% of total operating costs		CIA (UK), 1996
Health, safety and environment costs, Belgium	11% of total investment	4.5% of total operating costs		Company environmental report, 1999
Environmental costs, Netherlands			2.5-4% of total manufacturing costs	Bartolomeo, 1999
Health, safety and environmental expenditure, Denmark			1.3% of total expenditure	Company environmental report, 1999
Environmental expenditure, Germany	5% of total capital spending	4% of net sales		Company environmental report, 1999
Environmental expenditure, Finland	6% of total capital spending	2.6% of net sales		Company environmental report, 1999

Although there is some variation in the costs, environment-related investment is generally within the range of 5-11% of total capital expenditure whilst environment-related operating costs range from 2-4% of net sales or 4-5% of total operating costs. A number of sources give data on environmental expenditure as a whole, without separating investment from operating costs. These sources give a range of 1.3-4% of costs or 3-4% of net sales.

Information is also available on trends in environmental expenditure by the chemical industry over time. This is summarised in Table A4.3.

Table A4.3 shows that, in general, environmental costs for the chemical industry appear to have remained reasonably stable during the 1990s. Increases in costs in the early to mid-1990s were followed by a period of reducing costs in the late 1990s for most companies. This may be related to an increase in integrated approaches to environmental protection rather than end-of-pipe measures, and/or to improved efficiency in management of environmental measures.

Table A4.3: Trends in Chemical Industry Environmental Expenditure, 1990-99

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Environmental Investment (€ million)	EU[1]	2,978	3,072	3,064	2,434	1,972	2,113	2,489	2,292		
	UK[2]	299	391	503	466	391	434	413			
	Company A	31					24	31	19	15	13
	Company B	306		262		170		196		128	
	Company C	190		110				20		21	23
	Company D						120	150	220	270	240
	Company E								167	202	153
	Company F							87		57	
Environmental Operating Costs (€ million)	EU[1]	8,934	8,908	9,191	9,126	9,201	9,508	9,601	9,169		
	UK[2]	1,108	1,115	1,224	1,193	1,239	1,224	1,229			
	Company A						67	80	67	61	62
	Company B	1,020		1,071		1,122		1,122			
	Company C	500		560		500				470	432
	Company D						180	200	240	250	230
	Company E								626	617	621
	Company F							248		220	
Total Environmental Costs (€ million)	Company G					408	441	486	565	512	400

Source:
[1] CEFIC, 1999
[2] CIA, 1999
Other data from company environmental reports

A4.2.3 Chemical Industry Waste Management Costs

Data on specific waste management costs are more limited. A number of companies, however, have been able to provide information on the proportion of environmental costs that are associated with waste management. This is summarised in Table A4.4.

Table A4.4: Chemical Industry Waste Management Costs

Type of Cost	Investment Costs	Operating Costs	Overall Costs	Source
Waste-related expenditure, UK	15% of environmental investment	34% of environmental operating costs		ECOTEC, 1997
Waste-related costs, Company D			12% of total environmental costs	Company environmental report, 1999
Waste-related costs, Company C			29% of total environmental costs	Private communication, 2000
Waste-related costs, Company A	3-18% of environmental investment	9% of environmental operating costs		Private communication, 2000

There is considerable variability in the proportion of environmental investment costs allocated to waste management. This is because investment in new or improved waste facilities tends to involve a high level of expenditure over a relatively short period. Thus, during a period of investment in a new waste facility, it will account for an increased proportion of total environmental investment. In order to manage their capital costs, companies may tend to phase expenditure so that major investment in a waste facility does not coincide with major investment in other environmental facilities. This would increase the proportion of environmental investment accounted for by waste even further.

There is less variation over time in the proportion of environmental operating costs allocated to waste management. However, there is considerable variation between companies. A key factor here appears to be the proportion of hazardous wastes in the waste stream. Although there are differences in definitions, these appear to vary considerably. For Company A, for example, hazardous wastes generally comprise less than 1% of arisings, for Company D 26% of waste is hazardous and for Company C over 40%.

Based on the data summarised in Table A4.4, together with qualitative information from a range of sources, it seems reasonable to assume that at a maximum waste management would account for 30% of environmental investment and 33% of environmental operating costs. Table A4.5 uses these estimates, together with actual data where available, to calculate waste-related expenditure as a percentage of total investment by the chemical industry and of net sales.

Table A4.5: Chemical Industry Waste Management Costs as % Total Investment Costs and Net Sales									
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Investment Costs									
Company A						0.9	0.6	1.6	0.2
Company B (estimate[1])	4.8		5.4				3.0		1.6
UK (Source: ECOTEC)	1.2							1.7	
Europe (estimate[1])	4.0	4.2	4.5	4.2	3.6	3.3	3.6	3.0	
Operating Costs									
Company A				0.2	0.3	0.3	0.3	0.3	0.2
Company B (estimate[2])	1.7		1.7		1.7		1.7		1.3
UK (Source: ECOTEC)								1.7	
Europe (estimate[2])	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.8	

1. Assuming that waste-related investment accounts for 30% of total environmental investment
2. Assuming that waste-related costs account for 33% of total environmental costs

Table A4.5 indicates that, in general, waste management costs for the chemical industry have remained reasonably stable during the 1990s, or even reduced slightly in some cases. Waste-related investment costs are in the range of 1-5% of total investment costs, whilst waste-related operating costs range from 0.2-1.7% of net sales.

A4.2.4 Waste-related Employment in the Chemical Industry

None of the published sources, and none of the companies we contacted, have data on waste-related employment in the chemical industry. Even information on overall environment-related employment is limited. Company A, for example, had attempted to evaluate the number of full-time-equivalent jobs related to environmental protection but failed to develop robust estimates. This was because, apart from a small number of full-time environmental specialists in each of its businesses (generally no more than ten), environment-related activities are carried out by operational staff as an integrated part of their duties. The only exception lay with on-site landfills and incinerators, which sometimes have a separate staff. However, the company was increasingly out-sourcing incineration and landfill, so that the numbers of such staff were reducing.

There is also a general trend within the chemical industry to combine management systems for environment and health and safety (EHS), so specialists tend to be allocated to EHS as a whole. Table A4.6 presents available data from three companies that had been able to estimate numbers of specialist staff.

Table A4.6: Environment-related Employment in the Chemical Industry					
Source and Type of Job	**Numbers of employees**				**% of Total Employees**
	1990	**1997**	**1998**	**1999**	
Company B (Environmental)	1,673		1,792		1.2%
Company G (EHS)			931	920	1.4%
Company E (EHS)		1,669	1,667	1,631	2.0%

Table A4.6 indicates that environment or EHS jobs may account for 1-2% of employment in the chemical industry. If this percentage was repeated across the sector, it would indicate a total of 17,000 to 34,000 environment-related jobs within the chemical sector. If waste-related jobs accounted for a third of the total, in proportion to waste management's share of operating expenditure, there might be 5,700-11,300 waste-related jobs within the European chemical industry.

Trends in the numbers of jobs are difficult to discern. In general, discussion with companies indicates that there has been a slight reduction in the number of full-time jobs, as environmental protection is integrated into mainstream operations. Full-time environmental jobs are also reducing in line with the general reduction in employment in the chemicals industry. Company H indicated that the apparent increase in full-time employees was due to transfer of environmental engineering staff from the Engineering to the Environmental Protection Department.

A4.3 Impacts of Waste Management Measures on the Chemical Industry

A4.3.1 Impacts of Operational Costs on Profitability

Analysis of the data indicates that waste management accounts for between 0.2% and 1.7% of net sales for the sector. This compares with energy costs of around 9% of sales. The level of costs depends upon a range of factors, particularly the proportion of hazardous wastes (which are more costly to dispose of and/or require greater levels of treatment). Companies with low operational costs tend to be those producing large volumes of inert wastes. Whilst not negligible in absolute terms, it appears unlikely that waste management operational costs in themselves have had a significant impact on profitability.

It also seems unlikely that the increase in operational costs due to waste management has had a significant effect on the level of employment in the chemical industry. The industry itself indicates that the rise in unit labour costs during the 1990s was the key reason for reduction in numbers of jobs; with the aim of ensuring that labour costs did not rise above 17% of total costs.

The data also indicates that, during the 1990s, waste management operating costs (and overall environmental costs) have remained stable or even decreased for some companies whilst employment levels have fallen. This may be due to improved efficiency in waste management and/or the integration of waste-minimisation into process development. This issue is discussed further in A4.3.3 below.

A4.3.2 Impacts of Waste-related Investment Costs on Other Investment

The available data indicate that waste-related investment accounts for between 1% and 5.4% of total investment by the chemical industry. This represents a high level of expenditure, given the capital intensity of the sector as a whole, equivalent to €249 million to €1,347 million in 1999.

The trend in waste-related investment is again one of stability throughout the 1990s, with a slight reduction in investment in some companies. This compares with overall investment by the sector, which dipped significantly during the mid-1990s and only exceeded 1990 levels in 1997, reflecting market conditions. The fact that waste-related investment did not follow this dip indicates that it may have displaced some production-related investment, with potential knock-on effects on profitability.

It is difficult to estimate the potential impacts of any displacement of production-related investment by waste-related investment, as no data are available on the relative numbers of jobs associated with different types of investment.

A4.3.3 Impacts on Competition

It has not been possible, within the scope of this study, to compare waste management costs for the European chemical industry with costs elsewhere. Although Robinson (1995) indicates that pollution abatement expenditure in 1986 equated to 2.8% of the value of sales. The European chemical industry's main competitors are the USA and Japan, both of which have reasonably similar levels of environmental regulation to Europe. The average growth rate of the European chemical industry between 1988 and 1998 (2.7%) compares favourably with that of the USA (2.3%) and Japan (2.4%). This appears to indicate that waste management policy measures have not had an adverse effect overall on the competitive position of the European chemicals industry.

The position may be different, however, for particular processes that produce high levels of waste requiring extensive treatment. Chemical industry representatives indicate that environmental costs (including waste management costs) may be a contributing factor to the general trend towards re-location of bulk chemical processes outside Europe. One example cited was the move of fertiliser production to countries of the former Soviet Union, where waste management measures are considerably less stringent than in Europe. Other factors, though, such as labour and energy costs and proximity to markets, may be at least equally significant.

A4.3.4 Impact on Waste Management Jobs Within the Chemical Industry

Although the data are limited and there are significant definitional problems, there appears to be little evidence that waste management measures have increased waste-related jobs in the chemical industry. The trend towards out-sourcing of waste management may even have reduced the number of waste-related jobs within the sector. Even where significant investment has been made on in-house waste management facilities, these tend not to be labour-intensive. Indeed, the more advanced the facilities installed, the greater the degree of automation is likely to be.

A4.3.5 Business Benefits from Recycling and Waste Minimisation

One reason why waste-related operating costs have remained stable or reduced during the 1990s is the progress made by chemical companies in waste minimisation through process improvements:

- Company A has maintained waste volumes (and related costs) at similar levels, despite a 15% increase in sales, through a combination of waste management measures and product changes;

- Company B reduced waste generation by 13% between 1990 and 1998 whilst production volumes over the same period grew by 30%;

- Company C reduced the volume of its waste going to landfill by over 90% between 1990 and 1998 through improved production processes and recycling; and

- Despite an increase in production volume of 21% between 1988 and 1998, Company F reduced waste generation by 50%.

There are sound economic reasons for focusing on waste minimisation. Research in the UK has shown that the costs associated with waste are significantly higher than the costs of disposal. Research under the UK's Environmental Technology Best Practice Programme (ETBPP, 2000) indicated that the true cost of waste, taking account of raw material costs and lost product value, could be up to 25 times the cost of disposal alone. One chemical plant was able to identify savings of over 10% of manufacturing costs per year through waste minimisation (Bartolomeo, 1999).

A further approach to reducing waste management costs is to increase recycling of waste materials. Again, chemical companies have made considerable progress in this area:

- material recycling accounted for 36% of Company B's waste in 1998, compared with 20% in 1990. A further 14% was incinerated with heat recovery;

- Company C constructed a recycling plant in 1990 to handle building rubble, other materials are collected for recycling off-site or incinerated with energy recovery; and

- Company G recycles 73% of its chemical waste and by-products, resulting in "both environmental and financial gains".

In each case, significant capital investment in the early 1990s in incineration and recycling plant has enabled operating costs throughout the 1990s to be reduced. In some cases, the combination of investment and waste minimisation has enabled companies to offer waste management services to external organisations:

- since 1990, Company B has been able to treat external waste in capacity freed up by its waste minimisation programme; and

- Company C accepts some waste from customers for incineration.

It is unlikely that such services provide a major source of profit for the companies concerned (no data are available), but they can assist in off-setting waste-related operating costs.

The extent to which such savings are attributable to waste management measures is debatable. It could be argued that companies should adopt waste minimisation and recycling for economic reasons regardless of policy developments. However, few companies appear to have examined their waste-related costs in detail until triggered to do so by regulatory developments.

The impacts on employment of waste minimisation and recycling are unclear. Whilst waste minimisation might be expected to reduce the number of jobs in waste management, collection and recycling of materials might be expected to increase employment. Overall, there is little evidence from the chemical companies of significant changes either way.

A4.3.6 Impacts on Investment Outside the Chemicals Sector

The tendency for increased out-sourcing of waste management by the chemicals industry might be expected to result in increased investment, and potentially employment, in the waste management sector. The types of waste management activity out-sourced vary:

- **hazardous waste treatment**: as controls over hazardous waste disposal have tightened, some chemical companies have out-sourced rather than investing in their own treatment facilities. In some countries (for example Finland and Denmark) a central organisation has been developed, with public sector involvement, to handle hazardous waste for the country as a whole;

- **landfill**: reasons for out-sourcing of landfill include avoiding the investment costs of new landfill facilities, taking advantage of competitive prices and avoiding the potential liabilities associated with on-site landfills. Company B increased the proportion of waste going to external, as opposed to internal, landfill from 19% to 31% between 1990 and 1998; Company D increased external disposal of waste by 10% between 1997 and 1999 alone; and

- **recycling**: recycling of non-chemical materials is often carried out externally. Although Company C recycles building rubble on-site, metal scrap, incinerator ash, wood, cardboard and paper are recycled off-site.

Unfortunately, only limited data are available on investment and employment by the waste management sector in relation to services to the chemical industry. Nor is the total volume of waste out-sourced known. Research published by the European Environment Agency (Fischer, 1999) indicates that the chemical industry may account for around 30% of total EU waste arisings, which totalled approximately 30 million tonnes per year in the mid-1990s.

The specialist hazardous waste incineration sector has a current capacity for incineration of two million tonnes. This has required investment of around €2 billion over the last 10-20 years (EURITS, 2000). Assuming that the proportion of waste from the chemical industry treated by this sector is the same as the proportion of arisings, this would indicate that external investment attributed to the chemicals sector could be as high as €600 million.

EURITS does not maintain data on employment in the sector. However, the hazardous waste management organisation in Finland, Ekokem, employed 189 people in 1999 to treat 1.1 million tonnes of waste. The treatment methods included incineration, physico-chemical treatment and recycling as well as landfill of treatment residues. If a similar level of employment applies to treatment of all hazardous wastes, then the external employment associated with treatment of chemical industry wastes could total around 5,000 jobs.

Waste management policies appear to have been the driver behind investment by the hazardous waste incineration sector, which invested heavily in the 1980s and early 1990s in anticipation of regulatory changes. Indeed, commentators on the sector believe that lack of strict enforcement of waste management policies in some countries has led to the low profitability and 'unsustainably low prices' faced by waste management companies (Owen, 2000).

A4.4 Application of the E3ME Model

Cambridge Econometrics' E3ME model (see Annex 2 for a detailed description) was used to examine the impact of the chemical industry's current level of waste management expenditure on both employment and GDP. The case study is, therefore, general in nature, and does not refer to any single waste policy. The aim is to see what the net effects are of the industry currently spending some €804 million per annum on waste management.

The approach taken in applying the E3ME model is to assume that the chemicals industry is being required to spend the equivalent of 0.8% of its net sales on waste management. The model treats these extra costs as being passed on in higher prices, depending on the competitive position of the industry in different Member States. The extra costs will lead to higher prices and a loss in the European share of world markets. Since the waste management processes are generally integrated into the production process, it seems likely that the environmental investments have improved product qualities. The model, therefore, has not assumed that crowding out of other investment is taking place. Instead, the extra environmental investment expenditure implied by waste management regulations is assumed to lead to extra output and jobs in the investment industries (i.e. providers of the necessary waste management related goods and services), with multiplier effects throughout the EU economies. As the case study found little evidence that waste management measures affecting this industry have increased waste-related jobs, no extra direct employment in the chemicals sector or in chemicals waste management is assumed.

The results of the analysis are presented in Tables A4.7 and A4.8, for the period from 2000 (acting as the baseline) to 2005. The most important findings are that the current level of costs will lead to less than a 0.01% reduction in gross domestic product (GDP) by the end of the five year period as a result of increased prices being passed on to private domestic consumption and exports. The increase in consumer prices leads to reductions in household consumption and hence GDP. The increase in export prices leads to a fall in exports to countries outside the EU and hence GDP. The increase in prices also makes imports more price-competitive and so increases European imports. However, the fall in consumers' expenditure reduces imports, offsetting these increases, resulting in the net effect being negligible. A fall in employment of less than 0.01% is also predicted.

Table A4.7 provides a breakdown by country of the predicted employment effects (direct, indirect and induced) and for the EU as a whole. As can be seen from this table, the impacts of the waste management costs and investment vary considerably across the Member States. Some countries experience a net gain in employment, while others experience significant losses. Most notable of those experiencing losses are the UK and France, which by 2005 are predicted as losing 10,000 jobs between them. The pattern is generally one of an increase in employment followed by decreases, with the number of jobs lost by the end of the five year period estimated at around 17,000. The first-year increase in employment is a short-term effect arising from the initial fall in real labour costs across industries. This is the effect of the lag between rises in chemicals costs and, therefore, prices more generally and the consequent rise in wage rates. The effect is particularly noticeable for the UK, which according to the model has a more responsive labour market with more employment generated for a fall in real wage rates compared to most other EU economies.

Table A4.8 presents the percentage change in GDP by country, showing that the UK is expected to experience relatively significant losses, as do Greece and Sweden. In contrast, a number of countries, including France, realise small gains. GDP across the EU as a whole is reduced by 0.008% (equivalent to €600 million) by the fifth year of the modelling period (2005) as a result of higher prices and loss in exports. There is also a confounding factor in that the model is unable to take into account the extra competitiveness effects of regulations; in addition, the eco-efficiency gains that have been achieved within the industry may not be adequately accounted for. Some of the investment considered in the above analysis may also be creating efficiency gains, enhancing the ability of the EU industry to compete globally. These combined effects may, therefore, counteract the predicted reductions in GDP and employment.

Table A4.7: Change in Total Employment Resulting from Waste Management Policies Affecting the Chemicals Industry (change from 2000 figures)

	2000	2001	2002	2003	2004	2005
Austria	0	20	-40	-120	-130	-100
Belgium	0	30	100	80	30	-20
Denmark	0	20	100	130	130	90
Finland	0	10	-20	-240	-570	-910
France	0	1,500	400	-1,560	-3,690	-5,670
Germany	0	640	840	860	740	820
Greece	0	-50	-590	-1,100	-1,510	-1,880
Ireland	0	300	150	140	130	130
Italy	0	970	-180	-740	-1,610	-1,960
Luxembourg	0	-10	-10	-20	-20	-20
Netherlands	0	410	-80	-80	-130	-180
Portugal	0	490	-100	-320	-410	-520
Spain	0	-1420	-2140	-2120	-1820	-1340
Sweden	0	60	170	-430	-870	-1,060
United Kingdom	0	3,900	-2,900	-5,130	-4,550	-4,290
Total EU	0	7,430	-4,160	-10,450	-14,140	-16,830

Table A4.8: Change in GDP Resulting from Waste Management Policies Affecting the Chemicals Industry (% change from 2000 figures)

	2000	2001	2002	2003	2004	2005
Austria	0	0.014	0.024	0.029	0.038	0.047
Belgium	0	0.031	0.036	0.039	0.041	0.044
Denmark	0	-0.003	0.001	0.003	0.003	0.002
Finland	0	-0.066	-0.041	-0.026	-0.019	-0.016
France	0	-0.004	-0.006	-0.004	-0.001	0.003
Germany	0	0.007	0.009	0.009	0.008	0.007
Greece	0	-0.020	-0.019	-0.014	-0.010	-0.059
Ireland	0	-0.018	-0.040	-0.027	-0.010	0.000
Italy	0	0.002	0.002	-0.001	-0.004	-0.008
Luxembourg	0	0.338	0.342	0.343	0.340	0.338
Netherlands	0	0.011	0.020	0.025	0.027	0.028
Portugal	0	-0.125	-0.068	-0.041	-0.035	-0.036
Spain	0	-0.032	-0.045	-0.043	-0.035	-0.025
Sweden	0	-0.045	-0.113	-0.154	-0.162	-0.145
United Kingdom	0	-0.056	-0.025	-0.027	-0.036	-0.038
Total EU	0	-0.012	-0.008	-0.009	-0.009	-0.008

A5. WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT

A5.1 Background

A5.1.1 The Policy Context: EU

Measures at European level to address the environmental problems associated with waste electrical and electronic equipment have been under discussion for a number of years. An EC project group was established in 1994 to devise a strategy for reducing the end-of-life impact on the environment of such equipment. On 13 June 2000, the Commission's proposals for a Directive on Waste Electrical and Electronic Equipment and a companion Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment were adopted.

The main objectives of the Directive on Waste Electrical and Electronic Equipment (WEEE) are:

- the prevention of waste electrical and electronic equipment;
- increasing re-use, recycling and other forms of recovery of end-of-life electrical and electronic equipment, contributing to enhanced environmental protection and encouraging resource efficiency; and
- improving the performance of all operators involved in the life cycle of electrical and electronic equipment, particularly those involved in the treatment of WEEE.

The main measures used to achieve these objectives are set out in Box A5.1.

Box A5.1: Main Measures of the Draft Directive on Waste Electrical and Electronic Equipment
• Separate collection of WEEE, free of charge to households, and provision for collection of non-household WEEE; • Targets for separate collection of WEEE from private households; • Provision for treatment of WEEE to specified standards, at permitted treatment establishments; • Provision for recovery of WEEE, to meet specified rates for overall recovery, reuse and recycling of components, materials and substances; • Provision of appropriate information and marking of equipment; and • Financing of the system primarily by producers, either individually or through collective schemes.

The Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment aims to prevent the use of substances that could limit the potential for recycling and re-use of WEEE and to contribute to the environmentally-sound recovery and disposal of WEEE.

A5.1.2 The Policy Context: the Netherlands

Whilst the EU Directive is still at the proposal stage, legislation concerning WEEE has already been adopted and implemented in the Netherlands. The Decree on the Disposal of White and Brown Goods came into force from 1 June 1998 and was fully implemented from 1 January 2000. The Netherlands Decree imposes similar requirements to those in the proposed EU Directive; it may therefore provide a useful indication of the potential impacts of the proposed Directive.

The main provisions of the Decree are outlined in Box A5.2. Its overall objectives are to achieve a leak-tight structure for disposal of WEEE that will result in the re-use of as many products as possible and disposal of the wastes in such a way that risks to the environment are minimised. The operation of the scheme in practice is described in Box A5.3 (overleaf).

Box A5.2: Main Provisions of the Decree on the Disposal of Brown and White Goods

- Manufacturers and importers are obliged to take back and process all discarded brown and white goods and must notify the Minister of the means they propose to use to achieve this;
- When supplying a new product suppliers must take back free of charge, as a minimum, a similar product that has been discarded after use;
- The final user does not have to pay at the time of discarding a product;
- Landfill or incineration of products that have been taken back or collected separately is prohibited; and
- Commercial re-use of discarded refrigerators and freezers containing CFCs is prohibited.

A5.1.3 The Business Context

Table A5.1 compares the electrical and electronic goods sector in the Netherlands with that of the EU as a whole.

Table A5.1: Comparison of the Sector in the Netherlands and the EU

	Netherlands[1]	**EU[2]**
Turnover (€ million)	7,110	175,000
Number of enterprises (manufacturers + suppliers)	3,950	> 100,000
Annual volume of discarded equipment (1000 tonnes)	195[3]	6,000
Annual volume per person (kg)	12	12
Expected collection volume per person (kg)	3.9	4

1. Source: Netherlands Ministry of Housing, Spatial Planning and the Environment (1999)
2. Source: European Commission, ORGALIME
3. Anticipated level by 2005

Box A5.3: Operation of the Decree on the Disposal of Brown and White Goods
Consumers Consumers wishing to dispose of waste brown and white goods or ICT equipment (computers, telecommunications) can either hand their waste to the local authority for separate collection or hand it to a retailer when buying a similar new product. Consumers must pay the levy on new brown and white goods, shown separately on the invoice, that funds the collective scheme. *Retailers* Retailers must accept waste products handed in by consumers when buying a new product. Retailers can then either hand waste goods to the local authority, return them to a distribution centre (‘reverse logistics’), deliver them to a Regional Storage Station operated by the appropriate collective scheme or, if they hold a large volume of waste goods, ask the appropriate collective scheme to collect the goods. Retailers may also sell waste goods on the second hand market, except for refrigerators and freezers containing CFCs. Retailers are responsible for collecting the levy on new brown and white goods that finances the collective scheme. *Local Authorities* The Decree places obligations on local authorities to provide for separate collection of products discarded by households and to set up locations where retailers can deposit products discarded by households. *Manufacturers and Importers* The Decree allows manufacturers/importers to fulfil their responsibility for collection and reprocessing of brown and white goods either individually or collectively. In practice, although some individual schemes have been submitted, none have been approved and almost all manufacturers/importers have signed up to one of two collective schemes: • one scheme covers consumer goods and is operated by a specially-formed joint organisation (NVMP), financed by a levy on the price of new consumer goods. The levy is set at a fixed level for each type of product, sufficient to cover the costs of collection and reprocessing. Collection of waste goods from local authorities, 67 Regional Storage Stations, 20 distribution centres and individual retailers, is carried out by two contractors, one a distribution company and one a waste management company. Processing of the waste is carried out by three specialist recycling firms; and • the second scheme is a looser arrangement covering ICT equipment organised by the relevant trade associations. Collection of waste equipment, transport and processing is carried out by two transport and two recycling firms. The recycling companies sort and weigh the items according to brand and costs of transport and processing are allocated to individual manufacturers/importers accordingly. ‘Orphan’ brands, imported or manufactured by companies no longer operating in the Netherlands, are also weighed and their costs allocated to existing companies in the same proportion. (For example, if equipment manufactured by Company X accounts for 30% of the branded products processed, then Company X will pay 30% of the costs for ‘orphan’ brands).

At the EU level, there are over 100,000 small and medium sized enterprises involved in the manufacture and supply of electrical and electronic equipment. The market, though, is dominated by a small number of large companies that typically account for 80% of turnover and employment in the sector, where total employment is estimated at around 1.4 million. Manufacturers are located primarily in Germany, the UK, France, Italy, the Netherlands and Sweden.

In the Netherlands, there are around 600 manufacturers, most of which are very small companies. However, the majority of goods are imported and there are estimated to be several thousand importers. As in the overall EU situation, a small number of manufacturers or importers (30 for white goods and 33 for brown goods) cover 85% to 90% of the market. There are over 3,000 suppliers of electrical and electronic equipment.

A5.1.4 Potential for Impacts on Employment

There are a number of ways in which policy on WEEE might affect employment, both within the electrical and electronics industry and in other sectors:

- jobs may be created within the electrical and electronics industry in product re-design, establishing take-back systems and providing information to consumers, regulatory authorities and treatment facilities;
- WEEE regulations may encourage innovation and development of re-usable/upgradeable products in the sector, leading to improved profitability and potential new markets, which could increase employment;
- outsourcing of take-back and recycling may lead to increased investment and employment in the waste management sector, but potentially at lower salaries and in lower quality jobs;
- the operating costs for take-back and treatment of WEEE may affect the profitability of the electrical and electronics sector, leading to reduced growth rates and/or a reduction in employment levels;
- requirements for investment in take-back and treatment facilities, and in re-design of products to remove harmful substances and facilitate recycling, may divert funds from other investments, leading to reduced growth rates and a consequent reduction in employment levels; and
- where costs are passed on to consumers, in the form of increased prices, this may reduce or postpone sales leading to reduced turnover and profitability in the electrical and electronics sector and hence reduced employment.

The scale of these impacts will be influenced by the size of the costs involved in take-back and treatment of waste, the level of recycling required and the extent to which costs can be recovered through increased prices.

A5.2 Data Analysis

A5.2.1 Data Availability and Reliability

Clearly, no actual data on the costs of the proposed EU Directive on WEEE are yet available. Estimates of the potential costs, though, have been prepared by the European Commission, by industry organisations and by national governments including the UK Government. There is considerable variation between these estimates, as is usual in such circumstances, depending upon the underlying assumptions.

Prior to introduction of the Decree on the Disposal of Brown and White Goods, the Netherlands Government undertook a series of studies to estimate the costs of the proposed measure. This included an evaluation of the economic effects of introducing a different financing system for WEEE in the Netherlands from neighbouring countries, Belgium and Germany.

Following implementation of the Decree, data on the actual costs and amounts of WEEE were collected by industry representatives, local authorities and the Ministry of Environment. Financial data for 1999 are considered by the Ministry to be reliable estimates, although not based on fully-audited accounts. Based on the actual data for 1999, the Ministry of the Environment developed a model for the 'normal' situation, when the Decree is fully implemented, which provides information on expected costs and collection levels possible within a few years.

Additional information on the impacts of the Netherlands Decree has been provided by the two collective organisations implementing industry responsibilities for take-back. This again is based on monitoring of actual costs during the first year of operation of the Decree. Information from individual companies on the impacts of the decree is limited, partly because collective solutions to meeting industry obligations have been adopted. However, some qualitative information is available from company environmental reports on the wider implications of WEEE policy.

A5.2.2 Overall Costs of the Netherlands Decree on Disposal of Brown and White Goods

Table A5.2 presents the Netherlands Government's estimates of the costs of the Directive prior to its implementation. Table A5.3 shows the actual costs of the Decree in the first year of implementation, together with the estimated long-term costs once the Decree is fully operational (the 'normal' situation).

Unfortunately, the data on the actual and long-term costs of the scheme are not broken down between sectors in the same way as the estimated costs. Costs of transport, sorting and logistics, for example, include both local authority collection costs and some expenditure by retailers and by the collective schemes (for facilities at the regional collection centres). The treatment costs for collective schemes also include some transport costs born by one of the schemes. Nevertheless, a number of conclusions can be drawn about the costs of the Decree:

- the actual total costs of the scheme under the 'normal' situation are 10% lower than the estimated costs;
- actual costs of treatment are significantly below the estimated costs (35% lower for the 'normal' situation); and

Table A5.2: Estimated Costs of White and Brown Goods Disposal (1998 estimate, € million)[1]				
	Local Authority Costs Prior to Decree	**Local Authority Costs After Decree**	**Industry Costs After Decree**	**Total After Decree**
Collection	2.25	3.15		**3.15**
Processing products containing CFCs and HCFCs	3.60		4.95	**4.95**
Processing other white and brown goods			8.10	**8.10**
Logistics (transportation)	1.03	0.14	2.02	**2.36**
Management/ administration			1.48	**1.48**
Landfill/incineration	2.03	0.81		**0.81**
Total	**9.00**	**4.10**	**16.55**	**20.85**

[1] Overall costs, including annualised investment costs
Source: adapted from Netherlands Ministry of Environment

Table A5.3: Actual Costs of White and Brown Goods Disposal (1999 actual costs plus estimated long-term annual costs ('normal' situation), € millions)		
	1999	**'Normal' Situation**
Transport, sorting and logistics	5.85	7.65
Treatment by collective schemes	5.40	8.55
Management and administration	3.6	2.7
Start-up costs (1998 costs divided over two years)	0.45	0
Total	**15.30**	**18.9**

Source: adapted from Netherlands Ministry of Environment

- transport and logistics costs are significantly higher than estimated (nearly 40% higher, including the costs of collection), as are management and administration costs (80% higher).

A5.2.3 Capital Costs

Little information is available on the capital costs of the Netherlands Decree on Disposal of Brown and White Goods, although only limited investment is thought to have been required. The two collective schemes have contracted out collection and recycling services to existing transport and reprocessing companies, which already had facilities available to carry out these services. Any investment requirements have therefore been met by these companies and reflected in their charges to the collective schemes, making them difficult to identify. One company carrying out recycling of refrigerators and freezers is known to have invested in refurbishment of one of its two plants, at a probable cost of around €5 million. It is not clear whether the other recycling companies, or the transport companies, have faced similar investment costs.

The only other known capital cost has been the provision of facilities at the Regional Storage Stations for separation of waste products into different types. Under the NVMP scheme, containers for the four main types of waste (refrigerators and freezers, large white goods, televisions and small appliances) are provided at each of the 65 regional stations. Four containers are also provided at each regional station for ICT waste. These containers range up to the size of a sea freight container, and were specially manufactured. No detailed information is available on the cost; however a standard new sea freight container costs in the region of €3,500. This would indicate a total cost of nearly €2 million for eight containers at each regional station (the containers have an expected life of 10-15 years).

No information is available to indicate that significant additional investment has been made by manufacturers/importers, retailers or local authorities to meet the requirements of the Netherlands Decree to date.

Known investment costs associated with the Netherlands Decree therefore total approximately €7 million. This represents an initial outlay of €114- €209/tonne of waste (depending on whether the volume of waste collected is taken as the 1999 actual level or the expected 'normal situation' level). Further investment, though, may not be required for 10 or 15 years, depending on the lifetime of the assets.

A5.2.5 Operating Costs

Table A5.4 sets out the overall operating costs of the Netherlands Decree per tonne of waste recovered. Operating costs have been reduced considerably below the predicted level of €340 to €600 per tonne, depending upon the volume of waste collected.

Table A5.4: Operating Costs per Tonne of White and Brown Goods Disposal (1999 actual costs plus estimated long-term annual costs ('normal' situation), € per tonne)

	1999 (33,500 tonnes collected)	**'Normal' Situation (61,500 tonnes collected)**
Transport, sorting and logistics	174	125
Treatment by collective schemes	161	139
Management and administration	121	44
Total	**456**	**308**

Source: adapted from Netherlands Ministry of Environment

The operating costs of the decree have been minimised through the use of a collective scheme, which has been able to negotiate favourable prices for transport and recycling with existing firms. By using a limited number of recycling facilities, it has been possible to take advantage of economies of scale. There have also been opportunities to take advantage of existing routes and networks of the transport companies.

The proportion of the costs born by different manufacturers/importers depends upon the types and numbers of products they provide to the market. Under the ICT scheme, the costs to manufacturers/importers are standard, at €518 per tonne of waste collected. This is equivalent to around €13.5 for a complete personal computer or €2.3

for a printer. The costs to members of the NVMP scheme vary, from €18 for a fridge or freezer to €6.8 for a microwave oven or a video recorder. Individual price levies are set for each product type at a level sufficient to cover the full costs of transport and processing.

As well as the costs to manufacturers/importers, which are recovered through increased prices, there may be additional costs to retailers in handling products returned under the 'new for old' system. No information is available on retailer costs; however, it appears that most retailers pass waste products on to local authorities for storage, therefore minimising costs (the NVMP collects only 20% of its total waste direct from retailers or distribution centres).

A5.2.6 Employment Impacts

No detailed data has been collected by either the Netherlands Government or industry on the employment impacts of the Decree, however, they are thought to be minimal. One of the key effects of implementing the Decree primarily through collective schemes has been the consolidation of the recycling industry for WEEE. Between them, the two collective schemes contract with only five recycling companies. Only one company now recycles refrigerators and freezers whereas prior to the Decree there were twelve. Organisations that have lost out in this consolidation are primarily smaller organisations, including social welfare organisations. Jobs may therefore have been lost in the smaller organisations, although this may have been offset by greater employment in the large organisations to handle the additional throughput of waste.

A small number of additional jobs is also thought to have been created in local authorities, in separating out usable goods for sale on the second-hand market. The number of additional jobs in administering the scheme (fewer than 10) has been kept to a minimum to reduce costs.

There is no evidence of additional employment creation amongst retailers to deal with the requirements of the Decree. Nor is there evidence of any increased employment amongst manufacturers/retailers to complete the information requirements of the scheme (including twice-monthly reporting by NVMP members on product numbers put on the market).

A5.2.7 Comparison With Other Cost Data

Table A5.5 compares the costs per tonne of waste handled under the Netherlands Decree with other actual and estimated costs of WEEE collection and treatment.

It can be seen that the majority of actual costs and estimates lie within the range €200-€500 per tonne. Actual costs in Germany for reprocessing IT waste, at €500/tonne, are very similar to the costs of the ICT collective scheme in the Netherlands, €517/tonne. These probably represent the upper end of the range of costs for WEEE. One factor contributing to the variation in costs may be the proportion of WEEE expected to enter the system. The proportion of waste collected in the Netherlands, for example, is currently below the target set in the proposed Directive. The Netherlands actual data and cost estimates by the European Commission and the UK

Table A5.5: Comparison of WEEE Collection and Treatment Costs	
	Cost (€ per tonne)
Netherlands: actual costs, 1999	456
Netherlands: 'normal situation' costs	308
UK: estimated cost of WEEE Directive[1] (UK Government, low case)	174
UK: estimated cost of WEEE Directive[1] (UK Government, high case)	286
UK: estimated costs of WEEE Directive[1] including retailer take-back costs	2,679
Germany: actual costs of IT waste processing[2]	510
EU: estimated cost of WEEE Directive[3] (European Commission, low case)	400
EU: estimated cost of WEEE Directive[3] (European Commission, high case)	720
EU: estimated cost of WEEE Directive[4] (industry estimate)	5,000

Sources:
1. Department of Trade and Industry (2000): **Consultation Paper: Proposed EC Directive on Waste Electrical and Electronic Equipment**, London, DTI.
2. Commission of the European Communities (2000): **Proposal for a Directive on Waste Electrical and Electronic Equipment**, Brussels, CEC (COM (2000) 347).
3. Bartolomeo M *et al* (1999): **Eco-Management Accounting**, Dordrecht, Netherlands, Kluwer Academic Publishers.
4. Orgalime (2000): **Detailed Position of Orgalime's Electrical and Electronic Liaison Committee in Co-operation with the European Sector Committees**, Brussels, Orgalime.

Government all indicate that there are significant economies of scale in WEEE collection and treatment, with costs per tonne reducing considerably as volumes collected increase.

Two estimates are well outside this range; the industry estimate of costs of the WEEE Directive and the UK Government estimate including retailer costs. We have not been able to establish the basis for the industry estimates; this has been prepared on a confidential basis by Orgalime (although we understand that additional information has been made available to the European Commission). It is understood that collection and transport of wastes accounts for over 50% of the estimated costs. The UK Government figure includes an estimate of up to £500m per annum costs for retailer take-back, the majority of which relates to staff training. The basis of this estimate is not known, but it does not appear to be supported by the experience in the Netherlands. Clearly, however, the way in which take-back is organised can have a significant impact on costs and their allocation; the Netherlands experience has shown that collective schemes can increase the efficiency of collection and treatment, resulting in reduced costs.

The UK Government estimates make explicit reference to investment costs associated with WEEE collection and treatment. The costs of investment in additional treatment equipment are estimated to be minimal, at around €1.7 per tonne. There are also estimated to be one-off investment costs of around €12 million to €14 million associated with the modification of manufacturing equipment for product marking. It is acknowledged that some additional investment may be required, for example WEEE storage bins at local authority collection sites, but no estimates are made of the likely cost.

Orgalime has estimated that new investment totalling €15 billion will be required to address the requirements of the proposed EU policy on WEEE. The basis for this estimate is not known, but it is thought to relate primarily to the Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment.

A5.3 Impacts of WEEE Policy Measures

A5.3.1 Impact on Waste Management Jobs Within the Electrical and Electronics Industry

As noted in A5.2.5, data on the employment effects of WEEE policy are very limited. The UK Government analysis of the proposed WEEE Directive identifies some additional labour requirements, primarily associated with treatment of WEEE. It also identifies limited additional requirements in the electrical and electronics industry related to administration, including one day per year for each manufacturer/importer in compiling relevant information to be provided to treatment facilities. This appears unlikely to result in the generation of significant additional jobs.

This is born out by experience in the Netherlands, where few if any additional jobs in the electronics industry have been created by the Decree. The only exception to this is a small number of people involved in administration of the collective schemes. Additional employment here has been kept to a minimum in order to reduce costs.

A5.3.2 Impacts on Innovation

One potential benefit of the proposed EU Directive is to encourage better design of electrical and electronic equipment to reduce the generation of waste and to enhance the potential for recycling and re-use. This effect is most likely to occur when the costs to manufacturers of implementing WEEE policy are linked to the amount of waste associated with their products and the ease with which they can be recycled.

It could be argued, therefore, that the NVMP collective scheme in the Netherlands does not encourage innovation because a single levy is applicable to each type of product. There is no differentiation between products on the basis of their design. The fact that all the costs of recycling are recovered through a levy on the price of new products provides no incentive for producers in terms of reduced costs. By contrast, under the collective scheme for ICT waste, each manufacturer/importer pays the costs associated with collection and processing of its own equipment. Manufacturers/importers therefore have an incentive to reduce the costs of recycling their products, as this will generate direct financial savings. The Netherlands Decree has been in operation too short a time to determine whether any impacts on product innovation will occur in practice.

In the absence of clear regulatory drivers, it is interesting to note that a number of manufacturers of electrical and electronic equipment have already developed product innovation programmes. IBM, for example, has put in place an Environmental Conscious Products Programme that includes consideration of re-use and recycling, product lifetimes and up-gradeability, reducing the material content of products and the use of recycled materials. It has set up nine Materials Recovery Centres around the world; these dealt with 54,000 tonnes of materials in 1998. Xerox has also developed a programme to take-back and re-manufacture printer cartridges. Although this requires more handling and thus has higher labour costs than manufacturing from new, the material costs are considerably lower, leading to a reduced overall cost. This is an indication that product innovation to reduce waste and encourage recycling can have business benefits. Policies that encourage innovation could therefore be regarded as offering advantages to the electrical and electronics industry.

A5.3.3 Impacts Outside the Electrical and Electronics Sectors

In the Netherlands, the two collective schemes contract out all transport and processing of waste products. Only a small number of contractors are used; they comprise relatively large firms from the waste management and transport sectors. It is likely that schemes developed in other countries would take a similar approach, as it appears to offer opportunities for considerable economies of scale. WEEE policy therefore has potential for significant impacts on investment and employment in the waste management, and potentially the transport, sectors.

In the Netherlands, the majority of investment related to implementation of the Netherlands Decree on the Disposal of Brown and White Goods has been made by the waste management sector. Of the known capital investment total of €7 million, €5 million comprises the costs of upgrading a treatment facility operated by one of the recycling contractors. Clearly the investment costs faced by the recycling industry in other countries will depend upon the current level of recycling and the status of facilities. The UK Government, for example, estimated that expenditure by the UK recycling sector would amount to only around €300,000.

On the same basis, any positive impact of WEEE policy on jobs is most likely to arise in the waste management and transport industries. The UK Government has estimated that implementation of the proposed WEEE Directive in the UK could lead to the creation of 500 to 600 jobs (calculated on the basis of additional labour time required to process WEEE in line with the Directive). This is equivalent to 1 to 1.25 jobs per thousand tonnes of WEEE collected, which would imply creation of 1,500 to 2,000 jobs across the EU as a whole.

Such an increase in jobs might not, however, be realised in practice. One of the most significant impacts of the Netherlands Decree on the Disposal of Brown and White Goods has been the consolidation of the waste management sector responsible for recycling these goods. For example, prior to the Decree there were approximately twelve companies involved in recycling of refrigerators and freezers, whilst now there is only one large company. Similar consolidation has taken place amongst recyclers of other types of goods. This is thought to have resulted in little or no net change in the numbers of jobs associated with WEEE recycling. The loss of jobs in small organisations, which include some social welfare organisations, has probably been offset by increases in jobs in the large recyclers to deal with the additional throughput of WEEE. No firm data on this are available, however.

A5.3.4 Impacts of Operational Costs on Profitability

Table A5.6 compares the actual operating costs of the Netherlands Decree and the estimated costs of the proposed EU Directive with the turnover of the electrical and electronics industry at Netherlands and EU level. In the case of the Netherlands, because the distribution of the actual costs between industry and local authorities is not clear, it is assumed that all of the costs of the Decree are born by industry. In the case of the proposed EU Directive, estimates of costs made by the Commission and by the industry are included.

Table A5.6: Comparison of WEEE Operating Costs with Turnover (in € million)

	Operating Costs of WEEE Policy	**Turnover of Electrical and Electronics Sector**	**Operating Costs as % of Turnover**
Netherlands: actual costs, 1999	15.3	7,110	0.22 %
Netherlands: 'normal situation'	18.9	7,110	0.27 %
EU: Commission low estimate[1]	500.0	175,000	0.29%
EU: Commission high estimate[1]	900.0	175,000	0.51%
EU: Industry estimate[2]	7,500.0	175,000	4.29%

Sources:
1. Commission of the European Communities (2000): **Proposal for a Directive on Waste Electrical and Electronic Equipment**, Brussels, CEC (COM (2000) 347).
2. Orgalime (2000): **Detailed Position of Orgalime's Electrical and Electronic Liaison Committee in Co-operation with the European Sector Committees,** Brussels, Orgalime.

In most cases, the impacts of WEEE operating costs appear likely to be minimal as they account for well below 1% of operating costs. This is particularly the case where, as under the Netherlands NVMP scheme, costs are recovered through a levy on the purchase of new white and brown goods. Only in the case of the industry estimate do WEEE operating costs appear likely to have the potential for a significant impact on profitability. Orgalime has noted that collection and recovery of WEEE 'currently accounts for between 5% and 15% of manufacturing costs' and that this amount is 'regularly higher than industry's profits'. As discussed in A5.2.6, however, the industry estimate of costs is significantly higher than other estimates and than actual costs experienced in the Netherlands.

Provided that implementation of WEEE policy allows for the economies of scale that appear to be associated with collective schemes and the use of a small number of contractors for transport and recycling of WEEE, it appears unlikely that WEEE policy will have a significant impact upon profitability.

A5.3.5 Impacts of WEEE-related Investment Costs on Other Investment

The available data on the Netherlands indicates that WEEE-related investment costs for the electrical and electronics industry are minimal. Because of the way that the collective schemes are organised, the majority of the estimated €7 million of investment costs are born by the transport and recycling firms contracted by the schemes. The UK Government analysis of the proposed Directive identified potential costs of €12 million to €14 million for the electrical and electronics industry, to modify manufacturing equipment so that products can be appropriately marked.

Only the industry estimates indicate a significant investment requirement to ensure compliance with WEEE policy. Orgalime's estimate of €15 billion for investment appears to relate primarily to the Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment. If correct, this estimate would be equivalent to 8.6% of the industry's annual turnover. Unfortunately, no data is available on overall investment levels by the sector against which this figure can be compared. Nevertheless, if Orgalime's estimate is correct, it appears that there could be potential for a significant impact on overall investment by the industry, at least in the short-term.

A5.3.6 Impacts on Prices and Markets

Analysis by the European Commission indicates that the proposed WEEE Directive could increase the prices of electrical and electronic goods by an average of 1%, with increases of 2-3% for certain products such as refrigerators, televisions and other monitors. Under the Netherlands NVMP schemes, the cost-recovery levies charged on most white goods are around 1-2% of prices but can be up to 5% for some refrigerators and freezers. Of course, if industry estimates of the costs of WEEE policy are correct, price increases would be 8-15 times higher.

In the Netherlands, research was commissioned prior to adoption of the Decree on Disposal of Brown and White Goods into the potential impacts on markets and on cross-border traffic (KPMG, 1999). The research concluded that demand for many white and brown goods was inelastic (including refrigerators, washing machines, heating boilers, televisions and computers). An increase in prices of these goods by 1-3% was therefore unlikely to lead to long-term sales changes. Only a small number of products, including video recorders and electric razors, were classified as inelastic/elastic. For these products, the maximum loss of sales from a 1-3% price increase was estimated as 1-2%, but the loss of sales was likely to be made up in the longer term. The research also identified some potential for postponement of purchases, movement within price segments (to cheaper models) and loss of purchasing power associated with the price increases.

Given the likely price increases resulting from WEEE policy, therefore, the impact on prices and markets is likely to be significant. There is also evidence of customers' willingness to pay for the benefits of take-back of used electrical and electronic equipment. IBM in Germany takes back products from customers for recycling for a fixed fee, ranging from €26 for personal computers to €2,000 for mainframe computers. Sony Germany takes back and recycles computer monitors for a fee of

€15. If price increases were significantly larger than 1-3%, for example in line with industry estimates of the costs of the proposed WEEE Directive, there could of course be potential for more significant impacts.

A5.4 Application of the E3ME Model

The E3ME model was used to examine the macroeconomic implications arising from increase in consumer product prices with the adoption of WEEE legislation across the EU.

The modelling assumes that the direct effects of the legislation, estimated for the Netherlands, would be similar for all Member States. There would be some small extra direct employment by the waste recycling industry resulting from an increase in the purchase of waste recycling services by the electrical and electronics industries, leading to higher costs of their products and extra output of waste-related services. There would also be more investment in recycling equipment. The overall picture is of the increases in employment and investment increasing EU GDP and indirect employment.

The increases in costs and prices have negative effects on GDP via reductions in consumers' expenditures and exports, but these are generally smaller than the positive effects. The cost-inflation effects are modelled to outweigh the direct employment and investment effects only in those Member States that have had a tendency to high wage inflation (e.g. Greece and Spain). However, with the advent of the single currency it may well be the case that these countries will experience a change in behaviour implying smaller inflationary responses. In this case the results reported below will overstate the loss in GDP from the policy.

As Table A5.7 shows, the policy is predicted as yielding increases in employment, with a total gain in direct employment across the EU of roughly 2,800 jobs relative to the base year at the end of the five year simulation period. The effects are in direct proportion to the data provided for the Netherlands, hence the largest economies (Germany, France, UK, Italy) account for around 70% of the total, owing to their higher consumption of electrical goods.

Table A5.8 provides predictions of changes in total employment. These are generally small, but positive, across the Member States; they do, however, illustrate the potential importance of accounting for the indirect and induced effects when considering the employment implications of a policy. Added to the direct job gains of roughly 2,800 by the end of the period are a further 2,000 plus jobs resulting from multiplier effects. In other words, for almost every three direct jobs created, two additional indirect/induced jobs are created.

Table A5.9 shows that this increase in employment is accompanied by slight increases in GDP in most Member States. The gains would peak in 2002 at an estimated increase in GDP of 0.021% (€163 million), but by the end of the five year period the increase in GDP is slightly reduced at roughly 0.016% (€145 million). The countries benefiting most from increases in GDP would be Germany, followed by France.

It should be noted though that not all countries would experience a gain in total jobs. Indeed, it is predicted that the net effect in Greece and Spain would be a small decline in total employment (less than one hundred jobs in both cases). These results are due to the different behaviour for Greece and Spain estimated in the model. In the past, these economies have tended to respond to cost increases by greater-than-average price increases. This tendency is reflected in the parameters of the model which are estimated on data over the period 1960 to 1995. In consequence, in the model simulation GDP and consumption are reduced and employment is also lower. In the future, it may well be the case that since both countries are now in the European Monetary Union they will behave closer to the European average.

Table A5.7: Additional Direct Employment in Recycling Resulting from EU Directive on WEEE (change from 2000 figures)

	2000	2001	2002	2003	2004	2005
Belgium	0	40	40	30	30	30
Denmark	0	40	40	40	40	40
Germany	0	1,030	1,010	1,010	1,020	1,030
Greece	0	10	10	10	10	10
Spain	0	110	110	110	110	110
France	0	400	420	430	440	440
Ireland	0	40	40	40	50	50
Italy	0	250	250	250	240	230
Luxembourg	0	0	0	0	0	0
Netherlands	0	10	10	10	90	90
Portugal	0	30	30	30	30	30
United Kingdom	0	510	530	550	570	580
Austria	0	50	50	50	40	40
Finland	0	70	80	80	90	90
Sweden	0	30	30	30	30	30
Total EU	0	2,710	2,730	2,780	2,800	2,820

Table A5.8: Differences in Total Employment Resulting from EU Directive on WEEE (change from 2000 figures)						
	2000	**2001**	**2002**	**2003**	**2004**	**2005**
Austria	0	50	40	40	30	20
Belgium	0	110	100	90	60	30
Denmark	0	110	110	90	80	70
Finland	0	90	120	130	120	110
France	0	1,340	1,060	1,700	1,620	1,580
Germany	0	1,020	980	920	870	810
Greece	0	10	-50	-80	-100	-90
Ireland	0	60	50	50	40	30
Italy	0	870	1,170	1,590	1,980	2,280
Luxembourg	0	0	0	0	0	0
Netherlands	0	110	170	140	130	120
Portugal	0	50	50	50	40	30
Spain	0	70	40	-10	-50	-60
Sweden	0	190	130	150	170	200
United Kingdom	0	900	320	120	140	200
Total EU	0	5,040	4,340	5,030	5,150	5,320

Table A5.9: Change in GDP Resulting from EU Directive on WEEE (% change from 2000)						
	2000	**2001**	**2002**	**2003**	**2004**	**2005**
Austria	0	0.007	0.008	0.008	0.009	0.009
Belgium	0	0.001	0.002	0.002	0.002	0.002
Denmark	0	0.002	0.004	0.004	0.004	0.004
Finland	0	-0.001	0.004	0.004	0.005	0.005
France	0	0.000	0.004	0.003	0.004	0.004
Germany	0	0.004	0.005	0.005	0.005	0.005
Greece	0	-0.001	-0.001	-0.001	-0.001	-0.001
Ireland	0	0.002	0.000	-0.001	0.000	0.000
Italy	0	0.002	0.000	-0.002	-0.003	-0.005
Luxembourg	0	0.001	0.002	0.001	0.001	0.001
Netherlands	0	0.002	0.002	0.003	0.004	0.005
Portugal	0	0.001	0.001	0.002	0.003	0.003
Spain	0	0.000	0.000	-0.001	0.000	0.000
Sweden	0	-0.002	-0.003	-0.002	0.000	0.001
United Kingdom	0	-0.002	0.000	0.000	0.000	0.000
Total EU	0	0.001	0.002	0.002	0.002	0.002

A6. THE NON-FERROUS METALS RECYCLING INDUSTRY

A6.1 Background

A6.1.1 The Business Context

The ferrous and non-ferrous recycling industries are the two most widely and long established recycling sectors, with the non-ferrous secondary metals recycling industry employing a workforce of approximately 100,000 people in 1995. It is estimated to consist of approximately 15,000 enterprises of which 10% are large, 30% medium and 60% small (IPTS, 1997).

Statistics show that 40% of non-ferrous metal produced in the EU is currently produced from recycled materials, and this proportion is increasing. Clubb (1997) reports that the non-ferrous recycling industry is worth approximately €4.2 billion with 3.5 million tonnes traded within the EU, 441,000 tonnes exported outside the EU and 880,000 tonnes imported to the EU.

The recyclable material used is predominantly from high-grade streams arising from industrial sectors, although separately collected cans provide the best-organised source of metals from commercial and household waste. There are three main types of metal scrap:

- home scrap, such as trimmings, ingot croppings and other non-product material, which seldom enters the market;
- new scrap, which arises from the conversion of the raw material into finished products; and
- old scrap, from discarded products.

The recovery and recycling of metals is an economic activity, driven by market forces. The industry benefits from high prices for metals and well-established markets for their products. Where material is not recovered, it is generally because it is not financially viable to do so. It is influenced little by environmental legislation, although waste shipment legislation has been reported to restrict the markets for certain recyclable metals and this is discussed below.

When metal is recovered it can be done so with little or no loss in the properties of the metal and in many cases secondary metals are of a similar quality to primary metals. The recycling process can be much less energy-intensive than the production of primary metals, for example, re-melting aluminium scrap consumes only 5% of the energy needed in the whole primary production process and is therefore extremely attractive. The profit usually generated provides a margin for covering the costs of collection and separation of waste. The capital requirements for non-ferrous metal processing are lower than those of ferrous metal and hence entry into the non-ferrous secondary metals industry is somewhat easier, leading to a degree of fragmentation in the industry. Overall, there has been a trend for dealers to specialise in certain metals in order to take advantage of economies of scale.

Trade outside Europe is reaching highly significant proportions both in absolute and relative terms. A proportion of EU scrap metal is exported to developing countries, as these lack the pools of indigenous scrap from which to recover their own secondary metals. Price and transport costs are usually the determining factors in whether scrap is sold domestically or is exported, and the EU scrap industry relies heavily on exports for economic viability when the domestic market is depressed.

A6.1.2 The Policy Context

The non-ferrous metals recycling industry is affected by both the Waste Framework Directive and Council Regulation (EEC) 259/93 on the supervision and control of shipments of wastes within, into and out of the European Union. This case study focuses on the latter legislation due to data availability.

Council Regulation (EEC) 259/93 on the supervision and control of shipments of wastes within, into and out of the European Union implements the Basel Convention on the Transboundary Movements of Hazardous Wastes and their Disposal, but is much broader in scope, extending control to all wastes (except radioactive waste). The Convention was originally negotiated to protect developing countries from being used as cheap disposal sites for the industrial wastes of developed countries. The implication is that such wastes are sent to countries that are ill equipped to deal with them properly, and hence they pose environmental hazards which are accepted for the sake of the disposal fees that they earn. In 1994, at the Second Conference of the Parties, a consensus declaration was made that there was to be an immediate ban on hazardous wastes destined for final disposal between OECD and non-OECD countries, and a phased-in ban for materials destined for recycling, with complete cessation by December 31, 1997. In line with this, the Regulation was amended so that trade in certain wastes outside the OECD were forbidden.

The Regulation controls the shipment of waste based on a system of notification between the exporting/importing and transit countries. The level of control is variable depending on the proposed treatment of the waste, its destination and its assignment to one of three lists according to the degree of hazard of the waste (red, amber or green lists) (TN Sofres, 2000). Exports of red and amber listed wastes are banned outside the OECD. Most non-ferrous scrap metals traded internationally are green listed (non-hazardous), but some are amber listed. None currently appear on the red list (most hazardous), although Article 10 of the Regulation allows for red list procedures to be applied to any unlisted materials, and red list procedures may be applied by any non-OECD country to any listed material.

In this case then, it is the amber procedures for waste for recovery which are most important. This requires the notification of the competent authorities in the countries of dispatch, transit and destination, any of which may request additional information and documentation. These authorities then have a period of 30 days in which to object to the shipment. If no objection is lodged after 30 days the shipment may be effected, however the consent expires within a year of that date.

A6.2 Data Analysis

A6.2.1 Data Availability and Reliability

Like the majority of the waste management industry, there is no single source of reliable and comprehensive data on the recycling of non-ferrous metals, and data therefore have to be extracted from a number of sources. A number of reports give approximate values for employment, turnover, tonnage involved, etc., where in general this is given as a total for the EU.

Data from Eurostat relating to NACE codes 37.1 (recycling of metal waste and scrap) and 51.57 (wholesale of waste and scrap) have been used to give an indication of the distribution of the industry among Member States (see Annex 3 for further explanation of these statistics). Previous analysis has shown NACE 37 to compare favourably with other sources of data on employment in recycling, although it is expected that there may be a degree of underestimation relating to recycling activities in social enterprises and other sectors not covered by NACE 37. NACE 51.57 covers the wholesale of any waste and scrap, not just metal, and therefore may overestimate employment in the sector. However, the total for employment of NACE 37.1 and 51.57 falls well below the estimated 100,000 people given by the industry trade association, hence it has been scaled up according to the proportions indicated by Eurostat data. Data from Eurostat on the number of enterprises involved in this sector compares more favourably with industry estimates.

The value and volume of metal imports and exports, both intra- and extra- EU has also been obtained from Eurostat using the following customs codes:

- 7404 for copper scrap;
- 7602 for aluminium scrap;
- 7802 for lead scrap;
- 7902 for zinc scrap;
- 8002 for tin scrap;
- 7503 for nickel scrap; and
- 2620 for metal ash and residues.

Code 2620 for metal ash and residues is the only one of the above list to be included on the Amber list under Regulation (EEC) 259/93, and while it is considered that this covers the majority of non-ferrous metal on the list, it is recognised that this might underestimate the total volume/value of exports affected by amber list procedures. The remaining codes all fall under the green list and these are also considered to cover the majority of non-ferrous trade.

A6.2.2 Employment in the Non-Ferrous Metals Recycling Industry

As previously indicated, the EU non-ferrous metals recycling industry employs approximately 100,000 people in 15,000 enterprises. Table A6.1 shows the distribution of these among EU Member States.

Table A6.1: Number of Enterprises and Employment in the EU Non-Ferrous Metals Recycling Industry, 1995				
Country	**Number of Enterprises**		**Number Employed**	
	Actual	**% of Total**	**Actual**	**% of Total**
Austria	250	1.6	3,300	3.3
Belgium	255	1.6	2,800	2.8
Denmark	655	4.2	2,900	2.9
Finland	435	2.8	1,600	1.6
France	3,000	19.2	19,800	19.9
Germany	1,925	12.3	34,800	34.9
Greece	150	1.0	1,600	1.6
Ireland	35	0.2	100	0.1
Italy	4,475	28.7	15,000	15.0
Luxembourg	5	0.0	100	0.1
Netherlands	1,095	7.0	7,400	7.4
Portugal	150	1.0	1,400	1.4
Spain	25	0.2	500	0.5
Sweden	835	5.3	4,500	4.5
United Kingdom	2,325	14.9	3,900	3.9
Total EU	15,615	100	99,700	100

Table A6.1 shows that countries such as France, Germany and Italy dominate the industry, both in terms of number of enterprises and level of employment. While the average number of employees per enterprise varies between Member States, in no country is it more than 20, with an EU average of six, suggesting that the majority of non-ferrous metal recycling is undertaken by small businesses.

Eurostat data shows that on average 31 tonnes of metal are recycled per job, which compares to the figure of 44 tonnes/job given by the Association of Cities for Recycling (1999).

A6.2.3 Size of Export Market

The export market for non-ferrous secondary metal is considerable, accounting for 2.4 million tonnes within the EU (€2.3 billion), and 700,000 tonnes (€657 million) to non-EU countries in 1998. Table A6.2 illustrates the degree of change in the export markets, in terms of volume, between 1995 and 1998. This shows that during this period the volume of trade within the EU has decreased, while extra-EU exports have increased. However there are huge variations, both by country and by metal, with very few trends noticeable, even if yearly data are analysed. The most obvious trend is a reduction in intra-EU lead exports, which have declined significantly. This is

Table A6.2: Difference in Volume of Intra-EU and Extra-EU Exports between 1995-1998 ('000s tonnes)												
	Copper		Aluminium		Lead		Zinc		Metal Ash & Residue		Total[1]	
	Intra	Extra	Intra	Extra	Intra	Extra	Intra	Extra	Intra	Extra	Intra	Extra
AU	+10.4	+1.7	+25.5	-1.2	-0.2	0	+1.7	0	+13.8	+6.8	+51.3	+7.2
BE	-4.6	+17.9	+30.4	-2.9	-40.2	+1.0	+3.4	+2.2	-50.6	+12.4	-61.8	+30.6
DK	-20.1	-1.5	-5.7	-1.2	-14.0	+0.2	-0.1	-0.2	+0.9	+9.4	-38.2	+6.8
FI	-1.6	-0.4	-2.5	-3.5	-8.6	+0.8	+1.4	-1.5	0	+5.6	-12.4	+1.3
FR	-16.8	-2.7	+57.5	+6.4	-2.9	+0.4	+14.3	-2.0	-0.6	-21.2	+60.7	-20.0
DE	+24.8	+17.5	+17.9	+52.4	-12.4	+0.1	+9.8	+1.3	-88.5	-2.9	-51.4	+68.5
GR	-3.1	+0.3	+0.9	-0.5	-0.1	0	-1.8	+0.6	-11.4	-13.8	-15.5	-13.5
IR	-1.0	+0.8	-1.9	+0.1	-2.1	0	0	0	+0.1	0	-4.5	+0.9
IT	+4.9	-3.2	+4.0	-3.2	-3.2	0	+0.3	-2.8	+9.0	+6.8	+15.3	-2.1
NE	-26.6	-29.4	+28.8	-2.1	-10.4	+0.3	+0.3	+4.8	+27.9	-7.4	+16.0	-34.2
PO	+0.8	-0.2	-0.1	+0.1	-1.1	0	+2.3	0	+0.2	0	+6.6	-0.1
ES	-8.7	+0.8	+1.7	-0.3	-3.3	0	-0.7	+0.1	-62.0	-1.3	-73.6	-0.7
SW	-6.4	+3.4	+10.3	-5.3	+0.4	0	+0.3	-1.6	-20.6	+14.6	-16.2	+10.3
UK	+21.1	-22.4	+3.1	+10.5	-6.4	0	+4.7	-7.8	-10.3	-3.0	+11.7	-21.1
EU	-26.8	-18.1	+174.5	+50.2	-104.5	+2.8	+35.1	-7.1	-192.1	+6.0	-112.1	+34.3
[1] Total includes tin and nickel.												

thought to be due to other regulations concerning lead, rather than Regulation (EEC) 259/93.

Although there has been an overall increase in both intra- and extra-EU aluminium exports, this has not been experienced by all countries. Likewise, the overall decrease in exports of metal ash and residues has not been experienced by all countries, with Austria and the Netherlands both significantly increasing their exports.

Although 1999 export data was obtained from Eurostat, it was not used in this comparison as it was not complete for all of the Member States. Had it been used however, it would have had a significant effect on a number of trends, not least the Amber-listed metal ash and residues, where 1999 sees huge increases in extra-EU exports for Denmark, Italy and the UK. Therefore, the figures used in this analysis are very sensitive to the year assumed.

Exports in general have fluctuated over the 1995 to 1998 period, as has the price per tonne of metals. Again there is no clear trend between these two factors. In some cases where the volume of exports has decreased the price has risen, so that the total value of exports for a particular metal has increased. For example, in the UK, intra-EU exports of amber listed metal ash and residues fell by more than 10,000 tonnes, a reduction of nearly 40%. However, the price per tonne rose from €949 to €2,319, so that the total value of exports increased by more than 50% over the same period. In other cases, the value of exports has decreased in line with a reduction in volume.

Table A6.3 gives actual volume and value data for non-ferrous metal scrap exports, according to their classification by Regulation (EEC) 259/93, for 1995. In general, the volume and value of green listed metal scrap is much greater then that of amber listed. However, for Greece, Spain and Sweden, metal ash and residues accounts for more than 50% of their exports.

Table A6.3: Volume and Value of Green Listed and Amber Listed Non-Ferrous Metals, 1995

Country	Green Listed Metal Exports		Amber Listed Metal Exports	
	Volume of Metal/ Tonnes	Value of Metal/ 1000 €	Volume of Metal/ Tonnes	Value of Metal/ 1000 €
Austria	53,193	58,346	3,911	6,878
Belgium	233,439	172,729	100,025	33,438
Denmark	110,586	120,229	3,676	1,368
Finland	51,896	47,518	4,886	2,207
France	281,119	350,099	146,373	53,791
Germany	783,782	860,124	156,368	42,985
Greece	14,701	16,714	26,870	1,810
Ireland	23,929	29,194	100	154
Italy	75,285	78,268	57,445	23,513
Luxembourg	6,805	4,208	10,014	1,984
Netherlands	373,725	393,995	39,615	16,765
Portugal	17,403	21,909	165	59
Spain	49,328	69,724	72,554	27,270
Sweden	70,716	64,582	70,483	21,695
UK	259,407	337,738	37,050	63,612
EU	2,395,300	2,623,393	729,535	297,529

A6.3 Impacts of Waste Management Policies on the Non-Ferrous Metals Recycling Industry

Regulation (EEC) 259/93 may impact both positively and negatively on employment in the non-ferrous metals recycling industry. A study by TN Sofres (2000) attempts to quantify the costs associated with this legislation on the non-ferrous industry, but concludes that the costs are extremely heterogeneous due to the variety of situations experienced by companies (e.g. type of waste, country of exchange, role as importer/exporter etc.).

Table A6.4 indicates the compliance costs incurred by Italian non-ferrous recycling companies with respect to the strict application of Decree 22/97 (which implements Directives 91/156/EEC, 91/698/EEC and 94/62/EEC), where these costs are approximate to 0.5% - 1.0% of turnover. TN Sofres (2000) report the additional costs associated with Regulation (EEC) 259/93 are equal to a similar percentage of turnover, ranging from 0.0016% to 1.3%.

Table A6.4: Estimated Compliance Costs for the non-ferrous metal industry in Italy (€/Year)			
Costs	**Small Firm**	**Medium Firm**	**Large Firm**
Extra person for administrative procedures	n/a	20,776	25,970
Specific software	649	519	1,039
Account books, forms (keeping fill-in, checking, etc.)	4,000	2,960	4,414
External consultant	n/a	779	4,155
Other	4,648	623	2,337
Total	**9,297**	**25,657**	**37,915**
Cost as % of turnover	**0.5 to 1%**		
Source: ASSOFERMET (1997), cited in IPTS (1997)			

It has been suggested that many companies have had to hire at least one extra person in order to deal with the extra administration and legal aspects that have arisen from the Regulation. Table A6.4 shows that this was also the case in Italy, so if similar costs were incurred due to the implementation of Regulation (EEC) 259/93 then this would result in 40% (10% large and 30% medium sized companies) of the total 15,616 companies having to employ one extra person, creating an additional 6,246 jobs.

However, the restrictions to trade in non-ferrous metal scrap may also have a negative effect on employment. The extra burden of administration, variation in requirements for information, and delays in trade due to additional notification procedures have caused contract failures and have deterred some companies from dealing with certain countries. The main costs are reported as hidden costs in terms of losses of margins; but notification fees and administration costs are also significant, with administration fees varying greatly between countries (Clubb, 1997).

Extra administration costs can render the exportation of quantities lower than 100 tonnes unprofitable, causing a limitation of exports. A company surveyed by TN Sofres (2000), which specialises in aluminium scrap, suggests that the cost of lost opportunities resulting from administrative trade barriers are far greater than direct administration costs (20 to 30 times greater).

The price of primary and secondary metal can vary a good deal, sometimes daily. By contrast, scrap processing costs are relatively stable over periods of months or longer.

The lower the secondary price, the greater is the relative importance of processing costs, and the smaller is the profit margin, to a point at which reclamation may not be worthwhile (Henstock, 1996). Most trade in recyclable metals needs to be settled quickly to take advantage of world prices, exchange rates, interest rates, freight charges and the availability of the material. Some materials, such as aluminium drosses and lead drosses are perishable.

It should be remembered that the Regulation has the advantages of reducing illegal shipments and treatment practices through better control and protects developing countries from importing waste which they cannot handle. However, the ban on trade with non-OECD in red and amber listed wastes also has obvious effects on the industry, although it is not clear to what extent with the data available. Current exports of amber listed metals reach a value of approximately €400 million, where this includes both intra- and extra-EU trade, but there has been a noticeable decline in the volume of intra-EU trade between 1995 and 1999. Therefore such restrictions may have wider implications than at first thought, due to the fact that the EU scrap industry relies heavily on exports for economic viability when the domestic market is depressed. However, other, unrelated market developments may conceal the effects of waste management measures, or make them seem larger than they are in reality.

A6.4 Application of the E3ME Model

As for the other case studies, the Cambridge Econometrics model was used to predict the total net employment and GDP effects associated with the impact that Regulation (EEC) 259/93 has had on the export of secondary non-ferrous metals. The modelling assumes a theoretical situation where there is no international trade in amber listed non-ferrous metals. In practice, only exports to non-OECD countries are forbidden. This assumption was made on the basis that it was not possible to ascertain from the available data the proportion of exports going to non-OECD countries before the ban was implemented. The data also shows a decrease in trade in amber listed metals within the EU, which may have been caused by extra administration costs and delays. Hence, the results of the model present a worst case scenario where all trade is prevented, for whatever reason. It should be remembered though that the actual data does not show this to have happened and the decrease in trade experienced may be due to other, unrelated market developments.

The assumption was made in modelling the Regulation to treat the policy effects as if they were taking place in a closed system (in other words to assume that the metal was not exported, but simply ended up sitting in stockpiles). It was not possible to model a more dynamic system involving delayed sales. From the information on the size of export markets, it was possible to infer the number of job losses through not being able to trade in amber-listed metals. The job losses were added to the direct gains created by the additional administrative and legal requirements to work out the overall net employment effect and the consequent impact on GDP by Member State.

The results of the econometric modelling are presented in Tables A6.5 to A6.7. As can be seen from Table A6.5, in all but two countries the Regulation has led to an increase in direct employment. These direct job gains are as would be expected in that they reflect the need for companies to hire in additional legal and administrative assistance in order to deal with the additional burdens in these two areas stemming from the change in legislation. Note that the number of additional direct jobs remains fairly constant over the five year period, with them predicted at roughly 6,150 by the end of the modelling period.

Table A6.6 presents the net predicted losses in total employment, where this includes the multiplier effects of the changes in direct employment. As can be seen from this table, owing to predicted losses in GDP (as given in Table A6.7) the pattern for total employment for the EU moves from being positive in the first two years following implementation of the Regulation to being negative in year five, although the magnitude of the net losses (at 1,700 jobs) is small.

The losses in GDP are negative in each of the five years, however, due to the fact that the non-ferrous metals recycling industry is a highly integrated sector, with considerable demand and supply linkages to other sectors of the economy. Thus, impacts on this sector have significant knock-on effects for other sectors (through impacts on demand and supply relationships). The greatest impact on GDP occurs in year two at a predicted decrease in GDP of 0.006%, with GDP down by 0.005% by year five. However, these are likely to be over-estimates of the effects of the Regulation given that the impact may be more one of delaying export rather than preventing it.

Table A6.5: Change in Direct Employment in the Non-Ferrous Metal Recycling Industry Resulting from Regulation (EEC) 259/93 (change from 2000)

	2000	2001	2002	2003	2004	2005
Austria	0	100	100	100	100	100
Belgium	0	100	100	100	100	100
Denmark	0	260	270	280	280	280
Finland	0	170	170	170	170	170
France	0	1200	1220	1230	1210	1200
Germany	0	770	750	740	740	740
Greece	0	60	60	60	60	60
Ireland	0	10	10	10	10	10
Italy	0	1,790	1,780	1,780	1,780	1,780
Luxembourg	0	0	0	0	0	0
Netherlands	0	440	440	430	430	430
Portugal	0	60	60	60	60	60
Spain	0	10	0	-10	-20	-30
Sweden	0	340	340	330	330	340
United Kingdom	0	930	930	940	930	910
Total EU	0	6,250	6,230	6,230	6,190	6,150

Table A6.6: Change in Total Employment Resulting from Regulation (EEC) 259/93 (change from 2000)						
	2000	**2001**	**2002**	**2003**	**2004**	**2005**
Austria	0	90	80	80	90	100
Belgium	0	-10	-200	-330	-380	-340
Denmark	0	310	300	290	270	260
Finland	0	200	210	220	210	210
France	0	1,220	860	70	-620	-1,240
Germany	0	430	50	-30	-150	-200
Greece	0	70	70	60	50	60
Ireland	0	10	10	10	10	10
Italy	0	1,500	1,420	1,410	1,370	1,340
Luxembourg	0	0	-10	-40	-70	-90
Netherlands	0	400	390	400	400	410
Portugal	0	70	80	80	80	70
Spain	0	-190	-440	-550	-730	-920
Sweden	0	250	200	230	260	300
United Kingdom	0	1,760	1,040	-980	-1,600	-1,630
Total EU	0	6,110	4,060	940	-800	-1,690

Table A6.7: Change in GDP resulting from Regulation (EEC) 259/93 (% change from 2000)						
	2000	**2001**	**2002**	**2003**	**2004**	**2005**
Austria	0	0.001	0.003	0.006	0.008	0.011
Belgium	0	-0.020	-0.035	-0.029	-0.027	-0.008
Denmark	0	0.004	0.004	0.005	0.005	0.005
Finland	0	0.005	0.006	0.007	0.006	0.006
France	0	-0.005	-0.010	-0.010	-0.010	-0.011
Germany	0	-0.002	-0.004	-0.003	-0.004	-0.004
Greece	0	-0.001	-0.002	-0.002	-0.001	-0.001
Ireland	0	0.000	0.000	0.001	0.001	0.000
Italy	0	0.000	0.000	0.001	0.001	0.001
Luxembourg	0	-0.008	-0.011	-0.009	-0.010	-0.010
Netherlands	0	-0.003	-0.004	-0.001	0.001	0.001
Portugal	0	0.002	0.003	0.003	0.003	0.003
Spain	0	-0.005	-0.009	-0.010	-0.011	-0.013
Sweden	0	0.001	0.010	0.016	0.019	0.021
United Kingdom	0	-0.007	-0.011	-0.010	-0.013	-0.015
Total EU	0	-0.003	-0.006	-0.005	-0.005	-0.005

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