Quantification of the business benefits of resource efficiency

A research report completed for the Department for Environment, Food and Rural Affairs by Oakdene Hollins and Grant Thornton.

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Oakdene Hollins

Grant Thornton

defra
Department for Environment Food and Rural Affairs

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This report has been prepared by:	Dr Peter Lee – Oakdene Hollins Ltd Dr Ben Walsh – Oakdene Hollins Ltd Peter Smith – Grant Thornton UK LPP
Checked as a final copy by:	Katie Deegan / Jo Pearson
Reviewed by:	David Fitzsimons – Oakdene Hollins Ltd Stephen Gifford – Grant Thornton LLP

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Oakdene Hollins Ltd
22-28 Cambridge Street
Aylesbury
Bucks HP20 1RS

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David Vincent, Carbon Trust

Peter Seggie, CPI

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Glossary

ABI	Association of British Insurers
AEPUK	Association of Electricity Producers
BBPA	British Beer and Pub Association
BERR	Business Enterprise and Regulatory Reform
BGS	British Geological Survey
Billion	One thousand million
BOF	Basic oxygen furnace
BOP	Basic oxygen process
BRE	Buildings Research Establishment
C&I	Commercial and Industrial
CCA	Climate Change Agreement
CCGT	Combined Cycle Gas Turbines
CCL	Climate Change Levy
CDEW	Construction, Demolition and Excavation Waste
CIA	Chemical Industries Association
CMF	Cast Metals Federation
Defra	Department for Environment, Food and Rural Affairs
DUKES	Digest of UK Energy Statistics
EA	Environment Agency
EER	Energy Efficiency Ratio
FDF	Food and Drink Federation
FISS	Food Industry Sustainability Strategy
GVA	Gross Value Added
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrated Pollution Prevention and Control
MAS	Manufacturing Advisory Service
nec	Not elsewhere classified
OGC	Office of Government Commerce
ONS	Office for National Statistics
PPC	Pollution Prevention and Control
QCD	Quality Cost Delivery
RECIPE	Reduced Energy Consumption in Plastics Engineering
SEC	Specific Energy Consumption
SEPA	Scottish Environment Protection Agency

SIC	Standard Industrial Classification
SMMT	Society of Motor Manufacturers and Traders
TEBP	Transport Energy Best Practice Programme
UKQAA	UK Quality Ash Association
WRAP	Waste and Resources Action Programme

Executive summary

Study Aim

This report quantifies business resource efficiency opportunities in the UK economy. The report is the result of a study carried out by Oakdene Hollins Ltd and Grant Thornton UK LLP for the Department for Environment, Food and Rural Affairs (Defra) between March and September 2007.

This study focuses on resource efficiency savings that require low[1] or no financial investment whilst reducing the quantity of waste produced or the consumption of energy or water.

Methodology

The methodology used in this study comprised six main steps:

Quantification of the overall consumption (waste arisings - tonnes, energy consumption - kWh and water consumption - m^3) in each significant[2] subsector[3] of the UK economy: This was used as the current baseline for each subsector.

Quantification of the savings (percentage of consumption) in each sector or subsector: This represents the potential improvements each subsector or sector can make.

Conversion of physical savings into financial savings: This step focused on quantifying the direct savings i.e. waste disposal costs and expenditure on supplied water or energy.

The inclusion of any hidden or additional cost savings: This step focused on quantifying the additional savings, which were not directly related to the improvements in resource efficiency such as improved productivity or reduction in raw material costs. It also identified the

[1] "Low" in the context of this study means resource efficiency interventions with a payback period of less than one year

[2] "Significant" in the context of this study means the sectors with the highest consumption rates.

[3] Subsector refers to "group level" businesses categorised to three digit standard industry classification (SIC).

subsequent reduction in raw materials used within the production process.

Grossing up: The data from the "significant" subsectors was grossed up to sector and then UK economy level using a simple weighted average.

Regional analysis: The number of enterprises in each subsector in each region was used to breakdown the savings opportunity by UK region. NB: This method assumes that the opportunity is uniformly distributed across enterprises and regions and hence can only be used as a guide since it does not take into consideration regional cost variations.

Results

This study estimated the total value of low-cost / no-cost resource efficiency savings to range between £5.6 billion to £7.4 billion (mean £6.4 billion[1] annual savings opportunity) (Table A1), which equates to 0.6% of UK gross valued added[2] and 1.9% of UK gross operating surplus (profit)[3] . Energy (52%) and waste (41%) are the two areas where the most opportunity was identified.

Table A1: Summary of the estimated resource efficiency savings opportunity across the UK economy

Resource	Estimated Savings Opportunity (£M)	% of total estimated savings
Energy	3,349	52
Waste	2,659	41
Water	441	7
Total	**£6,449M**	**100%**

Table A2 gives details of the sectors where the most significant savings opportunities appear.

NB: The environmental benefits were not quantified within this study. The carbon benefits associated with energy can be calculated using the fuel mix tables shown for each sector (Section 4) and relevant conversion tables. However, quantifying the carbon benefits from the

[1] This represents the current short term (annual) resource efficiency savings opportunity and would remain (all else remaining equal) year on year if no intervention was undertaken.

[2] UK total GVA in 2006 = £1,154,959 million. Source: ONS UK economic accounts.

[3] UK total gross operating surplus in 2006 = £340,715 million. Source: ONS UK economic accounts.

waste savings would be particularly problematic due to the lack of base data on the composition of the waste being saved. In this study reference is made to the type of savings made, e.g. reuse, reduction or alternative waste management (predominantly increased recycling).

Table A2: A summary of the significant energy, water and waste savings opportunities by subsector

Energy

Activity	Estimated Savings Opportunity (£M)	% of overall energy savings
Transport (road freight)	2,017	60.3
Chemicals, rubber & plastics	189	5.7
Retail	141	4.2
Hotels & Catering	109	3.3
Commercial offices	101	3.0
Basic metals / mechanical engineering	83	2.5
Food & Drink	77	2.3
Warehouses	77	2.3

Waste

Activity	Estimated Savings Opportunity (£M)	% of overall waste savings
Food & Drink	858	32.3
Retail	489	18.3
Construction	239	9.0
Chemicals, rubber & plastics	235	8.8
Travel agents	233	8.8
Machinery, electrical & transport equipment	195	7.3
Hotels & Catering	70	2.6

Water

Activity	Estimated Savings Opportunity (£M)	% of overall water savings
Public administration	85.8	19.4
Food & Drink	60	13.6
Education	39.7	9.0
Chemicals, rubber & plastics	38.9	8.8
Agriculture	37.8	8.6
Health & social work	30.4	6.9

Findings

The waste savings opportunities

Fifty percent of the waste saving opportunities identified were in the manufacture of food and drink and the retail subsectors. Areas where large savings can be made are in reusable containers, purchasing of raw materials in bulk, improved production efficiency and increased packaging recovery.

A primary opportunity identified was improved waste management.

In many of the industrial sectors generating high levels of waste, e.g. construction (hard demolition waste), mining (extraction waste), basic metals (blast furnace slag) and paper (pulp sludge), much of the waste is considered to be unavoidable. Improvement of waste management by optimising the diversion of waste from landfill into recycling or reuse is thus the best option available.

Similarly the service sector waste has historically been collected and sent to land disposal mixed and hence a significant waste savings opportunity exists in segregating the waste at source. This can be regarded as a quick-win or interim solution with waste minimisation at source being the longer term objective.

The water savings opportunities

Many of the water savings opportunities identified are non-industrial process-based savings, e.g. toilets (improvements in urinal and toilet flushing), washing and cleaning (push taps and flow restrictors), as opposed to the more specific in-process savings. Since such savings are common to all sectors and represent an estimated savings opportunity of £78 million it is considered appropriate to single this out as a quick win. It is clear that these savings disproportionately affect businesses with large numbers of employees, such as in the service sector. The savings opportunity which remains from the in-process, predominantly industry based, savings amounts to a substantial £363.3 million and should not be disregarded.

The food and drink sector is much cited with regard to water savings opportunities but very little focus has been placed on public administration[1]

[1] This code includes all administrative activities performed by government. It is the administrative, policy or similar units which fall under this SIC as apposed to operational activities which should be classified to the appropriate UK SIC (2003) Section (for example, a primary school in Section M; a National Health Service hospital in Section N), for example the central government and civil service, local government and revenue services are public administration. This code also includes activities of defence, justice/prison/police and the fire service.

which was identified as the subsector with the highest expenditure on water and with the greatest water saving opportunity.

The energy savings opportunities

By far the biggest opportunity for savings through energy efficiency is within the transport sector. This is achieved through modest changes to logistics and haulage companies' methods of operation. These savings have already been realised in companies which have taken on recommendations made to increase energy efficiency.

Comparison with previous studies

The estimate of £2.3 to £3.1 billion in waste savings opportunity would appear to be in line with a previous estimate made of £2.0 to £2.9 billion[1]. In addition, the savings opportunity as a percentage of manufacturing profit (4.7% to 6.6%) and as a percentage of manufacturing gross value added (1.25% to 1.75%) also match the previous study, which estimated profit savings of 5% to 7% and GVA savings of 1.25% to 2%. The older study, however, focused solely on the manufacturing sector. This study estimates waste savings in this sector to be £1.2 to £1.7 billion. Although the realisation of some of the potential savings during the four years between the two studies would be expected, it should be noted that the estimated saving achievable by the chemicals industry in the 2003 study was considered by experts from within the industry to be overstated at £966 million. The estimated raw material savings in this previous study equates to a 1.3% reduction in raw material use, which was considered high in an industry that focuses heavily on maximising yields. This study estimates the waste savings opportunity from the chemicals sector to be £235 million.

The Energy Review estimated the potential for cost effective energy efficiency in transport to be £4.7 billion, considerably higher than the £2 billion estimated in this study. However the Energy Review incorporated savings from both industrial and domestic use, which makes direct comparison difficult.

Fitness for purpose of methodology

The systematic nature of the methodology has proven to be extremely useful in enabling outcomes to be challenged and verified at each key stage in the

[1] The Benefits of Greener Business" (Cambridge Econometrics and AEA Technology) for the Environment Agency 2003.

process. This has also enabled a number of supplementary observations to be made.

Key sensitivities

The estimate of waste savings opportunities within the commercial and Iindustrial (C&I) sectors rely heavily on the Environment Agency's 2002/03 C&I waste survey. This data is now four to five years old and hence rather dated. Unfortunately, in the majority of subsectors no surveys have been undertaken to supersede this data and hence it was necessary to project this data forward to 2006/07, which introduces a significant opportunity for error. To address this, key stakeholders were consulted to validate the projections and the estimated savings opportunities.

The hidden or additional saving associated with waste reduction was highlighted as a key sensitivity within this study since it is cited that, in some circumstances, these savings can be an order of twenty times greater than the associated waste disposal savings. This study found very few examples within the case studies or surveys identifying savings opportunities of this magnitude.

An example of an exception to this is the case of white paper use in office based businesses, which accounts for 20% of waste. This gives rise to a waste disposal cost of £65 per tonne and has a raw materials value of £1,200 per tonne[1].

Regional variations

Table A3 shows the regional analysis. The South East and North West of England can be seen to have the greatest level of resource efficiency opportunities and, in both regions, waste reduction in the food & drink and retail subsectors and energy efficiency in the transport sectors represent the most significant opportunities.

[1] Based on a standard ream of $80 g/m^2$ A4 white paper costing £3 and weighing 2.5kg.

Table A3 Summary table showing waste, energy and water savings by region

Region	**Waste (£M)**	**Energy (£M)**	**Water (£M)**	**Total (£M)**
South East	336	488	47	871
North West	299	373	41	713
London	272	318	40	630
East	247	334	34	615
South West	248	298	36	582
Scotland	245	273	43	561
West Midlands	213	315	33	561
Yorkshire & the Humber	234	285	34	553
East Midlands	191	267	32	490
Wales	132	163	23	318
Northern Ireland	104	114	15	233
North East	92	120	15	227

1 Introduction

1.1 This study focuses on quantifying the current potential for low-cost / no-cost resource efficiency gains in UK businesses. It focuses on two resources, water and energy, and also on discarded resources i.e. waste.

Background

1.2 Previous studies have quantified the savings opportunities from reducing waste arisings and improving energy efficiency. Two key reports are:

- The Benefits of Greener Business. Cambridge Econometrics and AEA Technology 2003.
- The Energy Review: The Performance and Innovation Unit. Defra 2002.

1.3 Table 1.1 shows the conclusions from the "Benefits of Greener Business" study. This concluded that if the manufacturing sector in England and Wales invested £1.5 billion in best-practice techniques they could achieve waste savings of £2.4 billion in annual operating costs, i.e. a payback period of less than 8 months. To put this into context, the study reports that this represents a savings opportunity equivalent to 6.7% of the manufacturing sector GVA.

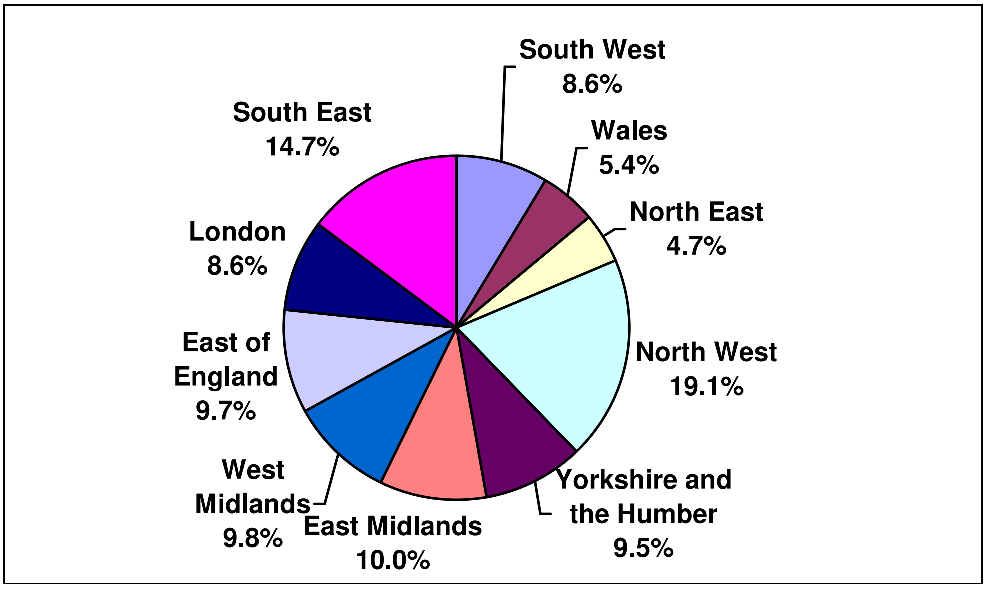
Table 1.1: Estimated waste savings opportunity in the manufacturing sector in 2003.

Sector	**Total savings**		**Savings as % of GVA**	**Investment required (£M)**
	(£M)	**% of total savings**		
Food, drink and tobacco	407.7	17.0	7.6	379.9
Textiles, leather and clothing	232.5	9.7	19.2	101.4
Coke, petrol and nuclear fuels	5.6	0.2	0.1	3.5
Chemicals and man-made fibres	966.1	40.3	24.0	574.6
Basic metal and metal products	139.2	5.8	2.3	128.8
Engineering and allied industries	262.6	11.0	2.2	145.5
Other manufacturing	381.0	15.9	4.3	177.8
Total	**£2,394.7m**	**100%**	**6.7%**	**£1,511.5m**

1.4 In addition, Table 1.1 also shows that the chemicals and food sectors were found to have the greatest savings opportunity accounting for 57% or £1.4 billion of the total estimated savings within the manufacturing sector.

1.5 Figure 1.1 shows the share of annual waste savings across England and Wales, as estimated in the "Benefits of Greener Business" study. This shows that the North West (19.1%) and South East (14.7%) of England accounted for over one third of the total estimated savings in 2003.

Figure 1.1: The estimated share of annual waste savings across England and Wales in 2003



1.6 The Energy Review of 2002[1] estimated the potential for cost effective energy efficiency improvements within the UK at £12.3 billion (Table 1.2) amounting to approximately 30% of final energy demand. The table shows the savings to be dominated by the domestic and transport sectors, accounting for 72% of the estimated savings. In this study focus is placed on the business sectors namely, service, industry and transport.

Table 1.2: Summary of energy savings opportunities in the UK in 2002

Sector	**Energy savings**		
	Mtoe/year	**%**	**£M**
Domestic	17.4	37.2	5,000
Service	3.8	21.0	1,190
Industry	8.6	23.8	1,380
Transport	19.3	35.0	4,700
Total	**49.1**	**31.4%**	**£12,300m**

[1] The Energy Review: The Performance and Innovation Unit. Defra 2002.

Context

1.7 Why is Government concerned with resource efficiency? Environmental objectives, in particular a reduction in the emission of greenhouse gases (GHG), present questions over the rate of adoption by businesses of resource efficient practices that could reduce these emissions. The Stern Review (2007) provides a summary of the barriers and market failures that hinder the uptake of such practices[1]. They include: hidden costs, transaction costs, lack of credible information and misaligned incentives as well as behavioural and organisational factors. Government is addressing these barriers by, amongst other interventions, funding the provision of resource efficiency expertise to business, through delivery bodies such as WRAP, Envirowise, NISP etc. The Government is currently reviewing the scope of the service being provided to businesses by these delivery bodies.

The definition of resource efficiency

1.8 In this study we are concerned only with a subset of activities that businesses regard as improving the efficiency of energy and material resource use. These are changes that require negligible or no financial investment but which reduce the consumption of energy or water or reduce the quantity of waste produced per unit of output.

1.9 The study does not measure the main sources of resource efficiency gains in businesses, namely capital investment in new plant and equipment, economies of scale achieved through merger and acquisition and in-house innovation. Nor does it measure the step-change improvements in resource efficiency that has been described by Weizacker, Lovins and Lovins[2].

1.10 It was with this type of "factor four" resource efficiency gain in mind that the European Environment Agency defined resource management in 2006 as follows:

"*Resource Management is taken to mean activities aimed at or effecting the efficient use of material resources throughout the economic system including*

[1] Chapter 17 "The Economics of Climate Change" ISBN 0 521 70080 9

[2] "Factor Four – Doubling Wealth, Halving Resource Use" Chapter 2. ISBN 1 85383 406 8

resource extraction, product design, production systems, distribution, consumption, re-use, waste prevention, recycling and disposal"

1.11 The type of resource efficiency opportunities considered in this study are largely those delivered by organisations such as Envirowise, WRAP, ENWORKS, NISP and the Carbon Trust or that can be identified through "Kaizen" methods[1] within the management discipline of "lean manufacturing"[2].

Objectives

1.12 This study aims to identify, analyse critically and synthesise quantitative (and qualitative where appropriate) evidence for the potential for further resource efficiencies in UK businesses in the use and production of:

- waste
- water
- energy.

1.13 Furthermore it aims to:

- identify the potential for further resource efficiency in a selection of business sectors
- measure the financial savings (losses) from resource efficiencies for businesses and, if possible, for the UK as a whole, commenting on any regional distribution as appropriate
- wherever possible, provide data on the volume of material resources so that the environmental benefits can be evaluated
- propose a framework for the type of data that should be collected in the future to permit updated valuations with improved data sets.

---

[1] A continuous improvement technique that includes activities such as "Deming Cycle" "5S" "5M Checklist" and "5 Whys" See the Kaizen Institute for Europe.

[2] There is an extensive literature in this area. "The Lean Toolbox" Bicheno ISBN 0 9513 829 93 provides a practical overview.

Layout of report

1.14 The report is split into the following sections:

Section 2. Methodology

Section 3. Waste

Section 4. Energy

Section 5. Water

Section 6. Regional Analysis

Section 7. Conclusions

Section 8. Further Work

2 Methodology

Preliminary analysis

2.1 Resource efficiency data is frequently drawn from case studies, which in their nature only focus on the best opportunities or on a single opportunity within each company, or is drawn from surveys undertaken in companies who have requested assistance, i.e. are self selecting. It is therefore inappropriate to assume that in such cases the data is representative of the resource efficiency opportunities (random) and can be simply multiplied up to derive the savings opportunity across a whole subsector or sector.

2.2 As a means of addressing this issue the "Benefits of Greener Business" study applied the following key assumption: *"In those case studies where no explicit figure was cited, the scope for replication for the process improvement to other firms was set at 20% (compared with the range of replication rates of 5-100% that are quoted). In other words, 20% of all firms (by employment) in the same sector were considered capable of achieving this saving".*

2.3 The formula used was:

$$GS = \sum_{i=1}^{n} \left(\frac{El - EC_i}{EC_i} \times R_i \times S_i \right)$$

Where:

GS = savings for the group,

n = the number of case studies in the group,

El = Group employment,

EC = Employment in the case study,

R = the replication across the group,

S = annual savings for the firm.

2.4 The introduction of a "replication rate" adds a level of subjectivity to the methodology and hence is not statistically robust.

2.5 As a means of overcoming this issue a two step preliminary assessment was undertaken within this study to determine the relative position of the case study / survey companies, i.e. do they represent the mean performance of the subsector in terms of resource efficiency, better than average performance or worst than average performance? The method of grossing up the data from company to subsector, sector and ultimately UK economy was developed using this analysis. The two steps are:

2.6 **Step 1.** Quantify the mean waste arisings in the manufacture of chemicals, plastics and rubber and the manufacture of food and drink subsectors. These two sectors accounted for 57% of the opportunity in the previous "Benefits of Greener Business" study.

2.7 **Step 2.** Map the case study data onto the subsector level data (Step 1) to determine the relative position of the case study companies with respect to overall subsector or sector performance.

2.8 Appendix 1 details the analysis, summarised below.

Step 1. Quantify the mean waste arisings in each subsector

2.9 The Environment Agency C&I survey 2002/03 was considered the most appropriate data source. Although the survey is now relatively old the methodology used is statistically robust and the data has not been superseded. In the C&I survey each sector (2 digit SIC – division level) is broken down to subsector (3 digit SIC – group level) and then by employment band. The employment band sizes were set by the Agency to ensure that the size difference within each band had no significant impact on waste arisings[1]. In this study this was interpreted as indicating that the variation in waste arisings within each employment band was due to the relative environmental performance of the company and not the size of the company. NB: the 2002/03 data was projected up to 2006/07, see Appendix 1.

Step 2. Map the case study data against the data in Step 1

2.10 The Envirowise FastTrack scheme and ENWORKS were the two key datasets used. Although ENWORKS is a regional scheme it is focused in the north west of England where the greatest tonnage of food and drink, and chemical waste arises (17% of food and drink waste and 24% of chemical, plastic and rubber waste from England and Wales, Appendix 2).

[1] The Commercial & Industrial Waste Production Survey. Environment Agency. Draft Final Report. September 2005.

2.11 In total 380 food and drink, and chemical company surveys undertaken in the two subsectors since 2005 were examined and 91 contained all the information required to undertake the mapping process. The main reason surveys were excluded was the focus of the surveys. It was important for this analysis to capture the data from surveys that focussed on the whole process and not simply one component of a business's activities to ensure that the savings opportunities identified represented total savings within each company.

The results of the preliminary analysis

2.12 Table 2.1 shows the results of the mapping process in terms of the relative position of the surveyed companies. This shows that three out of every four case studies or surveys analysed in both subsectors were in companies whose waste arisings fell below the average waste arisings of the subsector/ employment band and hence who can be considered as better than average performers.

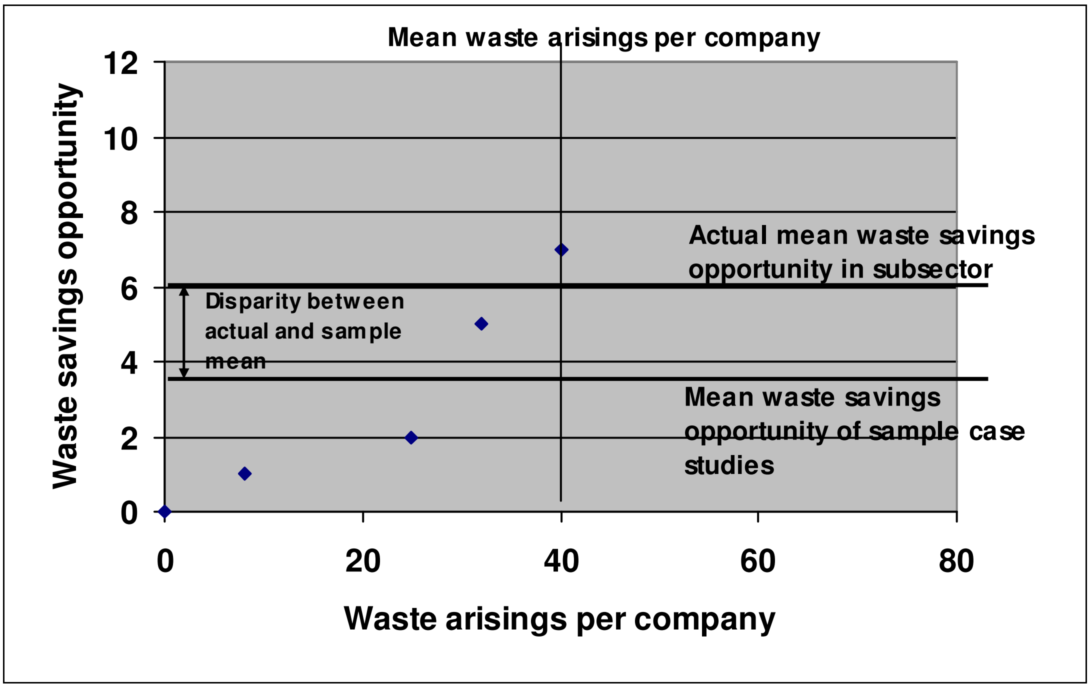
Table 2.1: Distribution of food, drink and tobacco companies

Subsector	**Relative performance of case study companies (waste arisings)**	
	Below subsector / employment band mean	**Above subsector / employment band mean**
Food and drink	75%	25%
Chemicals, plastic and rubber	77%	23%
Total	76%	24%

2.13 It is assumed that within any given subsector / employment band the level of waste savings opportunity within a company is directly proportional to their level of waste arisings, i.e. the reason a company is performing better than average is due to them having undertaken some form of resource efficiency measures, whereas a poor performing company has not. Therefore, the results of this analysis shows that if the absolute savings opportunities were taken directly from the surveys and simply multiplied up to subsector level a gross underestimate of savings will be made (due to the relative position or performance of the surveyed companies with respect to the subsector/ employment band average).

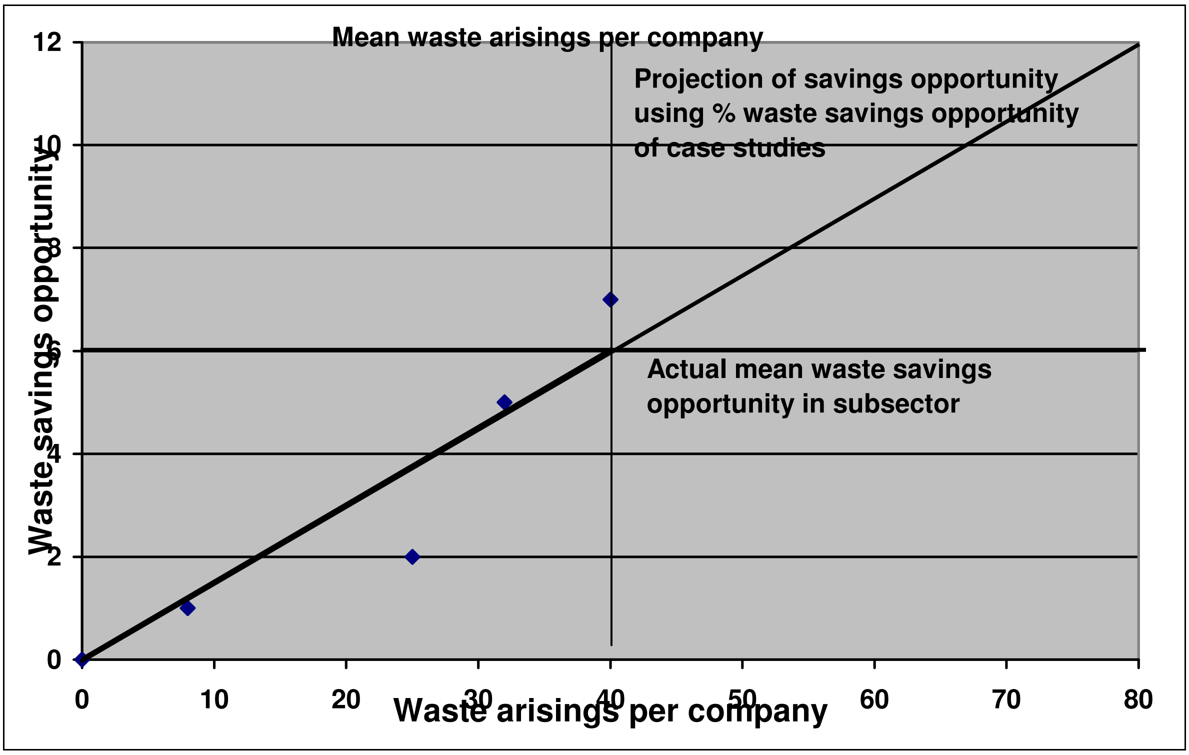
2.14 Figure 2.1 shows how this method can result in an underestimate of savings opportunity due to the sample mean being lower than the actual subsector mean due to the case studies falling to the left of the mean. NB: Only four data points are shown for illustrative purposes.

Figure 2.1: An example of the potential disparity between actual and sample mean waste savings opportunity



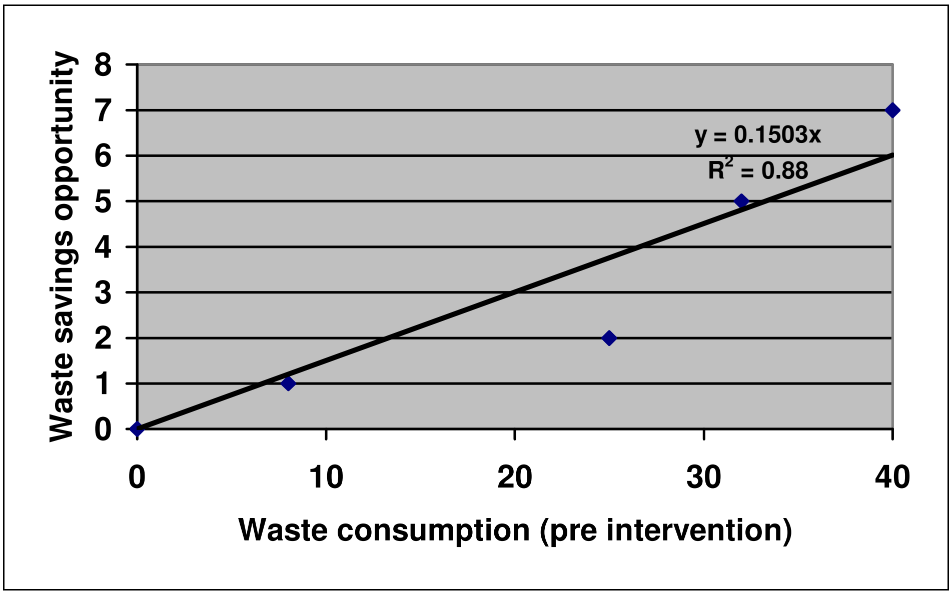
2.15 The use of the percentage waste savings opportunity rather than absolute savings to gross up the case studies and survey data to subsector/ employment band level is one way of overcoming this. Figure 2.2 shows the ideal scenario where the projection of savings opportunity trend line passes through the intersection of the mean waste savings opportunity and mean waste arisings lines.

Figure 2.2: An example of the projection method for estimating waste savings opportunity



2.16 The need to project the trend line to compensate for the lack of data to the right of the mean (see Figure 2.2) presents a potential inaccuracy in this methodology, i.e. how can we be sure that a linear trend exists? Therefore a sensitivity check was undertaken in the form of the coefficient of determination (R^2) to examine the strength of the relationship between the data points (case study data) and the trend line. Figure 2.3 shows an example, with the equation of the line (Y=0.1503X) indicating average savings of 15.03% and the coefficient of determination showing a strong relationship between the data points and the trend line (0.88). Within the analysis an R^2 value greater than 0.7 is interpreted as providing confidence that the projected linear trend is reliable.

Figure 2.3: An example of the estimate of waste savings opportunity plots



2.17 Additionally, the standard error is calculated to determine the uncertainty in the estimate and to provide the range of estimates. NB: this can only be determined where raw data is available. The range of estimates for each sector is calculated by grossing up the standard error.

The six step methodology

2.18 Based on the findings from the preliminary analysis a six-step methodology was developed:

Step 1. Quantification of overall consumption; waste arisings (tonnes), energy consumption (kWh) and water consumption (m^3).

Step 2. Quantification of waste savings (tonnes), energy savings (kWh) and water savings (m^3).

Step 3. Conversion of physical savings (Step 2) into financial savings.

Step 4. Addition of any hidden cost savings.

Step 5. Grossing up.

Step 6. Regional analysis.

Step 1: Quantification of overall consumption

2.19 The main objectives of this step were to determine the overall consumption by sector and to identify the significant users of energy and water, and waste generators within each sector. Focus would then be placed on these significant users on the assumption that these are likely to present the largest savings opportunity.

Waste

2.20 In terms of the top level data on waste, Defra was the main source since they are obligated to report total UK waste arisings to Eurostat as part of the EU Waste Statistics Regulation EC2150/2002. The Regulation requires member states to provide the European Commission with information on the generation, recovery and disposal of waste every two years.

2.21 For the C&I sectors the Production Surveys undertaken by the Environment Agency in 1998/99 and 2002/03, described in Appendix 1 and the preliminary analysis section, were used to develop subsector profiles.

2.22 Additional sources of information include trade associations, delivery bodies (Envirowise, WRAP, etc), government initiatives and other one-off studies.

Energy

2.23 The BERR Annual Business Inquiry (ABI) and Digest of UK Energy Statistics (DUKES) datasets were the primary sources of top level data on energy consumption. These show the total energy consumed in the UK by businesses from 1970 to 2005 in the case of the industrial sector and from 2000 to 2005 for the service sector.

2.24 The ABI holds data on employment and financial information collected from a survey of UK businesses. The ABI estimates the turnover, employment, gross value added and a number of other indicators for all businesses in the UK, split by four digit SIC code, from a survey of around 77,000 companies. The survey is sent to each legal unit with the companies identified from the ONS Inter Departmental Business Register. The response rate from the survey in 2006 was around 80.7%[1].

[1] ABI Quality Measures.

2.25 Unfortunately, unlike for the Environment Agency Waste Production Survey data, it was not possible to obtain the mean, standard error or standard deviation data[1] and hence the mapping approach could not be used to assess the relative performance of case study or surveyed companies.

Water

2.26 Water was found to be the resource with the least robust data available in terms of estimates of overall consumption (m^3) by sector. In addition, due to the nature of this resource it was considered inappropriate to use a methodology where a volumetric saving is converted to a fiscal saving using a standard water price (Step 3). The agricultural sector is a case in point since it represents a heavy water user but only a small proportion of the overall water used is supplied through public supply and charged at the standard rate. A gross overestimate of savings could therefore be made.

2.27 To overcome this, the UK national accounts input-output tables were used. These tables provide estimates for the inputs and outputs of UK industries in terms of output, gross value added and purchase of goods and services. The concept of 'intermediate consumption' is the most useful indicator for this study. Intermediate consumption is defined as the "cost of raw materials and other inputs which are used up in the production process"[2]. Intermediate consumption of water is obtained from the 'Supply and Use' part of the input-output tables. NB: The results of the ABI are used to compile the ONS input-output tables.

[1] Julian Prime (BERR) and Jon Darke (ONS) Personal Communication March 2007.

[2] This is a different concept to final consumption spending which is defined as "spending on goods and services that are used for the direct satisfaction of individual or collective needs".

Step 2: Quantification of resource savings

2.28 Using the consumption rates identified in Step 1 as a baseline, the objective of this step was to quantify the resources that can be saved through low-cost / no-cost intervention. Case studies and surveys on both a company and sector level were considered the best data sources. However, one of the key criteria for evaluating potential data sources was to determine whether focus was placed at a generic "whole company" level or whether focus was only placed in a selected area or activity of the company. For the purpose of this study it was important that focus was placed on generic savings, to reduce the risk of producing an underestimate of the overall savings opportunity.

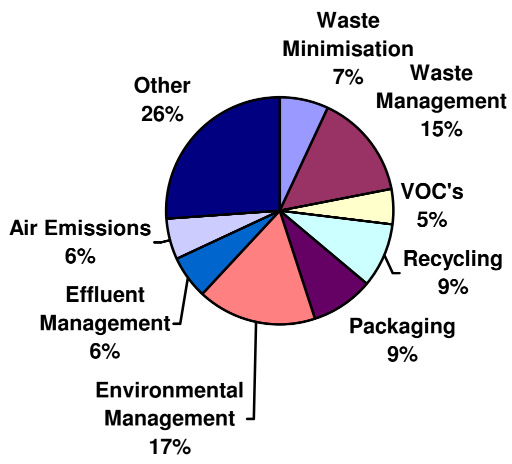
2.29 Specific initiatives that did not fall within this criterion included the Manufacturing Advisory Service (MAS). MAS reported that the process used typically considers a small element of the overall activity within an organisation, demonstrating the efficiencies that can be generated using the lean improvement methods. MAS teams are also tasked with assessing pre and post implementation impacts using the seven BERR Quality, Cost, Delivery (QCD) measures which do not explicitly capture separate water, waste and energy usage[1].

Waste

2.30 The key resources for the assessment of waste savings opportunities were the Envirowise FastTrack surveys and ENWORKS surveys and case studies. It is acknowledged that each company requesting a FastTrack or ENWORKS visit dictates the area of focus and hence not all case studies will cover generic savings and therefore will not meet the required criteria. Figure 2.4 shows that only 7% of companies contacting Envirowise request assistance on waste minimisation, which indicates that many case studies will not meet the requirements of this study.

[1] Al Talbot, MAS. Personal Communication March 2007.

Figure 2.4: Reasons companies call Envirowise[1]



Energy

2.31 The key data sources used within this study are:

- **Carbon Trust.** The Carbon Trust have undertaken benchmarking in a number of sectors and quantified the level of savings opportunity. In addition, the Carbon Trust has undertaken one-off studies, for example, the "Industrial energy efficiency fact base and market assessment" (Future Energy Solutions for the Carbon Trust, August 2003) both quantified and categorised the energy savings opportunity in a number of sectors in terms of operational, retrofitting and capital interventions. In this study the savings from operational and retrofitting interventions have been considered as the short to medium term or low-cost / no-cost savings opportunity.

- **BERR – Energy intensity tables.** The energy intensity tables accompany the consumption tables and assign any changes in consumption patterns between changes in production output of the sector or in terms of energy intensity. For the purpose of this study, energy intensity is considered to be representative of energy efficiency since it is a measure of energy use per unit of production.

- **Climate Change Agreement (CCA).** CCAs were agreed between certain energy intensive users and government in March 2001. Being

[1] www.iema.net/download/events/yorkhumb/20050610/john-mark%20zywko.pdf. Accessed May 2007.

party to a CCA, and meeting targets, allows relevant facilities to claim up to an 80% reduction in the Climate Change Levy (CCL) which was placed on non-domestic energy supplies from 1 April 2001. The progress made towards the targets represents an indicator of the energy efficiency improvements made in the companies covered by the CCA.

- **Envirowise - FastTrack / ENWORKS surveys.** Although the Carbon Trust tends to be the point of contact for energy queries for large companies or the high energy intensive companies, both Envirowise and ENWORKS have provided advice predominantly to the smaller energy users. This complements the information provided under the CCAs and by the Carbon Trust.

- **Trade associations.** Many trade associations report the specific energy consumption within their industry in annual reports.

2.32 The Carbon Trust study into the industrial energy efficiency fact base and market assessment (2003) was used as the 2002 savings opportunity base line. The BERR energy intensity data and the CCA performance to target between Target Period 1 (TP1) in 2002 and Target Period 3 (TP3) in 2006 was used to determine the change in energy efficiency between this 2002 base line and 2006.

2.33 For the sectors not covered by the Carbon Trust study the benchmarking studies undertaken by the Trust were used and the data verified through the Envirowise FastTrack, ENWORKS or trade association data.

Water

2.34 The key data sources on water were:

- Envirowise FastTrack surveys including the case study data from the "big splash" campaign

- ENWORKS

- Trade associations

- One-off studies.

Step 3: Conversion of physical savings (Step 2) into financial savings

2.35 This step involves converting the physical savings identified in Step 2 into the direct or visible financial savings, namely waste disposal savings, supply-side energy savings and supply-side water savings.

Waste

2.36 The objective of this step was to determine a standard waste disposal cost (£/tonne) within each sector or subsector to enable the savings opportunity identified in Step 2 to be valued. Trade associations, delivery bodies and waste management companies were the key sources of information in this area.

Energy

2.37 Table 2.2 shows the summary table used to calculate the weighted average p/kWh for each sector. The "Total consumption ktoe" figures were determined for each sector using the BERR consumption data (Step 1). The relative weighting of each fuel type was then calculated to determine the fuel mix. This was then multiplied by the fuel price p/kWh (determined using June 2007 energy prices as reported by the BERR) to determine the weighted average price for each fuel type. These were added together to obtain a weighted average fuel price.

Table 2.2: Template of the summary table for energy price (p/kWh)

Fuel	**Total consumption (ktoe)**	**Fuel mix**	**Fuel price (p/kWh)**	**Weighted average kWh price (p)**
Coal			0.626	
Heavy oil			2.0987	
Gas oil			2.957	
Electricity			5.85	
Gas			1.746	
			Total	

Water

2.38 As stated in Step 1 the water consumption data used were in financial terms and hence no conversion factor was required.

Step 4: Addition of any hidden cost savings

Waste

2.39 Envirowise offer the following description of the difference between visible and hidden waste costs. They identify direct waste costs as the visible costs which include waste collection and waste disposal costs. They specify that the bulk of the waste costs are indirect and hidden and include[1]:

- raw material costs
- energy consumption
- water consumption
- effluent generation
- packaging
- factory and office consumables
- wasted time and effort.

2.40 Envirowise report that some companies have found their waste costs to be over 20 times higher than they thought, an estimate also quoted by the Acorn Trust who suggest that additional costs (hidden savings) represent between 5 and 20 times the disposal cost[2].

2.41 Table 2.3 shows the assessment of the results from the "Benefits of Greener Business" study. This shows that the additional costs (hidden savings) represented between 5.2 and 39.8 times the disposal costs, with the average being 8.6 and all but the textiles, leather and clothing sector falling between 5 and 20.

[1] www.pcn.org/technical%20notes%20-%20waste%20.pdf

[2] http://www.theacorntrust.org/sc_sus_waste.shtml

Table 2.3: Estimated waste savings opportunity in the manufacturing sector in 2003

Sector	Visible cost savings		Hidden cost savings		Waste multiplier (hidden cost / visible cost)
	£M	% of total savings	£M	% of total savings	
Food, drink and tobacco	30.5	7.5	380	92.5	12.4
Textiles, leather and clothing	5.7	2.5	225	97.5	39.8
Coke, petrol and nuclear fuels	0.3	5.4	5.3	94.6	17.7
Chemicals and man-made fibres	156.5	16.2	810	83.8	5.2
Basic metal and metal products	13.0	9.3	126	90.7	9.7
Engineering and allied industries	15.2	5.8	250	94.2	16.5
Other manufacturing	28.7	7.5	352	92.5	12.3
Total	**249.9**	**10.4**	**2,148.3**	**89.6**	**8.6**

2.42 Table 2.4 shows a breakdown of the savings identified in the "Benefits of Greener Business" study. This shows that the savings associated with "reduced use of raw materials" is the most significant savings opportunity, accounting for 59% of total savings. The contribution of raw material savings to total savings varies considerably among the sectors accounting for just 16.4% of savings within the food sector and 93.5% within the textiles sector.

Table 2.4: A breakdown (%) of the identified waste savings by savings opportunity in 2003

Sector	Reduced use of raw materials (%)	Reduced costs from substitution (%)	Reduced waste disposal costs (%)	Other savings (%)
Food, drink and tobacco	16.4	1.8	7.5	74.3
Textiles, leather and clothing	93.5	0.9	2.4	3.1
Coke, petrol and nuclear fuels	75.0	1.8	5.4	16.1
Chemicals and man-made fibres	58.6	6.0	16.2	19.0
Basic metal and metal products	52.9	0.4	9.3	37.3
Engineering and allied industries	80.4	1.4	5.8	12.4
Other manufacturing	74.6	2.3	7.5	15.5
Total	**59.4**	**3.4**	**10.4**	**26.7**

2.43 Table 2.5 shows the savings opportunity as a percentage of total raw material inputs within each sector in 2003. This shows that the estimated raw material savings accounted for between 0 and 3.3% within the six sectors (mean 0.72%). These raw material savings opportunities appear realistic in some sectors, e.g. food and drink and basic metals, but appear high in others such as engineering and chemicals which typically work with low yield losses on expensive raw materials. In addition, for the textiles sector, showing the highest savings potential (3.3%), the current yield losses in the industry is 12.7%[1] and hence the estimated savings opportunity equates to a 26% improvement on yield losses. Much of the generated waste is due to the nature of the cutting process where irregular shapes are cut out of linear fabrics and hence yield losses are inevitable. This process is automated in the large textile manufacturers and hence savings opportunities will be small.

Table 2.5: Raw material savings opportunity as a percentage of total raw material costs

Sector	**Raw material savings (£M)**	**Total raw material costs (£M)[2]**	**Reduced raw material costs (%)**
Food, drink and tobacco	67	42,016	0.2
Textiles, leather and clothing	217	6,655	3.3
Coke, petrol and nuclear fuels	4	15,924	0.0
Chemicals and man-made fibres	566	42,286	1.3
Basic metal and metal products	74	25,150	0.3
Engineering and allied industries	211	26,006	0.8
Total	**1,139**	**158,037**	**0.72**

2.44 International studies show similar hidden to visible cost savings ratios with a case study by the US EPA on an electric utility company (ComEd) estimating that hidden costs were twice that of the disposal costs[3]. Conversely, another report undertaken in the US focusing on the retail sector reports that total cost can be 20 times the disposal cost[4].

[1] Well dressed? The present and future sustainability of clothing and textiles in the United Kingdom, University of Cambridge, 2006. Biffaward.

[2] ONS Input – Output tables 2003.

[3] The Lean and Green Supply Chain: A practical guide for materials Managers and Supply Chain Managers to Reduce Costs and Improve Environmental Performance - US EPA (2000)

[4] Gertman R, Hansen A, Pratt W, Shireman B. Profiting from Waste Prevention: Measuring the Benefits - A report to the Alameda County Source Reduction and Recycling Board. (prepared by Community Environmental Council, Environmental Planning Consultants, Global Futures, December 1999)

2.45 Unfortunately, not only is the relationship between hidden and visible cost inconsistent across sectors, it is also inconsistent within sectors. Table 2.6 shows the relationship for a number of different case studies undertaken within the construction sector. This shows the relationship to vary from 1.08 to 15.8.

Table 2.6: The hidden and visible cost multipliers for the construction sector

Source	**Hidden cost to visible cost multiplier**
Highways Agency (WRAP Case Studies. WRAP Sept 2006)	1.08
MACE (WRAP Case Studies. WRAP Sept 2006)	1.67
DETR (Now Defra)	7.50
Laing Homes (WRAP Case Studies. WRAP Sept 2006)	10.1
Begum RA, Siwar C, Pereira JJ, Jaafar, AH. A benefit-cost analysis on the economic feasibility of construction waste minimisation: The case of Malaysia. Resources, Conservation & Recycling 48 (2006), 86-98	10.8
An introduction to Site Waste Management Plans. Envirowise http://www.envirowise.gov.uk/page.aspx?mode=text&o=230713	15.0
AMEC (Darlington study)	15.8
Mean	**8.84**

2.46 The only reference that could be found regarding hidden savings within the service sector was the US study in the retail sector[1]. However the conclusion that hidden savings are 20 times that of visible savings appears very high since it is envisaged that the hidden savings would not be as significant as those within the industrial sector due to the composition of the waste being generated, i.e. much of the waste generated is packaging or consumables of lower value than that of the raw material savings.

2.47 The analysis above shows conclusively that hidden savings are significant. However, the analysis also shows the extreme variability in the relationship between the hidden and visible savings, which complicates the estimation of these savings. Therefore, to ensure a gross overestimate does not occur, a detailed assessment of the raw materials being saved in each sector, as detailed in the case studies or survey data was undertaken within each subsector.

[1] Gertman R, Hansen A, Pratt W, Shireman B. Profiting from Waste Prevention: Measuring the Benefits - A report to the Alameda County Source Reduction and Recycling Board. (prepared by Community Environmental Council, Environmental Planning Consultants, Global Futures, December 1999)

Energy

2.48 The hidden, or more correctly the additional, benefits associated with energy savings include:

- the reduction in the Climate Change Levy (CCL) being paid
- contribution towards Climate Change Agreement (CCA) targets
- the generation of a carbon surplus, which can be traded under the UK or European Emissions Trading Scheme (ETS).

2.49 These three factors are discussed below.

Overview of the Climate Change Levy

2.50 The Climate Change Levy (CCL), introduced in April 2001, is a tax on non-domestic use of energy. The levy applies to the supply of:

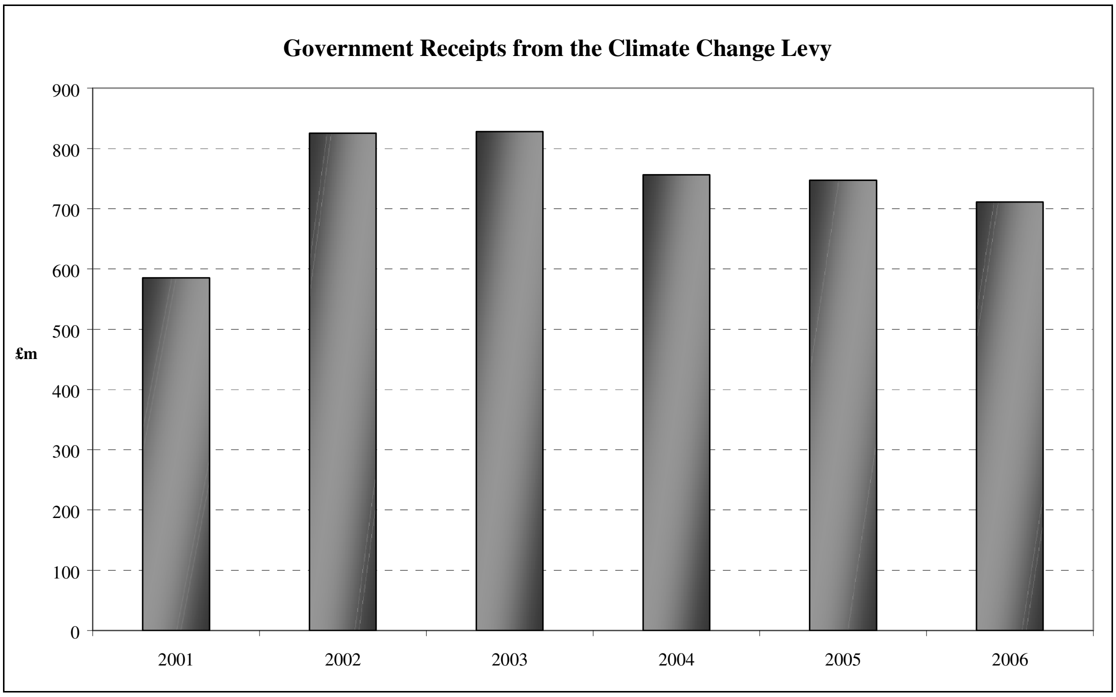
- electricity
- natural gas
- petroleum and hydrocarbon gas in a liquid state
- coal and lignite
- coke
- petroleum coke.

2.51 As of April 2007 the rates for each kind of fuel are:

- £0.00441 pence per kilowatt-hour (kWh) for electricity
- natural gas £0.00154 pence per kWh
- solid fuel e.g. coal and coke £0.01201 pence per kilogram
- liquid petroleum gas for heating £0.00985 pence per kilogram

2.52 The Levy is deducted at source by the facility's energy supply company and then passed to HMRC. The Office for National Statistics present figures on central government receipts from the Climate Change Levy. Figure 2.5 indicates the evolution of income from this source since 2001.

Figure 2.5: Central government receipts from CCL, 2001 to 2006



Source: Office for National Statistics

2.53 The ONS does not present an industrial breakdown of these receipts but does present an overall split of income from energy related environmental taxes.

2.54 To estimate the CCL expenditure for the different industries, we assume that the sectoral split of the fiscal burden for the CCL follows the division for energy taxes as a whole. Table 2.7 is presented for indicative purposes to give a sense of the likely scale of the CCL burden across industries.

Table 2.7:An estimate of the indicative expenditure on CCL by subsector in the UK

	Taxes on energy	CCL estimate (£M)	CCL sector (%)
Agriculture	95	4.9	1
Mining & quarrying	78	4.0	1
Manufacturing	2,439	124.8	18
Energy, gas & water supply	178	9.1	1
Construction	1,329	68.0	10
Wholesale & retail trade	2,151	110.1	15
Transport & communication	5,977	305.9	43
Other business services	820	42.0	6
Public administration	237	12.1	2
Education, health & social work	164	8.4	1
Other services	422	21.6	3

Source: ONS and Grant Thornton estimates

Climate Change Agreements

2.55 Climate change agreements were established in March 2001 and allow firms within energy intensive[1] business sectors to claim up to an 80% reduction in their Climate Change Levy liability. Eligibility to participate within a CCA was originally dependent upon a business operating processes already covered by the EU Integrated Pollution, Prevention and Control (IPPC) Directive. The eligibility criteria were extended in January 2006 to include processes where:

- energy intensity is in excess of 10%, OR
- energy intensity is between 3 and 10% and the product has a 50% import penetration ratio (i.e. there is significant competition in the UK market from foreign imports).

2.56 The granting of this discount is contingent upon the sectors which comprise the highest energy users agreeing to meet targets to improve energy efficiency and thereby reduce carbon emissions. The aim of the climate change agreements is to promote energy efficiencies and carbon savings without harming competitiveness.

2.57 The government lists ten major energy intensive sectors (aluminium, cement, ceramics, chemicals, food & drink, foundries, glass, non-ferrous metals, paper, and steel) and over thirty smaller sectors which fall within CCAs.

[1] An ‘energy intensive’ business sector carries out an activity listed under Schedule 1 of the Pollution Prevention and Control (PPC) (England and Wales) Regulations 2000 (as amended).

2.58 Although the target of the climate change agreements is to reduce carbon emissions, it also leads to lower energy costs for firms as they increase efforts to reduce energy usage in order to qualify for the discounted climate change levy rate.

EU Emissions Trading Scheme

2.59 The EU ETS operates through the allocation and trading of greenhouse gas emissions allowances. One allowance represents one tonne of carbon dioxide equivalent (CO_2e). Overall caps on emissions specified by allowances are established at a national level to be consistent with Kyoto or national reduction targets.

2.60 UK regulations require that all 'installations' carrying out activity listed in Schedule 1 of the regulations (which includes energy activities, production and processing of ferrous metals, mineral industries and pulp and paper industries) are to hold a greenhouse gas emissions permit. 93.7% of the allowances have been allocated to existing installations with the remaining 6.3% forming a new entrant reserve.

2.61 Allowances were allocated among sectors covered by the scheme with sector totals intended to reflect the projected emissions of each sector. Specific installations were then allocated a proportion of the sector total on the basis of their historic emissions data for the period 1998 to 2003 (excluding the lowest year's emissions).

2.62 Firms have the option to sell allowances which are in excess of their requirements, generating a financial benefit of increasing resource efficiency (in relation to their own baseline). By contrast, firms whose emissions requirements are in excess of their allowances are able to purchase additional allocations. The process for buying or selling allowances is very similar to the buying or selling of shares. Installations that do not surrender sufficient allowances to cover reported emissions for the year are liable to a fine of €40 per tonne of CO_2 equivalent. The price of carbon is established within a market and is therefore not subject to government control.

2.63 Unfortunately, the extent of the hidden or additional benefit is dependent on the individual companies' circumstances and whether they are signed up under a CCA or ETS. It is therefore difficult accurately to quantify the level of impact additional savings will have with regard to CCA or ETS. However, it was considered appropriate to define the additional savings as simply the reduction in CCL payments associated with a reduction in energy consumption. This is based on the fact that the CCA represents a rebate on CCL payments and hence is covered within this definition.

Water

2.64 The significant hidden saving with regard to water reduction is the subsequent saving in wastewater costs. For this study it is assumed that a saving in water supply will result in an equal saving (%) in wastewater cost, unless the nature of the sector dictates otherwise. For example, in the agriculture sector the optimisation of irrigation rates will have no impact on the quantity of wastewater discharge and hence no associated wastewater saving should be attributed.

Step 5: Grossing up

2.65 Steps 1 to 4 focused on the quantification of the resource savings within the high waste generating, and high energy and water consuming, sectors of the economy. It is anticipated that these will represent the significant savings opportunity: however for completeness it is necessary to include an assessment of the remaining sectors. Since it is not possible to undertake such a detailed analysis on these remaining sectors an alternative approach was required. The approach considered was the development of a financial proxy.

The development of a financial proxy

2.66 The idea of using financial proxies to gross up the data is based on earlier work "Exploring the Relationship between Environment and Competitiveness" (Metroeconomica / Paul Watkiss Associates) that suggested there is some evidence to support a link between financial and environmental performance.

2.67 The H score (described in detail in Appendix 6) was the selected proxy for evaluation. The H score is developed by Company Watch Limited to measure a company's performance objectively across a wide range of financial indicators in order to quantify the overall financial strength of a company. A low H score (0 to 20) represents a company with low financial standing and a high score (80 to 100) a high performing company from a financial strength perspective. The H score of each case study was compared against the value of savings identified (% of company turnover). The hypothesis tested in this study was therefore that companies with high H scores would have a smaller opportunity in terms of the potential savings from resource efficiency interventions since these firms that were well managed financially would also be relatively efficient from a resource usage perspective, i.e. waste less than average.

2.68 The relationship between H score and savings opportunity was tested on the two manufacturing sectors showing the highest savings opportunity in the "Benefits of Greener Business" study namely the food (SIC 15) and chemicals sectors (SIC 24 and 25). If a relationship was proven then it would enable the financial data to be used to estimate potential resource efficiency savings, this is beneficial since financial data is more readily available than data on resource use.

2.69 Data from Envirowise FastTrack surveys undertaken in the two subsectors were used to evaluate this methodology. Figure 2.6 shows the plot of GVA savings to H score within the chemical sector. This shows the data points to be extremely scattered as highlighted by the very low R^2 value of 0.0005. Figure 2.7 shows the plot for the food sector. This shows a very similar trend to that of the chemicals sector (R^2 = 0.0013) and hence it can be concluded that no relationship between H score and environmental performance was found.

Figure 2.6: H score versus savings opportunity within the chemicals sector

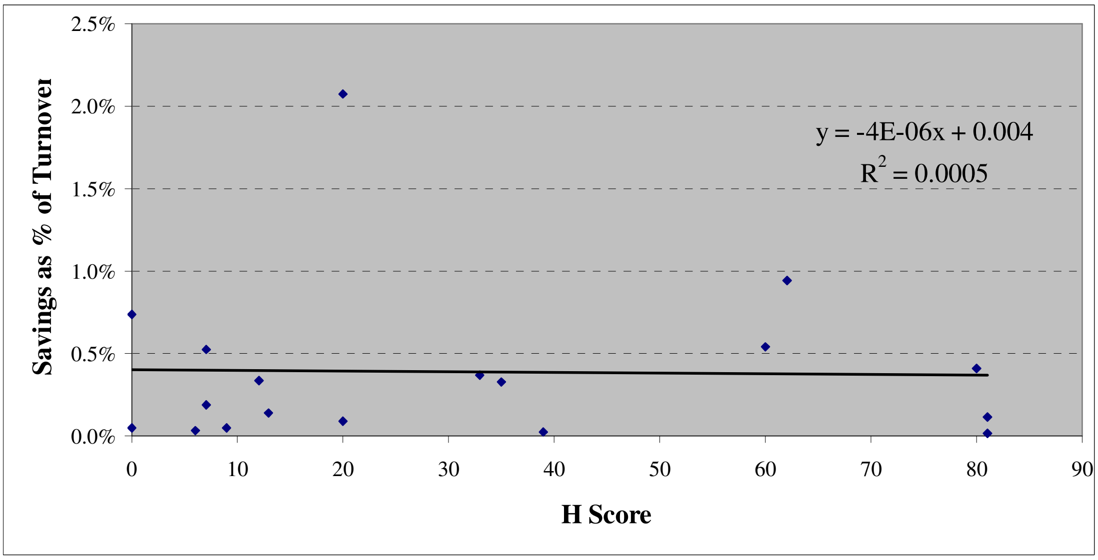
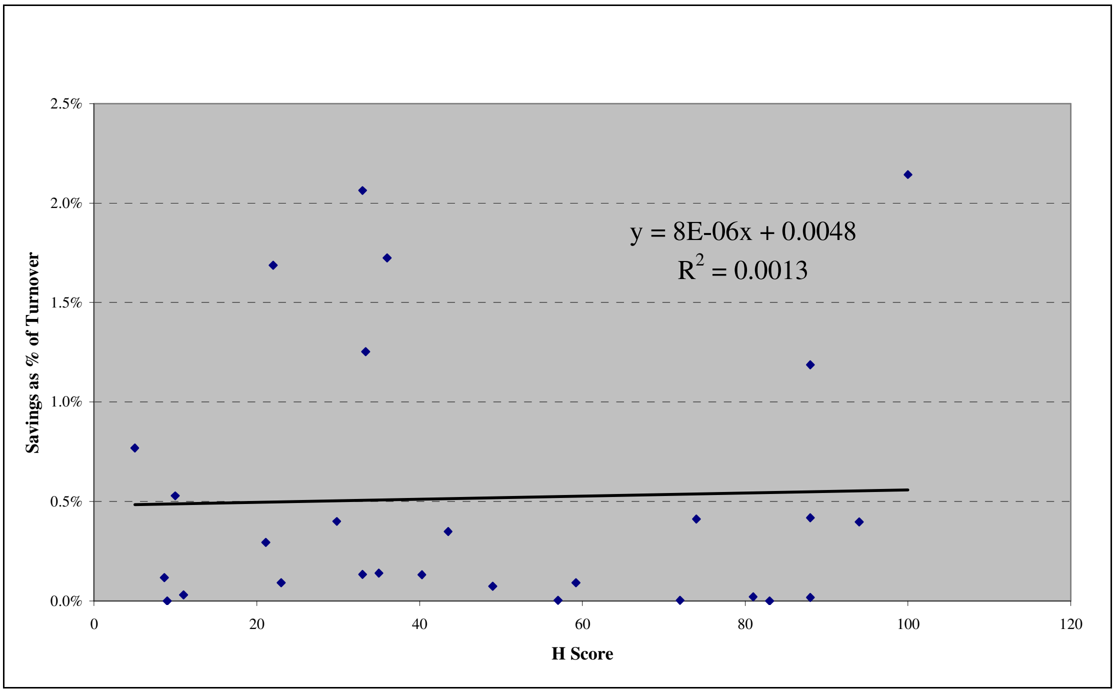


Figure 2.7: H score versus savings opportunity within the food sector



2.70 The alternative approach, considered more appropriate than the use of financial proxies was to undertake a literature review to identify work undertaken in any of the remaining sectors. After this, the approach taken was to contact trade associations and finally, where gaps still exist, to apply the mean savings (%) identified in the assessment of the "significant few" (Steps 1 to 4) as a weighted average.

Step 6: Regional analysis

2.71 The regional analysis provides a guide to the possible savings opportunity within each region. The analysis splits the projected savings derived in Steps 1 to 5 up by government region, namely:

- North East England
- North West
- Yorkshire & Humber
- East Midlands
- West Midlands
- East
- London
- South East
- South West
- Wales
- Scotland
- Northern Ireland.

2.72 The employment for each subsector in each of the regions was used to weight the savings by region. This was derived from the ONS report "UK Business: Activity, Size and Location – 2006".

3 Detailed resource analysis – waste

Background

3.1 Table 13.1 in Appendix 5 shows a breakdown of the waste generated by sector in the UK in 2004. The sectors generating the most waste were singled out for detailed analyses in this study. The sector analysis was split into two categories; industrial and commercial, and these are described below.

The industrial sector

3.2 Table 13.1 shows the industrial sector to account for 78% of the controlled waste generated in the UK. This study focuses on the eight largest waste generating sectors or subsectors within the overall industrial sector (Table 3.1). These eight sectors or subsectors account for 243 million tonnes or 95.2% of the waste arisings from the industrial sector or nearly three-quarters (74.5%) of the total UK controlled waste arisings.

Table 3.1: Total UK waste arisings, 2004

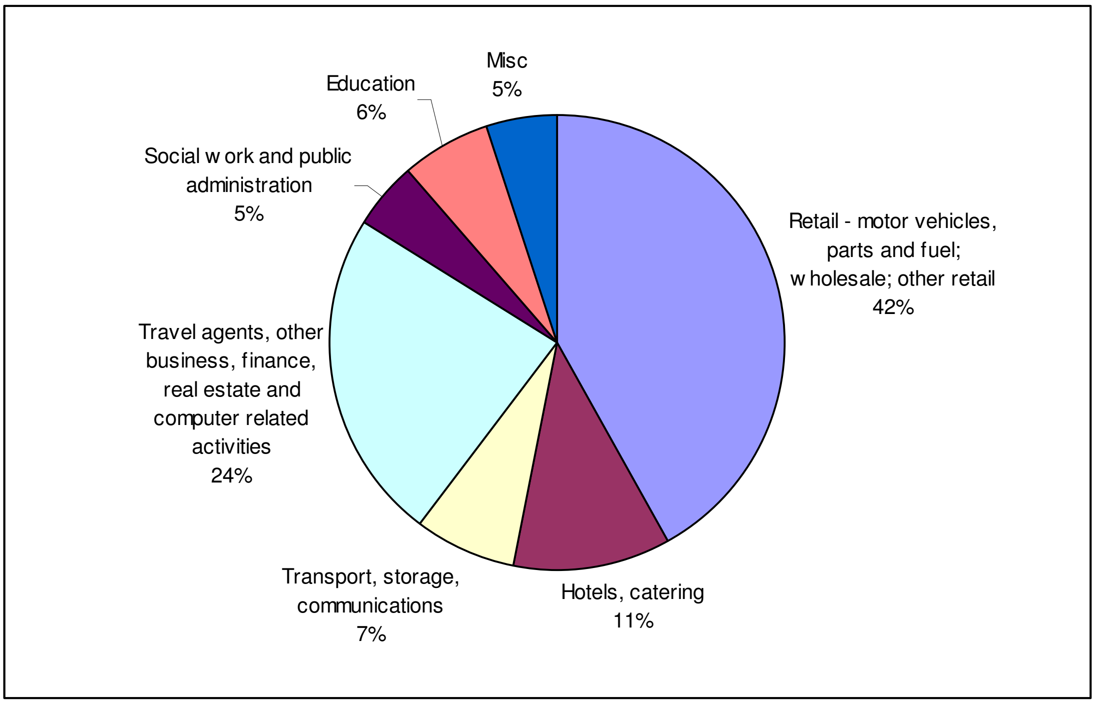
Sector code	Sector or subsector	Total tonnes (Mt)	% of total waste arisings
F	Construction	113.2	44.4
C	Mining & quarrying	93.9	36.8
DA	Manufacture of food products, beverages & tobacco	7.8	3.1
E	Electricity, gas, steam & hot water & water supply	6.9	2.7
DJ	Manufacture of basic metal & fabricated metal products	5.7	2.3
DK+ DL+ DM	Manufacture of machinery & equipment + Manufacture of electrical & optical equipment + Manufacture of transport equipment	5.5	2.2
DG+ DH	Manufacture of chemicals, chemical products, man-made fibres + Manufacture of rubber & plastic products	5.5	2.2
DE	Manufacture of pulp, paper & paper products; publishing & printing	4.1	1.6
	Sub Total	**242.6**	**95.2**
	Total waste arisings in the industrial sector	**254.9**	**100**

Source: EU Waste Statistics Regulation (EC 2150/2002) report 2004, UK. Defra July 2006.

The service sector

3.3 The service sector accounted for 39.4 million tonnes of controlled waste in 2004, or 12.1% of total controlled waste in the UK, Table 13.1 in Appendix 5. Figure 3.1 shows the breakdown of waste arisings by subsector. This shows three subsectors account for 77% of all the controlled waste generated in the service sector: Retail et al (42%), Hotels and catering (11%) and Travel agents et al (24%). This study focuses in detail on the six sectors shown in Figure 3.1, which accounted for 95% of waste within the service sector.

Figure 3.1: Service sector waste arisings broken down by subsector



Source: Defra

Section methodology

3.4 The waste savings opportunity within each "significant" sector shown in Table 3.1 and Figure 3.1 was examined in detail using the methodology described in Section 2. The mean waste savings opportunity derived for these sectors was then used to provide an estimate of the waste savings opportunities in the other sectors to enable the overall savings opportunity to be determined. The detailed analysis for each sector can be seen in Appendix 5.

Summary of findings

3.5 Table 3.2 shows the section summary with the estimated waste savings in the sectors and subsectors. This shows estimated savings from the reduction or improved management of waste through low-cost / no-cost interventions to be £2.7 billion. The standard error for the estimate is ± 16.35% making the range of savings £2.3 billion to £3.1 billion. The estimated mean waste savings from the industrial sector is £1.7 billion with 13.1% of current waste generation either being eliminated or put to a more economically beneficial use. The mean waste savings in the commercial sector is estimated at £927 million or 12% of waste.

Table 3.2: Section summary

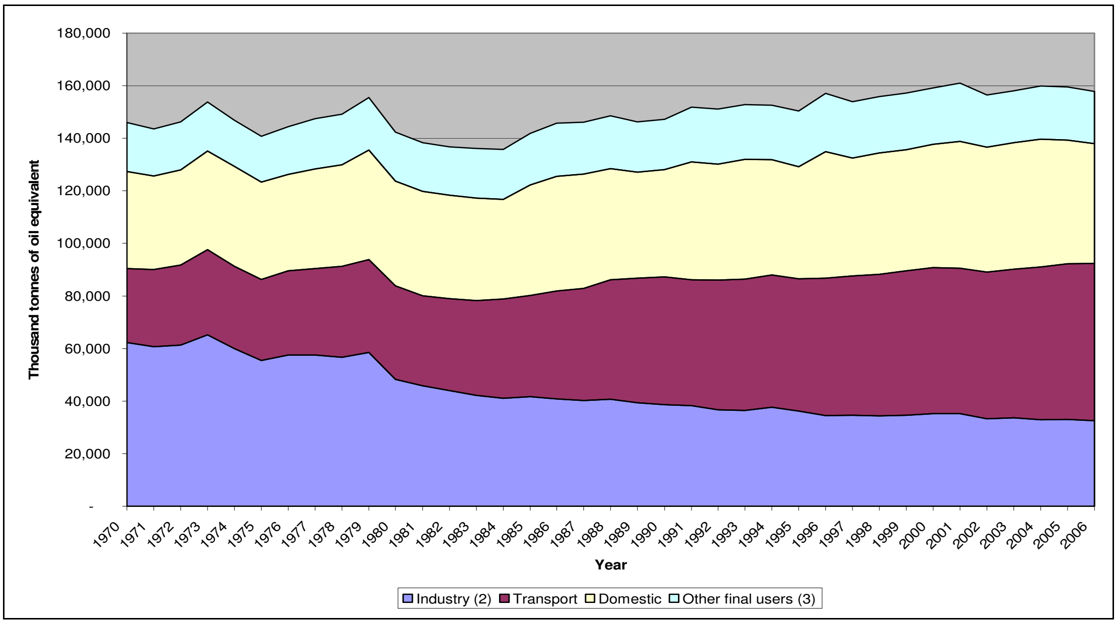
Sector	**Subsector**	**Estimated savings**		
		Reduction or recovery (%)	**Without hidden savings (£M)**	**With hidden savings (£M)**
Industrial	Construction	19.3	230	239
	Mining & quarrying	5.2	40	40
	Food & drink	19.3	94	858
	Energy supply	26.0	36	45
	Basic metals / Mechanical engineering	5.2	11	17
	Machinery, electrical & transport equipment	10.5	26	195
	Chemicals, rubber & plastics	9.1	47	235
	Paper, printing & publishing	7.4	10	20
	Other	13.1	25	83
Commercial (Service)	Retail et al	9.0	118	489
	Travel agents et al	10.8	68	233
	Hotels & catering	24.3	70	70
	Transport	13.4	12	12
	Education	20.0	53	53
	Misc service industries	2.8	24	24
	Other	12.0	17	46
	Total	**12.8**	**881**	**2,659**

4 Detailed resource analysis – energy

Background

4.1 Figure 4.1 shows the trend in energy consumption in the UK since 1970. It shows that consumption has increased from just under 146 million tonnes of oil equivalent (toe)[1] in 1970 to nearly 160 million toe in 2005; an increase of 9%.

Figure 4.1: The trend in UK energy consumption 1970 to 2006 (1).



Source: BERR

(1) Excluding non-energy use of fuels.
(2) Includes the iron and steel industry, but from 1994 onwards excludes iron and steel use of fuels for transformation and energy industry own use purposes.
(3) Mainly agriculture, public administration and commerce. Prior to 1990, includes electricity used at transport premises.

4.2 The Commission on the European Communities reports that[2]:

"Europe continues to waste at least 20% of its energy due to inefficiency. The direct cost of our inability to use energy efficiently will amount to more than 100 billion Euros annually by 2010"

[1] 1 toe = 11,630kWh BERR - Quarterly energy prices. June 2007, National Statistics.

[2] Action plan for energy efficiency: realising the potential. COM 2006 545 Final. Commission of the European Communities.

4.3 The Commission estimates that realising a 20% energy savings would mean a saving of around 390 million tonnes of oil equivalent (Mtoe) and 780 million tonnes of CO_2. Table 4.1 shows the main areas of opportunity identified by the Commission.

Table 4.1: Summary of energy savings opportunities in Europe in 2006

Sector	**Savings Opportunity (%)**	**Key areas of opportunity**
Residential	27	Wall and & roof insulation
Commercial buildings	30	Energy management systems
Manufacturing	25	Motors, fans & lighting
Transport	26	Shifts in mode of transport

4.4 Such savings are in line with the economically viable savings identified within the Energy Review of 2002[1], which estimated the potential annual energy savings opportunity within the UK at £12.3 billion (Table 4.2).

Table 4.2: Summary of energy savings opportunities in the UK in 2002

Sector	**Energy savings**		
	Mtoe/year	**%**	**£M**
Domestic	17.4	37.2	5,000
Service	3.8	21.0	1,190
Industry	8.6	23.8	1,380
Transport	19.3	35.0	4,700
Total	**49.1**	**31.4**	**12,300**

4.5 The Energy Review 2006[2] reported that the UK can improve energy efficiency in two ways:

- reducing the amount of energy that we need to support our economy (our energy demand) through technological improvements, for example, to the structure of buildings so as to reduce the energy required for heating and cooling or to appliances so they require less energy; and
- changing our behaviour to reduce the amount of energy that we waste.

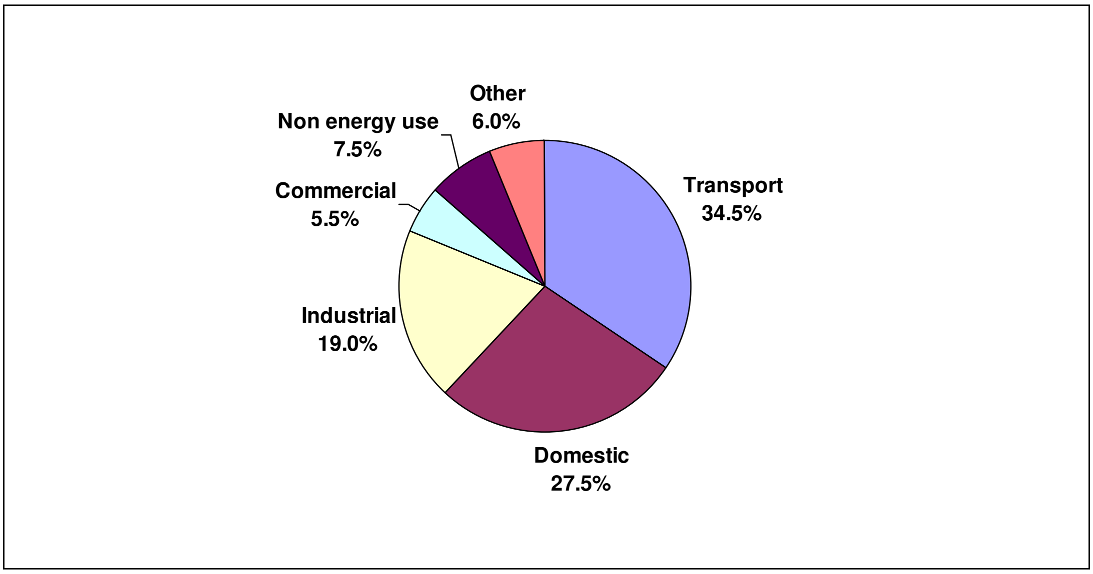
[1] The Energy Review: The Performance and Innovation Unit. Defra 2002.

[2] The Energy Challenge. Energy Review Report 2006. BERR. July 2006.

4.6 Figure 4.2 from the Digest of UK Energy Statistics (DUKES) 2006 shows that the four sectors shown in Table 4.1 and Table 4.2 accounted for 86.5% of the UK's energy consumption in 2005. This section focuses on the three business sectors, namely:

- industrial
- commercial
- transport.

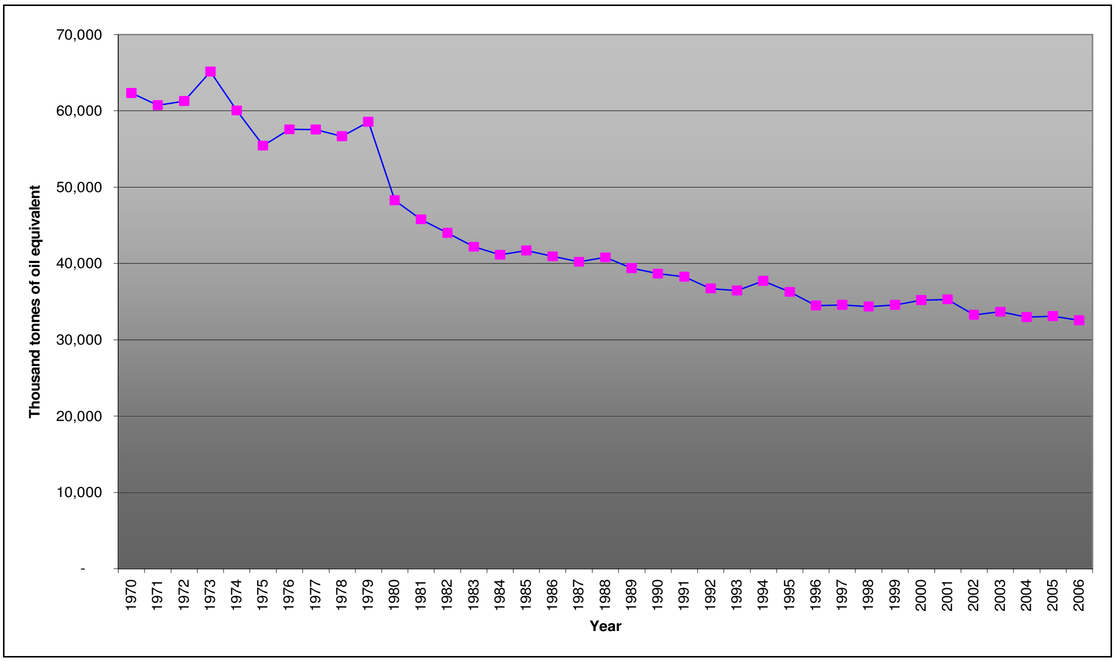
Figure 4.2: Total UK fuel consumption, by sector, 2005



The industrial sector

4.7 Figure 4.3 shows the trend in energy consumption within the industrial sector between 1970 and 2005. This shows that energy consumption has dropped by 47% over the 35 year period. Reductions in output would have played a significant part in the reduction between 1970 and 1990. However, Table 4.3 shows that since 1990 improvements in intensity have been the main factor for the reduction since the output from the sector actually increased by 9.8%. Intensity, typically measured as overall energy consumption per unit of output, can be regarded as a measure of energy efficiency and hence the 21% improvement in energy intensity highlights the efficiency savings that have been realised within the sector.

Figure 4.3: Energy consumption in the UK industrial sector 1970 to 2006.



Source: BERR

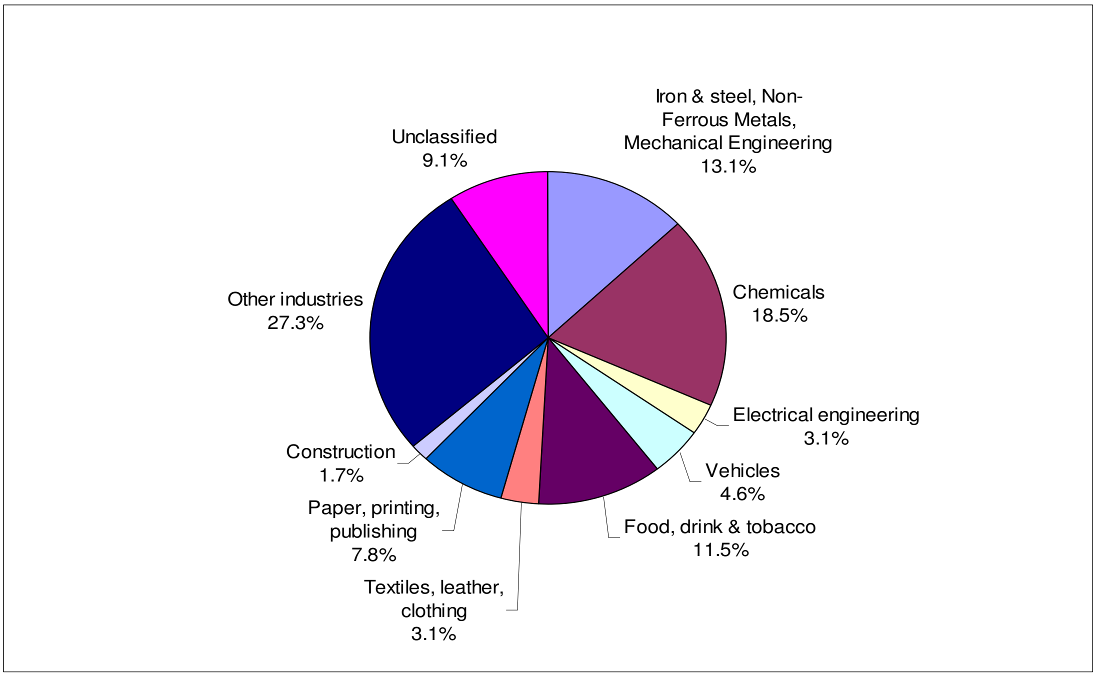
Table 4.3: Analysis of change in energy consumption with the industrial sector between 1990 and 2005

Subsector	Energy consumption (Mtoe)			Cause	
	1990	2005	Difference 1990 to 2005	Output	Intensity
Iron & steel, non-ferrous metals, mechanical engineering	10.7	4.4	-6.3	-1.1	-5.2
Chemicals	5.9	6.2	0.4	3.0	-2.6
Electrical engineering	1.2	1.1	-0.1	0.4	-0.5
Vehicles	1.8	1.6	-0.2	0.2	-0.4
Food, drink & tobacco	4.2	3.8	-0.3	0.4	-0.8
Textiles, leather, clothing	1.2	1.0	-0.2	-0.6	0.4
Paper, printing, publishing	2.4	2.6	0.2	-0.1	0.3
Construction	1.1	0.6	-0.5	0.2	-0.7
Other industries	8.7	9.1	0.4	1.1	-0.7
Unclassified	1.5	3.1	1.5	0.1	1.4
Total	**38.7**	**33.6**	**-5.1**	**3.8**	**-8.9**

Source: BERR

4.8 Figure 4.4 shows a breakdown of the 2005 energy consumption shown in Table 4.3. This shows the eight specific sectors shown in Table 4.3 account for 63.4% of total energy consumption in the industrial sector. One sector that is not included in the analysis shown in Table 4.3 is the coke, refined petroleum products and nuclear fuel sector which, according to BERR data accounted for 9.2ktoe in 2005. The study will therefore assess the energy savings potential within these nine sectors.

Figure 4.4: UK Energy consumption, by industry, 2005

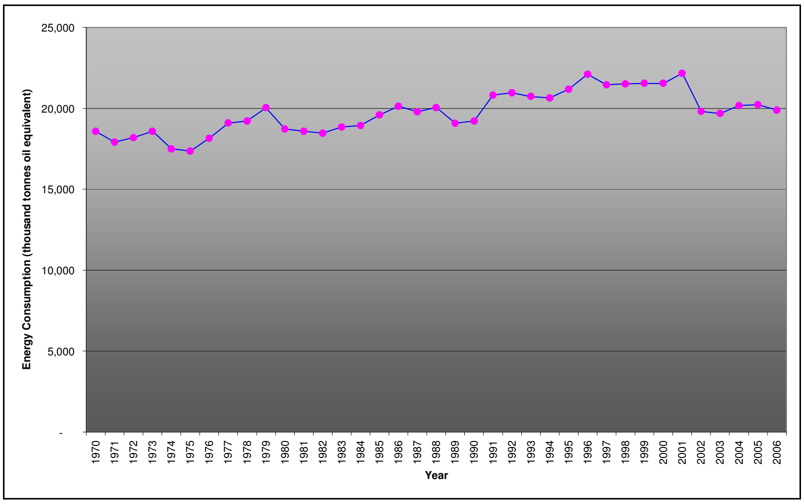


Source: BERR

The commercial, public administration and agricultural sector

4.9 Figure 4.5 shows that between 1970 and 2001 there was a gradual increase in the energy consumed within this sector in line with the growth in the commercial sector. However, a significant reduction in 2002 has seen a consolidation of energy consumption in the sector.

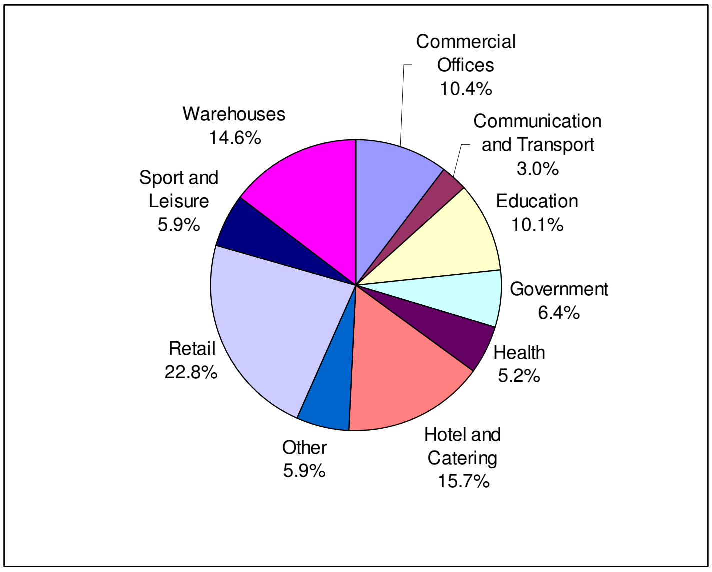
Figure 4.5: Energy consumption from commerce, public administration and agriculture 1970 to 2006.



Source: BERR

4.10 Figure 4.6 shows the breakdown by activity of the commercial and public administration sectors. This section analyses the nine significant activities to determine the value of energy savings opportunity within this sector. NB: These activities do not follow SIC convention but is a categorisation method adopted by both BERR and the Carbon Trust and hence is used in this section of the study.

Figure 4.6: A breakdown of energy consumption by subsector in the commercial and public administration sectors in 2005

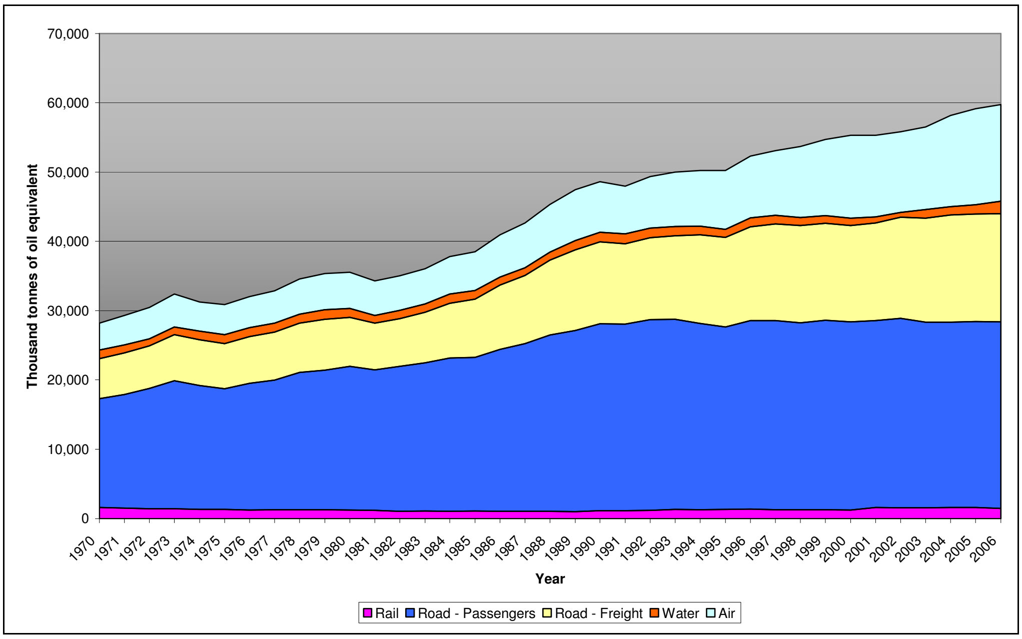


Source: BERR

The transport sector

4.11 Figure 4.7 shows the trend in energy consumption from transport since 1970. This shows a significant increase in energy consumption from 28.2Mtoe (328TWh) in 1970 to 59.2Mtoe (689TWh) in 2005. In 2005 transport accounted for 37% of UK energy consumption. Road passenger transport accounted for nearly half (45.5%) the total energy use in 2005 with road freight (26.2%) and air (23.5%) being the other main contributors.

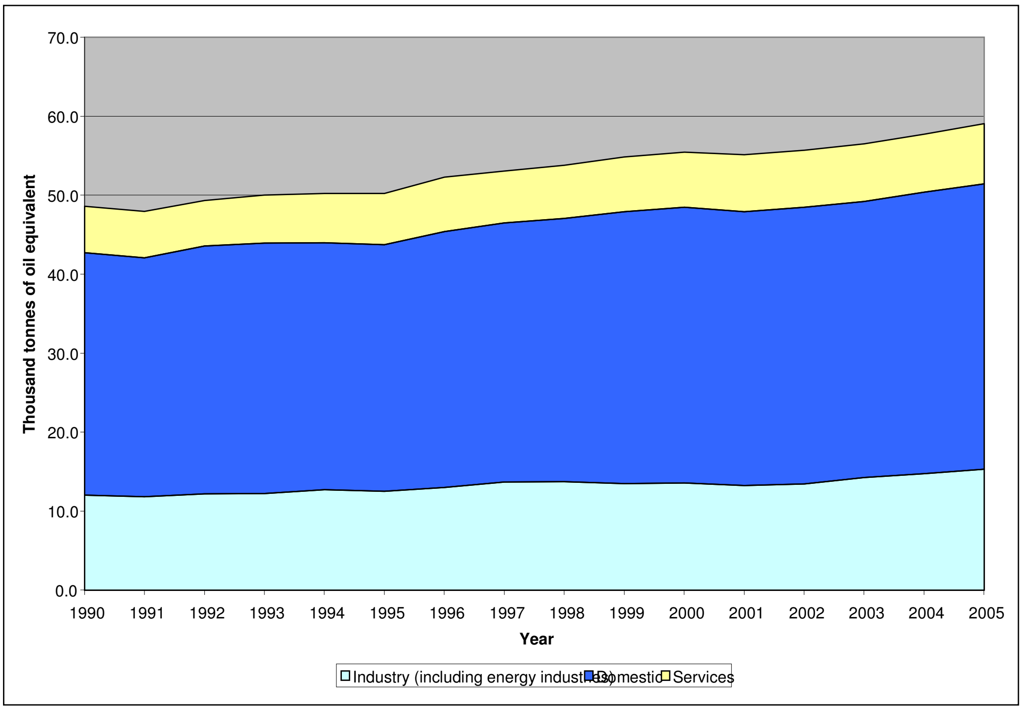
Figure 4.7: Final energy consumption in the transport sector by mode



Source: BERR

4.12 Figure 4.8 shows energy consumption broken down by subsector. This shows that domestic transport dominates, accounting for 61.1%, with industry (26%) and the service sector (12.9%) making up the rest. This study focuses on the industrial and service sector, which makes up 38.9% or 22.9Mtoe (266TWh) of total energy use in the transport sector.

Figure 4.8: Final energy consumption in the transport sector by subsector



Section results

4.13 Appendix 7 shows the detailed analysis undertaken to derive the energy savings opportunity.

Summary of findings

4.14 Table 4.4 shows the section summary with the estimated energy savings in each sector and subsector totalling £3.3 billion. The standard error of the estimate is ± 11.7% making the range of savings £3.0 billion to £3.7 billion. The transport sector represents the most significant opportunity accounting for £2.0 billion with industry at £687 million, commercial at £591 million and agriculture at £54 million making up the total estimated savings.

Table 4.4: Section summary

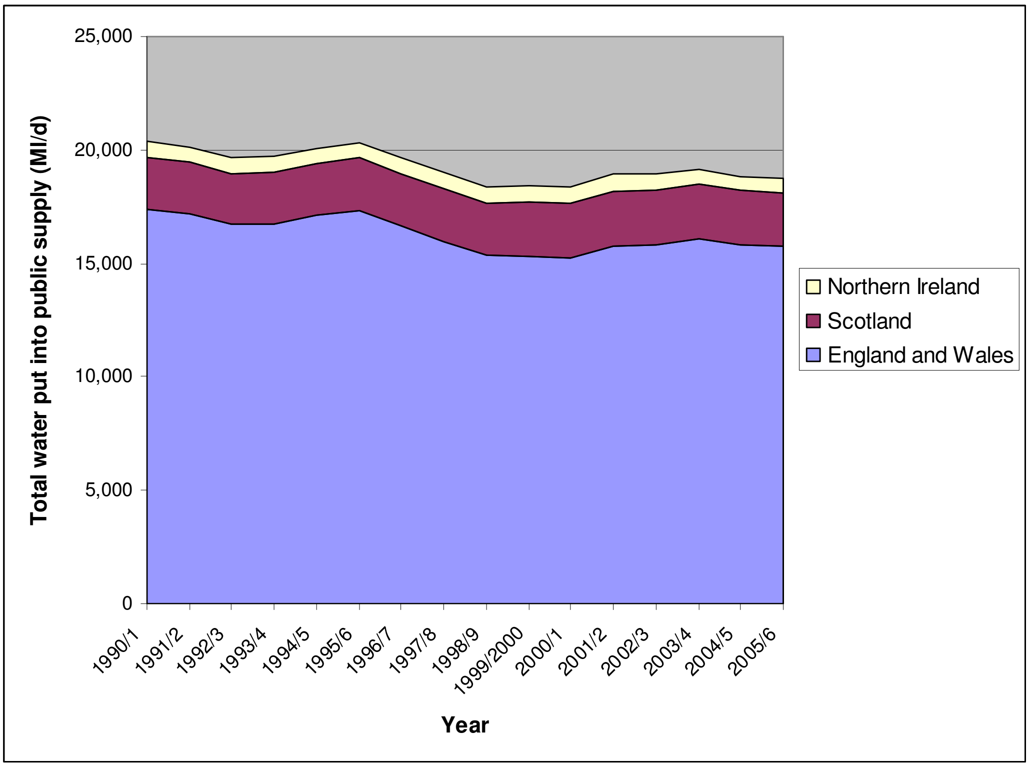
Sector	Subsector	Estimated savings (%)	Estimated savings (excluding CCL) (£M)	Estimated total savings (including CCL) (£M)
Industrial	Chemicals	7.0	176	189
	Coke, refined petroleum products & nuclear fuel	2.0	60	64
	Basic metals / Mechanical engineering	4.4	77	83
	Food & drink	5.5	72	77
	Paper, printing & publishing	4.5	49	53
	Vehicles	4.0	27	29
	Textiles	7.1	25	27
	Electrical engineering	6.2	25	27
	Construction	12.4	27	28
	Other	4.8	103	110
Commercial (Service)	Retail	11.3	130	141
	Hotels	13.0	101	109
	Warehouses	10.0	71	77
	Commercial offices	17.4	93	101
	Education	10.0	48	52
	Government	15.0	46	50
	Sports & leisure	7.4	24	26
	Health	6.7	16	17
	Other	11.0	17	18
Transport	Road freight	11.0	2,017	2,017
Agriculture	All	20.0	53	54
Total			**3,257**	**3,349**

5 Detailed resource analysis – water

Background

5.1 Figure 5.1 shows the trend in the public supply of water in the UK with the volume of supplied water dropping by 7.9% between 1990/1 and 2005/6 due predominantly to reductions made between 1995/6 and 1998/9. In 2005/6, 18,749Ml/day of water were supplied to the UK, with England and Wales accounting for 84%, Scotland 13% and Northern Ireland 3%.

Figure 5.1: Water put into public supply: 1990/1-2005/6

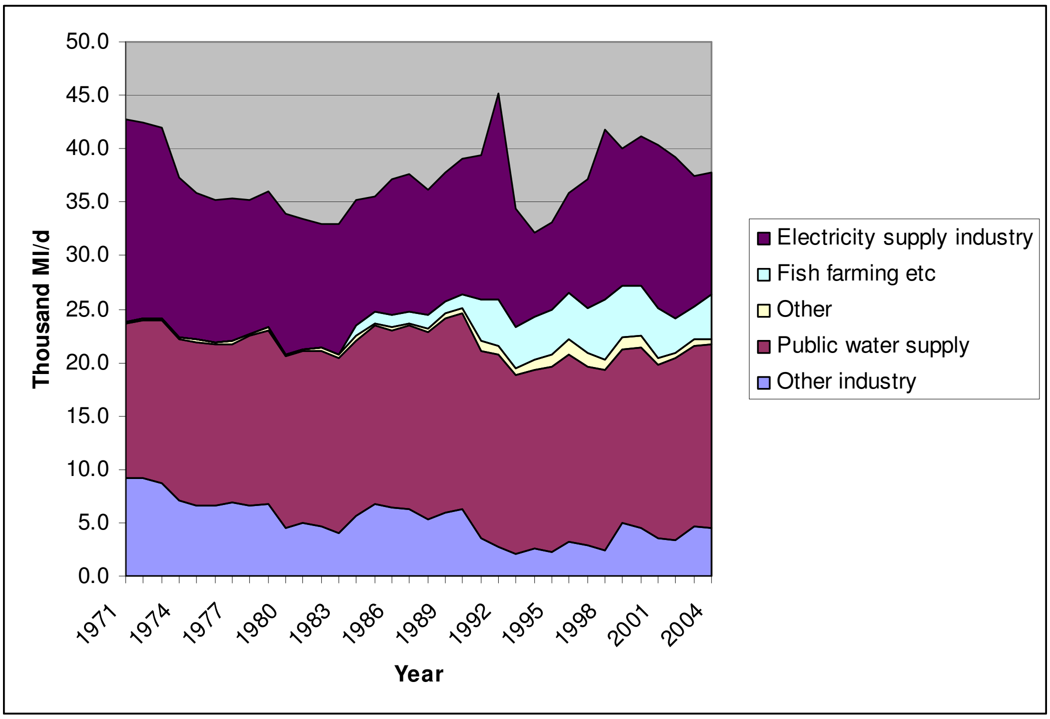


Source: WSA; WCA; Ofwat (from 1991/2); SOAEFD, SERAD (from 1999); DRD (NI) Water Service and Scottish Water (From 2003)
Source publication: e-Digest of Environmental Statistics, Published January 2007
Department for Environment, Food and Rural Affairs
http://www.defra.gov.uk/environment/statistics/index.htm

5.2 Figure 5.2 shows a breakdown of water consumption in England and Wales by use. “Public water supply” can be seen to be the largest water use, accounting for 45% of total water abstractions in 2004 with water use increasing by 20% since 1971. The electricity supply industry accounted for 31% of abstracted water in 2004 (NB: water use in this area has reduced by 39% since 1971). The “other industries”, which exclude electricity supply and fish farming, accounts for only 12% of abstracted water and this water use has reduced by 50% since 1971, due mainly to the reduction in heavy industry.

5.3 This section focuses on the water savings opportunities within the electricity supply industry and the other industry (including the commercial sector). These two broad sectors accounted for 16.2 megalitres per day or 42.7% of supplied public water in 2004.

Figure 5.2: Abstractions from non-tidal surface water and groundwater by use: 1971-2004 (England and Wales)



Source: Environment Agency
Source publication: e-Digest of Environmental Statistics, Published January 2007
Department for Environment, Food and Rural Affairs
http://www.defra.gov.uk/environment/statistics/index.htm

5.4 Table 5.1 shows the significant water consuming industries in the UK. This shows that in 2007 water consumption in the electricity, gas, steam and hot water supply sector accounted for over three-quarters of total non-household water use and the seven sectors shown in Table 5.1 account for 95% of water consumption.

Table 5.1: Consumption of water by subsector in 2007[1]

Subsector	**Average annual consumption (million m^3)**	**% of water consumed**
Electricity, gas, steam & hot water supply	112.2	76.0
Manufacture of basic metals	8.2	5.6
Manufacture of coke, refined petroleum products & nuclear fuel	7.7	5.2
Fishing, fish farming & related services	4.2	2.9
Manufacture of pulp, paper & paper products	3.2	2.2
Manufacture of chemicals, chemical products & man-made fibres	2.8	1.9
Supporting & auxiliary transport activities	1.8	1.2
Other	7.4	5.0

5.5 However, a large consumer of water need not have a high expenditure on water since expenditure is dependent on both the volume of water being consumed and the type of water, e.g. groundwater, surface water, etc. Table 5.2 shows an analysis of the cost of water supplied to UK non-household sectors in 2004 as reported in ABI input-output tables. This shows the relative ranking of the various subsectors to change considerably when compared against the consumption data shown in Table 5.1. For example, public administration is not ranked in the top seven sectors by water consumption but it is the most significant sector in terms of expenditure on water. This is due to its heavy reliance on mains water. The electricity supply industry is the largest water consumer but much of this is low value tidal water, hence its relatively low expenditure on water.

[1] A review of water use in industry and commerce. For Envirowise by Enviros. June 2007.

Table 5.2: Cost of water by subsector in 2004

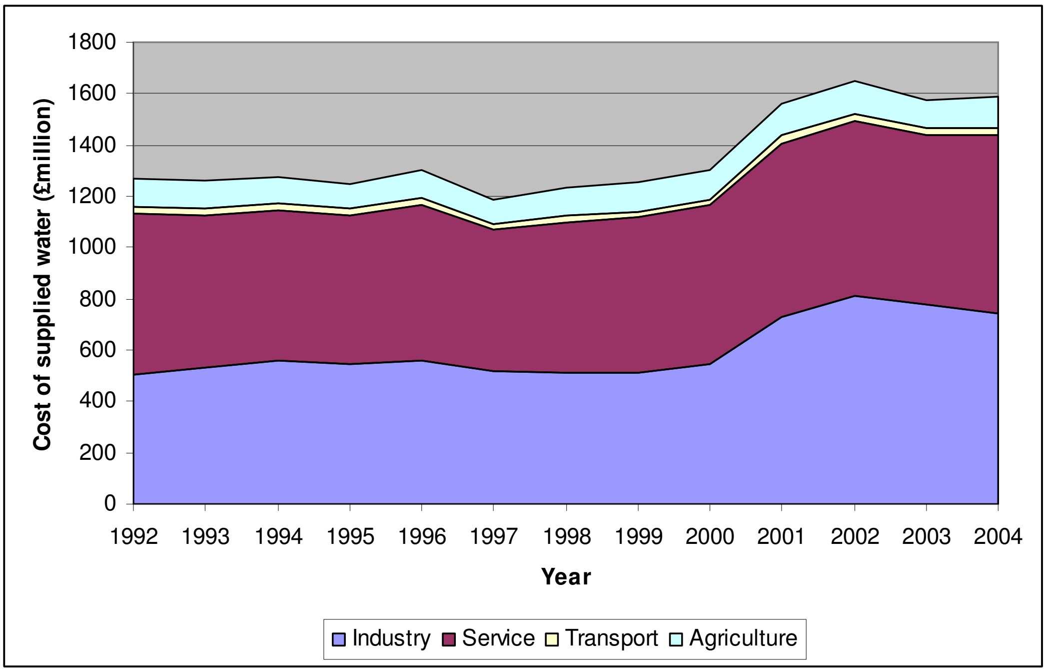
Subsector	Cost of water supplied (2004) (£M)	% of supplied water
Public administration & defence; compulsory social security	216	13.6
Manufacture of chemicals, chemical products & man-made fibres; Manufacture of rubber & plastic products	156	9.8
Manufacture of food products, beverages & tobacco	155	9.8
Health & social work	122	7.7
Agriculture, hunting & forestry	118	7.4
Education	111	7.0
Manufacture of basic metals & fabricated metal products	96	6.1
Other community, social & personal activities	75	4.7
Electricity, gas & water supply	70	4.4
Manufacture of transport equipment	63	4.0
Wholesale & retail trade; repair of motor vehicles, motorcycles & personal & household goods	59	3.7
Manufacture of pulp, paper & paper products; Publishing & printing	57	3.6
Manufacture of machinery & equipment nec	43	2.7
Real estate, renting & business activities	38	2.4
Manufacture of electrical & optical equipment	38	2.4
Manufacture of coke, refined petroleum products & nuclear fuel	31	2.0
Manufacture of textiles & textile products	25	1.6
Transport, storage & communication	24	1.5
Manufacture of other non-metallic mineral products	21	1.3
Mining & quarrying	17	1.1
Manufacturing	17	1.1
Construction	13	0.8
Hotels & restaurants	11	0.7
Manufacture of wood & wood products	7	0.4
Fishing	2	0.1
Manufacture of leather & leather products	1	0.1

5.6 For this study the expenditure on water is of more direct relevance than the consumption data and hence focus is placed in this area. Unlike the trend in overall water consumption which showed a decline in water use, expenditure has increased significantly (Figure 5.3); in fact expenditure on water increased by 24.8% between 1992 and 2004 with the main rise occurring since 2000. IGD report that[1]:

[1] IGD.com Water Use in the Supply Chain factsheet. Accessed September 2007.

"*the cost of water to UK businesses has grown by nearly 8% in 2006/07, with water charges having increased by 25% in the last three years. Given that these increases appear set to continue (Ofwat announced in December 2004 that all water costs are to increase by over 20% not including inflation, over the next 5 years), businesses are keen to address their levels of water use and sources*".

Figure 5.3: The trend in the cost of water by sector



5.7 Figure 5.3 also shows that the industry and service sectors represent the two most significant non-household sectors in terms of expenditure on water, accounting for 89% (industry 39.8% and the service sector 49.2%) of the total cost in 1992 and 90.9% (industry 46.6% and the service sector 44.3%) in 2004. Agriculture is the next largest sector accounting for 8.7% of the expenditure on water in 1992 and 7.6% in 2004.

5.8 In this study we undertake a detailed analysis of the three significant sectors: industry, service and agriculture, which accounted for 98.5% of total non-household expenditure on water in 2004. The sectors and subsectors focused on in detail in this study are shown in Table 5.3; between them they account for 82% of non-household water expenditure. These sectors and subsectors have been split between industry, service and agriculture in this section.

Table 5.3: Cost of water by subsector in 2004

Subsector	**Cost of water supplied (2004) (£M)**	**% of supplied water**
Public administration & defence; compulsory social security	216	13.6
Manufacture of chemicals, chemical products & man-made fibres; Manufacture of rubber & plastic products	156	9.8
Manufacture of food products, beverages & tobacco	155	9.8
Health & social work	122	7.7
Agriculture, hunting & forestry	118	7.4
Education	111	7.0
Manufacture of basic metals & fabricated metal products	96	6.1
Other community, social & personal activities	75	4.7
Electricity, gas & water supply	70	4.4
Manufacture of transport equipment	63	4.0
Manufacture of pulp, paper & paper products; Publishing & printing	57	3.6
Real estate, renting & business activities	38	2.4
Construction	13	0.8
Hotels & restaurants	11	0.7
Total	**1,301**	**82.0**

The industrial sector

5.9 Figure 5.4 shows the trend in expenditure on water in the industrial sector. This shows expenditure to have remained stable between 1992 and 2000 before increasing significantly in 2001. Figure 5.5 shows that when sector output (GVA) is taken into consideration this trend remains, indicating that it is due to the increased price of water described previously.

Figure 5.4: The expenditure on water in the industrial sector

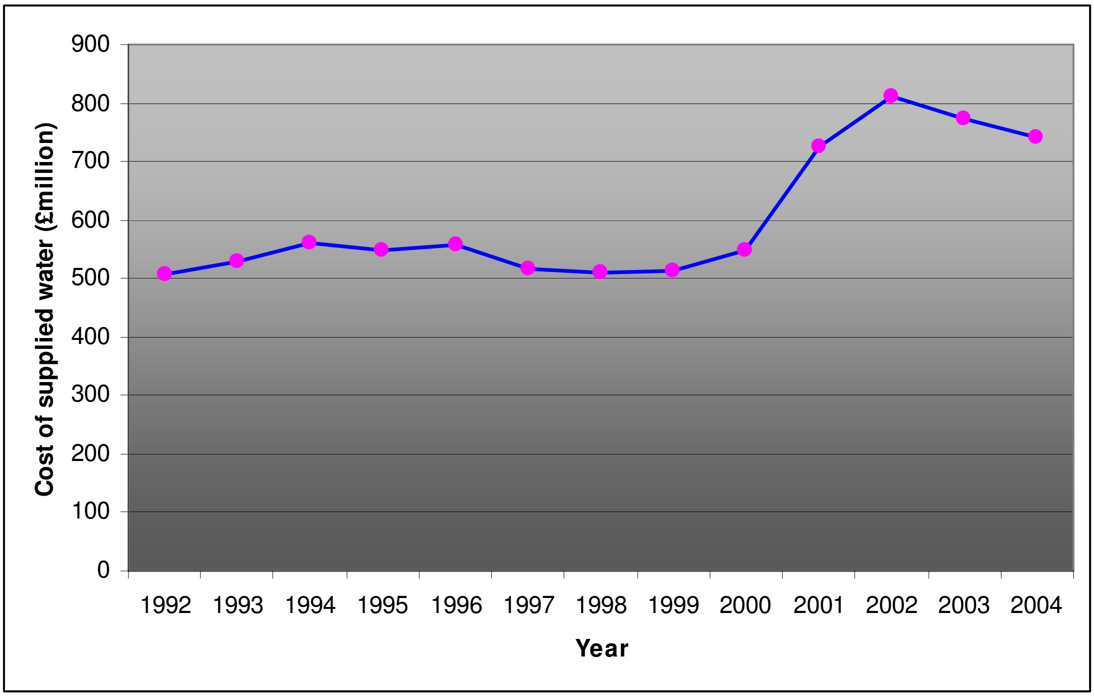
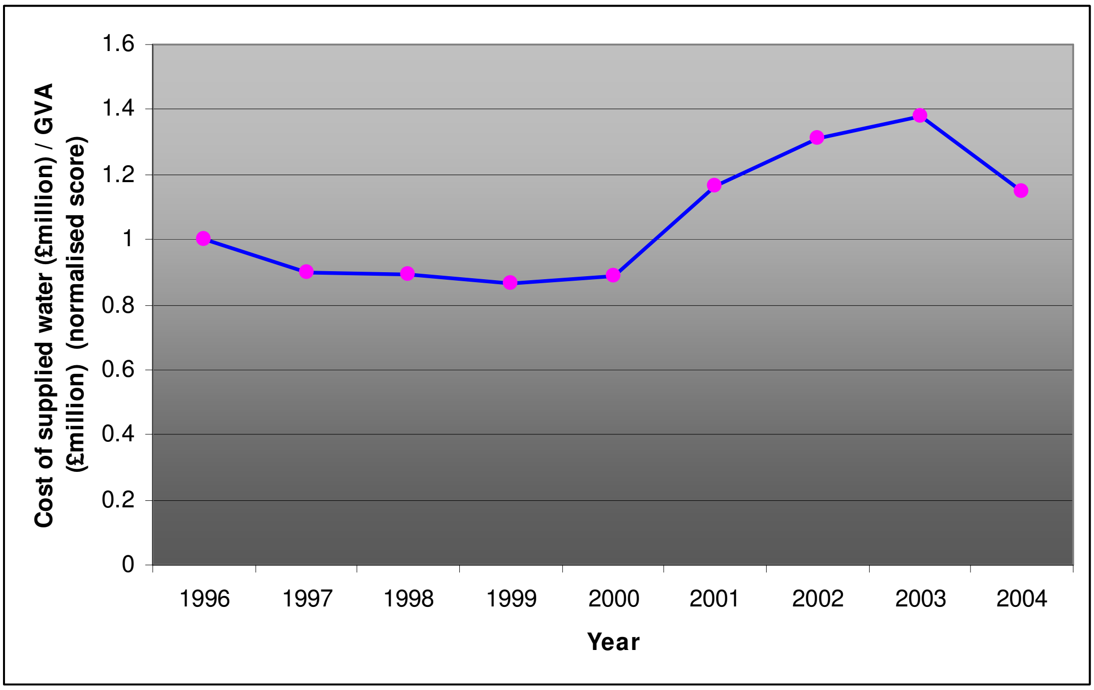


Figure 5.5: Spend / GVA on water in the industrial sector



5.10 Table 5.4 shows the seven industrial sectors focused on in this study. The seven sectors accounted for 76.9% of the expenditure on water in the industrial sector in 2004.

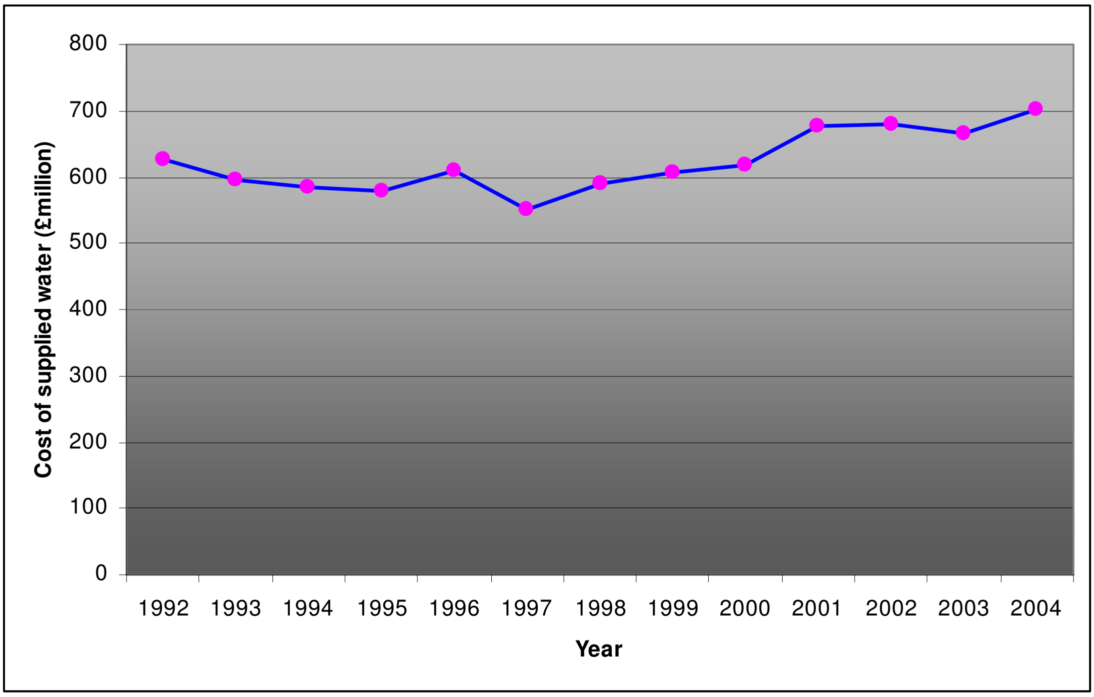
Table 5.4: A breakdown of the cost of water supplied to the industrial sector

Subsector	**Cost of supplied water (2004) (£M)**	**% of supplied water**
Manufacture of chemicals, chemical products & man-made fibres; Manufacture of rubber & plastic products	156	19.7
Manufacture of food products, beverages & tobacco	155	19.5
Manufacture of basic metals & fabricated metal products	96	12.1
Electricity, gas & water supply	70	8.8
Manufacture of transport equipment	63	7.9
Manufacture of pulp, paper & paper products; Publishing & printing	57	7.2
Construction	13	1.6
Subtotal	610	76.9
Industrial sector total	**793**	**100**

The service sector

5.11 Figure 5.6 shows that the expenditure on supplied water in the service sector has been increasing since 1997, with a 27% increase between 1997 and 2004.

Figure 5.6: The trend in water expenditure in the service sector



5.12 Table 5.5 shows the breakdown of cost and water supplied for the six service sectors focused on in this study. These six sectors accounted for 87.3% of the expenditure on water in the service sector in 2004.

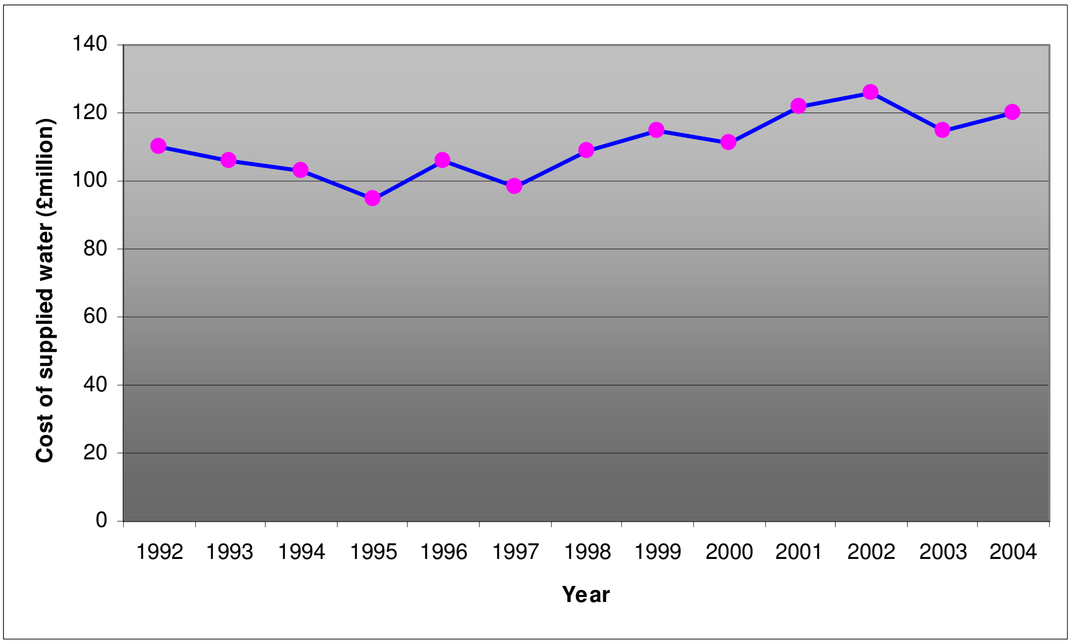
Table 5.5: Water expenditure in the 6 significant service sectors

Subsector	**Cost of supplied water (2004) (£M)**	**% of water supplied to the service sector**
Public administration & defence; compulsory social security	216	32.9
Health & social work	122	18.6
Education	111	16.9
Other community, social & personal service activities	75	11.4
Real estate, renting & business activities	38	5.8
Hotels & restaurants	11	1.7
Subtotal	573	87.3
Total for service sector	**656**	**100**

The agricultural sector

5.13 Expenditure on water by the agricultural sector was £118 million in 2004 or 7.4% of UK expenditure by non-householders. Figure 5.7 shows the trend in the cost of water supplied to the agriculture sector. This shows that costs have been gradually increasing since 1995.

Figure 5.7: The cost of water in the agriculture sector



Section results

5.14 Appendix 8 shows the detailed analysis undertaken to derive the water savings opportunity.

Summary of findings

5.15 Table 5.6 shows the section summary with the estimated water savings in each sector and subsector. This shows that businesses could save £441 million in water supply and wastewater costs. The standard error for the estimate is ± 20.95% making the range of savings £349 million to £533 million.

Table 5.6: Section summary

Sector	Subsector	Water supply (input) savings		Estimated total savings including wastewater (£M)
		Estimated savings (%)	**Estimated savings (£M)**	
Industrial	Chemicals	8.1	13.6	38.9
	Food & drink	20.0	34.3	60.0
	Basic metals	7.0	6.7	11.2
	Transport equipment	2	1.3	2.0
	Paper, publishing & printing	11.4	6.5	11.5
	Electricity, gas & water	2.7	1.6	2.5
	Construction	12.0	1.6	2.0
	Other	11.3	25.2	56.3
Commercial (Service)	Public administration	31	66.3	85.8
	Health & social work	20	23.8	30.4
	Education	28	30.8	39.7
	Other community activities	21	10.4	13.3
	Real estate, renting & business activities	31	12.2	15.6
	Hotels & restaurants	33	3.4	4.7
	Other	21.9	26.1	29.6
Agriculture	All	32	37.8	37.8
Total			**301.6**	**441.3**

6 Regional analysis

6.1 This section breaks down the savings opportunity by government region using regional employment data as a means of weighting the data. NB: this approach assumes the savings opportunity per employee is uniform across enterprises (large and small) and across regions and hence does not take into consideration regional cost variations, which would be particularly significant with respect to water. Therefore the data should be used as a guide to highlight where focus best be placed and should not be regarded as absolutes.

6.2 The source for the regional employment data in all the tables shown in this section is the "UK Business: Activity, Size and Location – 2006", ONS report.

6.3 Table 6.1 summarises the savings opportunity within each region and the top 10 significant opportunities for each resource in each region is shown in Appendix 9.

Table 6.1: Summary table showing waste, energy and water savings by region

Region	Waste (£M)	Energy (£M)	Water (£M)	Total (£M)
North East	92	120	15	227
North West	299	373	41	713
Yorkshire & the Humber	234	285	34	553
East Midlands	191	267	32	490
West Midlands	213	315	33	561
East	247	334	34	615
London	272	318	40	630
South East	336	488	47	871
South West	248	298	36	582
Wales	132	163	23	318
Scotland	245	273	43	561
Northern Ireland	104	114	15	233

7 Conclusions

7.1 The study estimates the total value of low-cost / no-cost resource efficiency savings within the UK business economy to range from £5.6 billion to £7.4 billion with a mean estimate of £6.4 billion (Table 7.1). It can be seen that energy (52%) and waste (41%) are the two significant savings opportunities.

Table 7.1: Summary of the estimated resource efficiency savings opportunity across the UK economy

Resource	Estimated Savings Opportunity (£M)	% of total estimated savings
Energy	3,349	52
Waste	2,659	41
Water	441	7
Total	**£6,449M**	**100%**

Energy

7.2 The energy savings opportunity is dominated by transport, which accounted for £2.0 billion or 60% of the total estimated savings. This is significantly less than the previous estimate of £4.7 billion made for transport in the 2002 Energy Review. However, the Energy Review focuses on the whole transport sector, which is heavily influenced by household or domestic transport. These savings can be met using the Department for Transport (DfT) “Freight Best Practice Programme” which focuses on tackling energy use in the freight sector and realising energy efficiency opportunities.

7.3 Table 7.2 shows the eight subsectors that account for 83.6% of the identified energy savings. This shows that the significant saving opportunities are split between the industrial and service sectors. Historically the industrial sector would have shown greater savings opportunity but a combination of changing industry profiles through consolidation and closures, the Climate Change Agreement (CCA) targeting the energy intensive industries and the growth in the UK service sector has resulted in this change.

Table 7.2: A summary of the significant energy savings opportunities by subsector

Activity	Estimated Savings Opportunity (£M)	% of overall energy savings
Transport (road freight)	2,017	60.3
Chemicals, rubber and plastics	189	5.7
Retail	141	4.2
Hotels & Catering	109	3.3
Commercial offices	101	3.0
Basic metals / mechanical engineering	83	2.5
Food & Drink	77	2.3
Warehouses	77	2.3
Total	**£2,794M**	**83.6%**

7.4 The Carbon Trust is best placed to assist in the realisation of the savings. Their benchmarking work focuses on the energy savings opportunities associated with specific functions of a business, i.e. heating, cooling, lighting, etc. Benchmarking by function rather than business activity enables savings opportunities to be identified and implemented across a variety of business types and reduces the need for the resource efficiency service provider to be an expert in every different sector.

Waste

7.5 The food and drink (32.3%) and retail (18.3%) sectors were the two significant sectors identified within the analysis of waste savings, accounting for over 50% or £1.3 billion of total waste savings. Defra has implemented the Food Industry Sustainability Strategy (FISS), which aims to tackle waste, energy and water use throughout the whole food chain and delivery bodies such as Envirowise focus heavily on waste minimisation in the food sector.

7.6 In the retail sector, the major retailers have signed up to the Courtaulds Agreement so committing them to making environmental improvements which in many cases include the reduction of waste. For example, Marks & Spencer have committed, under their "Plan A", to divert 100% of their waste from landfill by 2012. WRAP and Envirowise have teams working in this area.

7.7 Table 7.3 shows that the top seven subsectors account for 87% of the total estimated waste savings. As in the case of energy this is made up of a mix of both industrial and service sectors. The service sector waste has historically been collected mixed and sent for land disposal and hence, although improvements have been made, significant opportunities exist to divert waste from land disposal either through recycling, reuse or waste minimisation.

Table 7.3: A summary of the significant waste savings opportunities by subsector

Activity	**Estimated Savings Opportunity (£M)**	**% of overall waste savings**
Food & Drink	858	32.3
Retail	489	18.3
Construction	239	9.0
Chemicals, rubber and plastics	235	8.8
Travel agents	233	8.8
Machinery, electrical & transport equipment	195	7.3
Hotels & Catering	70	2.6
Total	**£2319**	**87.1**

7.8 The study has also shown a number of high volume industrial wastestreams, e.g. construction (hard demolition waste), mining (extraction waste), basic metals (blast furnace slag) and paper (pulp sludge), which due to the nature of their respective processes are difficult and costly to reduce at source. NISP, the National Industrial Symbiosis Programme, is well positioned to optimise the beneficial use of these materials.

7.9 Hidden costs were a key issue in the valuation of the waste savings since they can have such a significant impact on the overall valuation. Table 7.4 shows the comparison between the visible savings, i.e. savings in waste disposal, against the hidden savings (raw material savings, labour savings, etc). This shows that three industrial sectors have the highest levels of hidden savings, namely: food and drink; machinery, electrical and transport equipment; and chemicals. The hidden savings in the food and drink and chemicals sectors were cited by Envirowise. These hidden saving were validated through an assessment of the waste savings opportunities detailed in case studies and surveys. The savings were also validated by industrial stakeholders such as the Chair of the Food Industries Sustainability Strategy.

7.10 Unlike the case studies in other sectors the automotive sector, included under transport equipment, focused primarily on savings relating to the inputs to the process, namely raw materials, rather than the outputs (waste). This ensured that focus was placed on the high value opportunities where significant savings can result from relatively small improvements. In the context of this study this raises the question whether focus should be placed on the three input resources of water, energy and raw materials in such studies rather than focusing on an output, waste.

Table 7.4: A summary of the hidden to visible savings

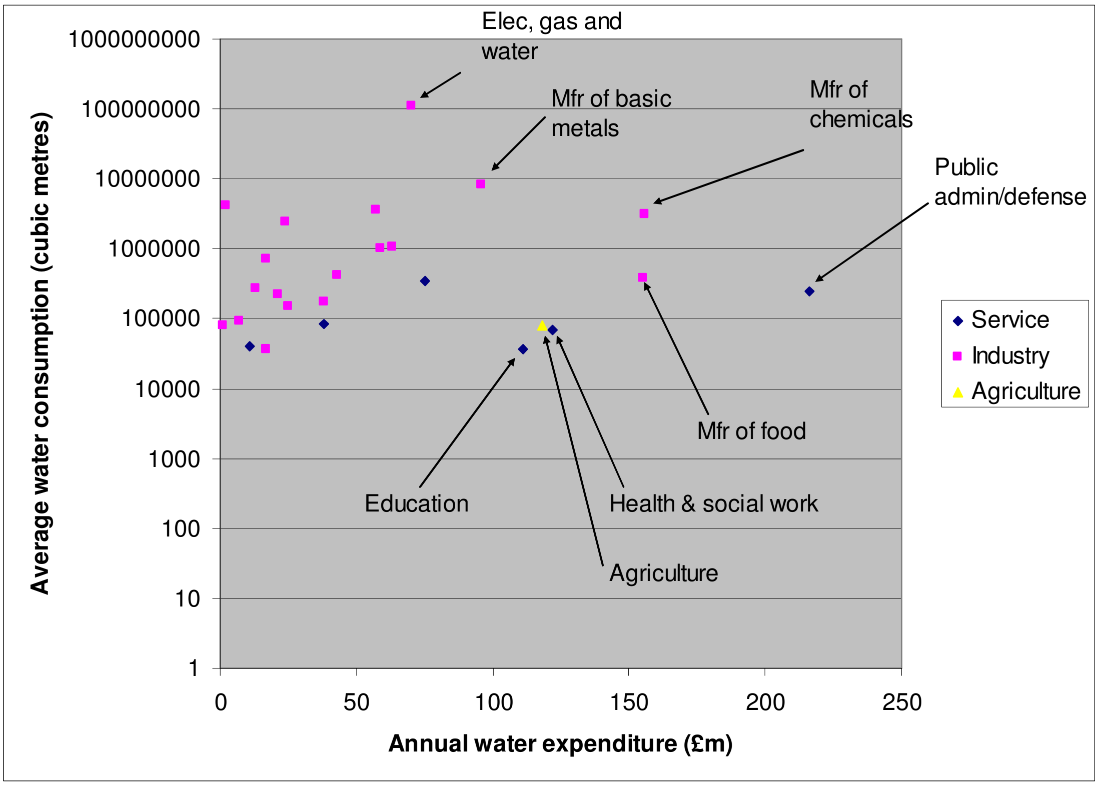
Sector	Subsector	Estimated Savings (£M)		Hidden savings/ visible savings
		Visible savings	Hidden savings	
Industrial	Construction	230	239	1.04
	Mining & quarrying	40	40	1
	Food & drink	94	858	9.13
	Energy supply	36	45	1.25
	Basic metals / Mechanical engineering	11	17	1.55
	Machinery, electrical & transport equipment	26	195	7.5
	Chemicals, rubber & plastics	47	235	5
	Paper, printing & publishing	10	20	2
	Other	25	83	3.32
Commercial (Service)	Retail et al	118	489	4.1
	Travel agents et al	68	233	3.43
	Hotels & catering	70	70	1
	Transport	12	12	1
	Education	53	53	1
	Misc service industries	24	24	1
	Other	17	46	2.71

7.11 The estimate of £2.7 billion in waste savings opportunity would appear to fit within the previous estimate made in the “Benefits of Greener Business” study of £2.2 to £2.9 billion, however this previous study focused solely on the manufacturing sector. For comparative purposes, this study estimates waste savings in the manufacturing sector at £1.45 billion, significantly lower than the previous study. Although the realisation of some of the savings would be expected in the four years between the two studies the estimated savings attributed to chemicals in the previous study is considered overstated at £966 million.

Water

7.12 The approach taken to value the water savings opportunities differed from that for waste and energy since focus was placed specifically on expenditure. Figure 7.1 shows the scatter plot of consumption against expenditure and shows the random nature of the relationship between the two factors. The incentive to improve water efficiency is clearly greater for a company with a high expenditure on water than a company with a high consumption rate and hence the focus in this study.

Figure 7.1: A comparison of water consumption versus water expenditure



7.13 Table 7.5 shows the six sectors which accounted for 66.3% or £293 million of the total identified water savings. The food and drink sector is much cited with regard to water savings opportunities but very little focus has been placed on public administration which was identified as the subsector with the highest expenditure on water and with the most water saving opportunity.

Table 7.5: A summary of the significant water savings opportunity

Activity	**Estimated Savings Opportunity (£M)**	**% of overall water savings**
Public administration	85.8	19.4
Food & Drink	60.0	13.6
Education	39.7	9.0
Chemicals, rubber and plastics	38.9	8.8
Agriculture	37.8	8.6
Health and social work	30.4	6.9
Total	**292.6**	**66.3**

7.14 The mix of sectors included in Table 7.5 is again diverse and it is suggested that the industrial sector has undertaken significant in-process water efficiency improvements whereas significantly less water savings activity has occurred in the service sector. This is reflected in the percentage savings opportunity identified within the two sectors with the industrial sector having a mean savings opportunity of 11.3% and the service sector 21.9%.

7.15 It is estimated that of the £441 million savings identified in water use that £78 million is through non-industrial process (domestic type) use by employees in both the service and industrial sectors. Much of the water used in the service sector is in domestic type uses, i.e. toilets (urinal and toilet flushing), washing and cleaning. In addition subsectors such as education and hotels would also have domestic type water use by pupils and guests respectively. These are regarded as the quick win opportunities.

Regional analysis

7.16 Table 7.6 shows the regional analysis. The South East and North West of England can be seen to have the greatest level of resource efficiency opportunities. This is in keeping with the findings of the "Benefits of Greener Business" study. In both regions waste reduction in the food and drink and retail subsectors and energy reduction in the transport sector represent the most significant opportunities.

Table 7.6: Summary table showing waste, energy and water savings by region

Region	Waste (£M)	Energy (£M)	Water (£M)	Total (£M)
South East	336	488	47	871
North West	299	373	41	713
London	272	318	40	630
East	247	334	34	615
South West	248	298	36	582
Scotland	245	273	43	561
West Midlands	213	315	33	561
Yorkshire & the Humber	234	285	34	553
East Midlands	191	267	32	490
Wales	132	163	23	318
Northern Ireland	104	114	15	233
North East	92	120	15	227

Study methodology

Fitness for purpose of methodology

7.17 The systematic nature of the methodology has proved to be extremely useful in enabling outcomes to be challenged and verified at each key stage in the process. This verification was undertaken predominantly through consultation with sector stakeholders. Additionally, this has also enabled a number of supplementary observations to be made. For example:

7.18 The detailed preliminary analysis showed that 76% of case studies and surveys focused on waste savings opportunities in the manufacture of food and drink and the manufacture of chemicals, plastics and rubber were in companies that can be regarded as performing better than the subsector average prior to intervention. This observation influenced the grossing up methodology used in this study but also raises the question on how to engage with more of the poorer performing companies where the savings opportunities are higher?

7.19 This study found that 77% of the resource efficiency case studies and surveys reviewed focused only on specific parts of the business or lacked the required data, e.g. total waste consumption or total savings opportunity. This is due to the nature of the enquiries made by businesses to the resource efficiency service providers or the narrow expertise of the service providers.

7.20 The structure of this study and layout of the report should provide a strong basis for targeting the largest potential resource efficiency savings within the UK economy. For example, a supply chain approach focussing on the manufacture of food and drink, transport and retail would be particularly advantageous. Where possible, the accuracy of the savings has been verified through confirmation with experts in the field. As updated studies on various parts of the economy are performed, however, the results can be easily incorporated into this report which will further increase its accuracy and validity.

8 Further Work

8.1 Many of the opportunities detailed in this study are currently being addressed through Government initiatives, such as the DfT Freight Best Practice Programme and the Defra Food Industries Sustainability Strategy, or through the delivery bodies, Envirowise, ENWORKS, WRAP, Carbon Trust and NISP. However, the study has revealed a number of opportunities that are not currently receiving sufficient attention. For example:

8.2 Water consumption in public administration. Little could be found detailing the significant water users within this subsector and hence given its status in terms of savings opportunity a programme of work to drive down water use in this subsector is recommended.

8.3 In-process industrial water use. Many of the water case studies focused on the non-industrial process use of water and it is considered beneficial to adopt an approach similar to that of the Carbon Trust benchmarking methodology for energy to target in-process use. The Carbon Trust benchmark focuses on the functions or activities for which the resource is being used rather than a sector by sector approach. This approach would simplify the delivery of water efficiency in the industrial sector.

8.4 Waste in the service sector. Investigate how the mixed wastes from the service sector can best be diverted from land disposal.

8.5 Additionally, although this study focused on the quick win or low-cost / no-cost opportunities a study investigating the absolute savings opportunity in each sector would be beneficial to quantify how much resource efficiency can contribute to such targets as the UK's Kyoto protocol commitments based on current best technology. This will enable UK science and industry policy makers to target areas where there is a need for innovation to reduce businesses environmental burden.

8.6 The preliminary analysis showed that it is the companies performing better than the sector average that is most likely to engage with delivery bodies in resource efficiency. It would be extremely useful to investigate this further to provide a detailed profile of the companies most likely to engage with delivery bodies. For example, what is the structure of the company, environmental management culture, etc? This would assist in the development of a strategy for engaging with the poorer performing companies who currently are less likely to engage.

8.7 Resource efficiency case studies were found to be extremely diverse in terms of the information provided. It would be advantageous if a standard reporting protocol could be developed. The environmental benefits (carbon savings) would be particularly useful along with the pre-intervention costs. This would enable a full analysis to be undertaken.

8.8 The primary objective of this study was to quantify the savings opportunity in the UK economy. Further work is needed however to determine how these savings can best be realised, i.e. what is the best form of resource efficiency intervention, what are the barriers, constraints and enablers to realising these savings?

9 Appendix 1: The preliminary analysis

9.1 A key focus during the development of the methodology used in this study was the grossing up factor to be used to extrapolate the sample data gathered from case studies and surveys on resource efficiency up to a population value. A single grossing factor is the simplest form, for example, waste / energy / water per employee or per company.

9.2 In the Commercial & Industrial Waste Production Survey 2002/03 the Environment Agency used a three step approach to gross up the waste arisings from a sample of companies within each subsector and employment size band to sector level, namely[1]:

9.3 **Step 1**: Determine the average sample weight per site (X), within the subsector and employee size band, by dividing the total sample weight (*w*) by the number of sample sites (*n*).

$$X = w/n$$

9.4 **Step 2:** Determine the grossed up population value (*W*), for each subsector and size band, by multiplying the population (*N*) by the average sample weight (X).

$$W = N \times X$$

9.5 **Step 3:** The grossed up weights (*W)* for each subsector and size band can then be added together to give the overall subsector and sector values.

9.6 This methodology is statistically robust when the sample is selected at random since there is a high probability that the mean of the sample is equal to the mean of the population. In the case of the waste survey data the Office for National Statistics (ONS) Inter-Departmental Business Register (IDBR) provided the sample data, ensuring its randomness.

9.7 Unfortunately, resource efficiency data is frequently drawn from case studies, which in their nature only focus on the best opportunities or on a single opportunity within each company, or is drawn from surveys undertaken on

[1] The Commercial & Industrial Waste Production Survey. Environment Agency. Draft Final Report. September 2005.

companies who have requested assistance, i.e. are self selecting. This provides sufficient doubt over the randomness of the sample data.

9.8 In an earlier study Cambridge Econometrics (2003) overcame this issue by applying a replication rate in grossing up the resource efficiency opportunity from Envirowise case studies to sector level. The formula used was:

$$GS = \sum_{i=1}^{n} \left(\frac{El - EC_i}{EC_i} \times R_i \times S_i \right)$$

Where:

GS = savings for the group,

n = the number of case studies in the group,

El = Group employment,

EC = Employment in the case study,

R = the replication across the group,

S = annual savings for the firm

9.9 Cambridge Econometrics reported that:

"The cost savings realised by companies that replicate the approach in a case history can be variable. Therefore, in determining the likely savings based on these case histories a very conservative estimate of average savings is used".

9.10 The report continues with the key assumption:

"In those case studies where no explicit figure was cited, the scope for replication for the process improvement to other firms was set at 20% (compared with the range of replication rates of 5-100% that are quoted). In other words, 20% of all firms (by employment) in the same sector were considered capable of achieving this saving".

9.11 It can be seen that the introduction of a "replication rate" potentially causes overcompensation for the non-random nature of the sample data and adds a level of subjectivity to the methodology. In order to remove the need to apply such a factor it was considered appropriate to develop a methodology which would enable the mean of the sample to be compared against the mean of the population prior to grossing up, i.e. the adaptation of the methodology used by the Environment Agency. The two step preliminary analysis comprised of:

Step 1. Quantify the mean waste arisings (tonnes) in each subsector.

Step 2. Map the case study data against the data in Step 1.

9.12 Focus was placed on the Food and Drink and Chemicals sectors, the two most significant sectors in terms of savings opportunities identified in the "Benefits of Greener Business" study.

Step 1. Quantify the mean waste arisings (tonnes) in each subsector

9.13 In the Environment Agency's Commercial and Industrial 2002/03 survey was the primary data source for this analysis. In the survey each subsector was split into 7 employment bands, 1-3, 4-9, 10-24, 25-99, 100-249, 250-499 and 500+. The employment bands were selected to ensure that the variation in waste arisings within each band was not significantly influenced by the size of the companies. Based on this it was assumed that the variation in each band is due to the relative environmental performance of the companies within each band, i.e. a company producing less waste than the sector/band mean was a good performing company and vice versa.

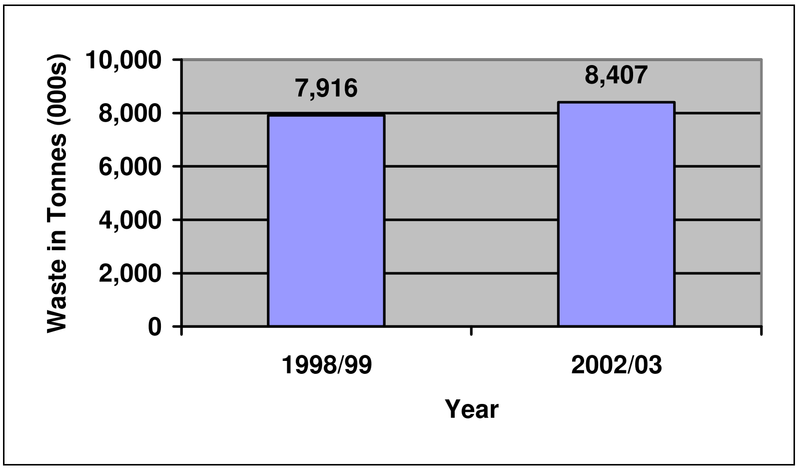
The Manufacture of Food and Drink

Background

9.14 Figure 9.1 shows the results of the two Environment Agency C&I waste surveys undertaken in 1998/99 and 2002/03. This shows an increase in waste arisings over the four year period between the surveys of around 0.5 million tonnes. However this data should be treated with caution since the standard error associated with the survey data is of sufficient magnitude for this variation not to be statistically significant.

9.15 Table 9.1 shows the range of possible waste arisings from the two surveys when taking the standard error into account. This shows that there is significant overlap between the two survey datasets indicating that the increase seen in 2002/03 is not statistically significant.

Figure 9.1: Waste arisings in UK food, drink and tobacco sector



Sources:
1998/9 data; The 10 regional reports for the National Production Waste Survey 1998/99. The Environment Agency[1]. Appendix 2.
2002/3 data; The National Production Waste Survey 2002/03. The Environment Agency[2].

Table 9.1: Analysis of food and drink sector waste arisings 1998/99 and 2002/03

Survey year	Estimated waste arisings (kt)	Standard error	Minimum waste arisings (kt)	Maximum waste arisings (kt)
1998/99	7,920	± 12.7%	6,910	8,920
2002/03	8,410	± 9.6%	7,600	9,210

9.16 Table 9.2 shows the trend in waste arising shown in Table 9.1 projected forward to 2006/07. The projected 6% increase in waste arisings between 2002/03 and 2006/07 is in line with the increase in GVA for the sector, which increased by 8.7% over the same period (Table 9.3).

Table 9.2: Projection of food and drink waste arisings to 2006/07

Survey year	Minimum waste arisings (kt)	Mean waste arisings (kt)	Maximum waste arisings (kt)
1998/99	6,910	7,920	8,920
2002/03	7,600	8,410	9,210
2006/07	8,290	8,890	9,510

[1] This survey reported waste arisings in the sector of 7.204 Mt for England and Wales only and hence was grossed up to UK level using the same methodology as above.

[2] This survey reported waste arisings in the sector of 7.230 Mt for England only. This was grossed up to UK level using the ratio of arisings from the sector for the four countries detailed in the 2004 report, namely England 86%, Wales 5%, Scotland 6% and Northern Ireland 3%.

Table 9.3: Historical industry performance

Survey year	Mean waste arisings (kt)	GVA (£M)	Arisings / GVA	Normalised score
1998/99	7,920	20,050	0.39	1.00
2002/03	8,410	21,050	0.40	1.01
2006/07	8,900	23,050	0.39	0.99

Quantification of waste arisings

9.17 To estimate the waste arisings in 2006/07, to supplement the estimate made above, the change in the number of companies operating within the sector since the 2002/03 survey was first taken into account. This approach was used by Defra to determine the 2004 waste arisings as required under EU waste Statistics Regulation (EC2150/2002).

9.18 This analysis places heavy reliance on the 2002/03 EA C&I survey data and assumes the mean waste arisings per company remained constant from 2002/03 to 2006/07. The 2002/03 survey results are considered robust since the survey sampled 573 companies, equivalent to 6% of the companies in this sector in the UK in 2003. A detailed analysis of the sample structure is shown in Appendix 3. In addition, within the sample, weighting was given to the larger companies, e.g. it was planned to sample all companies with more than 500 employees but only 0.6% of companies with between 10 and 24 employees[1]. This results in the waste arisings from the sample companies (2.1 million tonnes) representing 25% of the UK waste arisings from the sector in 2002/03 (8.4 million tonnes).

9.19 The analysis in Table 9.4 shows a significant increase in the projected total waste arisings (9.0 million tonnes) when compared against the 1998/99 and 2002/03 figures (Table 9.1). Since this analysis is based on the 2002/03 survey the same standard error (9.6%) is applied. This results in the estimated waste arisings from the sector ranging from 8.1 million tonnes to 9.8 million tonnes. These estimates are slightly higher than those shown in Table 9.2 calculated by simply projecting the trend between the two C&I surveys forward. The difference between the two methods, i.e. 8.967 Mt and 8.898 Mt, however is considered insignificant (below 1%) and hence endorses

[1] The commercial and industrial waste production survey. Draft final report. Environment Agency, September 2005.

the use of the “projection method” in the valuation of other sectors within this report.

9.20 Table 9.4 also highlights the significant few subgroups, e.g. SIC 151 and SIC 158 account for 56% of waste arisings from the sector.

Table 9.4: Projected waste arisings in the food and drink sector in 2006/07

3 digit SIC	**Employment groupings**[1]	**Mean weight per company in sample (2002/03)**	**No of companies in UK (2006)**[2]	**Grossed up subtotal weights for subsector (kt)**	**Grossed up weight for subsector (kt)**	**% of sector total**
151	1 to 9	104	625	65	2,273	25.4
	10 to 19	335	160	54		
	20 to 49	322	195	63		
	50 to 99	6,326	90	569		
	100 to 249	6,561	105	689		
	250+	7,247	115	833		
152	1 to 250+	1,311	400	524	524	5.8
153	1 to 49	950	350	333	1,169	13.0
	50 to 99	2,790	35	98		
	100 to 249	7,562	45	340		
	250+	8,849	45	398		
154	1 to 250+	2,073	35	73	73	0.8
155	1 to 19	181	415	75	547	6.1
	20 to 99	373	115	43		
	100 to 250+	4,516	95	429		
156	1 to 49	274	115	31	115	1.2
	50 to 250+	1,389	60	83		
157	1 to 250+	1,049	590	619	619	6.9
158	1 to 9	14	2,725	38	2,733	30.5
	10 to 49	182	1,230	224		
	50 to 99	829	200	166		
	100 to 249	5,702	210	1,197		
	250+	7,150	155	1,108		
159	1 to 9	17	640	11	914	10.2
	10 to 49	378	240	91		
	50 to 99	1,717	60	103		
	100 to 249	5,688	55	313		
	250+	9,921	40	397		
				Total waste arisings from the sector	**8,967kt**	**100%**

NB: SIC descriptions shown in Appendix 3.

9.21 Table 9.5 shows the results of the analysis. NB: some employment bands were combined since the sample size (companies sampled within the

[1] Employment groupings with a sample size of 10 or less companies were aggregated with adjacent groups under ONS reporting guidelines.

[2] Figures extracted from table 3.1 of UK Business 2006.

employment band) fell below the ten company *de minimus*, as specified by ONS[1].

Table 9.5: Detailed analysis of the food and drink sector results

Employment groupings	Mean weight
151 (1-9)	104
151 (10-19)	335
151 (20-49)	322
151 (50-99)	6,326
151 (100-249)	6,561
151 (250+)	7,247
152 (1-250+)	1,311
153 (1-49)	950
153 (50-99)	2,790
153 (100-249)	7,562
153 (250+)	8,849
154 (1-250+)	2,073
155 (1-19)	181
155 (20-99)	373
155 (100-250+)	4,516
156 (1-49)	274
156 (50-250+)	1,389
157 (1-250+)	1,049
158 (1-9)	14
158 (10-49)	182
158 (50-99)	829
158 (100-249)	5,702
158 (250+)	7,150
159 (1-9)	17
159 (10-49)	378
159 (50-99)	1,717
159 (100-249)	5,688
159 (250+)	9,921

The Manufacture of Chemicals, Plastic and Rubber

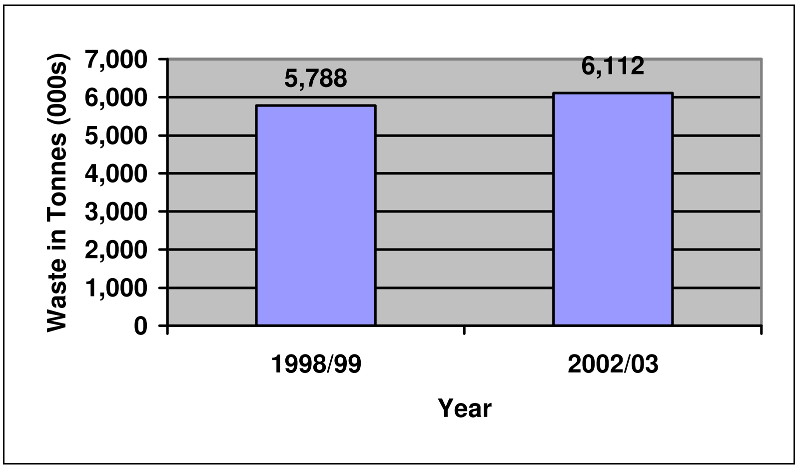
Background

9.22 Figure 9.2 shows the waste arisings from the manufacture of chemicals, chemical products, man-made fibres and rubber and plastic products in the UK in 1998/99 and 2002/03. This shows waste arisings to have increased by

[1] Jon Darke, ONS, Private Communication April 2007.

0.3 million tonnes. However, like the food sector, this cannot be regarded as statistically significant since the standard error of the two surveys is high.

Figure 9.2: Waste arisings from chemicals sector



1998/99 data; The 10 regional reports for the National Production Waste Survey 1998/99. The Environment Agency[1].
2002/03 data; The National Production Waste Survey 2002/03. The Environment Agency[2].

9.23 Table 9.6 shows the range of possible waste arisings from the two surveys when taking the standard error into account. This shows that there is significant overlap between the two survey datasets indicating that the increase seen in 2002/03 is not statistically significant.

Table 9.6: Analysis of the manufacture of chemicals sector waste arisings, 1998/99 and 2002/03

Survey year	Estimated waste arisings (kt)	Standard error	Minimum waste arisings (kt)	Maximum waste arisings (kt)
1998/99	5,790	± 14.4%	4,960	6,620
2002/03	6,110	± 19.0%	4,950	7,270

Quantification of waste arisings

9.24 The quantification of waste arisings from this sector relies heavily on the 2002/03 Environment Agency Commercial and Industrial survey. The survey

[1] This survey reported waste arisings in the sector of 5.209 Mt for England and Wales only and hence was grossed up to UK level using the same methodology as above.

[2] This survey reported waste arisings in the sector of 5.257 Mt for England only. This was grossed up to UK level using the ratio of arisings from the sector for the 4 countries detailed in the 2004 report, namely England 86%, Wales 4%, Scotland 9% and Northern Ireland 1%.

sampled 5% of companies operating within the chemical sector (Appendix 6), which is considered a significant sample size. The estimated waste arisings shown in Table 9.7 (4.9 million tonnes) is lower than that of 1998/9 (5.8 million tonnes) and 2002/03 (6.1 million tonnes) due to a reduction in the number of companies operating in the sector (reducing from 11,765 in 2003 to 11,390 in 2006).

Table 9.7: Waste arisings in sector

3 digit SIC	Employment groupings	Mean weight per company in sample (2002/03)	No of companies in UK (2006)	Grossed up subtotal weights for subsector (kt)	Grossed up weight for subsector (kt)	% of total sector waste
241	1 to 9	58	595	35	2,009	40.9
	10 to 19	111	180	20		
	20 to 49	297	180	53		
	50 to 99	962	140	135		
	100 to 249	2,980	95	283		
	250+	37,086	40	1,483		
242	1 to 49	149	65	10	488	10.0
	49 to 250+	23,936	20	479		
243	1 to 99	257	565	145	185	3.8
	99 to 250+	892	45	40		
244	1 to 49	173	360	62	180	3.7
	50 to 249	387	65	25		
	250+	1,673	55	92		
245	1 to 49	134	555	74	205	4.2
	50 to 99	489	40	20		
	100 to 249	904	45	41		
	250+	1,763	40	71		
246	1 to 19	48	605	29	144	2.9
	20 to 49	80	120	10		
	50 to 99	349	75	26		
	100 to 249	724	50	36		
	250+	2,864	15	43		
247	No data		20	0	0	0
251	1 to 250+	1,343	750	1,007	1,007	20.5
252	1 to 19	19	4,755	91	689	14.0
	20 to 99	202	1,510	305		
	100 to 249	506	325	165		
	250+	1,617	80	129		
				Total waste arisings from the sector	**4,908kt**	**100%**

NB: SIC descriptions shown in Appendix 4.

9.25 Taking the standard error from the 2002/03 survey (±19%) the estimated mean waste arisings in 2006/07 ranges between 4.0 million tonnes and 5.8 million tonnes.

9.26 The 2002/03 EA data was used to develop the subgroup / band profiles, Table 9.8.

Table 9.8: Detailed analysis of the chemicals sector results

Employment groupings	Mean weight
241 (1-9)	58
241 (10-19)	111
241 (20-49)	297
241 (50-99)	962
241 (100-249)	2,980
241 (250+)	37,086
242 (1-49)	149
242 (50-250+)	23,936
243 (1-99)	257
243 (99-250+)	892
244 (1-49)	173
244 (50-249)	387
244 (250+)	1,673
245 (1-49)	134
245 (50-99)	489
245 (100-249)	904
245 (250+)	1,763
246 (1-19)	48
246 (20-49)	80
246 (50-99)	349
246 (100-249)	724
246 (250+)	2,864
251 (1-250+)	1,343
252 (1-19)	19
252 (20-99)	202
252 (100-249)	506
252 (250+)	1,617

Step 2. Map the case study data against the data in Step 1

9.27 This analysis was undertaken to assess the relative position of the case studies with respect to the mean waste arisings within each subgroup/employment band, determined in Step 1.

9.28 The data required from the case studies are:

- the SIC code for the company
- the number of employees working within the focus site
- waste consumption (pre-intervention)
- waste savings opportunity identified.

The Manufacture of Food and Drink

9.29 The Envirowise FastTrack scheme and ENWORKS were the two key datasets used to map the sample data onto the sector profiles. Although ENWORKS is a regional scheme it is focused in the north west of England where the greatest tonnage of food and drink waste arises (17% of food and drink waste from England and Wales, Appendix 2).

9.30 In total 221 food and drink company surveys undertaken since 2005 were examined and 61 contained all the information required to undertake the mapping process. The two most significant reasons for excluding surveys were the lack of baseline data, i.e. total waste arisings, and the focus on particular activities, e.g. many surveys focused on water only or did not investigate the potential in-process savings, simply advising on better waste management practices such as waste segregation.

9.31 Table 9.9 shows the results of the mapping process in terms of where the survey companies are positioned with respect to the subgroup / employment band mean waste arisings. It can be seen that 46 of the 61 survey companies (75%) produced less waste than the sector mean arisings prior to intervention, indicating that it is the better performing companies that often seek advice rather than the neediest.

Table 9.9: Distribution of food, drink and tobacco companies

	Performed better than the mean	Performed worst than the mean
Surveyed companies (number)	46	15
Surveyed companies (%)	75	25
Theoretical distribution (%)	50	50

The Manufacture of Chemicals, Plastic and Rubber

9.32 The Envirowise FastTrack scheme and ENWORKS were the two key datasets used. In total 159 chemical company surveys undertaken since 2005 were examined and 30 contained all the information required to undertake the mapping process. As in the case of the surveys undertaken within the food and drink sector, the two most significant reasons for excluding surveys were the lack of baseline data, i.e. total waste arisings, and the focus on particular areas of the plant, e.g. many surveys focused on water only or did not investigate the potential in-process savings instead advising on better waste management or office practices.

9.33 Table 9.10 shows the results of the mapping process in terms of the relative performance of the survey companies. It can be seen that 23 of the 30 survey companies (77%) performed better than average prior to intervention.

Table 9.10: Distribution of chemicals companies

	Performed better than the mean	Performed worst than the mean
Surveyed companies (number)	23	7
Surveyed companies (%)	77	23
Theoretical distribution (%)	50	50

Preliminary analysis conclusion

9.34 The analysis shows that more than three out of every four case studies (76%) focused on companies that can be regarded as better performing companies with respect to the subsector mean, Table 9.11. This suggests that the case studies cannot be regarded as a random sample and hence the mean waste savings in the case studies cannot be simply multiplied up to provide a grossed up sector value. Instead it was considered more appropriate to use the percentage savings within each case study and to test the robustness of the data using the coefficient of determination (R^2).

Table 9.11: Distribution of case study data.

Subsector	**Relative performance of case study companies (waste arisings)**	
	Below subsector / employment band mean	**Above subsector / employment band mean**
Food and drink	75%	25%
Chemicals, plastic and rubber	77%	23%
Total	76%	24%

10 Appendix 2: Regional waste arisings

Table 10.1: Regional analysis of the 1998/99 Environment Agency 2002/03 Commercial and Industrial waste survey data

Region	Waste arisings (kt)			
	Food, drink & tobacco	**Chemical**	**Plastic & rubber**	**Total industry**
East	769	336	139	3,652
East Midlands	852	251	140	5,919
South East	653	350	151	4,958
West Midlands	685	234	186	5,219
South West	808	113	118	2,914
North West	1,229	1037	205	6,475
Yorkshire and Humber	1,015	743	181	9,465
North East	330	405	74	3,761
London	525	186	63	2,740
Wales	338	214	83	4,978
Total	**7,204**	**3,869**	**1,340**	**50,081**

11 Appendix 3: Food and drink sector analysis

Table 11.1: Analysis of the food and drink companies surveyed for the Environment Agency 2002/03 Commercial and Industrial waste survey data

3 digit SIC	Description	Employment groupings	Companies in sample	No of companies in UK	% of total companies sampled
151	Production & processing of meat & poultry	1 to 9	14	635	2
		10 to 19	18	185	10
		20 to 49	13	210	6
		50 to 99	28	115	24
		100 to 249	28	110	25
		250+	40	120	33
152	Processing & preserving of fish & fish products	1 to 250+	14	430	3
153	Processing & preserving of fruit & vegetables	1 to 49	15	430	3
		50 to 99	13	35	37
		100 to 249	14	50	28
		250+	16	40	40
154	Manufacturing of vegetable & animal oils & fats	1 to 250+	12	60	20
155	Manufacturing of dairy products	1 to 19	21	460	5
		20 to 99	12	140	9
		100 to 250+	22	90	24
156	Manufacturing of grain mill products, starches & starch products	1 to 49	10	120	8
		50 to 250+	18	75	24
157	Manufacturing of prepared animal feed	1 to 250+	16	655	2
158	Manufacturing of other food products	1 to 9	24	2,995	1
		10 to 49	22	1,320	2
		50 to 99	13	215	6
		100 to 249	38	220	17
		250+	58	165	35
159	Manufacturing of beverages	1 to 9	12	575	2
		10 to 49	28	280	10
		50 to 99	21	65	32
		100 to 249	16	65	25
		250+	17	50	34
		Total	**573**	**9,950**	**6**

12 Appendix 4: Chemical sector analysis

Table 12.1: Analysis of the chemical companies surveyed for the Environment Agency 2002/03 Commercial and Industrial waste survey data

3 digit SIC	Description	Employment groupings	Companies in sample	No of companies in UK 2003	% of total companies sampled
241	Manufacture of basic chemicals	1-9	18	635	3
		10-19	19	180	11
		20-49	32	190	17
		50-99	34	140	24
		100-249	43	110	39
		250+	29	55	53
242	Manufacture of pesticides & other agro-chemical products	1-49	15	65	23
		49-250+	10	25	40
243	Manufacture of paints, varnishes & similar coatings, printing inks & mastic	1-99	27	640	4
		99-250+	29	45	64
244	Manufacture of pharmaceuticals, medicinal chemicals & botanical products	1-49	10	375	3
		50-249	12	80	15
		250+	27	70	39
245	Manufacture of soap & detergents, cleaning & polishing preparations, perfumes & toilet preparations	1-49	20	540	4
		50-99	14	45	31
		100-249	17	45	38
		250+	29	50	58
246	Manufacture of other chemical products	1-19	18	635	3
		20-49	13	115	11
		50-99	21	70	30
		100-249	20	40	50
		250+	12	25	48
247	Manufacture of man-made fibres	No data		25	0
251	Manufacture of rubber products	1-250+	15	815	2
252	Manufacture of plastic products	1-19	20	4,730	0
		20-99	22	1,615	1
		100-249	24	310	8
		250+	22	95	23
		Total	**572**	**11,765**	**5**

13 Appendix 5: Waste savings opportunities

13.1 Table 13.1 shows the total UK waste arisings in 2004 as reported to Eurostat in July 2006 as part of the EU Waste Statistics Regulation EC2150/2002. The Regulation requires member states to provide the European Commission with information on the generation, recovery and disposal of waste every two years. In total, 325 million tonnes of waste were generated in 2004. Construction (113 million tonnes) and mining and quarrying (94 million tonnes) accounted for over 63% of total waste.

Table 13.1: Total UK waste arisings, 2004

Sector code	Sector or subsector	Total tonnes (Mt)	% of total waste arisings
F	Construction	113.2	34.8
C	Mining & quarrying	93.9	28.9
G-Q	Services activities	39.4	12.1
HH	Waste generated by households activities & consumption	31.0	9.5
DA	Manufacture of food products, beverages & tobacco	7.8	2.4
E	Electricity, gas, steam & hot water & water supply	6.9	2.1
DJ	Manufacture of basic metal & fabricated metal products	5.7	1.8
DK+ DL+ DM	Manufacture of machinery & equipment + Manufacture of electrical & optical equipment + Manufacture of transport equipment	5.5	1.7
DG+ DH	Manufacture of chemicals, chemical products, man-made fibres + Manufacture of rubber & plastic products	5.5	1.7
DE	Manufacture of pulp, paper & paper products; Publishing & printing	4.1	1.3
37	Recycling	2.7	0.8
DI	Manufacture of other non-metallic mineral products	2.5	0.8
90	Sewage & refuse disposal, sanitation & similar activities	2.1	0.7
DD	Manufacture of wood & wood products	2.0	0.6
DB+DC	Manufacture of textiles + Manufacture of leather & leather products	0.9	0.3
DN	Manufacture not elsewhere classified (nec)	0.8	0.3
A	Agriculture	0.5	0.2
DF	Manufacture of coke, refined petroleum products & nuclear fuels	0.3	0.1
51.57	Wholesale of waste & scrap	0.3	0.1
B	Fishing	0.2	0.1
	Total	**325.3**	

Source: EU Waste Statistics Regulation (EC 2150/2002) report 2004, UK. Defra July 2006.Basic metals

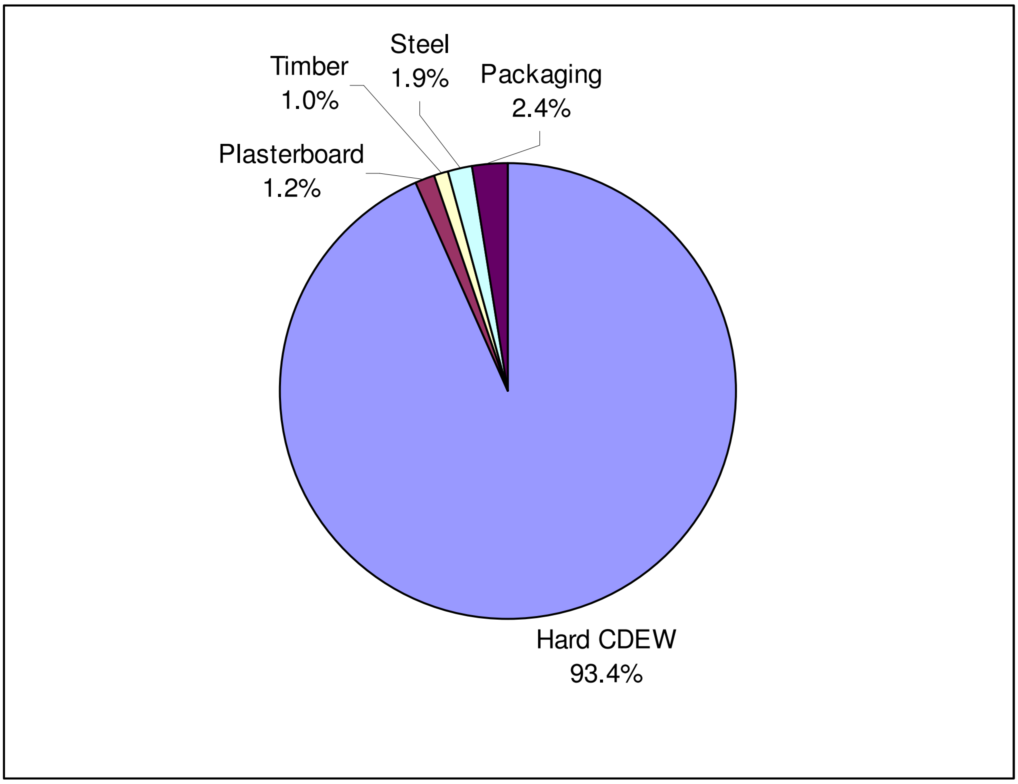
The industrial sector

The construction sector

Background

13.2 Unfortunately, there is limited published data available to determine the split of waste arisings[1] between subsectors (construction, demolition and refurbishment) and hence it is difficult to analyse waste at a subsector level. However, it is possible to analyse the waste composition. Figure 13.1 shows the composition of construction, demolition, and excavation waste (CDEW). This shows that hard CDEW accounts for 93% of the waste generated by the sector and hence this will be a major focus of this section.

Figure 13.1: Composition of construction waste



[1] WRAP – WAS7-001 Final report on waste management quick wins. July 2006.

Quantification of waste savings opportunities

13.3 Table 13.2 summarises the waste management methods used for each waste stream. This shows that 53.6 million tonnes, or 50.9%, of waste generated is recycled with a further 18.5 million tonnes, or 17.6%, exempt, i.e. re-used.

Table 13.2: Waste arisings from construction sector

	Total waste arisings (Mt)	Recycled (Mt)	Landfilled (Mt)	Exempt (Mt)	Burned (Mt)
Hard CDEW	98.3	49.2	30.7	18.5	
Plasterboard	1.3	0.4	0.9		
Timber	1.1	0.6	0.2		0.4
Steel	2.0	1.9	0.1		
Non-ferrous metals	0.02	0.02			
Packaging	2.5	1.4	1.1		
Total	**105.2**	**53.6**	**33.0**	**18.5**	**0.4**

Source: WAS7-001 Final Report on Waste Management Quick Wins. WRAP 2007

Hard CDEW

13.4 Due to the nature of the hard CDEW, opportunities for minimising the waste "at source" through short to medium term intervention are modest. However, the WRAP "Quick Wins" study reported that an estimated 75% of all inert wastes in the UK can be described as being recovered for real applications, on the basis of the following assumptions:

- that 49.2 million tonnes or 50% of CDEW is currently recycled.
- that one half (15.35 million tonnes or 15.6% of hard CDEW waste) of waste sent to landfill (30.7 million tonnes or 31.2%) is actually used for "real" engineering, cover and site restoration applications
- that one half of the material sent for re-use in exempt activities is actually landfilled by another name; leaving 9.3 million tonnes or 9.5% re-used.

13.5 The Quick Win study continues that 95% of inert waste can be recovered through good practice (quick wins). Since Table 13.2 reports waste arisings of inert material at 98.3 million tonnes the savings through the realisation of these quick wins, increasing recovery from its current level of 75% to 95%, equates to 19.66 million tonnes.

Other materials

13.6 'New build' represents the area of greatest resource efficiency opportunity due to the quantity of material being used. In the consultation on site waste management plans it is reported that[1]:

"In England and Wales, the construction sector uses some 400 million tonnes of materials each year and generates an estimated 109 million tonnes of waste. It is estimated that 13% of all materials delivered to site go into skips without ever being used. The potential for greater resource efficiency is therefore considerable"

13.7 Through their Smartstart benchmarking model BRE has estimated that the full adoption of current best practice would result in a 15% waste saving. In addition, BRE has produced a future best practice target, set at 50%. Table 13.3 summarises the projected savings. The waste volume figures shown can be converted to tonnes using BRE conversion factors initially developed by the Environment Agency[2]. Using these conversion factors the total waste arisings of 7.6 million m^3 shown in Table 13.3 equates to 4.7 million tonnes; the 15% savings opportunity (1.1Mm^3) equates to 0.7Mt; and the 50% savings (3.8Mm^3) to 2.3Mt.

[1] Consultation on site waste management plans for the construction industry. April 2007. Defra

[2] BRE Developing a strategic approach to construction waste, 2006.

Table 13.3: Construction sector waste arisings by project type

Project type[1]	Value (2006) (£bn)[2]	KPI converter[3]	Waste arising (Mm^3)	Current best practice savings @ 15% (Mm^3)[4]	Future best practice savings @ 50% (Mm^3)[5]
Residential	23.0	12.36	2.8	0.4	1.4
Civil engineering	6.5	16.98	1.1	0.2	0.6
Commercial offices	6.9	12.25	0.9	0.1	0.4
Industrial buildings	5.0	16.45	0.8	0.1	0.4
Commercial retail (inc leisure)	8.9	8.52	0.8	0.1	0.4
Education	7.9	9.15	0.7	0.1	0.4
Healthcare	3.0	7.56	0.2	0.03	0.1
Public buildings	1.1	19.11	0.2	0.03	0.1
Total	**62.4**		**7.6**	**1.1**	**3.8**

13.8 The current and future best practices have been applied to all new builds in Table 13.3. This was applied after estimating how many sites are currently achieving best practice in each product type to determine whether such savings are realistic across the whole sector. This was achieved by statistical means, by determining the Z score at 15% and at 50% of the current mean (KPI). For example, for the residential sector, Table 13.3 shows a mean of 12.36 so that a 15% improvement would therefore shift the mean to 10.51. Dividing the shift in mean (1.85) by the standard deviation (7.14) produces a Z-score of 0.26. Using Z-score statistical tables, 0.26 equates to 39.7%, i.e. according to the Smartstart data 39.7% of the sector currently performs better than the 10.51, indicating that the saving is realistic.

13.9 Table 13.4 shows the results of the Z score analysis. The table shows that current best practice is being achieved by over 30% of sites in all product types and hence was deemed realistic i.e. is more representative of current good practice than best practice. For the future best practice target of a 50% reduction in waste the results were more varied, ranging from 6% of new

[1] NB: the classification of project types as used by BERR does not correspond to that of BRE and hence for the purpose of this study it was necessary to reclassify the BERR data into the BRE format.

[2] BERR quarterly construction statistics, Q4 2006

[3] BRE Private Communication May 2007.

[4] BRE Developing a Strategic Approach to Construction Waste, 2006

[5] BRE Developing a Strategic Approach to Construction Waste, 2006

builds in the education sector to 32% of industrial buildings. It does however indicate that such savings are achievable in all sectors.

Table 13.4: Results of Z score analysis

Project type	KPI	Standard deviation[1]	% of sites working to current best practice	% of sites working to future best practice
Residential	12.36	7.14	39.7	19.2
Civil engineering	16.98	6.81	35.6	10.6
Commercial offices	12.25	8.80	41.7	25.1
Industrial buildings	16.45	18.05	44.4	32.3
Commercial retail (inc leisure)	8.52	3.51	35.9	11.3
Education	9.15	3.03	32.6	6.5
Healthcare	7.56	2.67	33.7	7.8
Public buildings	19.11	13.79	41.7	24.5

Valuation of waste savings

13.10 In 2001, CIRIA reported in a guidance document that[2]:

"The demonstration projects in this guidance show that it is perfectly feasible to halve the waste that is produced on most building projects. If this were achieved throughout the building construction industry in the UK, then the full waste cost savings could be in the order of £400 million. Savings in the full cost take account of the purchase costs of materials, its transport to the site and its storage, as well as the direct waste disposal costs."

13.11 The average cost of waste disposal is material specific and hence separate calculations were undertaken for inert waste savings and for other wastes.

Inert waste savings

13.12 The WRAP Quick Win study reported that once the labour cost associated with segregating and processing the recovered material is taken into account the saving equates to £10.80 per tonne. Therefore, the 19.66 million tonnes savings opportunity, identified above, equates to a financial saving of £212 million.

[1] BRE Private Communication May 2007.

[2] CIRIA C536. Demonstrating waste minimisation benefits in construction. S Coventry, B Shorter and M Kingsley. London 2001.

Other waste savings

13.13 The consultation on site waste management plans report “typical commercial waste disposal costs are presently between £12 and £38 per tonne”. This takes into consideration both the material that is recovered and that which is disposed of, primarily to landfill using mixed skips. The mean of £25 is in line with Amec estimates of £22 per tonne. In this study £25 per tonne was used.

13.14 The waste savings in disposal costs therefore range from £17.7 million with a 15% saving to £56.5 million with a 50% saving. Table 13.5 summarises the waste disposal savings in the construction sector assuming that the 15% savings opportunity in “other waste savings” represents the low-cost / no-cost opportunities.

Table 13.5: Total construction sector resource efficiency waste disposal savings

Material	**Waste disposal savings (excluding hidden cost savings) (£M)**
Inert waste	212.3
Other waste	17.7
Total	**£230.0M**

Hidden savings

13.15 The savings in inert waste cannot be regarded as in-process savings rather they are the savings associated with improved waste management and hence no hidden savings have been attributed.

13.16 The savings in “other waste” represent a combination of in-process and waste management savings and hence hidden savings will be made in the in-process component of these. The hidden savings will include those in raw material expenditure, labour associated with waste handling etc. However, to determine the hidden savings it is necessary to identify the material types being saved since this clearly has a significant bearing on the level of raw material savings. Metal represents a significant raw material cost but a review of case studies showed this to seldom be cited as a significant in-process saving. Instead most case studies refer to less expensive materials such as gypsum (plasterboard – utilisation of offcuts, custom boards, etc), timber (pallets reuse, custom timbers), inert materials (brick rubble – on site reuse) or packaging (increasing the use of reusable packaging).

13.17 Minimising waste does not automatically result in a reduction in raw material costs. For example, discounts are often offered if plasterboard is purchased by the full pallet load and hence reducing plasterboard use by 2 or 3 sheets may not impact on the price paid per board. Additionally, packaging is often an embedded cost and hence reducing packaging may not result in a price reduction. For the purposes of this study it was assumed that the hidden savings associated with the in-process improvements are equivalent to the waste disposal costs, i.e. £25 per tonne.

13.18 Additionally, it is assumed that the split between in-process and waste management savings is 50:50. Table 13.6 shows the estimate of the total resource efficiency savings opportunity within the construction sector.

Table 13.6: Total construction sector resource efficiency waste disposal savings

	Waste disposal savings (excluding hidden cost savings) (£M)	**Total savings (including hidden savings) (£M)**
Inert waste	212.3	212.3
Other waste	17.7	26.6
Total	**£230.0M**	**£238.9M**

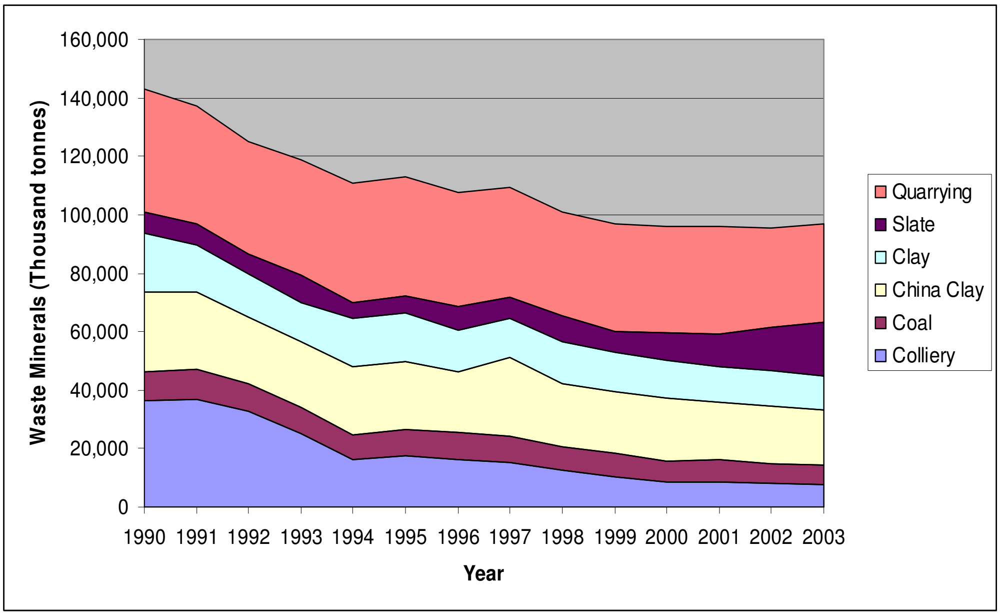
The mining and quarrying sector

Background

13.19 Figure 13.2 shows that annual minerals waste arisings in the UK have decreased by 32% from 1990-2003. This is due in particular to:

- colliery waste arisings decreasing by 79%
- clay waste arisings decreasing by 39%
- coal waste arisings decreasing by 37%.

Figure 13.2: Minerals waste arisings within the mining sector



Quantification of waste savings opportunity

13.20 Mineral Industry Services[1] reports that much like the construction sector, mining and quarrying is made up predominantly of inert materials (95% of total) which in their nature cannot be minimised.

13.21 Mineral Industry Services reports that the waste can be split into three main categories as follows:

[1] Peter Huxtable, Mineral Industry Services, Personal Communication, September 2007.

- **Extraction products:** Overburden and topsoil are the classic for surface operations. These materials are mainly used for eventual restoration, and are often stored in a manner to give some screening, bunding and landscape enhancement in the interim period. Surplus materials are either left underground or in the quarry or markets are sought to sell them at a low value. There has been an increase in these materials since the introduction of the aggregates tax in 2002 as they are now subject to a levy in excess of the market value.

- **Processed products – aggregates:** These are largely scalpings and chatter and silts etc from quarrying and subsequent crushing and washing operations which do not meet full product specifications. Again the aggregates tax has made many of these products less attractive for the same reasons as stated above. There has been considerable use of these materials for various applications - there is no shortage of technology, but market value is the key. For industrial minerals and coal with simple processing (crushing and washing) this is also true - but the aggregates can be sold free of tax so this has increased saleability from china clay, slate waste etc. This is a smaller portion of the quoted volume.

- **Processed products – other:** For many industrial minerals and coal (as for metalliferous ores in the past) there is the need to fine grind and in some cases have a flotation process to produce the finished products - which generates fine tailings which are either stored in process lagoons, or filtered and disposed of in a solid form. This produces very low volumes of material a year. In many cases, either as a dried-out material or filtercake, this is used for restoration / landform etc.

13.22 The British Geological Survey (BGS) reports[1] that “processed products” represents the major savings opportunity in terms of the improved utilisation of “fines”. Fines currently account for 25% of sandstone production and 20% of sand and gravel, limestone and dolomite, igneous rock and chalk production. Table 13.7 shows the weight of fines being generated and BGS reports that 15% of these fines are fit for purpose. It is therefore estimated that a further 4.85 million tonnes can be sold as marketable material.

[1] Clive Mitchell, British Geological Survey. Personal Communication September 2007.

Table 13.7: Analysis of UK fines

Material	Total quarry fines (Mt)	Marketable filler grade quarry fines @ 15% of fines, excluding limestone (Mt)
Sand and gravel	15.4	2.31
Limestone & dolomite	18.0	0
Igneous rock	10.8	1.62
Sandstone	4.8	0.71
Chalk	1.4	0.21
Total	**50.4**	**4.85**

Valuation of waste savings

13.23 Table 13.8 shows the analysis of resource savings from the improved utilisation of fines based on 2005 market prices. This shows material savings opportunities of £39.8 million.

Table 13.8: Analysis of resource savings from the improved utilisation of fines

Material	Sales (£M)	Production (Mt)	Price per tonne (£)	Marketable filler grade quarry fines @ 15% of fines, excluding limestone (Mt)	Material savings (£M)
Sand & gravel	746	77	9.7	2.31	22.38
Limestone & dolomite	687	90	7.6		0
Igneous rock	335	54	6.2	1.62	10.05
Sandstone	146	19	7.7	0.71	5.48
Chalk	112	7	16.0	0.21	3.36
Total	**2,026**	**247**	**8.2**	**4.85**	**41.27**

13.24 No hidden savings are applied since the savings are associated with a change in waste management protocol rather than an in-process improvement.

The food, drink and tobacco sectors

13.25 This subsector was the focus of the preliminary analysis and hence the first steps of the valuation are shown in Appendix 1.

Quantification of waste savings

13.26 Table 13.9 shows the analysis of the case study data. These sectors account for 74.5% of the sector waste arisings. The seven subgroups in Table 13.9 with an R^2 value greater than 0.7 accounts for 47.3% of sector waste and the four subgroups with an R^2 value below 0.7 accounts for 27%. For the subgroups showing a strong R^2 value a linear trend was assumed to gross up the data. Grossing up entailed multiplying the equation of the line by the mean waste arisings. For example, in the case of SIC 158 (employment band 250+) the equation of the line is 0.1697x and the mean waste arisings is 7,150 tonnes (Appendix 1) and hence the mean savings opportunity per company is 1,213 tonnes. This can be grossed up to subgroup level by multiplying the mean waste arisings by the number of companies working in the subgroup (155 companies in 2006) generating a total waste savings figure of 188,000 tonnes.

Table 13.9: Test of reliability of data for food, drink and tobacco sector

SIC / Employment band	Coefficient of determination (R^2)	Trend line equation	% of sector waste
158 (250+)	0.8827	0.1697x	12.4
158 (100 to 249)	0.2312	0.0419x	13.4
151 (250+)	0.9545	0.2764x	9.3
155 (100 to 250+)	0.7339	0.196x	4.8
153 (100 to 249)	0.8485	0.3177x	3.8
158 (10 to 49)	0.8015	0.3119x	2.5
154 (1 to 250+)	0.3638	0.1891x	0.8
155(20 to 99)	0.8046	0.3153x	0.5
157 (1 to 250+)	0.2546	0.1856x	6.9
152 (1 to 250+)	0.6543	0.0852x	5.8
151 (50 to 249)	0.9998	0.0902x	14.0

NB: for the coefficient of determination the closer to "1" the stronger the correlation between an increase in waste arisings and an increase in waste savings opportunity.
NB: Appendix 3 describes the SIC codes.

13.27 Table 13.10 shows the estimated total waste savings opportunities within these subgroups to be 815,000 tonnes. Since these subgroups represent nearly half of all waste arisings from the sector (47.3%) it was considered appropriate to gross up to population level based on these findings. The projected waste savings opportunity is therefore 1.7 million tonnes. Taking the standard error of ±9.6% into account, the estimate of waste savings ranges from 1.5 million tonnes to 1.9 million tonnes or 17 to 21% of total waste arisings (8.97 million tonnes). This is in line with the findings from the Food Industries Sustainability Strategy waste champions group[1] who reported a waste savings opportunity of 15 to 20% by 2010.

Table 13.10: Waste saving opportunities

SIC/Employment groupings	Mean waste arisings (t)	Trend line multiplier	Mean waste savings (t)	No of companies in UK (2006)	Total waste savings (t)
158 (250+)	7,150	0.1697	1,213	155	188,073
151 (50-249)	6,453	0.0902	582	195	113,502
151 (250+)	7,247	0.2764	2,003	115	230,363
153 (100-249)	7,562	0.3084	2,332	45	104,946
155 (100-250+)	4,516	0.1960	885	95	84,083
158 (10-49)	182	0.3119	57	1,230	69,744
155 (20-99)	373	0.3153	117	115	13,510
				Total	**815,026**

Valuation of waste savings

13.28 Yorkshire Forward report[2] that many of the region's food and drink companies are using the Envirowise estimate for the total cost of waste of £500 per tonne, with the cost of waste management being £55 per tonne. These figures were deemed reasonable by the chairperson of the FISS waste champions group[3] and by Defra[4]. Case studies also showed examples where such savings would be made. For example, optimising (increasing) the size of raw material delivery units in line with the needs of production (bulk

[1] Food Industries Sustainability Strategy waste champions group. Final Report. Defra May 2007.

[2] www.recyclingaction-yorkshire.org.uk/site/viewsection.php?id=192 Accessed May 2007.

[3] Gus Atri, Northern Foods, Private Communication. August 2007.

[4] Christina Goodacre, Defra, Private Communication. August 2007.

packing) was found to result in modest savings in packaging waste but significant labour savings and improvements in productivity.

13.29 Table 13.11 shows the valuation of the savings in resource efficiency from the food and drink sector. This shows the waste savings opportunities in the food, drink and tobacco sector to equate to £755m - £940m.

Table 13.11: Summary of savings in the food, drink and tobacco sector

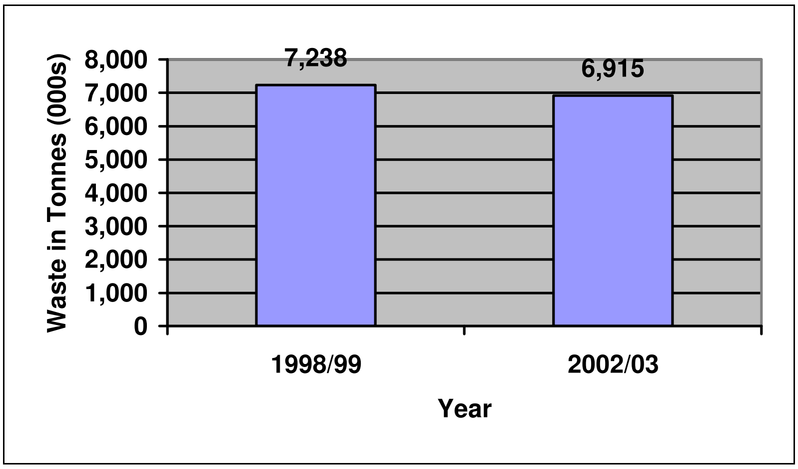
	Waste savings (Mt)	**Waste disposal savings @ £55/t (£M)**	**Total waste savings @ £500/t (£M)**
Minimum	1.55	85.3	775.5
Mean	1.72	94.4	857.9
Maximum	1.88	103.4	940.3

The electricity, gas, steam and hot water and water supply sectors

Background

13.30 Figure 13.3 shows the estimated waste arisings from this sector in 2002/03 and 2004/05. This shows that mean waste arisings dropped by over 300,000 tonnes between the two datasets. However, when taking the standard error of the surveys into consideration (Table 13.12) it can be seen that the change is not statistically significant, i.e. there is significant overlap in the data ranges of the two datasets.

Figure 13.3: Waste arisings in electricity, gas, steam and water supply sector



Source: Defra[1].

Table 13.12: Analysis of electricity, gas, steam and water supply sector waste arisings 2002/03 and 2004/05

Data year	Estimated waste arisings (kt)	Standard error[2]	Minimum waste arisings (kt)	Maximum waste arisings (kt)
2002/03	7,240	±31.3	4,970	9,500
2004/05	6,920	±31.3	4,750	9,080

[1] Figures for England only have been grossed up to UK level using the ratio of arisings for the 4 countries as detailed in the EU waste statistics regulation (EC2150/2002) UK 2004 report by Defra July 2006, namely England 78.5%, Wales 4%, Scotland 15.1% and Northern Ireland 2.4%.

[2] The same standard error was used in the two data years since the 2004 data was an extrapolation of the 2002/03 survey data.

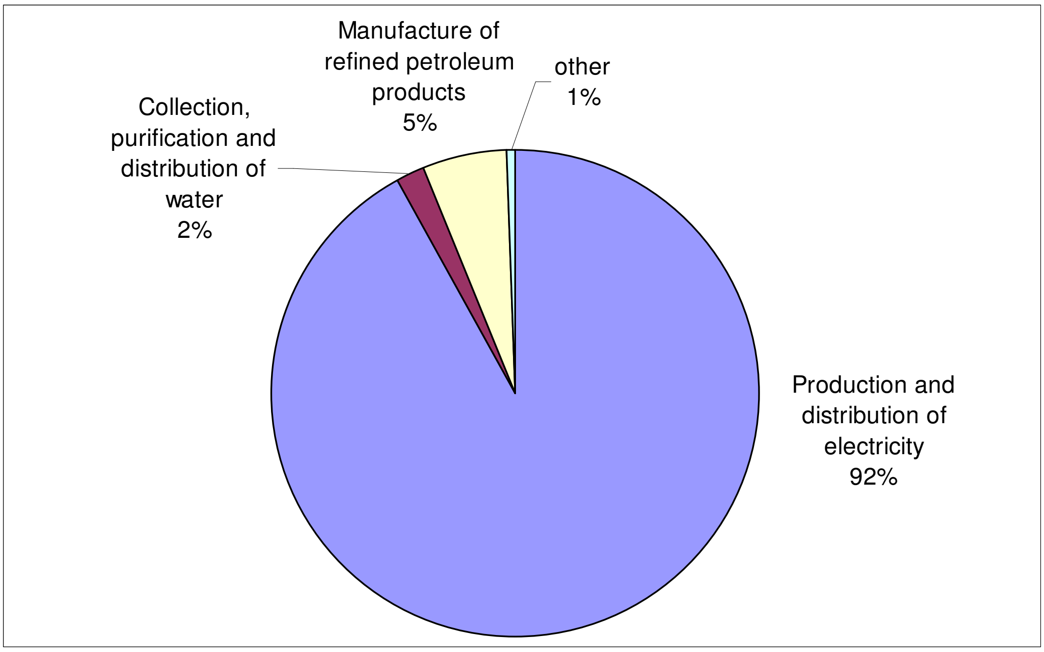
13.31 Table 13.13 shows the projection of the data to 2006/07. This shows the estimated mean waste arisings in 2006/07 to be 6.6 million tonnes.

Table 13.13: Projection of electricity, gas, steam and water supply waste arisings to 2006/07

Survey year	Minimum waste arisings (Mt)	Mean waste arisings (Mt)	Maximum waste arisings (Mt)
2002/03	4.97	7.24	9.50
2004/05	4.75	6.92	9.08
2006/07	4.53	6.59	8.66

13.32 Figure 13.4 shows the breakdown of waste arisings from this sector as reported in the 2002/03 Environment Agency C&I Survey. This shows that the waste generated from the "production and distribution of electricity" accounts for 92% of the total sector waste and is therefore the focus of this sector.

Figure 13.4 Waste arisings from the electricity, gas, steam and hot water and water supply sectors



Quantification of waste savings opportunity

13.33 The Association of Electricity Producers (AEPUK) report the major waste product generated from coal-fired power stations to be ash. The nature of the process makes it extremely difficult to minimise the ash and hence efforts have focused on the recovery of this waste rather than waste reduction.

13.34 The UK Quality Ash Association (UKQAA) estimates that 6.8 million tonnes pa of ash is produced by electricity producers of which 5.8 is fly ash and 1.0 is bottom ash.

Fly ash

13.35 Currently, approximately 31% (1.8 million tonnes) of fly ash is landfilled and another .83 million tonnes of ash is used in landfill reclamation. According to UKQAA, it is possible to use all the material that is currently landfilled. Barriers to utilisation range from distance to end market, i.e. distance between a prospective market and the power plant, to variations in quality of material. Dr Lindor Sear from the UKQAA believes that these barriers are not insurmountable and that, in principle, all fly ash produced from UK power stations can be utilised. Accordingly there is an opportunity to divert 1.8 million tonnes pa of fly ash from landfill.

Bottom ash

13.36 The UK coal-fired power stations use a technique known as “wet bottom” furnaces, in which the ash is flushed from the furnace using water. This means that the bottom ash is washed in water making it suitable for use as an aggregate[1]. As a result, all bottom ash is utilised in aerated block production and, in fact, there is a market deficit for this material that forces block manufacturers to import material.

13.37 The waste savings opportunity therefore equates to the 1.8 million tonnes pa of fly ash that can be diverted from landfill.

Valuation of waste savings

13.38 AEPUK report[2] that the draft Financial Impact Assessment (FIA) on PFA (pulverised fuel ash) produced by the Environment Agency includes an assessment of the average amount paid for PFA, which is £20 per tonne including transport costs. Therefore, based on 1.8 million tonnes pa, the savings opportunity is £36 million.

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[1] www.sustainableconcrete.org.uk/main.asp?page=41 Accessed September 2007

[2] Andy Limbrick, AEPUK, Personal communication. August 2007.

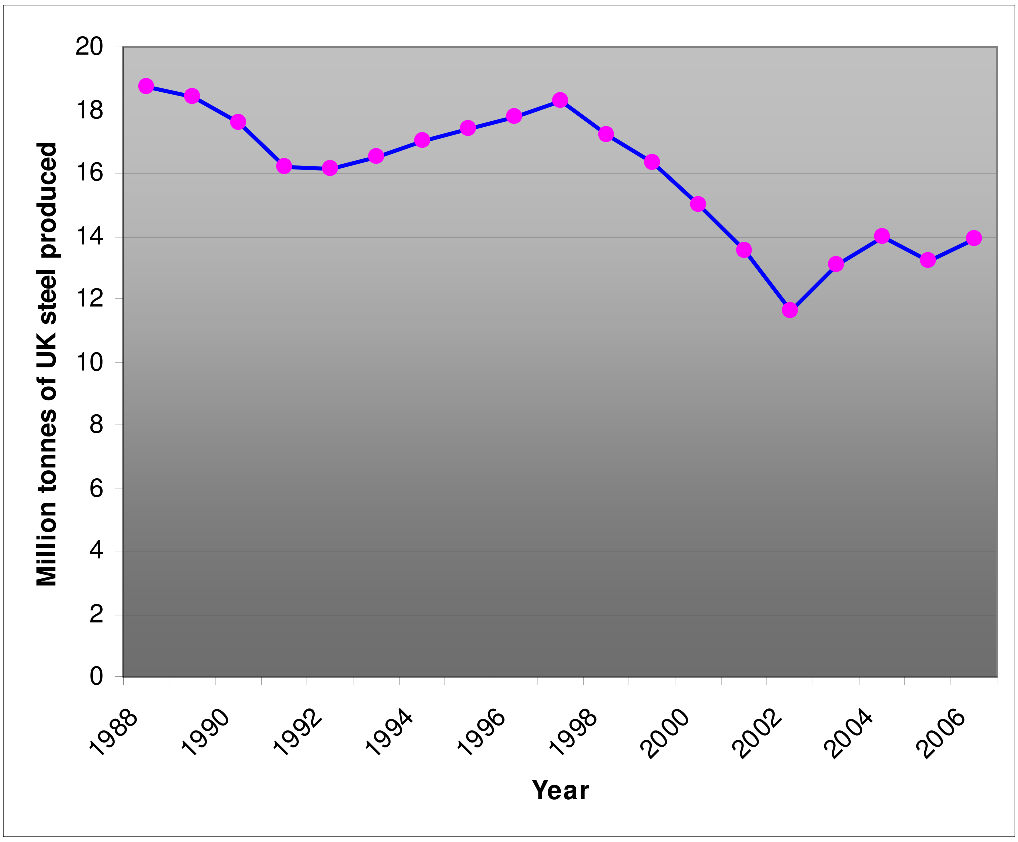
13.39 Additionally, the FIA reports that there are hidden savings associated with the elimination of the need for generators to maintain their landfill sites (£3 per tonne) and the avoided Landfill Tax (£2 per tonne). Taking the hidden savings into consideration, the savings opportunity equates to £45 million.

The manufacture of basic metal and fabricated metal products

Background

13.40 In the 2004 Defra report to Europe it was estimated that this sector accounted for 5.7 million tonnes of waste or 2.25% of UK controlled waste arisings, Appendix 5. The production output for 2004 and 2006 from the most significant waste generating subsector, steel production, was very similar (Figure 13.5) and hence it is assumed that the waste arisings from the sector will not have changed significantly between 2004 and 2006.

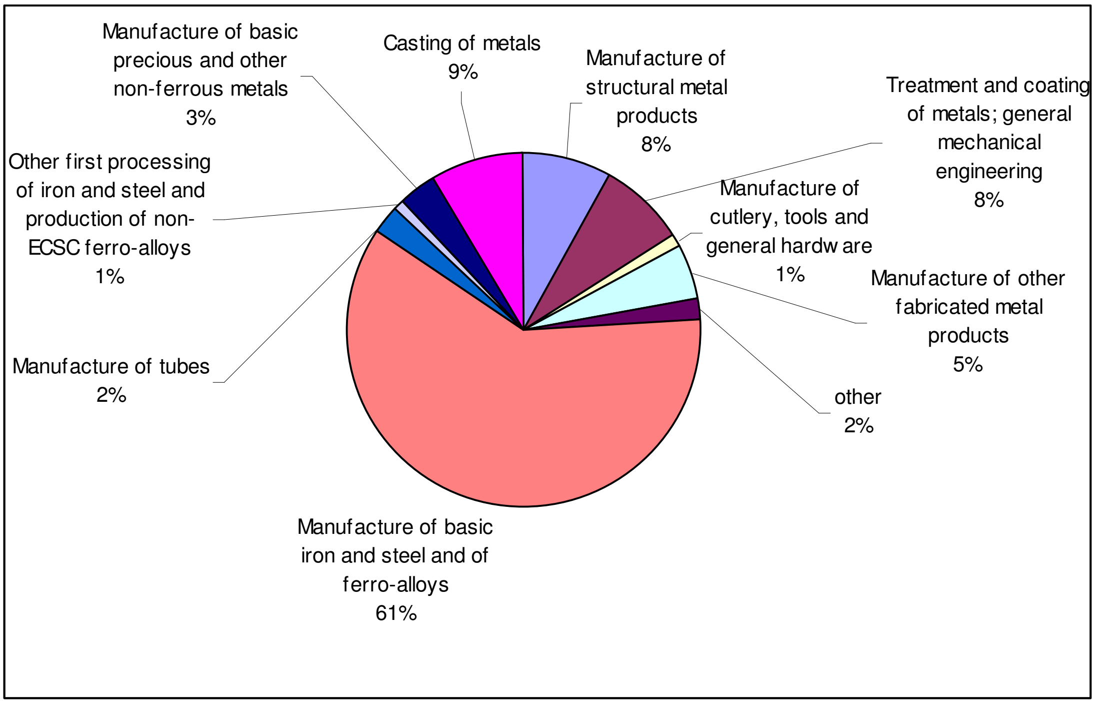
Figure 13.5: UK steel production 1998 to 2006



13.41 Figure 13.6 shows the detailed breakdown of waste arisings by subsector as estimated in the 2002/03 EA C&I waste survey. This shows that the manufacture of basic iron and steel and of ferro alloys accounted for 61% of total waste arisings from the sector, with the castings of metals (9%), manufacture of structural metal products (8%) and the treatment and coating of metals: general mechanical engineering (8%) accounting for a further 25%.

This section will focus on the waste savings opportunity within these four sectors, accounting for 86% of total sector waste arisings.

Figure 13.6: Waste arisings in the basic metals sector



Quantification of waste savings opportunity

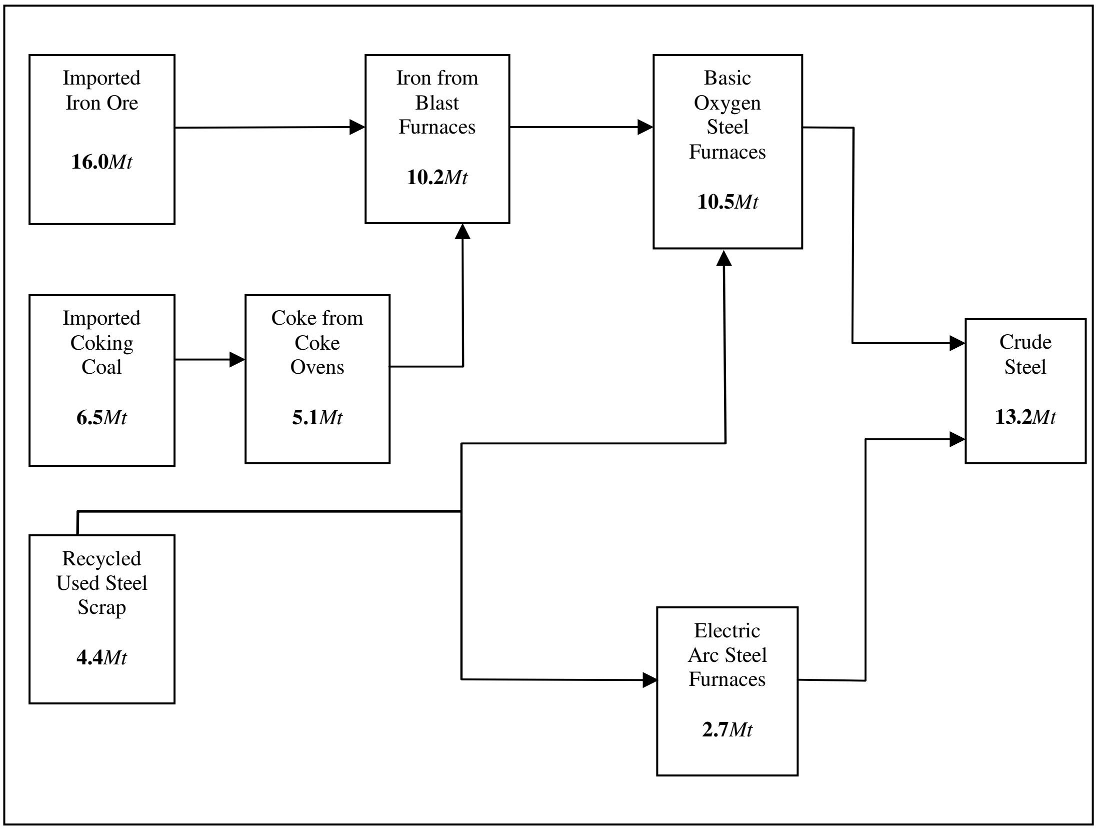
The manufacture of basic iron and steel and of ferro alloys

13.42 Figure 13.7 shows a schematic of the steel making process. This shows that 26.9 million tonnes of raw material is used to produce 13.2 million tonnes of crude steel. This would appear to show that yield losses are significant, however, a report into the material flows of iron, steel and aluminium in 2004 reported that:

"Over the time period studied, the UK iron and steel industry has improved the efficiency with which it uses materials and energy inputs substantially. In relative terms, fewer inputs are needed per unit of output now compared to 30 years ago. Between 1968 and 2001, the amount of crude steel produced from a tonne of material inputs increased by 6% to 830kg. These improvements are related to the gradual closure of old plants and the uptake of continuous casting techniques."[1]

[1] Iron, Steel and Aluminium in the UK: Material flows and their economic dimensions. Final Project Report, March 2004. Policy Studies Institute, London and Centre for Environmental Strategy, University of Surrey.

Figure 13.7. A flow diagram of UK steel production



Source: UK Steel

13.43 Figure 13.7 also shows that the blast furnace operation represents a significant producer of waste since 16 million tonnes of iron ore and 5.1 million tonnes of coke are used to produce 10.2 million tonnes of iron. Blast Furnace Slag (BFS) is a major solid waste stream from blast furnaces alongside the carbon dioxide generated through the carbonation of the limestone. UK production of BFS originates from three remaining integrated steel making facilities in the UK. These are all owned by Corus UK Ltd and located at Teesside, Scunthorpe and Port Talbot. Currently, together the three plants typically produce around 3 million tonnes of BFS annually, down from approximately 4.3 million tonnes in 2002[1].

13.44 The waste status of BFS has been disputed for a number of years and in February 2007 the EU Commission published an Interactive Communication on waste and by-products, which gave BFS as a possible example of a by-product:

"BFS is produced in parallel with hot iron in a blast furnace. The production

[1] Waste Protocols Project. Blast Furnace Slag: A technical report on the manufacturing of blast furnace slag and material status in the UK. WRAP and the Environment Agency. 2007

process of the iron is adapted to ensure that the slag has the requisite technical qualities. A technical choice is made at the start of the production process that determines the type of slag that is produced. Moreover, use of the slag is certain in a number of clearly defined end uses, and demand is high. BFS can be used directly at the end of the production process, without further processing that is an integral part of this production process. This material can therefore be considered to fall outside of the definition of waste"[1]

13.45 A subsequent technical report produced as part of the Waste Protocols Project[2] was used as evidence that BFS was a by-product and not a waste and the Environment Agency reported that[3]:
"Having considered the content of the technical report on the production and use of blast furnace slag in light of the Commission Communication, the Environment Agency is now satisfied that BFS produced in the UK as Air Cooled Blast Furnace Slag (ACBFS) or Ground Granulated Blast Furnace Slag (GGBFS) is not a waste".

13.46 This clearly has a major impact on the "waste" generated by the basic metals sector. The technical report stresses that:
"Approximately 75 per cent of BFS production in the UK is converted into ground granulated BFS (GGBFS) and the remainder into air-cooled BFS (ACBFS). Virtually all GGBFS produced is for sale to the UK concrete market, whereas ACBFS is crushed and screened for UK aggregate sales".

13.47 Table 13.14 shows that the residues generated from the manufacture of iron and steel and the disposal routes taken. This shows that 2.8 million tonnes of residue were either sold (2.3 million tonnes) or reused (0.5 million tonnes) generating a revenue of £19.9 million. It also shows that 0.8 million tonnes were sent to landfill, with basic oxygen furnace slag accounting for 33% and electric arc furnace slag 32.5% of total waste sent to landfill. Table 13.14 shows that significant volumes of both slags are currently sold, and research has been undertaken investigating the end markets for these wastes. For example, the US Department of Energy funded a study into the "recycling and reuse of basic oxygen furnace (BOF) and basic oxygen process (BOP)

[1] Brussels 21.2.2007 COM (2007) 59 final, p11, Annex 1 – examples of waste and non-waste.

[2] A joint Environment Agency and Waste & Resources Action Programme (WRAP) initiative, funded by the Defra BREW programme.

[3] Environment Agency. Regulatory Position Statement: Blast Furnace Slag as a by-product. August 2007

steelmaking slags"[1], and research has been undertaken on the use of "electric arc furnace slag in concrete"[2] . Increasing the diversion from landfill of these wastes is considered a significant savings opportunity. Based on this it is assumed that 20% of these wastes can be diverted from landfill representing a savings opportunity of 103,000 tonnes.

Table 13.14: An analysis of residue waste management in the manufacture of iron and steel

Material	**Sold**		**Reused**		**Landfilled**	
	t	**£**	**t**	**£**	**t**	**£**
Sinter plant						
Dust			9,240			
Sludge			3,080			
Coke oven plant						
Benzene	22,100	4,421,760				
Tar	230	30,040				
Sulphur			4,150			
Sulphuric acid			11,050			
Ammonium sulphate			4,700			
Blast furnace						
BF slags	2,013,120	14,091,810			41,080	-739,510
Dust			66,760			
Rubble					143,790	-2,588,290
Sludge					30,810	-862,760
Basic oxygen furnace						
Slag	191,680	958,390	277,460		260,900	-4,696,270
Dust			13,560		1,850	-51,770
Mill scale			8,220			
Spittings			12,330			
Rubble					8,220	-147,900
Electric arc furnace						
Slag	83,900	419,490	60,880		253,650	-4,565,760
Dust					32,720	-916,160
Refractory bricks					6,540	-183,230
Total	**2,311,030**	**19,921,490**	**471,430**		**779,580**	**14,751,660**

Source: Iron, Steel and Aluminium in the UK: Material flows and their economic dimensions. Final Project Report, March 2004. Policy Studies Institute, London and Centre for Environmental Strategy, University of Surrey.

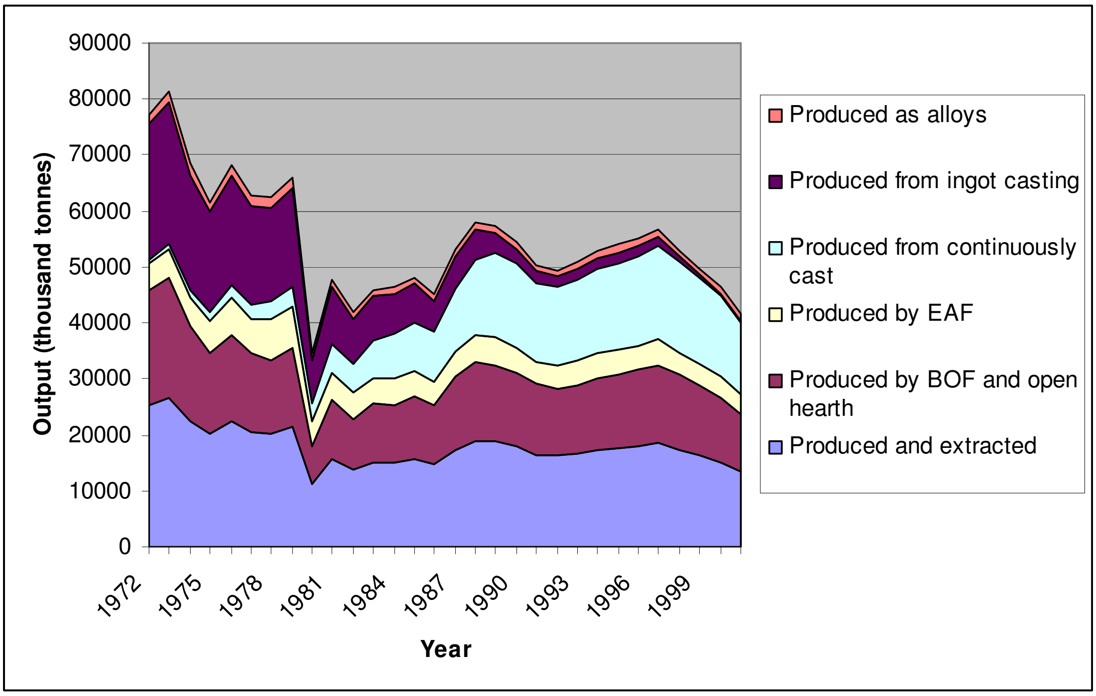
[1] Recycling and reuse of basic oxygen furnace (BOF) and basic oxygen process (BOP) steelmaking slags. Office of Industrial Technologies. Energy efficiency and renewable energy. US Department of Energy.

[2] Electric arc furnace slag in concrete. Journal of materials in civil engineering. Vol 16 No6 Nov/Dec 2004.

The casting of metals

13.48 Figure 13.8 shows the technologies used in the casting of metals. This shows that the methods have changed considerably since 1972 with castings produced from ingots and to a lesser extent BOF and open hearth castings making way for the more efficient continuous casting (yield rate increase of 10 to 15%).

Figure 13.8: Technology trends in the casting of metals



Source: Iron, Steel and Aluminium in the UK: Material flows and their economic dimensions. Final Project Report, March 2004. Policy Studies Institute, London and Centre for Environmental Strategy, University of Surrey.

13.49 The Cast Metals Federation (CMF) reports[1] that the primary types of waste generated by the industry are used sand, which may contain a chemical binder (usually phenolic resin) and slag from the melting process in ferrous foundries. Some foundries also produce significant amounts of dust from extraction systems. Sand can be reused within the foundry under some circumstances and both slag and sand have been used in secondary processes such as cement, asphalt and concrete block manufacture – although the extent to which this is done is unknown. The CMF stresses that the potential users of the waste often require large volumes of relatively

[1] David De Courcy, CMF, Private communication. September 2007.

consistent material and this cannot be achieved by a single foundry. Transport of low value materials of this type can also be commercially problematic and the overall cost of reuse, according to a company's existing business plans, could be higher.

13.50 Table 13.15 shows the mean savings opportunity identified in the Envirowise and ENWORKS surveys and case studies. This shows an average savings opportunity of 8.8%. Sand reuse and recycling was a major focus of many of the surveys and case studies. Assuming that the casting of metals still accounts for 9% of total sector waste arisings, the waste savings opportunity is estimated at 45,000 tonnes. NB: The CMF is about to launch a "zero waste initiative" to raise awareness within the industry.

Table 13.15: A summary of case study findings in the casting of metals sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Casting of metals	12	8.8	11.3	0.74

The treatment and coating of metals; general mechanical engineering

13.51 The general mechanical engineering sector comprises companies undertaking turning, milling and welding activities. Table 13.16 shows the savings opportunities identified by Envirowise and ENWORKS. Improved management of stock (i.e. inventory control including offcut and stock utilisation), improved recovery of cutting fluids and improved quality of swarf (i.e. reducing the contamination to increase scrap metal value) were identified as the key savings opportunities. Table 13.14 shows that the average savings opportunity equates to 10.9%.

Table 13.16: A summary of case study findings in the general mechanical engineering sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
General mechanical engineering	18	10.9	6.1	0.71

13.52 No Envirowise or ENWORKS case studies or surveys could be identified that provided the required information on the waste savings associated with the treatment and coating of metals. A literature review identified one case study produced in the US reporting that a 6.5% reduction in waste can be achieved through better housekeeping and operating practices[1]. Assuming that this is representative of the savings opportunity from such interventions in the UK and that other opportunities would exist it was considered realistic to assume that the same level of waste savings opportunity as for general mechanical engineering (10.9%) would be achievable.

13.53 Assuming that this subsector still accounts for 8% of total sector waste arisings the savings opportunity is estimated at 50,000 tonnes

[1] www.p2ad.org/documents/ma_fabmetal.html#characteristics Accessed September 2007

The manufacture of structural metal products

13.54 The majority of products produced within this activity are destined for the construction sector, namely, metal supports and structures, prefabricated buildings, metal doors, window frames or shutters. The typical solid wastes generated by the sector include:

- steel scrap and other metals
- wood packaging, i.e. pallets and other wood crating
- cardboard, stretch wrap, Styrofoam, and other packaging
- office wastes including paper, cardboard, food, beverage containers and construction materials.

13.55 Envirowise and ENWORKS case studies identified improved inventory control and the increased reuse of wood packaging as the two major savings opportunities. Table 13.17 shows an average saving within the case studies of 12.3%. Assuming this subsector accounts for 8% of total waste arisings from the sector the waste savings opportunity is estimated to be 56,000 tonnes.

Table 13.17: A summary of case study findings in the structural metal products sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Structural metal products	12	12.3	13.1	0.69

13.56 Table 13.18 summarises the waste savings opportunity from this sector.

Table 13.18: Summary of waste savings opportunity within the structural metal products sector

Activity	Waste generation (kt)	Waste savings opportunity	
		%	kt
Basic iron & steel	3,492	2.9	103
Casting of metals	515	8.8	45
General mechanical engineering	458	10.9	50
Structural metal	458	12.3	56
Total	**4,923kt**	**5.2%**	**254kt**

Valuation of waste savings

13.57 The cost of sending the waste to landfill is valued at £40 per tonne (gate fee of £16/tonne and Landfill Tax £24/tonne). The estimated savings of diverting 254,000 tonnes from landfill is therefore £10 million. Additionally, the waste savings from the manufacture of basic iron and steel also creates an additional revenue stream and based on the price for BOF slag being £5/tonne this equates to a saving of £515,000.

13.58 The total saving in waste disposal costs is therefore £10.7 million.

13.59 The estimated waste savings from the manufacture of basic metals can be regarded as waste management savings and hence will not include any significant hidden savings. In the other activities, however, there are in-process improvement opportunities. The metal itself will clearly be the most high value raw material and any savings here will increase the value of the savings opportunity considerably. However, the 2002/03 EA C&I Survey indicated that within the general category of "the manufacture of basic metal" for which the casting of metals will be included, the weight of metallic waste generated was 316,000 tonnes or 6.5% of the total waste stream, and 61% of all waste within the basic metals sector was either recycled or reused. Hence it is concluded that very little metallic waste is not currently recovered and hence no associated raw material saving can be applied to metallic wastes.

13.60 In the case of the manufacture of fabricated metal products 840,000 tonnes (55% of the waste stream) of metallic waste was generated, and 922,000 tonnes or 60% of all waste was either recycled or reused. This again suggests that the majority of metallic waste is either recycled or reused.

13.61 Based on this analysis and the feedback received from the CMF and others it is assumed that the raw material savings associated with the in-process improvement are derived from the lower value materials. The hidden savings is therefore valued at £40 per tonne, which equates to a saving of £6.1 million.

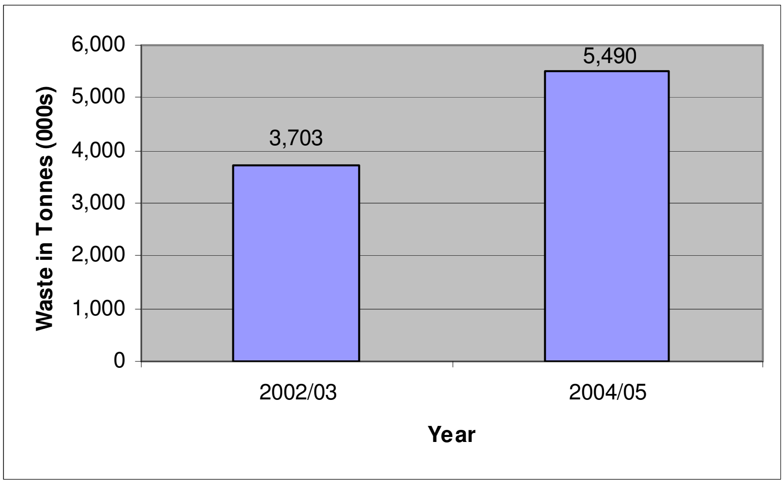
13.62 The total savings opportunity is therefore valued at £16.7 million ± 10.2%.
NB: 10.2% represents the mean standard error.

Manufacture of machinery and equipment; Manufacture of electrical and optical equipment; Manufacture of transport equipment.

Background

13.63 Figure 13.9 shows that in 2004/05 the sector accounted for 5.49 million tonnes or 2.15% of the UK's industrial waste. This shows a significant increase when compared to the estimate of 2.9 million tonnes made in 2002/03 for England in the EA C&I waste survey (grossed up to UK level in Figure 13.9). Since the 2004/05 figure is simply a projection of the 2002/03 EA C&I waste data based on the change in the number of enterprises operating in the sector, it reflects a significant growth in the number of enterprises operating in the sector.

Figure 13.9: Waste arisings in manufacture of machinery and equipment sector



13.64 Table 13.19 shows the results when grossing the 2002/03 estimates up to UK level and taking account of the standard errors of the surveys. This shows that the change in waste arisings is statistically significant since there is no overlap between the two datasets.

Table 13.19: Analysis of the manufacture of machinery and equipment; manufacture of electrical and optical equipment; manufacture of transport equipment sector waste arisings, 2002/03 and 2004

Survey year	Estimated waste arisings (kt)	Standard error	Minimum waste arisings (kt)	Maximum waste arisings (kt)
2002/03	3,700	±16.3	3,100	4,280
2004	5,490	±16.3	4,600	6,390

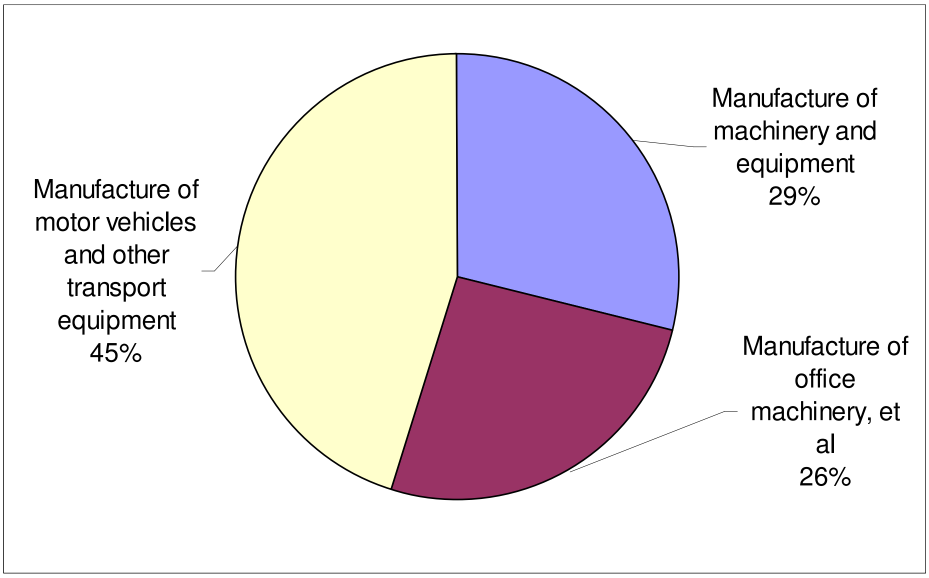
13.65 Table 13.20 shows the projection of the data to 2006/07 based on the growth shown between the two studies. This shows that the estimated mean waste arisings in 2006/07 is 7.3 million tonnes.

Table 13.20: Projection of the manufacture of machinery and equipment; manufacture of electrical and optical equipment; manufacture of transport equipment sector waste arisings to 2006/07

Survey year	Minimum waste arisings (Mt)	Mean waste arisings (Mt)	Maximum waste arisings (Mt)
2002/03	3.10	3.70	4.28
2004/05	4.60	5.49	6.39
2006/07	6.09	7.28	8.50

13.66 Figure 13.10 shows the split of the waste arisings within the sector. This shows that the manufacture of motor vehicles accounts for the largest portion of the waste (45%) with the rest of the waste being quite evenly distributed among the other two categories. This section will review the three categories.

Figure 13.10 Waste arising split for Manufacture of machinery and equipment; Manufacture of office machinery, computers, electrical, radio, television and communication equipment; medical and optical instruments and clocks; and Manufacture of machinery and equipment



Quantification of waste savings opportunity

Manufacture of motor vehicles and other transport equipment

13.67 On reviewing the case studies and surveys undertaken by Envirowise and ENWORKS in this area it was evident that much focus had been placed on raw material savings rather than waste disposal savings. This focus is in line with the observations made by the House of Commons Trade and Industry Committee, which stresses that[1]:

"Recent management focus [in the UK car manufacturing industry] has been on taking waste out of the business and reducing costs. Some of this is saving on raw materials, some is configuration on factory floor space so that there is minimal handling of components between machines and operations, some is to ensure that products are made to the required quality first time and that rework is kept to a minimum".

13.68 The SMMT reports that the focus on raw material reduction was not only based on the need to cut costs out of the business for competitive reasons, but was also targeting the light-weighting of vehicles[2].

13.69 Table 13.21 shows the raw material savings opportunity identified by Envirowise and ENWORKS. This shows average savings to equate to 0.54%. Unlike the previous sectors where focus was placed on waste and hence the tonnage savings can be projected at this stage, the focus on raw materials means an alternative approach is required. This is described in the "valuation of waste savings" section.

Table 13.21: A summary of case study findings in the manufacture of motor vehicles and other transport equipment sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Manufacture of motor vehicles and other transport equipment	10	0.54	4.3	0.99

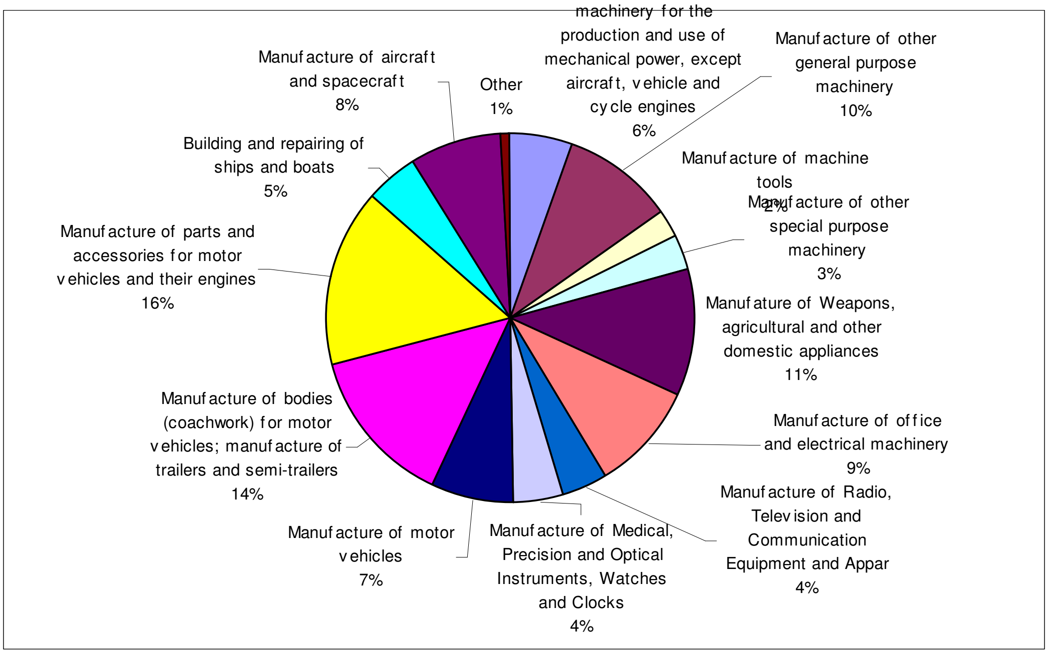
Manufacture of machinery and equipment, and manufacture of office machinery, computers, etc.

13.70 Figure 13.11 shows the sector to be extremely diverse in terms of waste generation with the "manufacture of parts and accessories for motor vehicles and their engines" being the most significant waste producer accounting for just 15% of total waste arisings.

[1] Success and failure in the UK car manufacturing industry. Fourth Report of Session 2006-07. House of Commons. Trade and Industry Committee, March 2007.

[2] Russ Murty SMMT, Private Communication, September 2007.

Figure 13.11: Breakdown of waste arisings by subsector in Manufacture of office machinery, computers, electrical, radio, television and communication equipment sector



13.71 On undertaking a literature review to identify case studies or surveys undertaken in this area no reliable data could be found, as although eight case studies were found which quantified the waste savings opportunity (£), none included a valuation of the present cost of waste. A best fit approach was considered the best alternative option. This involved comparing the characteristics of this sector against those of other sectors where data does exist. The general mechanical engineering subsector, within the category of basic metals in the study, was considered the most suitable due to the nature of the process and the skill level of the employees. The estimate of savings opportunity is therefore assumed at 10.9%.

13.72 Based on the assumption that these two sectors account for 55% of total waste generated and that 6.1 million tonnes of waste was generated in 2006/07 the savings opportunity equates to 364,000 tonnes.

Valuation of waste savings

13.73 The savings opportunity within the motor vehicles sector is calculated using ABI input – output tables. The tables show that the raw material purchases excluding electricity, gas and water supply cost the industry £28.7bn in 2004. The savings opportunity of 0.54% therefore equates to a financial saving within the sector of £155 million. The waste disposal savings are difficult to quantify since it is not known how much of the raw material saved would previously have been disposed of as physical waste and how much was embedded into a heavier weight product. Due to the lack of data in this area it is considered necessary to provide an estimate and, based on the average savings within other similar sectors, it is thought that a 10% saving on waste disposal could be made. Assuming a disposal cost of £40 per tonne the waste savings are therefore £11 million (6.1 tonnes x 45% share of sector waste arisings x 10% saving opportunity x £40/t).

13.74 For the other sectors, assuming a disposal cost of £40 per tonne the savings associated with a 364,000 tonne reduction in waste arisings equates to £14.5 million. Using the same rationale as used in the section on "general mechanical engineering" the hidden savings are estimated at £40 per tonne, increasing the savings opportunity to £29 million.

13.75 Table 13.22 summarises the savings opportunity within this sector.

Table 13.22: A summary of waste savings opportunity within the manufacture of machinery et al sector

Activity	**Waste disposal savings (£M)**	**Hidden savings (£M)**	**Total (£M)**
Motor vehicles	11.0	155.0	**166**
Machines & equipment, etc.	14.5	14.5	**29**
Total	**£25.5M**	**£169.5M**	**£195M**

Manufacture of chemicals, chemical products, man-made fibres; Manufacture of rubber and plastic products

13.76 This was one of the two sectors covered in the preliminary analysis (Section 2) and detailed in Appendix 1.

Quantification of waste savings

13.77 The coefficient of determination (R^2) and the equation for the (trend) line were determined to assess the reliability and robustness of the data. Table 13.23 shows the subgroups / employment bands where sufficient data points (surveys) were available. The coefficient of determination show strong correlations in six out of eight of the subgroups. These six subgroups account for 62.3% of the sector and hence can be considered a representative sample.

Table 13.23: Test of reliability of data for chemicals sector

SIC / Employment band	Coefficient of determination (R^2)	Trend line equation	% of sector waste
241(250+)	0.92	0.07x	30.2
251 (1 to 250+)	0.77	0.17x	20.5
241 (100 to 249)	0.78	0.10x	5.8
252 (20 to 99)	0.18	0.17x	6.2
252 (100 to 249)	0.89	0.10x	3.4
252 (250+)	0.96	0.24x	2.6
241 (50 to 99)	0.74	0.24x	2.7
244 (50 to 249)	0.99	0.20x	0.5

NB: for the coefficient of determination the closer to "1" the stronger the correlation between an increase in waste arisings and an increase in waste savings opportunity.
NB: Appendix 4 describes the SIC codes

13.78 Table 13.24 shows the estimated total waste savings opportunities within the six subgroups to be 382,000 tonnes. Since these subgroups represent a significant proportion of the sector (62.3%) it was considered appropriate to gross up to population (sector) level based on these findings. The projected waste savings opportunity for the sector is therefore 588,000 tonnes. Taking the standard error into consideration the range of estimated savings is 476,000 tonnes to 699,400 tonnes or between 10% and 14% of total waste arisings (4.9 million tonnes). The Chemical Industries Association has confirmed that the waste savings opportunities fit within their range of expectation.

Table 13.24: Waste saving opportunities

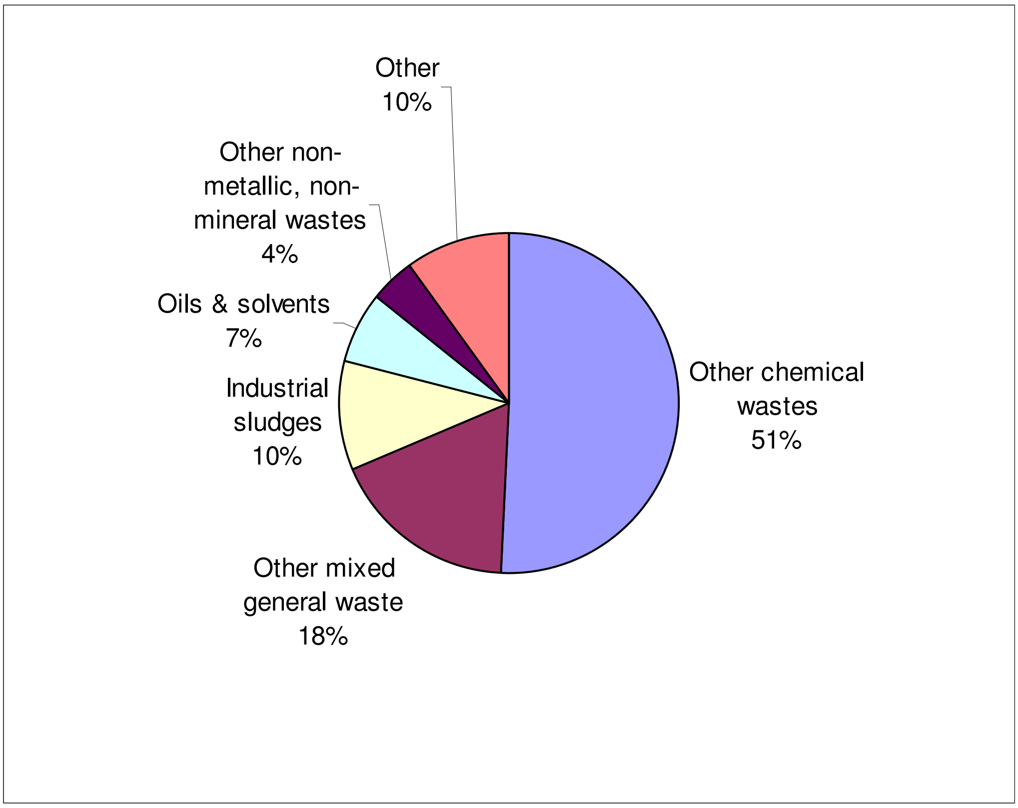
Employment Groupings	Mean waste arisings (t)	Trend line multiplier	Mean waste savings (t)	No of companies in UK (2006)	Total waste savings (t)
241 (250+)	37,086	0.074	2,759	40	110,368
251 (1-250+)	1,343	0.175	235	750	176,168
241 (100-249)	2,980	0.097	288	95	27,319
252 (250+)	1,617	0.240	388	80	31,046
241 (50-99)	962	0.240	231	140	32,323
244 (50-249)	387	0.200	77	65	5,031
				Total	**382,256**

Valuation of waste savings

13.79 Envirowise valued the cost of waste disposal from the sector at £80 per tonne[1] and estimated hidden costs at £400 per tonne. Figure 13.12 shows that raw materials, namely chemicals, represent over half the waste arisings (51%) and hence it is considered realistic that waste reduction savings will result in significant raw material savings.

[1] Benchmarking environmental performance in the chemical industry. Environmental Technology Best Practice Programme 2000.

Figure 13.12: Waste arisings by waste type in the chemicals sector, 2002[1]



13.80 Table 13.25 shows the valuation of waste resource efficiency using the Envirowise cited costs. This shows potential savings of £235m to £304m.

Table 13.25: Summary of savings in the chemicals sector

	Waste savings (kt)	**Waste disposal savings @ £80/t (£M)**	**Total waste savings @ £400/t (£M)**
Minimum	476	38.1	190.4
Mean	588	47.0	235.1
Maximum	699	55.9	279.7

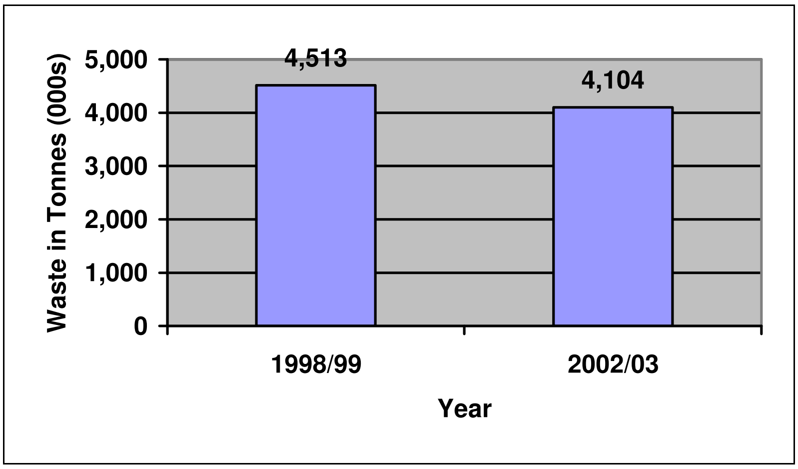
[1] Environment Agency 2002/03 C&I waste production survey

Manufacture of pulp, paper and paper products; Publishing and printing

Background

13.81 Figure 13.13 shows that this sector accounted for 4.1 million tonnes or 1.6% of the UK's industrial waste in 2004/05 an increase of about 0.4 million tonnes compared with the grossed up 2002/03 EA C&I waste estimates.

Figure 13.13: Waste arisings in manufacture of paper, publishing and printing sector



13.82 Table 13.26 shows that this reduction is not statistically significant when the standard error of the survey data is taken into consideration.

Table 13.26: Analysis of the paper, publishing and printing sector waste arisings, 2002/03 and 2004

Survey year	Estimated waste arisings (Mt)	Standard error	Minimum waste arisings (Mt)	Maximum waste arisings (Mt)
2002/03	4.51	±16.0	3.79	5.24
2004/05	4.10	±16.0	3.45	4.76

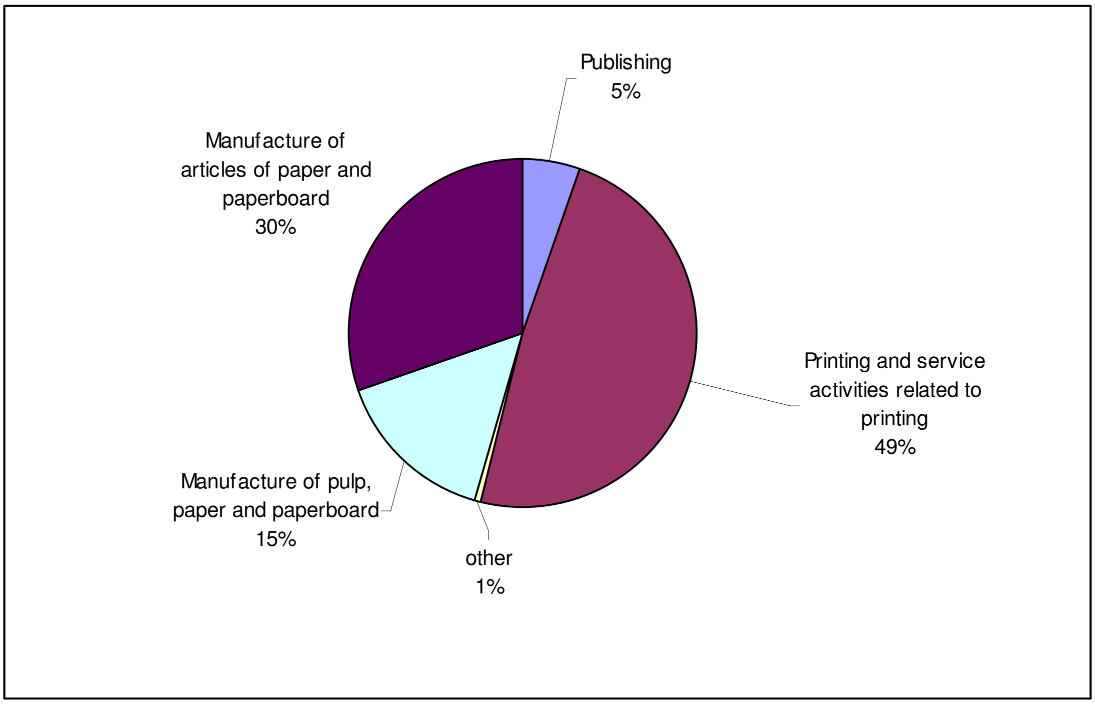
13.83 Table 13.27 shows the projection of the waste arisings to 2006/07 based on the change between 2002/03 and 2004/05. This shows mean waste arisings from the sector to be 3.7 million tonnes.

Table 13.27: Projection of paper, publishing and printing waste arisings to 2006/07

Survey year	Minimum waste arisings (Mt)	Mean waste arisings (Mt)	Maximum waste arisings (Mt)
2002/03	3.79	4.51	5.24
2004/05	3.45	4.10	4.76
2006/07	3.10	3.70	4.29

13.84 Figure 13.14 shows the breakdown of waste arisings by subsector. This shows that the printing sector accounts for nearly half the waste; the manufacture of articles of paper 30% and the manufacture of pulp, paper and paperboard a further 15%. This section will focus on these three sectors, which account for 94% of waste arisings within the sector.

Figure 13.14: A breakdown of waste arisings from the manufacture of pulp, paper et al sector[1]



Quantification of waste savings opportunity

Printing and service activities related to printing

13.85 Figure 13.15 shows the breakdown of the material types within the waste stream. Unsurprisingly, given the nature of the sector, paper and card accounts for 62% of waste generated in the sector. Much of this waste is

[1] Environment Agency 2002/03 C&I waste production survey

recycled and Figure 13.15 shows that in 2002, 63% of waste was either recycled or reused.

Figure 13.15: A breakdown of waste arisings by material type in the printing sector[1]

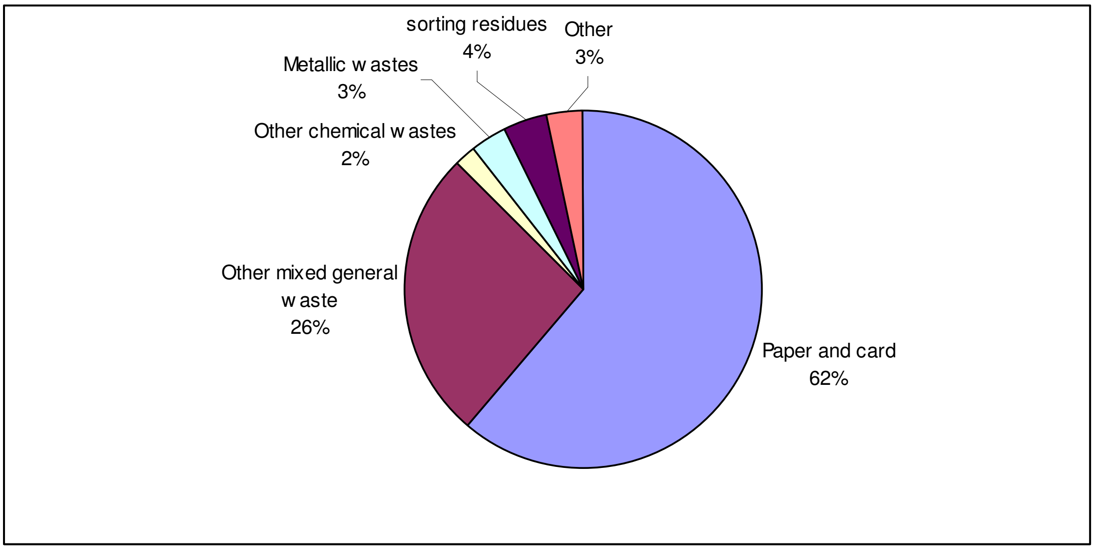
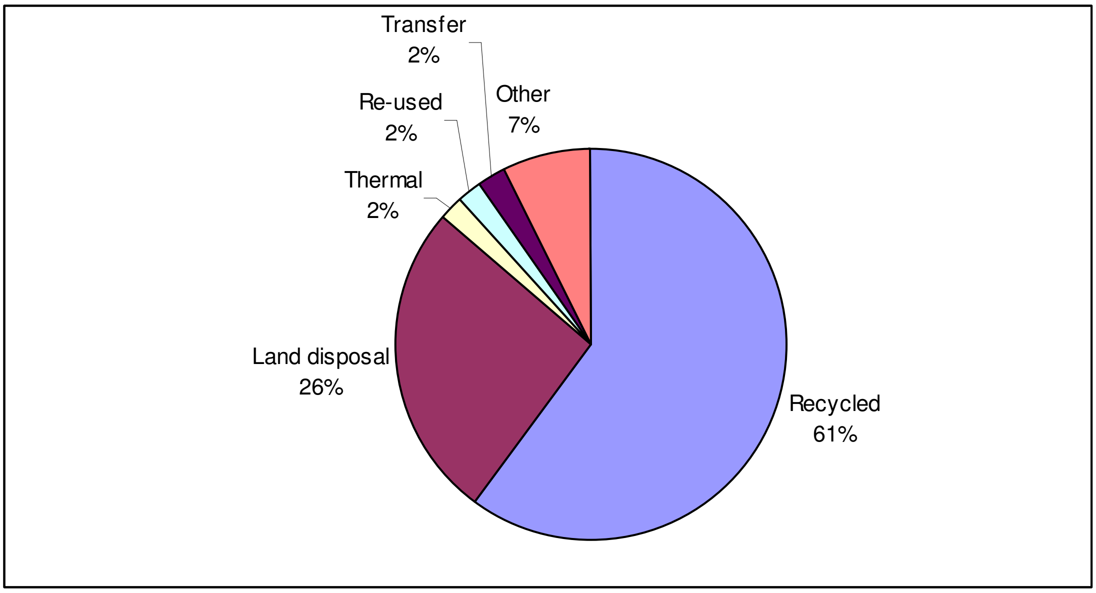


Figure 13.16: A breakdown of waste arisings by waste management method in the printing sector[2]



[1] Environment Agency 2002/03 C&I waste production survey

[2] Environment Agency 2002/03 C&I waste production survey

13.86 Case studies and surveys undertaken by Envirowise and ENWORKS show that significant savings opportunities exist to reduce the level of paper waste generated. The key areas are:

- reducing trim waste – optimising the size of reel used.
- minimising warehouse stock damage – removing broken pallets repairing uneven floors or snagging points, reducing damage caused by fork lift trucks, etc.
- 'just in time' ordering – to ensure the right material is ordered at the right time and to reduce the risk of on-site damage.

13.87 Table 13.28 shows the savings opportunities identified in the studies with a mean savings of 8.1%, which equates to 185,000 tonnes.

Table 13.28: A summary of case study findings in the printing sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Printing	15	8.1	8.7	0.8

Manufacture of articles of paper and paperboard; Manufacture of pulp, paper and paperboard

13.88 Figure 13.17 shows the waste materials generated in this sector. This shows that there is a much lower proportion of paper and card waste than in the printing sector. In addition, Figure 13.18 also shows that much less waste is recycled or re-used (42%).

Figure 13.17 A breakdown of waste arisings by material type in the paper sector[1]

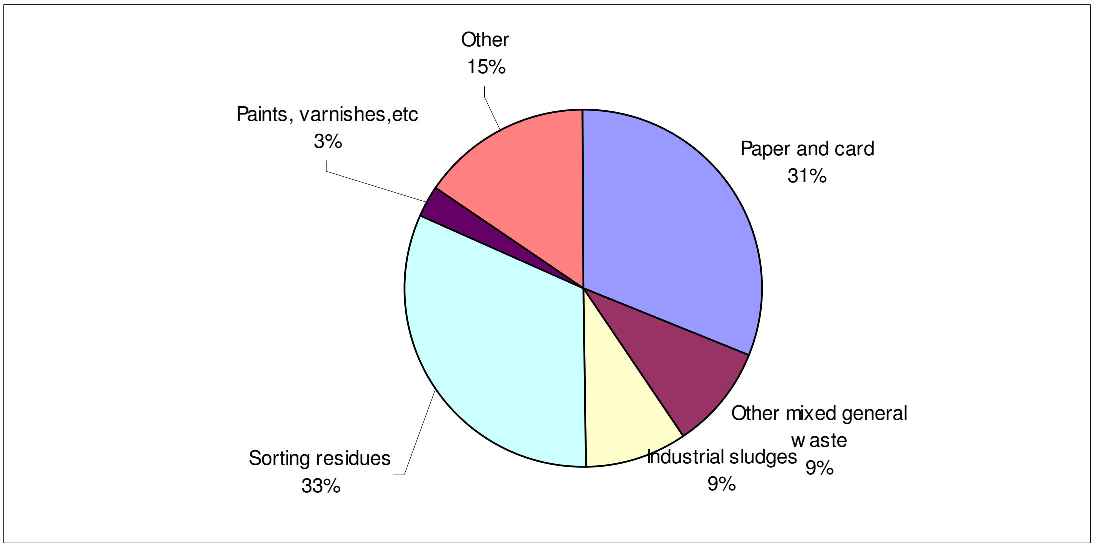
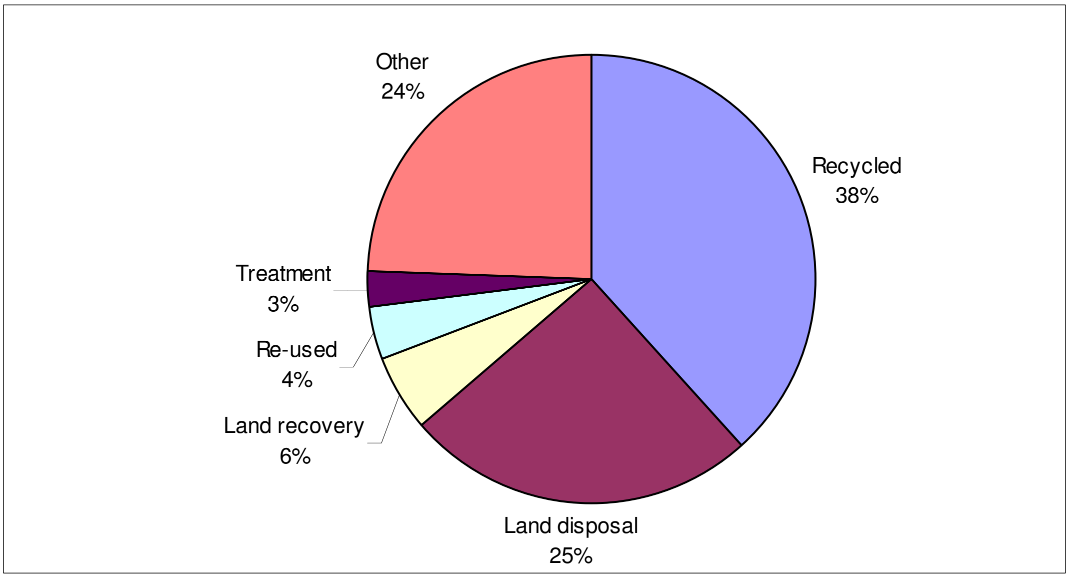


Figure 13.18: A breakdown of waste arisings by waste management method in the printing sector[2]



[1] Environment Agency 2002/03 C&I waste production survey

[2] Environment Agency 2002/03 C&I waste production survey

13.89 One of the key wastes generated from this sector is paper mill sludge and WRAP described the issues surrounding this material as follows[1]:
"paper mill sludge is a major economic and environmental problem for the paper and board industry. Around 1 million tonnes is produced annually, and losses rise as increased amounts of recycled paper is used in the process, with fibre shortening as it goes through repeated cycles until it is of little use for paper manufacture"

13.90 The Confederation of Paper Industries (CPI) reports that the use of recovered paper pulp in place of virgin material increased by 5% from 62% of total fibre feedstock in 1996 to 67% in 2006[2].

13.91 The improved extraction of fibres from recovered paper was one issue covered in the WRAP study. Unfortunately the study concluded that there is too high a proportion of fillers in the recovered paper, even after processing, to increase utilisation rates.

13.92 The WRAP study also concluded that of the current methods of disposal only third party landfilling is available on a longer term basis with any degree of certainty. The current cost of sending the material down this route is estimated at £36 to £39 per tonne, which clearly represents a significant cost to the industry.

13.93 Envirowise and ENWORKS case studies focus predominantly on reducing the paper waste generated during the cutting and trimming of the paper machine reels, and in-process material handling damage. Table 13.29 shows that the average savings identified within the case studies and surveys is 5.3%.

Table 13.29: A summary of case study findings in the paper sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Paper	11	5.3	18.2	0.77

13.94 This equates to a savings opportunity of 87,460 tonnes.

[1] A new approach to paper mill sludge. WRAP. March 2007.

[2] Confederation of Paper Industries Facts 2006.

Valuation of waste savings

13.95 The total waste savings opportunity for the sector is thus 272,460 tonnes, totalling the 185,000 tonnes and 87,460 tonnes arrived at above. Taking the cost of waste disposal as cited by WRAP for third party landfilling of between £36-£39 per tonne this equates to a value of £9.8 to £10.6 million or an average of £10.2 million.

13.96 The hidden costs associated with the waste savings are difficult to estimate accurately since many of the case studies and surveys did not disclose whether raw material savings had been made. Pulp and paper is likely to be the most significant material (hidden cost) saving since the cost of pulp alone is £364/t[1]. Assuming that 10% of the waste savings (272,460 tonnes) translates into raw material savings, i.e. a 27,240 tonne raw material saving and assuming the price of pulp is representative of the average raw material savings, the hidden savings equate to £9.9 million. The total savings are therefore estimated at £20.1 million.

[1] www.paperco.co.uk/2005/information/priceincreasejan07.pdf Accessed September 2007

Grossing up of waste savings opportunity within the industrial sector

13.97 Table 13.30 summarises the estimated savings within the eight focus subsectors within the industrial sector. Based on the fact that these represent 95.2% of the waste arisings within the industrial sector it was considered reasonable to use the mean savings opportunity (13.1%) to gross the savings up to sector level. Table 13.31 shows that, on this basis, the estimated savings in the remaining sectors equates to 1.57 million tonnes. Taking the average savings per tonne within the focus sectors (£53 per tonne) this equates to a total saving within these remaining subsectors of £83 million.

Table 13.30: Summary of waste savings opportunity within the eight focus subsectors of the industrial sector

Subsector	**Waste arisings (Mt)**	**Estimated waste savings**	
		%	**Mt**
Construction	113	19.3	21.9
Mining & quarrying	94	5.2	4.9
Food & drink	8	19.3	1.5
Energy supply	7	26.0	1.9
Basic metals	6	5.2	0.3
Machinery	5	10.5	0.6
Chemicals	5	9.1	0.5
Paper	4	7.4	0.3
Total	**243Mt**	**13.1%**	**31.8Mt**

Table 13.31: Summary of waste savings opportunity within the remaining subsectors of the industrial sector

Subsector	**Waste arisings (kt)**	**Estimated waste savings**	
		%	**kt**
Recycling	2,710	13.1	354
Other non-metallic mineral products	2,470	13.1	323
Sewage, sanitation & similar activities	2,130	13.1	279
Wood & wood products	1,960	13.1	257
Textiles & leather	910	13.1	120
Manufacture of machinery nec	810	13.1	105
Agriculture	540	13.1	71
Wholesale of waste & scrap	250	13.1	32
Fishing	180	13.1	24
Total	**11,950**	**13.1**	**1,565**

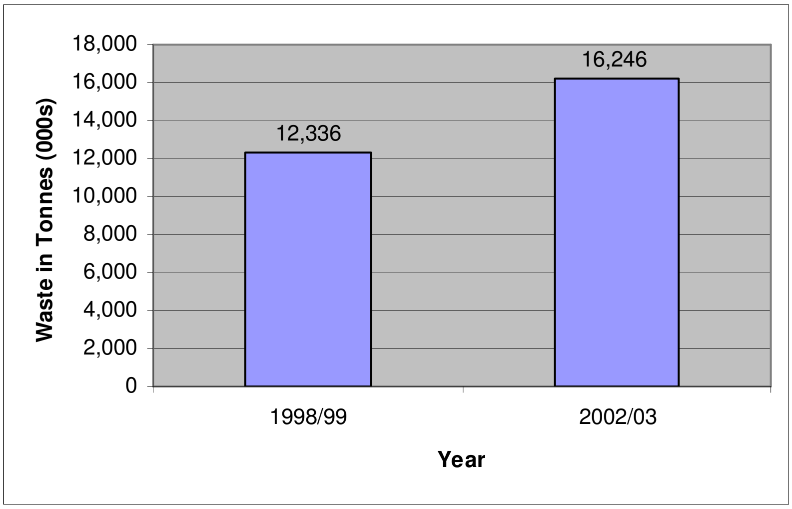
The service sector

The retail sector – motor vehicles, parts and fuel; wholesale; other retail sectors.

Background

13.98 Figure 13.29 shows the estimated waste arisings from the retail sector in the UK in 1998/99 and 2002/03. This shows waste arisings to have increased by 3.9 million tonnes. However, the standard error of the two surveys is high and hence needs to be taken into consideration.

Figure 13.19: Waste arisings from the retail sector



Source: Defra[1].

13.99 Table 13.32 shows the range of possible waste arisings from the two surveys when taking the standard error into account. This shows that there is no overlap between the two survey datasets indicating that the increase seen in 2002/03 is statistically significant.

Table 13.32: Analysis of retail waste arisings,1998/99 and 2002/03

Survey year	Estimated waste arisings (Mt)	Standard error	Minimum waste arisings (Mt)	Maximum waste arisings (Mt)
1998/99	12.34	± 3.8%	11.87	12.80
2002/03	16.25	± 12.1%	14.28	18.21

[1] Figures for England only have been grossed up to UK level using the ratio of arisings from the service sector for the 4 countries as detailed in the EU waste statistics regulation (EC2150/2002) UK 2004 report by Defra July 2006, namely England 78.5%, Wales 4%, Scotland 15.1% and Northern Ireland 2.4%.

13.100 Table 13.33 shows the projected waste arisings in 2006/07 assuming the growth seen between 1998/99 and 2002/03 continued. This shows that the mean waste arising in 2006/07 is estimated to be 20,156,000 tonnes.

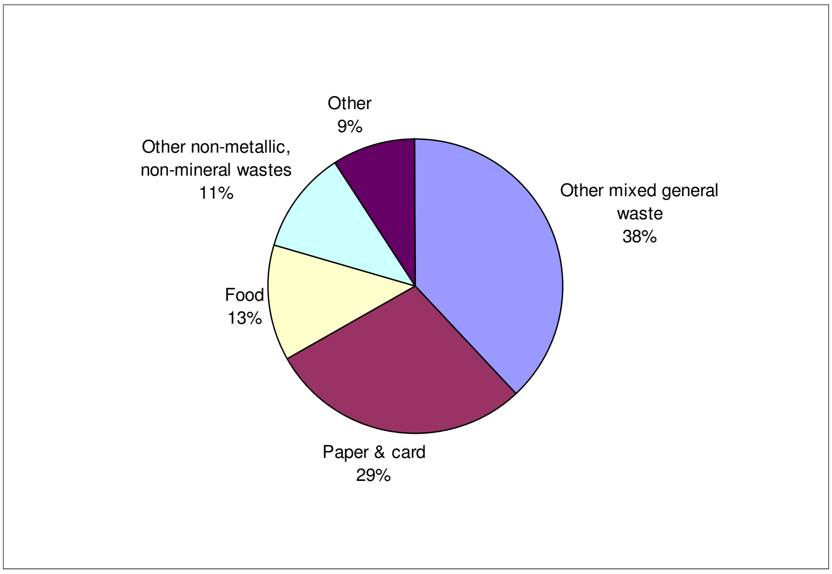
Table 13.33: Projection of retail waste arisings to 2006/07

Survey year	Minimum waste arisings (Mt)	Mean waste arisings (Mt)	Maximum waste arisings (Mt)
1998/99	11.87	12.34	12.81
2002/03	14.28	16.25	18.21
2006/07	16.69	20.16	22.14

Quantification of waste savings opportunity

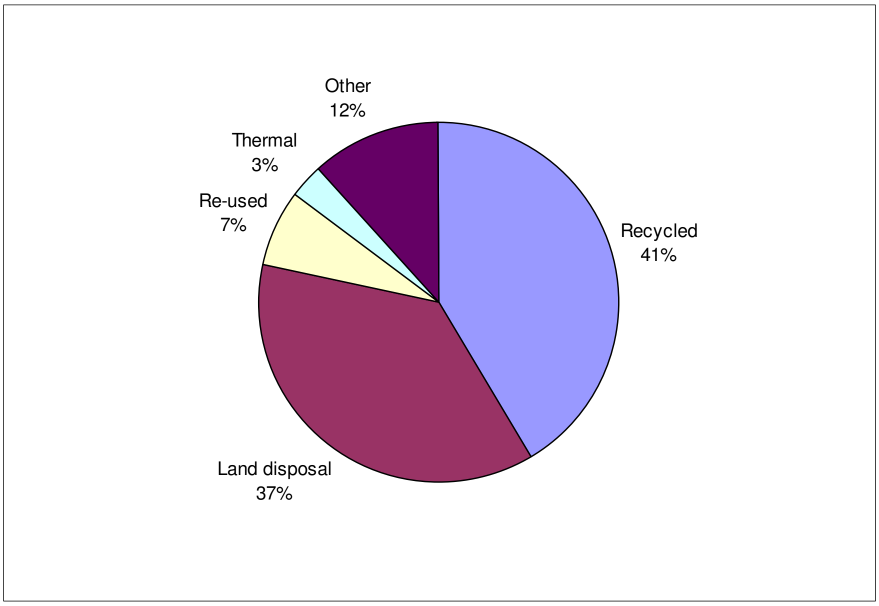
13.101 Figure 13.20 shows the analysis of waste arisings in terms of the waste types, as reported in the 2002/03 EA C&I waste survey. This shows that three categories accounted for nearly 80% of the waste generated; "other mixed general waste" accounts for 38% paper and card 28.6% and food waste 12.9%.

Figure 13.20: Waste arisings by waste type in the retail sector, 2002



13.102 Figure 13.21 shows the breakdown of waste arising by disposal or recovery route, as reported in the 2002/03 EA C&I waste survey. This shows that 48.5% of waste is either recycled or reused. However, it also shows that 36.7% of waste was sent to land disposal.

Figure 13.21: Waste arisings by waste management method in the retail sector, 2002



13.103 Significant improvements have been made in the recovery and recycling of waste materials since 2002, particularly for packaging material as a result of the Packaging Waste Regulations. However, a study was undertaken in April 2006 to determine the potential savings opportunity in the retail and wholesale sector[1]. Using the data from this study and the 2002/03 EA C&I waste data the waste savings for the sector equates to 1.8 million tonnes or 9% of total sector waste arisings in 2006/07 and a savings of £489 million (Table 13.34).

[1] The economic and environmental benefits of resource efficiency in retail, April 2006, Entec

Table 13.34: The estimated savings opportunities in the retail sector

Mitigation for waste arisings	**Savings (kt/yr)**	**Savings (£M)**	**Notes**
Replace cardboard packaging for reusable packaging	820	480	This takes Entec's best guess figures for waste reduction in intermediate packaging
Recycling of paper & card	150	5.4	
Recycling of plastic film	33	3.4	
Composting of waste food	820	Negative	Composting is likely to be more expensive than landfill
Total	**1,823**	**489**	

Valuation of hidden waste savings

13.104 The four savings opportunities detailed in Table 13.34 take account of the hidden savings and hence it is the waste disposal costs that need to be determined. Based on a standard disposal fee of £65 per tonne[1] the saving of 1.8 million tonnes equates to a saving in waste disposal costs of £118 million.

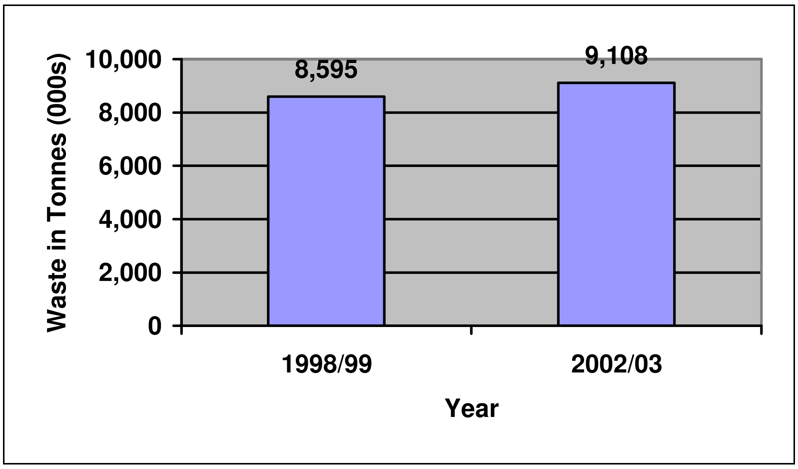
[1] Peter Jones. Biffa. Private communication September 2007.

Travel agents, other business, finance, real estate and computer related activities

Background

13.105 Figure 13.22 shows the estimated waste arisings from this sector in the UK in 1998/99 and 2002/03. This shows waste arisings to have increased by 0.51 million tonnes. However, the standard error of the two surveys needs to be taken into consideration to determine the statistical significance of this increase.

Figure 13.22: Waste arisings from the travel agents et al sector



Source: Defra[1].

13.106 Table 13.35 shows the range of possible waste arisings from the two surveys when taking the standard error into account. This shows that there is overlap between the two survey datasets indicating that the increase seen in 2002/03 is not statistically significant.

Table 13.35: Analysis of travel agent et al waste arisings,1998/99 and 2002/03

Survey year	Estimated waste arisings (Mt)	Standard error	Minimum waste arisings (Mt)	Maximum waste arisings (Mt)
1998/99	8.60	± 7.2%	7.98	9.22
2002/03	9.11	± 10.2%	8.18	10.04

[1] Figures for England only have been grossed up to UK level using the ratio of arisings from the service sector for the 4 countries as detailed in the EU waste statistics regulation (EC2150/2002) UK 2004 report by Defra July 2006, namely England 78.5%, Wales 4%, Scotland 15.1% and Northern Ireland 2.4%.

13.107 Table 13.36 shows the projected waste arisings in 2006/07 assuming the growth seen between 1998/99 and 2002/03 continued. This shows that the mean waste arising in 2006/07 is estimated to be 9.6 million tonnes.

Table 13.36: Projection of travel agent et al waste arisings to 2006/07

Survey year	Minimum waste arisings (Mt)	Mean waste arisings (Mt)	Maximum waste arisings (Mt)
1998/99	7.98	8.60	9.22
2002/03	8.18	9.11	10.04
2006/07	8.38	9.62	10.86

13.108 Figure 13.23 shows that in 2002 "other mixed general waste" was the most significant waste stream accounting for 61% of waste. As is typically the case when mixed waste is collected, landfill disposal is a prominent disposal route and Figure 13.24 shows that 57% of waste was sent to land disposal.

Figure 13.23: Waste arisings by waste type in travel agents et al sector, 2002

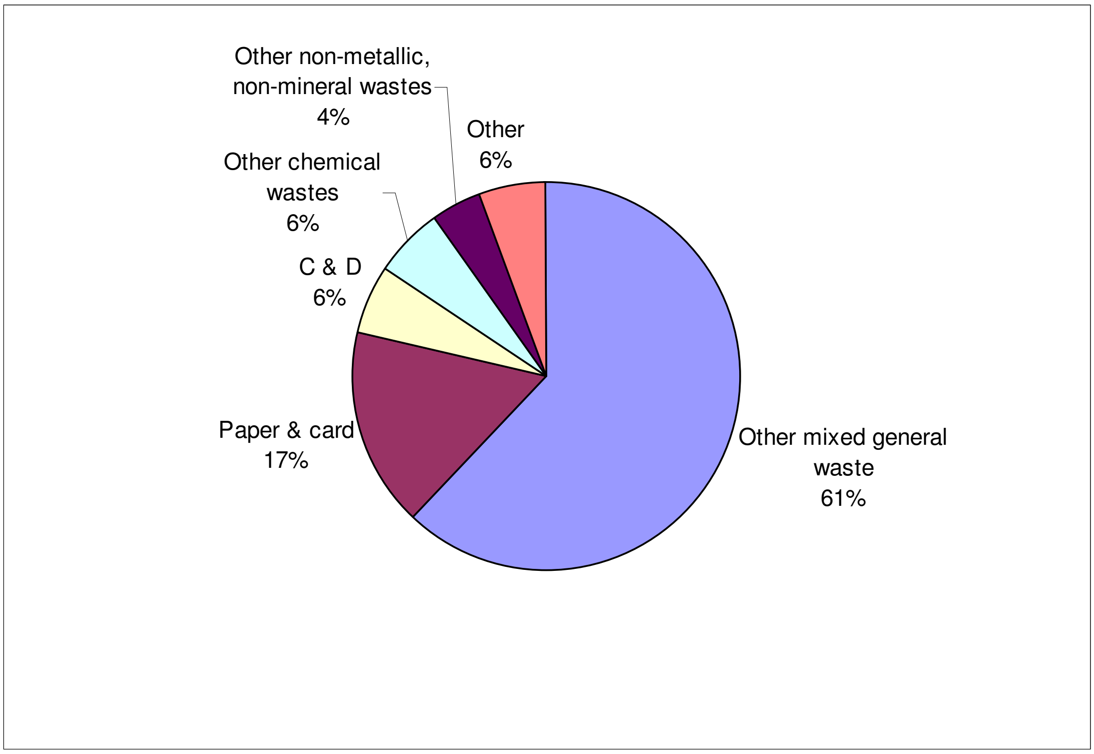
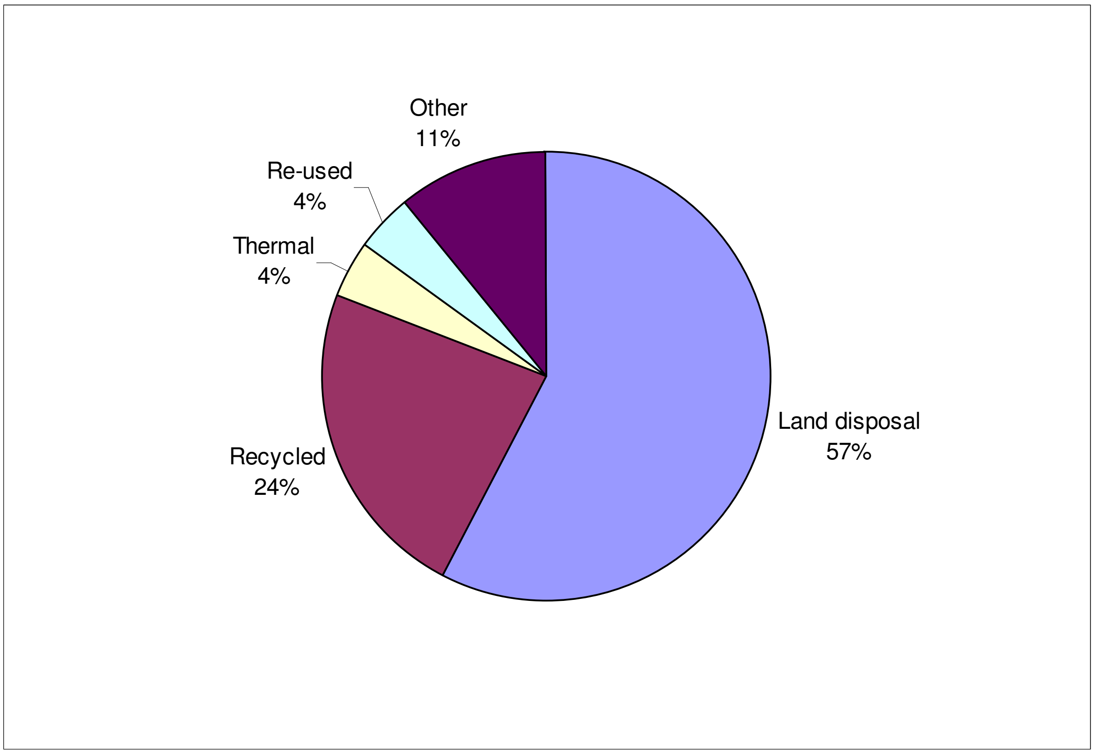


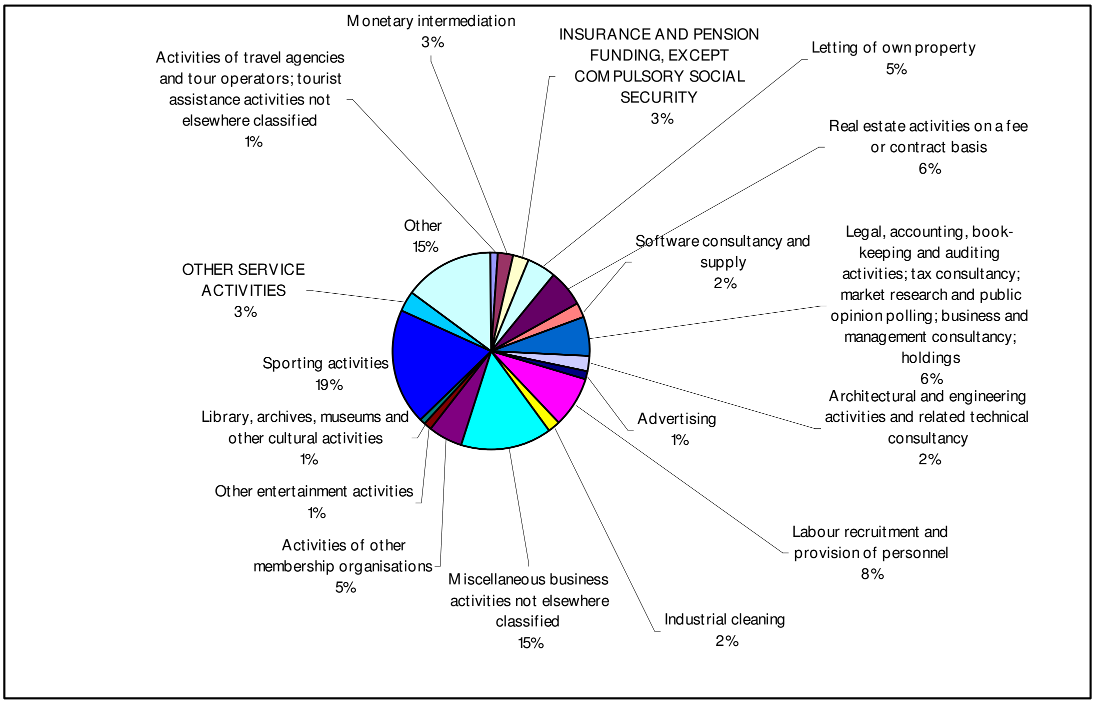
Figure 13.24: Waste arisings by waste management method in travel agents et al sector, 2002



Quantification of waste savings opportunity

13.109 Figure 13.25 shows the diverse range of activities undertaken within this category. This shows no one activity accounts for more than 9% of the waste generated in this sector. However, many of the activities can be regarded as similar, e.g. many are office based activities, which would generate similar wastes and have similar savings opportunities.

Figure 13.25: A breakdown of waste arisings in the travel agents et al sector in 2002/03



13.110 On reviewing the Envirowise and ENWORKS case studies and surveys in this area much of the focus was placed on the segregation of waste, which is clearly significant considering the high volumes of mixed waste going to land disposal from this sector. Table 13.37 shows the savings opportunities identified in the case studies and surveys. This shows that the average savings opportunity was 10.8%, which equates to a savings opportunity of 1.04 million tonnes.

Table 13.37: A summary of case study findings in the travel agents et al sector

Subsector	**Sample Size**	**Mean Savings (%)**	**Standard Error (%)**	**Coefficient of Determination**
Travel agents et al	25	10.8	21.2	0.65

Valuation of waste savings

13.111 Based on the mean cost of waste disposal of £65 per tonne the waste savings opportunity is estimated to be £67.6 million.

13.112 Additionally, a key material stream is white paper. It is estimated that 20% of office waste is white paper[1]. By analysis of the SIC codes for this sector it is estimated that 60% of the activities are office based, which based on the 2006 projected waste figure (9.6 million tonnes) equates to 5.8 million tonnes. At 20%, white paper accounts for 1.15 million tonnes. Lexmark report that the UK throws away approximately 33% of all printed paper produced each day compared to only 8% in Spain. Therefore assuming that a 12% reduction in white paper use could be achieved through low-cost / no-cost interventions a saving of 138,000 tonnes would be achieved. Based on an average ream of paper costing £3 and weighing 2.5kg, a saving in raw material purchases of £1,200 per tonne could be achieved. Therefore a reduction of 138,000 tonnes of white paper would result in a raw material saving of £165.6 million.

13.113 The total waste savings opportunity from this sector is therefore estimated to be £233 million ±21.2%.

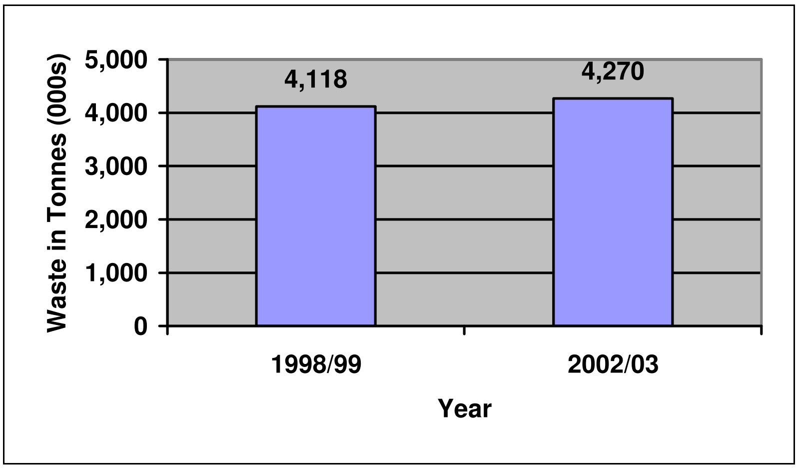
[1] www.wasteonline.org.uk quoting source EA C&I 2002/03 waste survey.

The hotels and catering sector

Background

13.114 Figure 13.26 shows the estimated waste arisings from the hotels and catering sector in the UK in 1998/99 and 2002/03. This shows waste arisings to have increased by 0.15 million tonnes. However, the standard error of the two surveys needs to be taken into consideration to determine the statistical significance of this increase.

Figure 13.26: Waste arisings from the hotels and catering sectors



Source: Defra[1].

13.115 Table 13.38 shows the range of possible waste arisings from the two surveys when taking the standard error into account. This shows that there is overlap between the two survey datasets indicating that the increase seen in 2002/03 is not statistically significant.

Table 13.38: Analysis of hotel and catering sector waste arisings, 1998/99 and 2002/03

Survey year	Estimated waste arisings (kt)	Standard error	Minimum waste arisings (kt)	Maximum waste arisings (kt)
1998/99	4,120	± 7.2%	3,890	4,340
2002/03	4,270	± 10.2%	3,920	4,620

[1] Figures for England only have been grossed up to UK level using the ratio of arisings from the service sector for the 4 countries as detailed in the EU waste statistics regulation (EC2150/2002) UK 2004 report by Defra July 2006, namely England 78.5%, Wales 4%, Scotland 15.1% and Northern Ireland 2.4%.

13.116 Table 13.39 shows the projected waste arisings in 2006/07 assuming the growth seen between 1998/99 and 2002/03 continued. This shows that the mean waste arising in 2006/07 is estimated to be 4.4 million tonnes.

Table 13.39: Projection of hotel and catering sector waste arisings to 2006/07

Survey year	Minimum waste arisings (kt)	Mean waste arisings (kt)	Maximum waste arisings (kt)
1998/99	3,890	4,120	4,340
2002/03	3,920	4,270	4,620
2006/07	3,960	4,420	4,890

13.117 Figure 13.27 shows the material stream making up the waste arisings from the sector in 2002/03. Much of the waste was collected in mixed format (65%) and Figure 13.28 shows that much of this waste was sent to land disposal (58%).

Figure 13.27: Waste arisings by waste type in hotels and catering sector, 2002

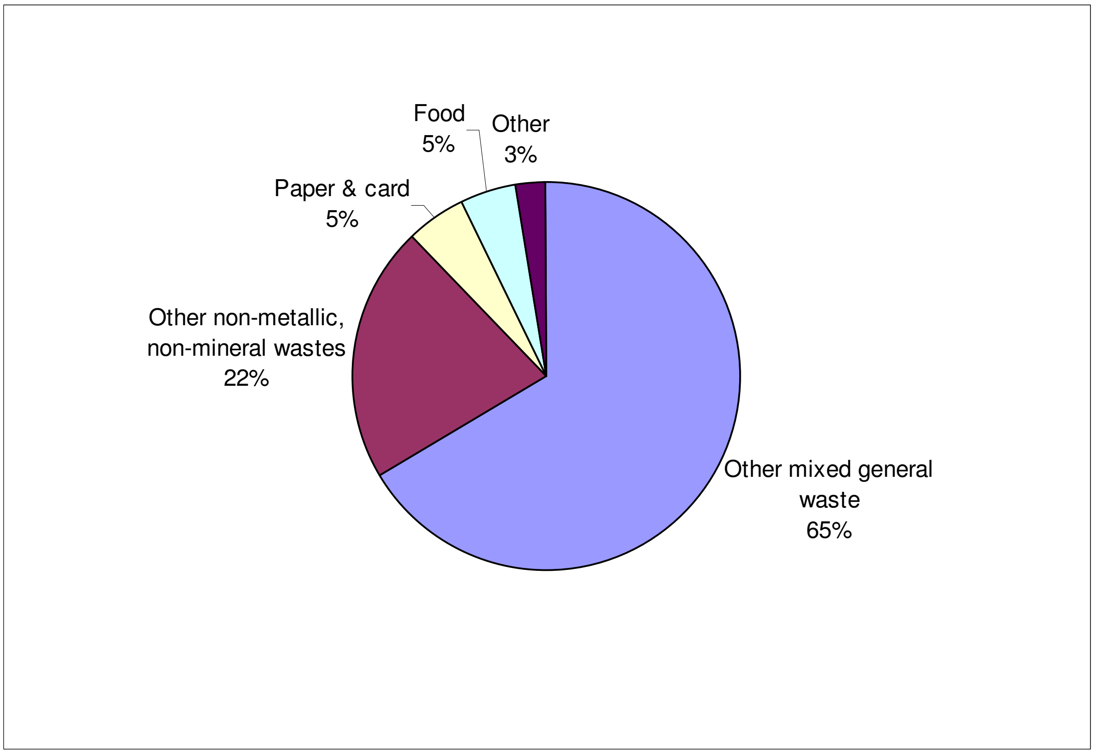
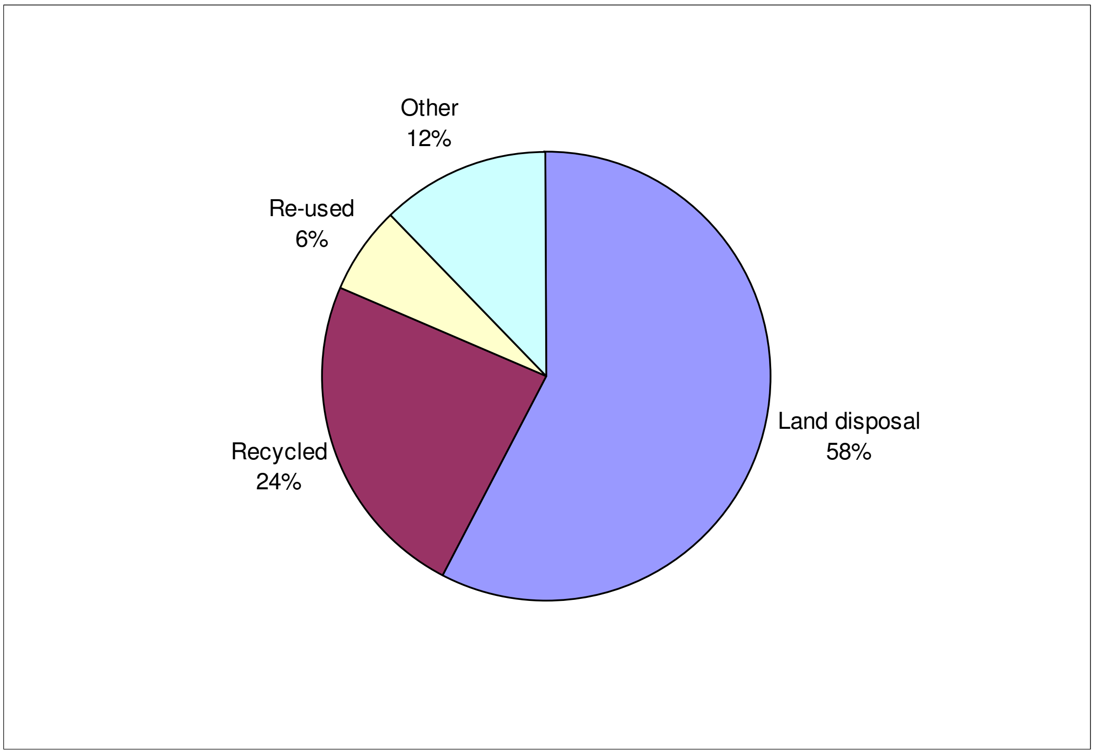


Figure 13.28: Waste arisings by waste management method in hotels and catering sector, 2002



Quantification of waste savings opportunity

13.118 Table 13.40 shows the results of the analysis of case studies and surveys undertaken in this area. This shows the average savings opportunity to be 24.3%. Much focus has been placed on improving the segregation of wastes and the recycling of such materials as glass, cardboard, paper, cans, organic kitchen waste, vegetable oil and plastic milk bottles. The savings opportunity of 24.3% equates to 1.07 million tonnes, based on the 2006/07 waste projections from this sector.

Table 13.40: A summary of case study findings in the hotels and catering sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Hotels and Catering	53	24.3	18.8	0.82

Valuation of waste savings

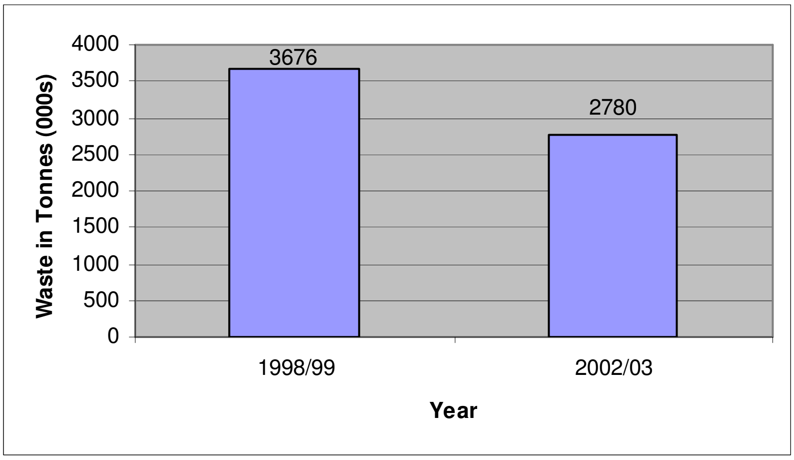
13.119 Based on the savings opportunity of 1.07 million tonnes and a waste disposal cost of £65 per tonne the savings opportunity is estimated at £69.8 million ± 18.8%. Since the vast majority of the case studies and surveys focused on the diversion of waste from land disposal and not the reduction in waste arisings through in-process interventions no hidden savings are attributed.

The transportation and communications sector

Background

13.120 Figure 13.29 shows the estimated waste arisings from the transportation and communications sector in the UK in 1998/99 and 2002/03. This shows waste arisings to have decreased by 0.9 million tonnes. However, the standard error of the two surveys needs to be taken into consideration to determine the statistical significance of this decrease.

Figure 13.29: Waste arisings from the transportation and communications sector



Source: Defra[1].

13.121 Table 13.41 shows the range of possible waste arisings from the two surveys when taking the standard error into account. This shows that there is no overlap between the two survey datasets indicating that the increase seen in 2002/03 is statistically significant.

Table 13.41: Analysis of transportation and communications sector waste arisings, 1998/99 and 2002/03

Survey year	Estimated waste arisings (Mt)	Standard error	Minimum waste arisings (Mt)	Maximum waste arisings (Mt)
1998/99	3.68	± 5.5%	3.47	3.88
2002/03	2.78	± 13.5%	2.41	3.16

[1] Figures for England only have been grossed up to UK level using the ratio of arisings from the service sector for the 4 countries as detailed in the EU waste statistics regulation (EC2150/2002) UK 2004 report by Defra July 2006, namely England 78.5%, Wales 4%, Scotland 15.1% and Northern Ireland 2.4%.

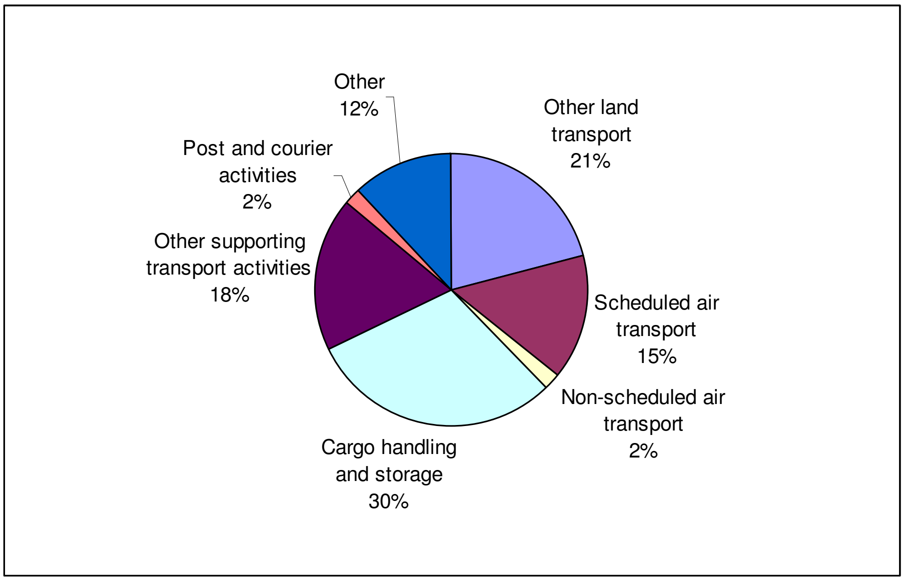
13.122 Table 13.42 shows the projected waste arisings in 2006/07 assuming the decline seen between 1998/99 and 2002/03 continued. This shows that the mean waste arising in 2006/07 is estimated to be 1.9 million tonnes.

Table 13.42: Projection of transportation and communications sector waste arisings to 2006/07

Survey year	Minimum waste arisings (Mt)	Mean waste arisings (Mt)	Maximum waste arisings (Mt)
1998/99	3.47	3.68	3.88
2002/03	2.41	2.78	3.16
2006/07	1.34	1.88	2.43

13.123 Figure 13.30 shows the breakdown of the sector with cargo handling and storage (31%) and sea and coastal water transport (24%) being the two most significant contributors to waste arisings.

Figure 13.30: The Transportation and communication sector waste arisings broken down by subsector



13.124 Figure 13.31 and Figure 13.32 shows the land disposal (45%) of mixed general waste (49%) to be the most significant method of managing waste in this sector in 2002.

Figure 13.31: Waste arisings by waste type in transportations and communications sector, 2002

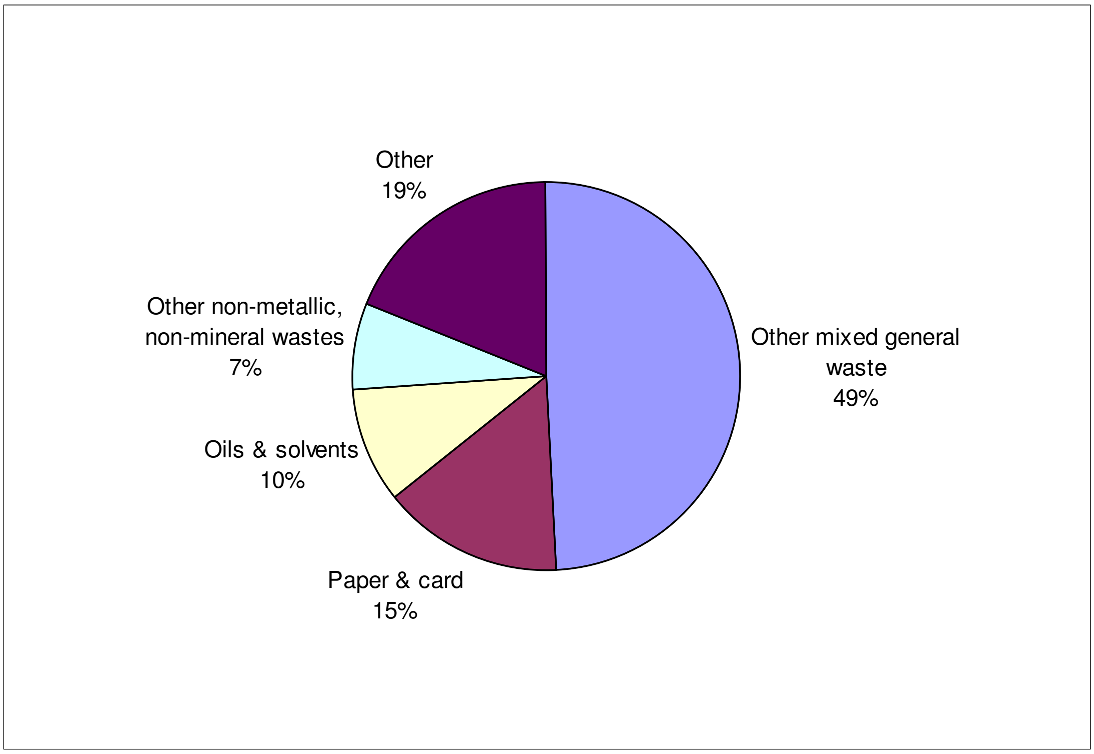
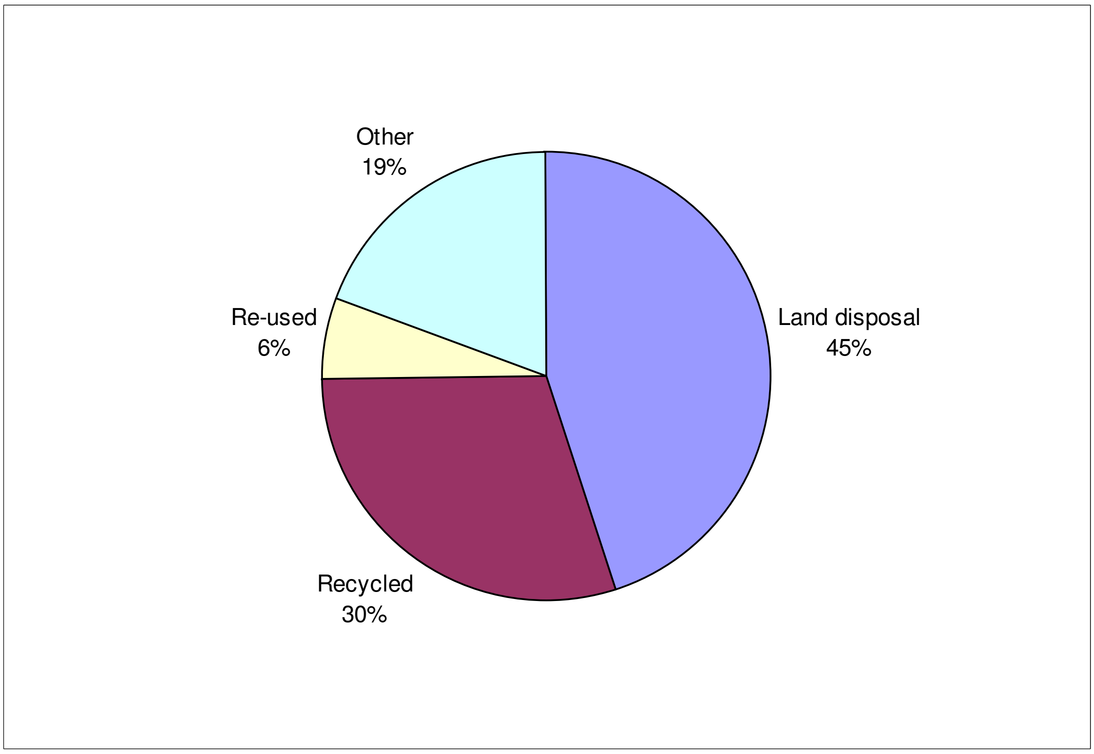


Figure 13.32: Waste arisings by waste management method in transportation and communications sector, 2002



Quantification of waste savings opportunity

13.125 The cargo handling and storage industry reports that it is difficult to minimise their waste without commitment from the whole supply chain since the design and specification of products and packaging has traditionally been undertaken by either the suppliers or purchasers[1].

13.126 Corrugated cardboard transit packaging and timber pallets and are two significant waste streams. Corrugated cardboard is reported to have a recycling rate of 84% in the UK, the highest recycling rate of any packaging[2]. The opportunity for increased recovery is therefore minimal.

13.127 Conversely, the average recovery rate for unwanted pallets in the UK is only 35%[3] and a literature review showed the best re-use rate of 86.6%[4]. A study of the composition of waste arisings from a food distribution centre was undertaken in the US showing wooden pallets to account for 18% of waste arisings[5]. Assuming these facts are relevant within this sector it is estimated that pallets account for 569,000 tonnes of waste, with 199,000 tonnes (35%) currently recovered. Assuming an improved recovery rate of 86.6% an additional 293,000 tonnes of pallets could be recovered.

Valuation of waste savings

13.128 The current price paid for high-grade wood for recycling is between zero and -£18/tonne with the Packaging Recovery Note value for pallets of £2 to £4 per tonne[6]. Therefore the average value of the wood is -£9/tonne. This is better than the cost of land disposal which for the commercial sector averages £65 per tonne. However, pallet recovery companies pay circa £1 per pallet, which at a weight of 24kgs equates to revenue of £41/tonne. Therefore the recovery of 293,000 tonnes of pallets generates revenue of £12 million.

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[1] Murray Devine, MSC, Private Communication. September 2007.

[2] www.paper.org.uk/corrugatedrecycles.htm. Accessed September 2007.

[3] www.scott-timber.co.uk Accessed September 2007.

[4] www.ssl-international.co.uk Accessed September 2007.

[5] www.nycedc.com Accessed September 2007.

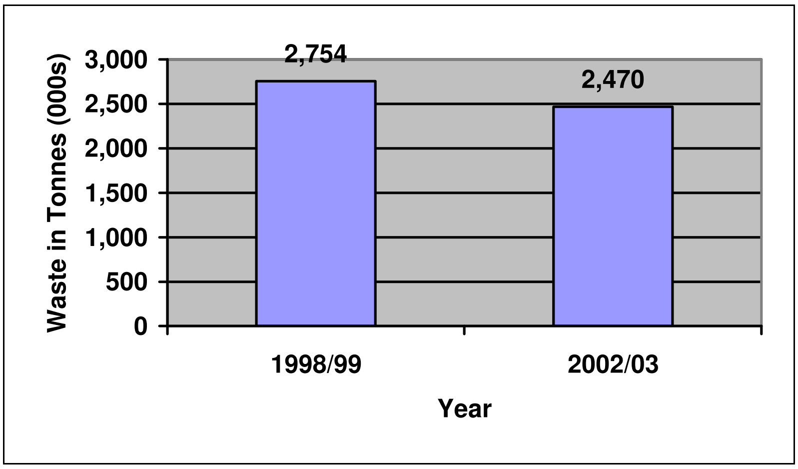
[6] www.letsrecycle.com. Accessed September 2007.

The education sector

Background

13.129 Figure 13.33 shows the estimated waste arisings from the education sector in the UK in 1998/99 and 2002/03. This shows waste arisings to have decreased by 0.28 million tonnes. However, the standard error of the two surveys needs to be taken into consideration to determine the statistical significance of this decrease.

Figure 13.33: Waste arisings from the education sector



Source: Defra[1].

13.130 Table 13.43 shows the range of possible waste arisings from the two surveys when taking the standard error into account. This shows that there is overlap between the two survey datasets indicating that the increase seen in 2002/03 is not statistically significant.

Table 13.43: Analysis of education sector waste arisings, 1998/99 and 2002/03

Survey year	Estimated waste arisings (Mt)	Standard error	Minimum waste arisings (Mt)	Maximum waste arisings (Mt)
1998/99	2.75	± 6.3%	2.58	2.93
2002/03	2.47	± 10.5%	2.21	2.73

[1] Figures for England only have been grossed up to UK level using the ratio of arisings from the service sector for the 4 countries as detailed in the EU waste statistics regulation (EC2150/2002) UK 2004 report by Defra July 2006, namely England 78.5%, Wales 4%, Scotland 15.1% and Northern Ireland 2.4%.

13.131 Table 13.44 shows the projected waste arisings in 2006/07 assuming the reduction seen between 1998/99 and 2002/03 continued. This shows that the mean waste arising in 2006/07 is estimated to be 2.2 million tonnes.

Table 13.44: Projection of education sector waste arisings to 2006/07

Survey year	Minimum waste arisings (Mt)	Mean waste arisings (Mt)	Maximum waste arisings (Mt)
1998/99	2.58	2.75	2.93
2002/03	2.21	2.47	2.73
2006/07	1.84	2.19	2.53

13.132 Figure 13.34 and Figure 13.35 shows the land disposal (64%) of mixed general waste (72%) to be the most significant method of managing waste in this sector in 2002.

Figure 13.34: Waste arisings by waste type in education sector, 2002

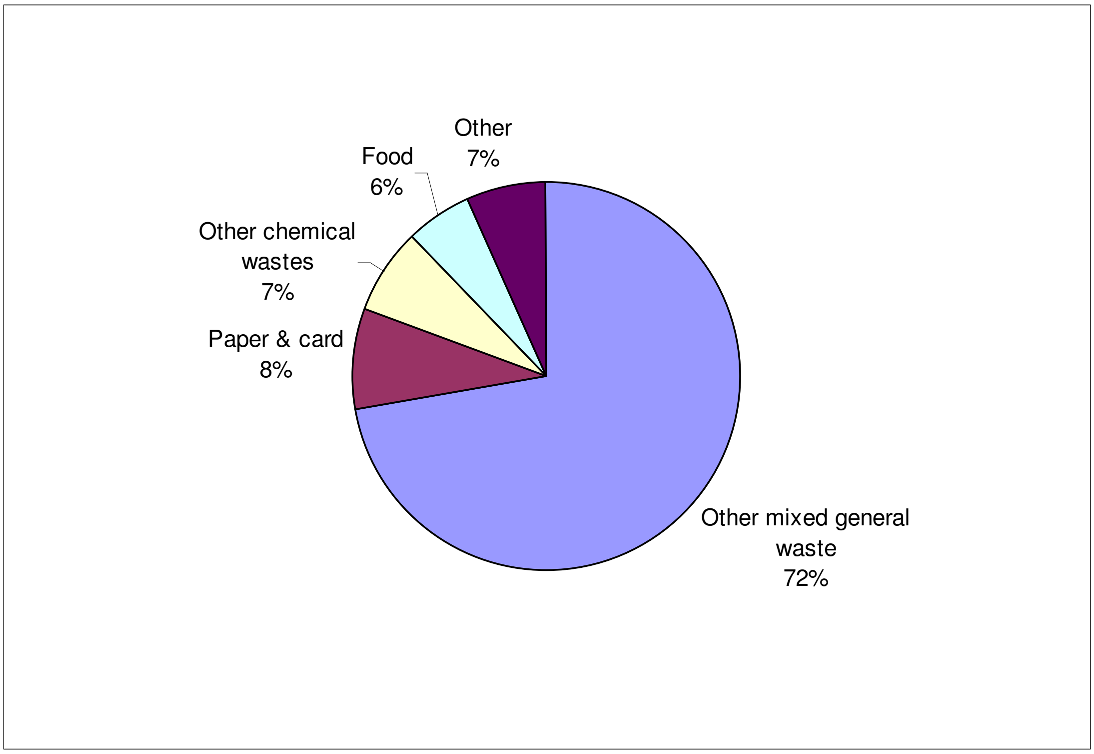
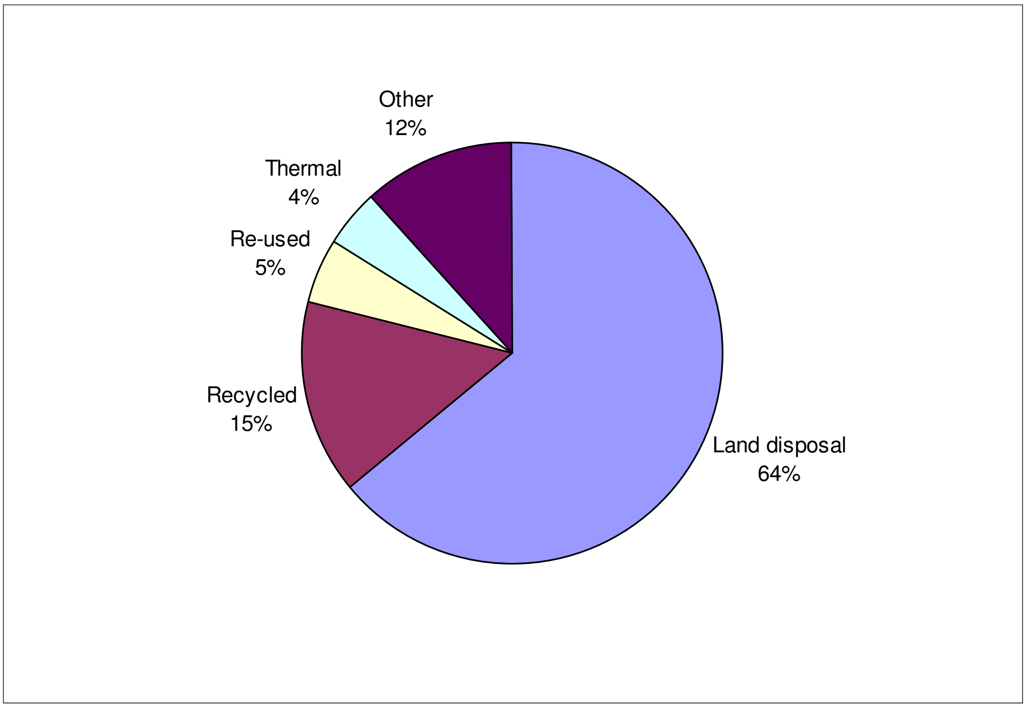
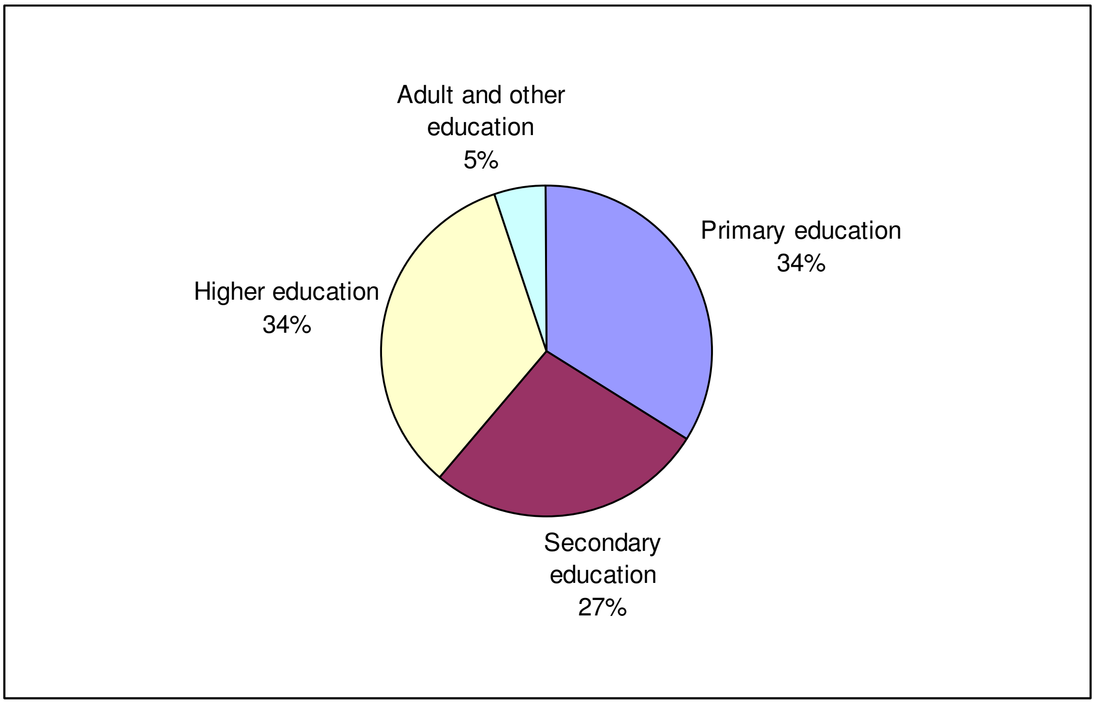


Figure 13.35: Waste arisings by waste management type in education sector, 2002



13.133 Figure 13.36 shows the breakdown of the sector with primary, secondary and higher education accounting for 95% of waste arisings.

Figure 13.36: A breakdown of waste arisings in the education sector

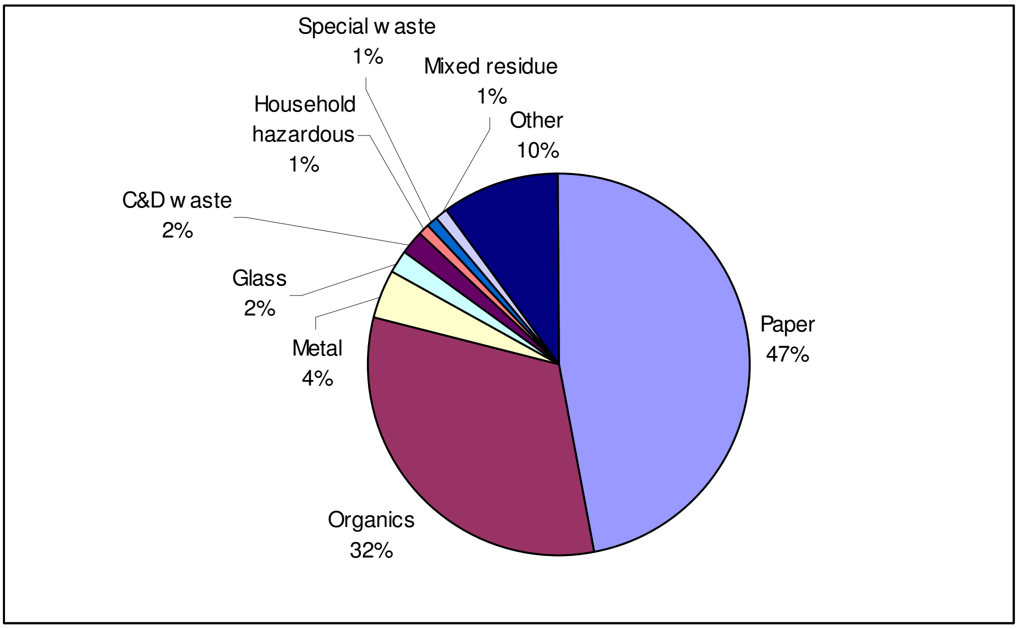


Quantification of waste savings opportunity

13.134 The Department for Children, Schools and Families estimates that a 20% reduction in waste is achievable through low cost interventions. The department covers both primary and secondary education, which represents 61% of the total waste arisings[1].

13.135 Figure 13.37 shows the composition of school waste as identified in a study undertaken in the USA[2]. This shows that paper and organics represent the two greatest opportunities for savings since they account for 79% of waste arisings.

Figure 13.37: A breakdown of the composition of school waste.



13.136 For the purposes of this study it is assumed that the saving of 20% is achievable across the sector equating to a waste reduction of 438,000 tonnes, based on mean waste arisings of 2.2 million tonnes (Table 13.44).

Valuation of waste savings

13.137 Based on waste disposal costs of £65 per tonne, the estimated saving is £28 million.

[1] A bursar's guide to sustainable school operation, Department for Education and Skills, pg 21, 2007

[2] www.ciwmb.ca.gov/schools/wastereduce/composition.htm Accessed August 2007

13.138 An estimation of the hidden cost of waste can also be made. It is a fair assumption that the waste from the higher and adult education sector is similar to the waste composition from offices and therefore comprises 20% white paper. In a similar calculation to that made for the travel agents, other business, finance, real estate and computer related activities (see relevant section), a 75% reduction in white paper generation is feasible, resulting in a saving opportunity of £25 million.

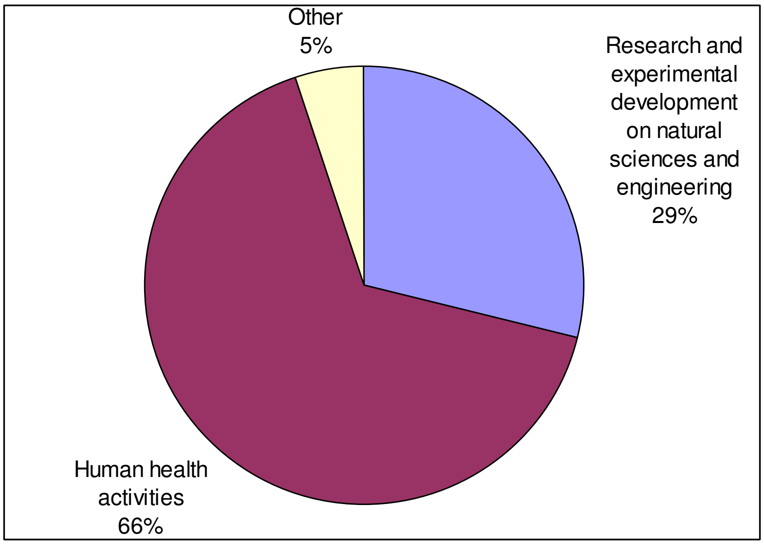
13.139 Based on the reduction in disposal and the hidden savings, the total savings for the education sector can be valued at £53 million.

Miscellaneous service industries

Background

13.140 Figure 13.38 shows that human health activities account for two-thirds of the waste generated within miscellaneous service industries. In the 2002/03 C&I survey it was estimated that waste arisings of 1.6 million tonnes were generated from the sector. The standard error of the survey was ±9.4% making the estimated range of waste arisings 1.4 to 1.7 million tonnes.

Figure 13.38: An analysis of waste arisings from the miscellaneous service industries



13.141 Figure 13.39 and Figure 13.40 show the same trend as observed in all the previous service sectors with the land disposal (54%) of mixed general waste (51%) to be the most significant method of managing waste in this sector in 2002.

Figure 13.39: Waste arisings by waste type in miscellaneous service activities sector, 2002

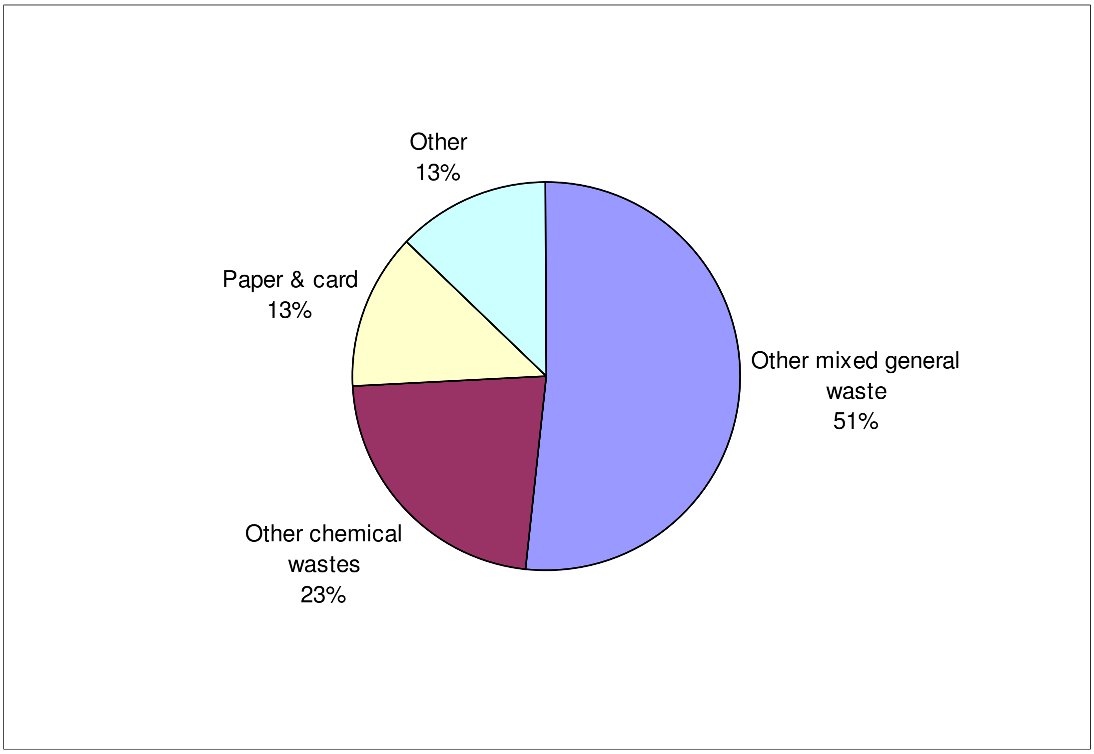
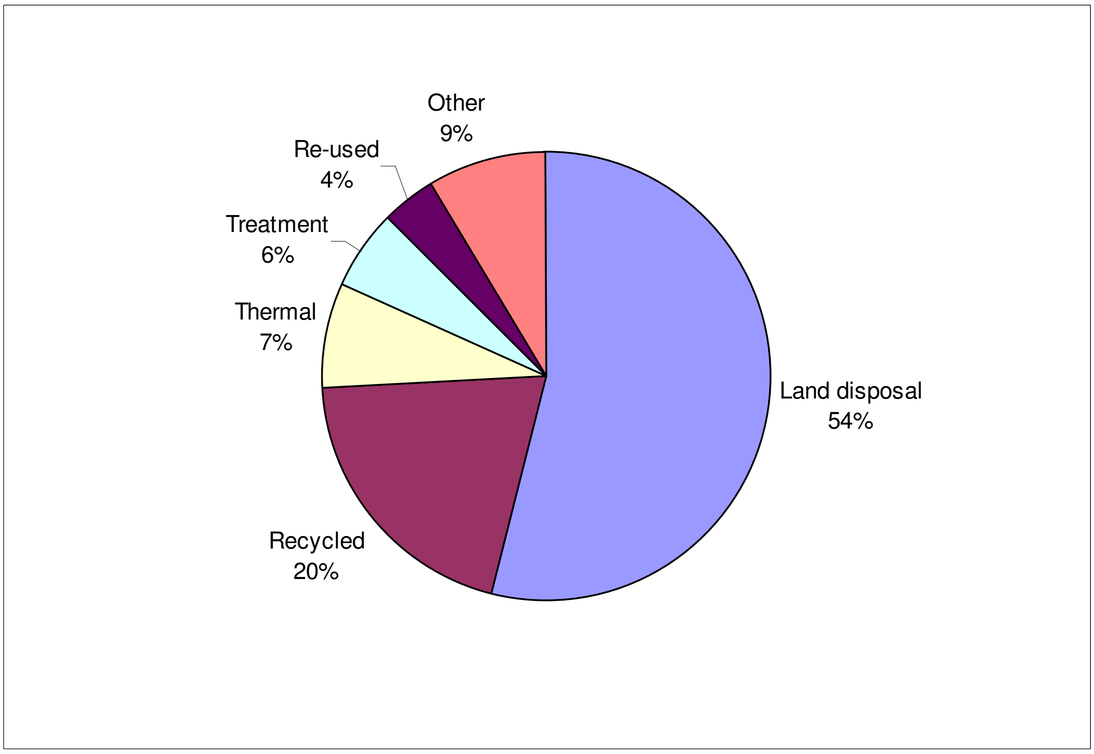


Figure 13.40: Waste arisings by waste management method in miscellaneous service activities sector, 2002



Quantification of waste savings opportunity

13.142 The waste manager for the NHS reports that waste reduction has not been a major priority for the NHS[1]. One area where there is potential reduction in waste is in the separation of clinical and domestic waste. Due to fears over contamination, large portions of uncontaminated domestic waste are entering the clinical waste stream. Estimates from the NHS suggest that 50% of all clinical waste is misassigned domestic waste. It is believed that this costs the NHS approximately £20 million per annum equating to approximately 55,000 tonnes per annum. Assuming that the private healthcare industry has similar issues with waste a further £4 million per annum could be saved. The total waste savings opportunity from this sector is therefore valued at £24 million.

[1] Lorraine Brayford. NHS, Private Communication August 2007.

Grossing up of waste savings opportunity within the commercial sector

13.143 Table 13.45 summarises the estimated savings within the six focus subsectors within the commercial sector. Based on the fact that these represent 95% of the waste arisings within the commercial sector it was considered reasonable to use the mean savings opportunity (12.0%) to gross the savings up to sector level. The savings opportunity in the remaining "other" sector, which generates 1.97 million tonnes of waste, is therefore 236,000 tonnes with an estimated total savings opportunity of £46 million (including a saving in waste disposal of £16.8 million).

Table 13.45: Summary of waste savings opportunity within the eight focus subsectors of the industrial sector

Subsector	**Waste arisings (Mt)**	**Estimated waste savings**		
		%	**Mt**	**£M**
Retail et al	20	9.0	1.8	607
Travel agents et al	10	10.8	1.0	233
Hotels & catering	4	24.3	1.1	70
Transport	2	13.4	0.3	12
Education	2	20.0	0.4	53
Misc. service industries	2	0	0	24
Total	**40Mt**	**11.5%**	**4.6Mt**	**£999M**

14 Appendix 6: "H Score" methodology

14.1 H scores are derived from a company's published financial results. The H score quantifies how closely financial information from the company under consideration resembles the information from companies which subsequently failed. The research methodology is based on in-depth analysis of the two sets of financial data. The first set includes data on companies which failed subsequent to their financial data being published. The second set of data includes companies which continue to operate. The statistical analysis of the data sets identifies the differences in indicators that determine the likelihood of company failure.

14.2 This likelihood of failure is captured within the H score where lower scores indicate increasing likelihood of business failure. The scores take a value from 0 to 100, the value of which indicates the extent to which the company's financial characteristics resemble companies that fail. An H score of 20 indicates that only 20% of the business population have characteristics that are even more indicative of failed companies indicating that the company's financial health is relatively weak. By contrast a score of 90 indicates strong financial health, since only 10% of companies are less likely to fail.

14.3 The H score is built up from seven key factors within the following three categories:

- **profit management** measures the contribution that earnings are making towards minimising financial risk
- **asset management** measures the strength of financial management of assets - particularly liquidity and working capital
- **funding management** measures the strength of the company's funding, the adequacy of the capital base and dependence on debt

14.4 More details on the development of H scores can be found at: http://www.companywatch.net/hs_bb.html. More details on the interpretation of H scores can be found at: http://www.companywatch.net/hs_over.htm

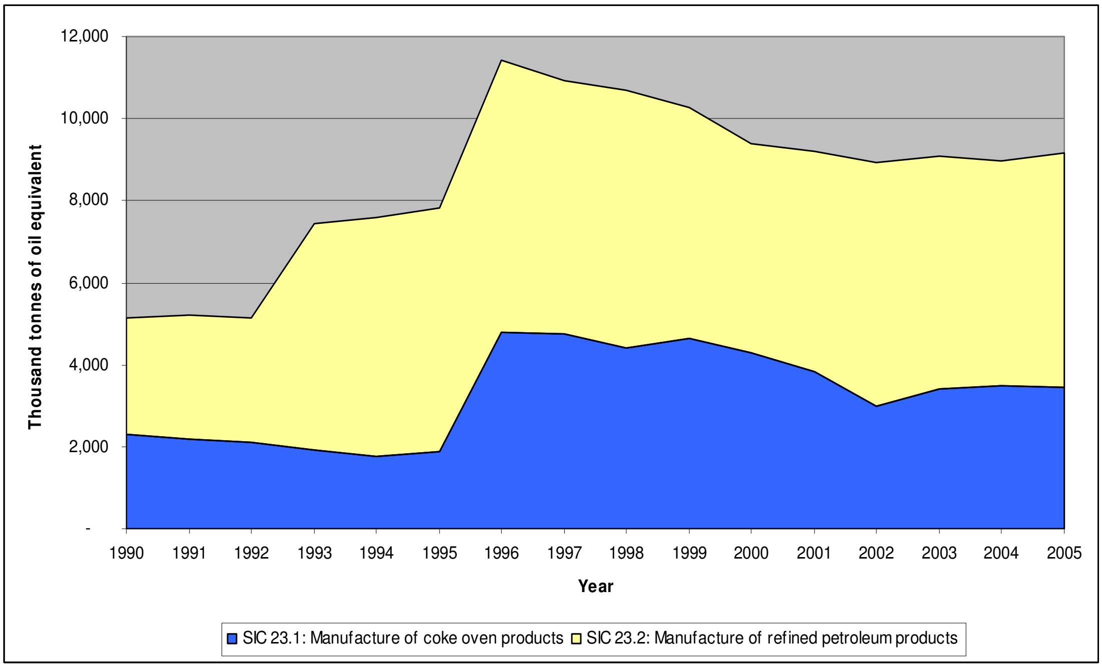
15 Appendix 7: Detailed analysis of energy savings opportunities

The industrial sector

The coke, refined petroleum products and nuclear fuel sector

15.1 Figure 15.1 shows the trend in energy consumption within the coke, refined petroleum products and nuclear fuel sector between 1990 and 2005. This shows that overall energy consumption within the sector has increased significantly over the 15 year period (78%) with the period between 1990 and 1996 showing the most significant increase. Since 2000 the overall energy consumed in the sector has remained static.

Figure 15.1: The trend in energy consumption in the coke, refined petroleum products and nuclear fuel sector



Source: BERR.

15.2 Figure 15.1 also shows that the manufacture of refined petroleum products is the most significant energy user accounting for 55% of the sector's energy use in 1990 increasing to 62% in 2005. The manufacture of coke oven products makes up the remainder.

Quantification of energy savings

Refineries

15.3 Figure 15.2 shows the relationship between the energy consumed by UK refineries and their overall throughput. This shows that energy use has fluctuated between 6 and 7% of overall refinery throughput. This is a key measure of performance since circa 90% of the energy used in refineries is for process heating[1] and hence is directly related to sector output. Two significant factors influencing future energy use are:

- the need to process petroleum products to meet tighter product standards, which require more energy input. Entec (August 2006) report that this trend is likely to continue due to the increased conversion of heavier feedstock's to meet the demand for lighter fraction transport fuels, e.g. aviation fuel, and a drop in demand for heavier fuels, e.g. fuel oil.

- the fact that production rates of sweet light North Sea crude oil (typical density 834kg/m^3) are declining and many refineries designed to process this feedstock are now installing additional process units to process imported heavier sourer crude oil (typical density 851kg/m^3). This will increase refinery energy use.

15.4 However, Defra reports that[2]:
"Additional sulphur removal from fuels (desulphurisation) requires additional energy use, even though throughput does not change. Emission increases from desulphurisation can be offset by ongoing energy efficiency measures implemented by refineries, so it is difficult to discern the consequences of additional sulphur removal from total plant emissions"

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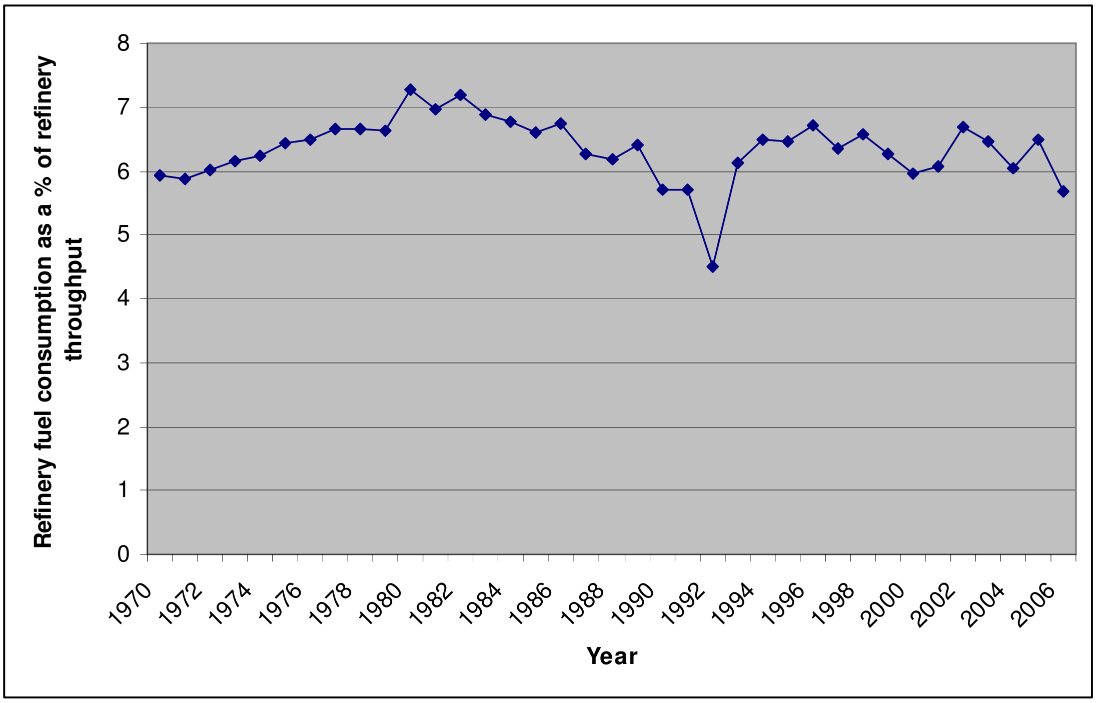
[1] BERR-EU emissions trading scheme phase 2. Review of new entrants' benchmarks – refineries. Report version 2. August 2006. Entec.

[2] EU emissions trading scheme – 2005 results for the UK. Summary sheet 3 refineries sector. Defra 2006.

Figure 15.2: Energy consumption in the refinery sector



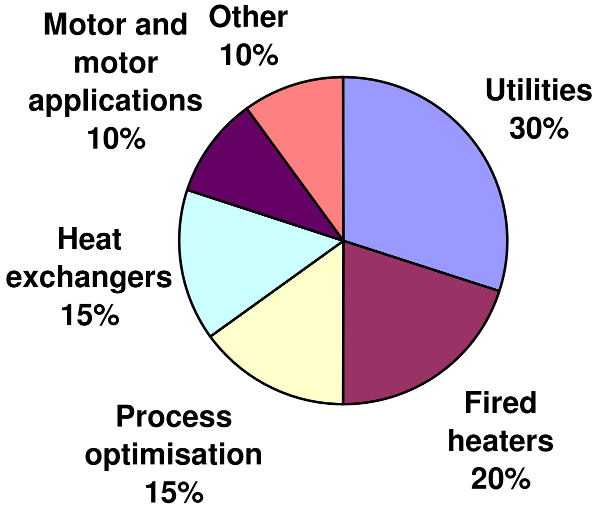
15.5 A study undertaken in 2001[1] estimated the economic energy efficiency savings potential within Western European refineries to be in the range of 5% to 8% by 2010 and 7% to10% by 2020.

15.6 A benchmarking study undertaken in the USA in 2004 indicated that most petroleum refineries can economically improve energy efficiency by 10% to 20%[2]. Figure 15.3 shows the breakdown of savings opportunity from the study. The study reports that, of these areas, optimisation of utilities, heat exchangers and fired heaters offers the most low investment opportunities, while other opportunities may require higher investments. Assuming that the overall savings opportunity is 15% the low-cost / no-cost savings from these three factors, which equate to 65% of overall savings opportunity, represent a savings opportunity of 9.75%.

[1] Securing a sustainable energy future in an enlarged European Union, April 2001. Green / EFA group in the European Parliament.

[2] Energy efficiency improvement and cost savings opportunities for petroleum refineries. An energy star guide for energy and plant managers. Ernst Worrell and Christina Galitsky. Berkeley Lab, Feb 2005.

Figure 15.3: A breakdown of savings opportunity within USA refineries



15.7 A case study undertaken at the Shell Frederica refinery in Denmark in 2004, as part of their Energise energy efficiency programme, states:
"A significant number of operational changes are now under way and should cut the refinery's annual energy bill by 9% with minimal capital expenditure".

15.8 The "Review of new entrants' benchmarks – refineries[1]" report stresses that new entrants in the UK should achieve a performance equivalent to that of the top 10% worldwide performing refineries. Using the Solomon E11[2] tool as a benchmark this represents a 15% improvement on the current mean performance of European refineries. This is in agreement with the findings of the benchmark study of refineries in the USA in terms of the total energy savings opportunity, although it must be stressed that the retrofitting of existing plant is unlikely to achieve the efficiencies of new plant.

15.9 The US benchmarking study and the Danish Refinery case study suggest that the low-cost / no-cost savings opportunity within the UK refinery sector is circa 9%. However, UKPIA[3] (UK Petroleum Industries Association) stresses that energy efficiency has received significant management attention from the UK refiners. This attention has increased in recent years due to the EU ETS

[1] BERR-EU emissions trading scheme phase 2. Review of new entrants' benchmarks – refineries. Report version 2. August 2006. Entec.

[2] The Solomon E11 is a proprietary energy efficiency index for refineries operating across the world.

[3] Ian McPherson, UKPIA Personal Communication.

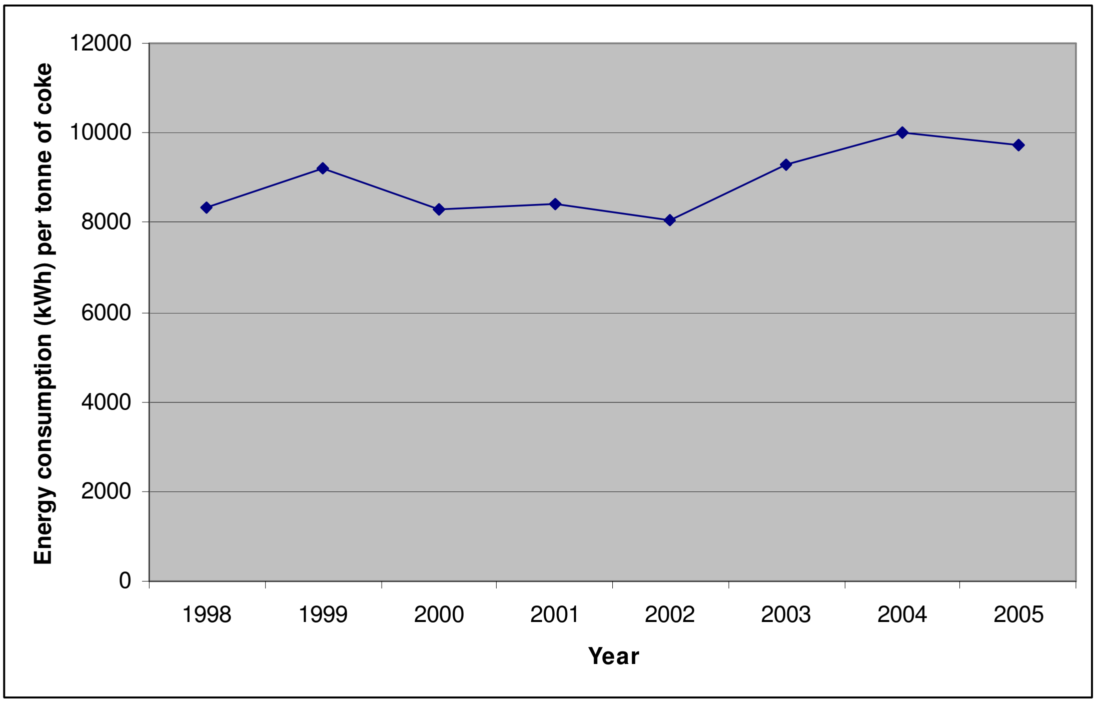
(which involves permitting, monitoring, reporting, verification, registry and trading), higher energy prices justifying more investment in energy efficiency, heat integration and new CHP / COGEN investment. In addition, UK refiners report energy improvements, for example, Exxon Mobil report that at their Fawley facility:
"energy efficiency improvements over recent years have led to significant reductions in emissions – equivalent to taking 250,000 cars off the British roads every year".

15.10 It is estimated therefore that the low-cost / no-cost energy savings opportunity remaining within UK refineries is quite modest and hence a value of 2% is applied.

Coke manufacture

15.11 Figure 15.4 shows the assessment of energy use per tonne of product processed within coke manufacture. This shows that the energy intensity has increased significantly between 2002 and 2005.

Figure 15.4: Energy consumption per unit of output in coke manufacture (kWh/t)



15.12 A study[1] undertaken in 2001 estimated the economic potential energy savings in Western Europe from iron and steel, coke ovens at 9-15% by 2010 and 13%-20% by 2020.

15.13 The iron and steel industry is the major user (and converter) of coke and it is reported[2] that as part of their research and development programme Corus are focusing on reducing emissions from coke ovens, improving coke quality and the efficiency of coke making and maximising the impact of direct coal injection into furnaces as a way of reducing costs and improving efficiency.

15.14 Coke ovens are similar to the refining process in that they are both high temperature users of energy and hence have been subject to the same constraints. It is therefore considered appropriate to assume that the same savings opportunity exists. Therefore it is estimated that the savings potential in the coke sector is 2%.

15.15 Table 15.1 shows a summary of the estimated savings potential within this sector.

Table 15.1: Summary of estimated energy savings in the coke et al sector

Sector	**Energy use (TWh)**	**Energy savings potential (%)**	**Mean energy savings potential (TWh)**
Refineries	66.45	2	1.33
Coke	40.01	2	0.8
Total	**106.45**	**2**	**2.13**

Valuation of energy savings

15.16 The cost of energy for the sector has been calculated according to the fuel mix used in the sector and the mean cost per fuel (Table 15.2). Applying an energy price of 2.80p/kWh to the savings shown in Table 15.1 the short to medium term savings opportunity within this sector is £59.6 million.

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1 Securing a sustainable energy future in an enlarged European Union, April 2001. Green/EFA group in the European Parliament. 2002.

2 www.ukerc.rl.ac.uk/landscapes/coal_conversion_section4.pdf Accessed September 2007.

Table 15.2: Summary of energy price (p/kWh) within the coke, refined petroleum products and nuclear fuel sector

Fuel	Total consumption (ktoe)	Fuel mix	Fuel price (p/kWh)	Weighted average kWh price (p)
Coal	880	0.14	0.626	0.09
Heavy oil	1,950	0.30	2.0987	0.63
Gas oil	280	0.04	2.957	0.13
Electricity	1,640	0.26	5.85	1.49
Gas	1,680	0.26	1.746	0.46
			Total	**2.80**

15.17 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.3. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £4.4 million, making the estimated total savings for the sector £64 million.

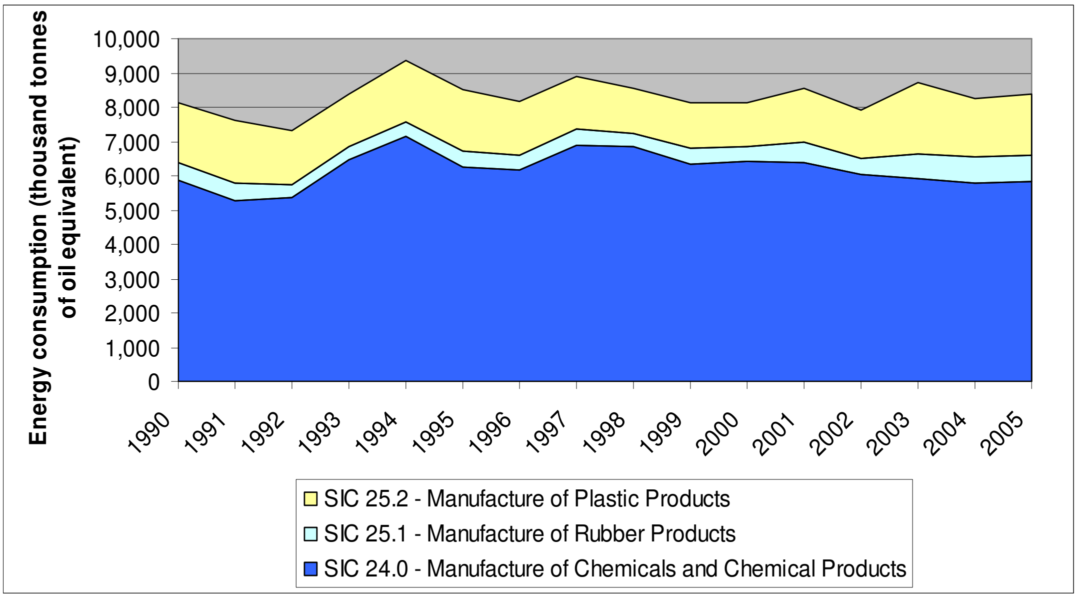
Table 15.3: Summary of energy price (p/kWh) within the coke, refined petroleum products and nuclear fuel sector (CCL)

Fuel	Total consumption (ktoe)	Fuel mix	CCL (p/kWh)	Weighted average kWh price (p)
Coal	880	0.14	0.17	0.024
Heavy oil	1,950	0.30	0.08	0.023
Gas oil	280	0.04	0.08	0.003
Electricity	1,640	0.26	0.44	0.115
Gas	1,680	0.26	0.15	0.040
			Total	**0.205**

The chemicals sector

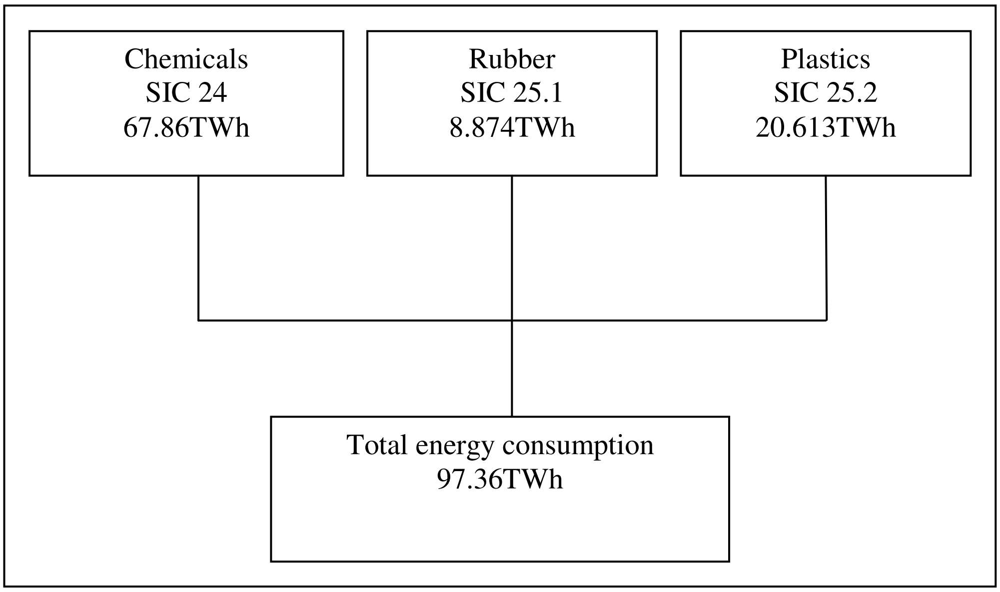
15.18 The chemicals sector accounted for 18.5% of the overall energy consumption from the industrial sector in 2006 and Figure 15.5 shows the trend in energy consumption within the chemicals sector between 1990 and 2005.

Figure 15.5: The trend in energy consumption in the chemicals sector



15.19 Figure 15.6 shows a breakdown of the energy consumed within the chemicals sector in 2005. This shows that the energy usage is split with chemicals (SIC 24) accounting for 70%, plastic (SIC 25.2) 21% and rubber (SIC 25.1) 9%.

Figure 15.6[1]: Total energy use (TWh) in the chemicals sector in 2005[2]



Quantification of energy savings

15.20 Table 15.4 shows the baseline energy savings opportunity within the three subsectors, chemicals, rubber and plastics as estimated in a 2003 Carbon Trust report. This estimated the short to medium term savings (improvements in operational practices and retrofitting) in the chemicals subsector to be 8.7%, rubber 10.3% and plastics 12.2%. The overall average short to medium term savings opportunity for the sector is 9.4%.

Table 15.4: Energy savings in the chemicals sector 2003

Subsector	Carbon impact (MtC)	Cost effective carbon savings (% of total impact)			
		Improvements in operational practices	Retrofitting	New plant	Total savings opportunity
Chemicals	6.24	2.88	5.77	5.77	14.42
Rubber	0.39	5.13	5.13	5.13	15.39
Plastics	1.47	7.45	4.76	2.72	14.93

Source: Adapted from Industrial energy efficiency fact base and market assessment. Future Energy Solutions for the Carbon Trust. August 2003. NB: short to medium term savings is made up of improvements in operational practices and retrofitting.

15.21 Using the intensity information contained in Table 4.3 the chemical sector has improved by 29.4% over the 15 year period between 1990 and 2005,

[1] http://www.dti.gov.uk/energy/statistics/publications/ecuk/industrial/page18171.html Table 4.6 Accessed July 2007.

[2] Converted from Tonnes Oil Equivalent (toe) within the BERR data source using the conversion factor 1 toe = 11,630 kWh

representing an annual improvement of 1.95%. Therefore, assuming the same level of improvement will have taken place between 2002 and 2006 only 1.6% savings opportunity would remain, i.e. 9.4% - (4 x 1.95%).

15.22 An additional source of information is the Climate Change Agreements (CCAs) described in the methodology section of this report. The chemicals and rubber subsectors have CCAs in place. Table 15.5 shows the results of the CCA for the chemicals subsector. This shows that energy efficiency has improved by 5.6% between 2002 and 2006, i.e. the Energy Efficiency Ratio (EER) has reduced by 0.056, and absolute consumption has reduced by 20%. The Chemical Industries Association (CIA) reports that the savings in energy efficiency falls into the categories of[1]:

- plant improvement / replacement (including de-bottlenecking and expansion)
- process improvement (including process control)
- new installation / expansion of improvement to CHP plants and boilers
- improvements to steam distribution
- replacement of motors and drives
- refrigeration and compressed air improvements
- better energy management.

15.23 Such factors fall under the category of short to medium term improvements and hence suggest that 5.6% of the 8.65% savings opportunity shown in Table 15.4 have been realised within the energy intensive users. This leaves a short to medium term savings opportunity of 3.05% for these energy intensive companies. This relatively modest savings opportunity is in line with the thoughts of the CIA who report[2]:
"if we add CCA achievements to our record under the previous voluntary energy efficiency agreement with government, we have now improved our efficiency by a massive 34% since 1990. We are committed to further

[1] EU emissions trading schemes results for the UK – 2005. Summary sheet 11: chemical sector. Defra 2005.

[2] www.cia.org.uk Accessed July 2007.

optimising our use of energy through more innovative approaches and to continuing to provide energy saving products to others"

Table 15.5: Results of the third CCA target period assessment for the chemicals sector[1]

	Primary energy consumption (TJ)	Primary energy consumption (TWh)[2]	Energy Efficiency Ratio (EER)
2002 (TP1)	288,070	80.0	0.855
2004 (TP2)	279,200	77.6	0.805
2006 (TP3)	230,380	64.0	0.799

15.24 The CCA in operation within the rubber sector focuses specifically on the manufacture of new tyres and the associated tyre compounds. Table 15.6 shows the results from the third target period assessment. The analysis shows that both absolute and specific energy consumption have improved by 19% between 2002 and 2006. This therefore implies that the 10.26% short to medium term savings opportunity shown in Table 15.4 for this sector has been realised or will be extremely modest and hence a savings opportunity of zero will be applied.

Table 15.6: Results of the third CCA target period assessment for the rubber sector[3]

	Primary energy consumption (TWh)	Production (kt)	Specific energy consumption (kWh/t)
2002 (TP1)	1.76	289	6,073
2004 (TP2)	1.66	332	5,004
2006 (TP3)	1.42	290	4,899

15.25 Table 15.7 summarises the savings opportunity in companies working within a CCA. NB: The primary energy consumption shown in Table 15.5 and Table 15.6 have been converted to secondary energy using the BERR consumption data[4].

[1] Climate Change Agreement. Results of the third target period assessment. July 2007. AEAT for Defra.

[2] Converted from TJ reported in the CCA to TWh using the conversion factor of 1 kWh = 3,600,000 Joules.

[3] Climate Change Agreement. Results of the third target period assessment. July 2007. AEAT for Defra.

[4] http://www.dti.gov.uk/energy/statistics/publications/ecuk/industrial/page18171.html Table 4.6 Accessed May 2007. The relationship between primary and secondary energy consumption was derived by firstly determining the total primary energy consumed within the two sectors. This involved applying a factor of 2.6 to the electricity consumed within each sector. This results in the primary energy consumed within the chemical sector to be estimated at 8,893ktoe and 1,142ktoe for the rubber sector. Therefore the 5,850 ktoe secondary energy consumed within the chemical sector represents 65.78% of the primary energy and the 765ktoe secondary energy consumed by the rubber sector represents 67.0% of the primary energy consumed in the rubber sector. These ratios were applied to the primary energy figures shown in tables 6.3.1b and 6.3.1c to convert primary energy to secondary energy.

Table 15.7: Analysis of energy consumption, chemicals sector

Organisation	Product group	Total energy consumed TP2 (TWh) [1]	Estimated S-M savings opportunity in 2002	S-M savings opportunity remaining (%)	S-M savings opportunity remaining (TWh)
CIA chemicals	Chemicals	42.09	8.65	3.05	1.28
BRMA	Rubber	0.95	10.3	0.00	0
	Total	**43.04**		**Total**	**1.28**

15.26 The Carbon Trust reports[2] that energy savings opportunities exist within the rubber processing sector by improving the efficiency of combustion and insulation on the distribution systems. The Carbon Trust continues: *"Typically, energy costs (within the plastics and rubber sectors) can be reduced by 15%, and competitiveness improved, using low-cost / no-cost help from the Carbon Trust"*

15.27 This 15% saving within plastic processing is in line with the findings of RAPRA, who as part of the EU RECIPE (Reduced Energy Consumption in Plastics Engineering) programme have developed a best practice guide[3] where it is reported that a saving of 15% could be made across the sector through simple measures.

15.28 A savings opportunity of 15% is in agreement with the average savings from all interventions (including capital investment) shown in Table 15.4. Therefore it is assumed that the full short to medium term savings opportunities shown in Table 15.4 still exist for non-CCA companies. Table 15.8 shows the estimated savings opportunities from the three subsectors. This shows estimated savings of 5.49TWh. Adding the savings of 1.28TWh for the CCA obligated companies the overall sector savings are estimated at 6.77TWh or 5.6% of total energy consumption in the sector.

[1] Climate change agreements. Results of the second target period assessment. Future Energy Solutions, July 2005.

[2] www.carbontrust.co.uk/energy/startsaving/sectorselector/ Accessed May 2007

[3] Low Energy Plastics Processing European Best Practice Guide. Reduced Energy Consumption in Plastics Engineering. October 2006. RAPRA.

Table 15.8: Analysis of energy savings opportunity by non-CCA companies

Subsector	Total energy consumption (TWh)	CCA energy consumption (TWh)	Non-CCA energy consumption (TWh)	S-M savings opportunity (%)	Total savings opportunity (TWh)
Chemicals	67.86	42.09	25.77	8.4	2.16
Rubber	8.87	0.95	7.92	10.26	0.81
Plastics	20.61	0	20.61	12.21	2.52
Total	**97.36**	**43.04**	**54.31**		**5.49**

Valuation of energy savings

15.29 The cost of energy for the sector has been calculated according to the fuel mix used in the sector and the mean cost per fuel (Table 15.9). Applying an energy price of 3.22p/kWh to the savings shown in Table 15.8 the short to medium term savings opportunity within this sector is £176 million.

15.30 To verify this, the CIA estimates[1] that the energy bill for the chemical industry is circa £3 billion. Applying a savings of 5.6% results in an estimated saving of £168 million.

Table 15.9: Summary of energy price (p/kWh) within the chemicals sector

Fuel	Total consumption (ktoe)	Fuel mix	Fuel price (p/kWh)	Weighted average kWh price (p)
Coal	210	0.02	0.626	0.02
Heavy oil	340	0.04	2.0987	0.08
Gas oil	850	0.10	2.957	0.30
Electricity	2,780	0.33	5.85	1.94
Gas	4,220	0.50	1.746	0.88
			Total	**3.22**

15.31 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.10. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £13 million, making the estimated total savings for the sector £189 million.

[1] Mike Lancaster, CIA, Personal communication. July 2007.

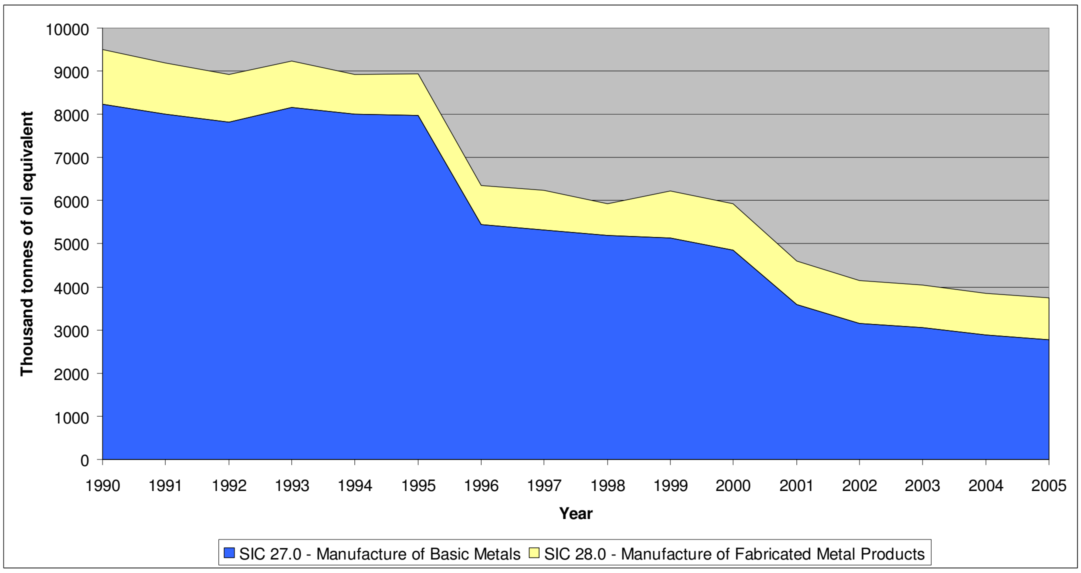
Table 15.10: Summary of energy price (p/kWh) within the chemicals sector (CCL)

Fuel	**Total consumption (ktoe)**	**Fuel mix**	**CCL (p/kWh)**	**Weighted average kWh price (p)**
Coal	210	0.02	0.1695	0.003
Heavy oil	340	0.04	0.07544	0.003
Gas oil	850	0.10	0.07544	0.008
Electricity	2,780	0.33	0.441	0.146
Gas	4,220	0.50	0.154	0.077
			Total	**0.237**

The iron and steel, non-ferrous metals and mechanical engineering sectors

15.32 This sector accounted for 13.1% of the total energy consumed by industry in 2005 and Figure 15.7 shows the trend in energy use in the sector between 1990 and 2005. This is dominated by the 66% reduction in energy consumption within the manufacture of basic metals. The key sector influencing this reduction is the manufacture of basic iron and steel and of ferro-alloys (SIC 2710), which dropped from 6,215ktoe in 1990 to 1,578ktoe in 2005 due to consolidation in the industry.

Figure 15.7: The trend in energy consumption in the metals sector



Quantification of energy savings

15.33 The Carbon Trust study of 2003 estimated that the short and medium term energy savings opportunity from this sector equated to 9.7% and the total savings opportunity, including capital expenditure, 11.4% (Table 15.11).

Table 15.11: Energy savings in the metals sector 2002

Subsector	Carbon impact (MtC)	Cost effective carbon savings (% of total impact) Improvements in operational practices	Retrofitting	New plant	Total savings opportunity
Steel	5.79	0.5	4.8	-	5.3
Engineering	4.22	11.4	4.7	2.8	19.0
Non-ferrous	1.19	1.7	3.4	3.4	8.4
Foundries	0.56	8.9	8.9	5.4	23.2
Total	**11.76**	**4.9**	**4.8**	**1.6**	**11.4**

Source: Adapted from Industrial energy efficiency fact base and market assessment. Future Energy Solutions for the Carbon Trust. August 2003. NB: "Engineering" is a cross sectoral grouping and not simply mechanical engineering (SIC 28)

15.34 Table 4.3 shows that the improvements in energy consumption shown in Figure 15.7 are predominantly due to improvements in energy intensity, i.e. energy intensity accounted for 82.5% of the reduction in energy consumption between 1990 and 2005 and a reduction in sector output accounted for the remaining 17.5%. The 48.5% improvement in energy intensity between 1990 and 2005 equates to an annual improvement of 3.2%. Therefore, it would be anticipated, based on this analysis, that a significant proportion of the 9.7% savings opportunity shown in Table 15.11 would have been realised in the period since 2002.

15.35 As an alternative methodology for evaluating the savings opportunity the Climate Change Agreements within the sector can be analysed. The areas in which CCAs exist within this sector are:

- steel sector
- non-ferrous metals (excluding aluminium)
- metal packaging
- metal forming
- foundries
- aluminium sector.

The steel sector

15.36 The CCA for the steel sector is managed by UK Steel who reports that members of the trade association account for 98% of the energy consumed within the steel sector. Table 15.12 shows the CCA returns up to 2006, i.e. up to the end of the third CCA reporting period (target period TP3). The analysis shows that specific energy consumption (energy consumption per tonne output) improved by 6.9% over the period; an annual improvement of 1.73%. This suggests that the 5.3% short to medium term savings opportunity identified in 2002 (Table 15.11) will have been realised. Further evidence of this can be seen in Figure 15.7 which shows specific energy consumption dropping from 32.8 GJ/t output in 1972 to 19.3GJ/t in 2004[1]. It is therefore estimated that no or minimal quick win savings opportunity remains in this sector.

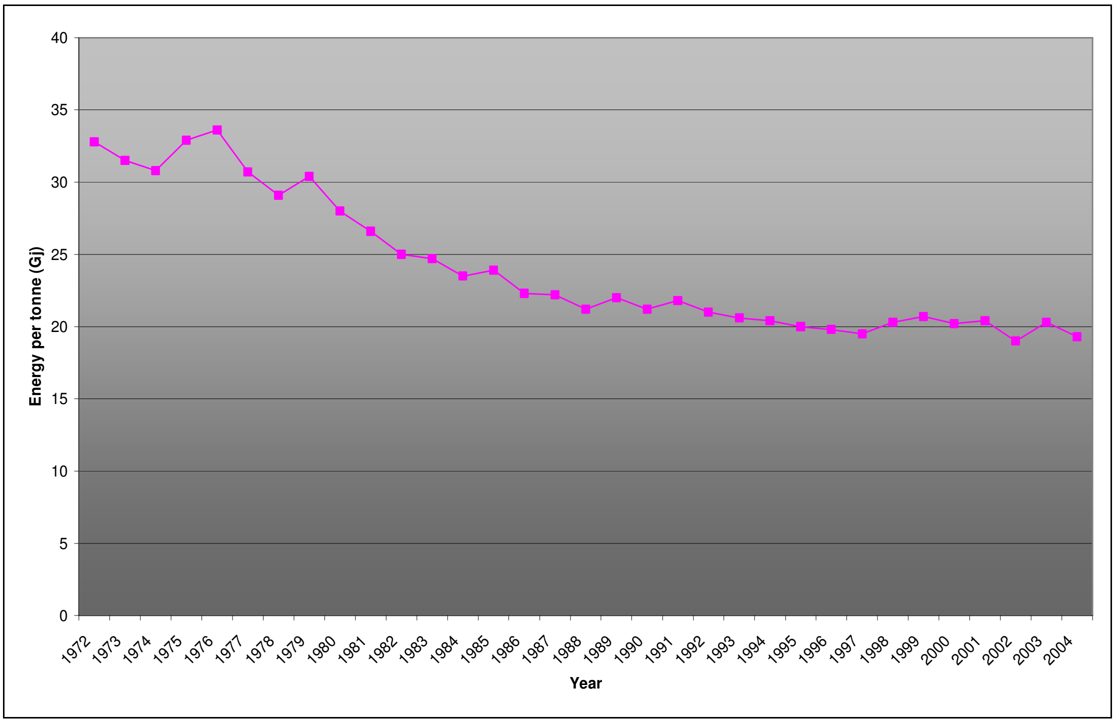
Table 15.12: Results from the CCA TP3 steel sector returns[2]

	TP1 (2002)	**TP2 (2004)**	**TP3 (2006)**
Energy consumption (PJ)	281	308	307.6
Energy consumption (TWh)	78.06	85.56	85.44
Production output (Mt)	14.5	17.0	17.1
Specific energy consumption (kWh/t)	5,390	5,030	5,020

[1] www.uksteel.org.uk/download/uk%20steel%20stats%20guide%202006.pdf Accessed July 2007

[2] Climate Change Agreement. Results of the third target period assessment. July 2007. AEAT for Defra.

Figure 15.8: Energy per tonne of steel produced: 1972 - 2004



Source: UK Steel

The mechanical engineering sector (SIC 28)

15.37 Table 15.13 shows the results from the metal forming sector, a sector within the "engineering" category shown in Table 15.11. This shows that over the period 2002 to 2006 specific energy consumption improved by 10.3%, which equates to an annual improvement of 2.6%. This suggests that the short or medium term savings opportunity will now be in the region of 5.8%. Unlike the steel sector, however a much larger proportion of the sector is not covered by a CCA and hence may not have had the same incentive to improve.

Table 15.13: Results from the CCA TP3 metal forming returns[1]

	TP1 (2002)	TP2 (2004)	TP3 (2006)
Primary energy consumption (TWh)	2.35	2.40	2.26
Production output (kt)	948	1,083	1,014
Specific energy consumption (kWh/t)	2,480	2,210	2,230

[1] Climate Change Agreement. Results of the third target period assessment. July 2007. AEAT for Defra.

15.38 Table 15.14 shows the energy savings opportunities identified by ENWORKS within the engineering sector in 2005 and 2006. This shows average energy savings of 16.5%. This is in line with the 16.1% short and medium term savings opportunity shown for engineering companies in Carbon Trust estimates and hence was interpreted as showing that the savings remain for those companies working outside of a CCA.

Table 15.14: A summary of case study findings in the engineering sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Engineering	23	16.5	20.4	0.52

15.39 Table 15.15 shows the estimated savings opportunity from this sector to be 1.67TWh or 14.9%.

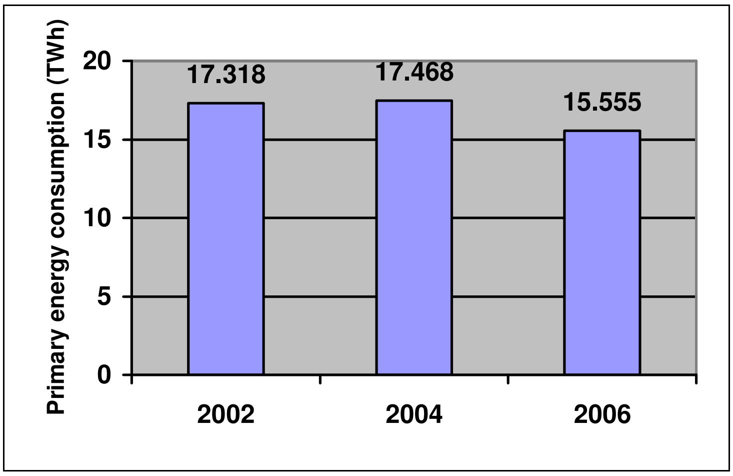
Table 15.15: The estimated energy savings opportunity from the mechanical engineering sector

	Secondary energy consumption (TWh)	Savings opportunity	
		%	TWh
CCA companies	1.30	5.8	0.08
Non-CCA companies	9.86	16.1	1.59
Total	**11.16**	**14.9**	**1.67**

The non-ferrous metal sector

15.40 The CCA for the aluminium industry targets relative carbon and is measured in terms of kgC/kWh. This provides us with the trend in absolute energy consumption (kWh) within the subsector (Figure 15.9). This shows that absolute energy consumption dropped by 10.2% between 2002 and 2006, an annual reduction of 2.55%. This follows that of the downward trend in energy consumption observed within the whole sector (Figure 15.7) and of which 82.5% was attributed to an improvement in intensity or energy efficiency (Table 4.3). Therefore assuming that 82.5% of the 10.2% reduction is due to energy efficiency an improvement of 8.4% has been made over the four year period from 2002 to 2006. Table 15.11 shows that within the non-ferrous sector short to medium term savings were estimated at a relatively modest 5.1% in 2002 hence it is assumed that all or the majority of these savings will have been realised. A value of zero is therefore assigned to the short to medium term savings opportunity from this subsector.

Figure 15.9: The primary energy consumption in the aluminium sector



15.41 The Aluminium Federation (ALFED) reports that[1]:

"Over the past 30 years the energy used to produce primary aluminium has been reduced by 30% as part of a continuing programme of energy efficiency in all sectors of the aluminium industry".

15.42 In addition, Anglesey Aluminium Metal, the UK's biggest primary smelter of aluminium reports[2]:

"We are a large energy user. We use 12% of Wales' electricity and it's expensive. Guess what, we've got our eye on that ball already. It's a big part of our monthly expenditure, so of course we want to keep costs down"

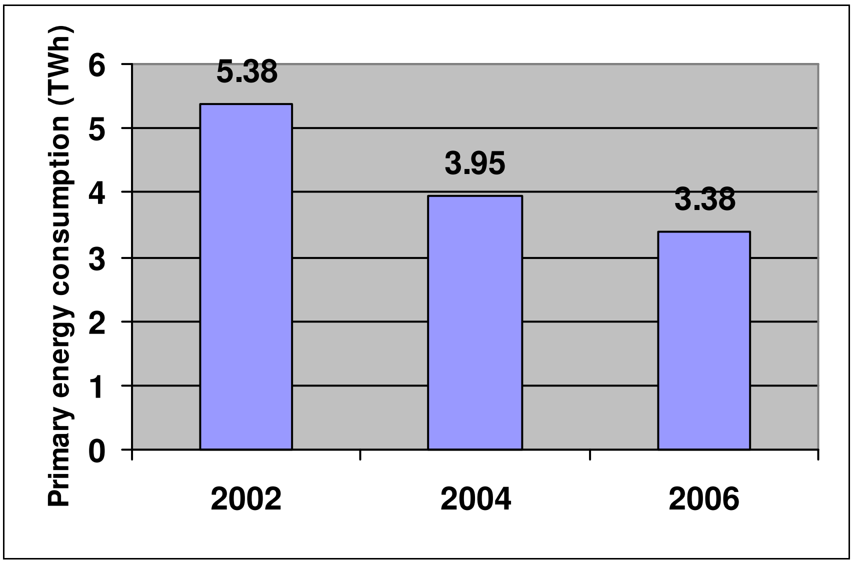
15.43 This provides the reasoning behind the relatively low savings opportunity identified within the Carbon Trust 2003 study (Table 15.11). It is therefore considered likely that the savings opportunity will be extremely modest in this sector.

15.44 The CCA for the non-ferrous metals, excluding aluminium, targets absolute primary energy savings (kWh) shows that a reduction in energy consumption of 37% has been achieved between 2002 and 2006. This would therefore suggest that the savings opportunity within this subsector is also very modest.

[1] www.alfed.org.uk/templates/alfed/contents.asp?pageid=109 Accessed July 2007.

[2] David Bloor, Managing Director of Anglesey Aluminium Metal, Aluminium faces up to a low-carbon future. Ends Report 389. June 2007.

Figure 15.10: The primary energy consumption in the non-ferrous metals sector



Foundries (SIC 27.5)

15.45 The CCA for the foundries (ferrous and non-ferrous) focuses on relative or specific energy consumption (kWh/t) (Table 15.16). The table shows that a reduction of 2.8% in Specific Energy Consumption (SEC) was achieved between 2002 and 2006. Table 15.11 showed the short and medium term energy savings opportunities in the foundry sector to be 9.6% in 2002, which suggests that a 6.8% savings opportunity remains in the sector.

Table 15.16: Results from the CCA TP3 foundries returns[1]

	TP1 (2002)	TP2 (2004)	TP3 (2006)
Primary energy consumption (TWh)	7.68	6.84	5.45
Production output (kt)	1,171	1,015	856
Specific energy consumption (kWh/t)	6,550	6,740	6,370

15.46 The BERR reports[2] that in 2005 the foundry sector consumed 181 thousand tonnes of oil equivalent secondary energy or 2.1TWh. This appears very low when the CCA foundries report primary consumption rates of 6.8TWh in 2004 and 5.4TWh in 2006 (Table 15.16). Converting the BERR data to primary energy by multiplying the electricity used by a factor of 2.6 results in a primary

[1] Climate Change Agreement. Results of the third target period assessment. July 2007. AEAT for Defra.

[2] http://www.dti.gov.uk/energy/statistics/publications/ecuk/industrial/page18171.html Table 4.6 Accessed July 2007.

energy value of 3.99TWh, which is much lower that the CCA results (Table 15.16). The CCA results are considered the more appropriate in this case since they represent a 100% sample of CCA member companies. The energy savings opportunity is therefore 0.37TWh (6.8% of 5.45TWh).

15.47 To conclude this section, the two energy savings opportunities exist within the mechanical engineering sector and the foundries sector (Table 15.17).

Table 15.17: The estimated energy savings opportunity from the metals sector

	Secondary energy consumption (TWh)	Savings opportunity	
		%	TWh
Mechanical engineering	11.16	14.9	1.66
Foundries	5.45	6.8	0.37
Steel	19.53	0	0
Non-ferrous	10.59	0	0
Total	**46.74**	**4.35**	**2.03**

Valuation of energy savings

15.48 Applying a standard energy price of 3.78p/kWh (Table 15.18) to the savings shown in Table 15.17 values the short to medium term savings opportunity within this sector at £77 million.

Table 15.18: Summary of energy price (p/kWh) within the metals sector

Fuel	**Total consumption (ktoe)**	**Fuel mix**	**Fuel price (p/kWh)**	**Weighted average kWh price (p)**
Coal	33	0.01	0.626	0.01
Heavy oil	48	0.02	2.0987	0.03
Gas oil	85	0.03	2.957	0.08
Electricity	1,535	0.49	5.85	2.86
Gas	1,443	0.46	1.746	0.80
			Total	**3.78**

15.49 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.19. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £6 million, making the estimated total savings for the sector £83 million.

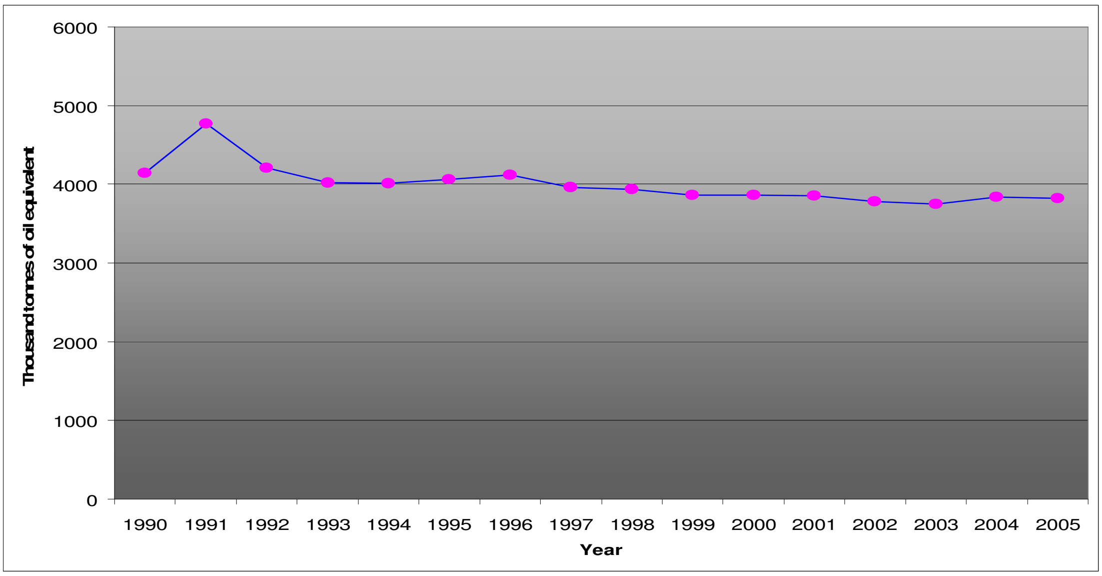
Table 15.19: Summary of energy price (p/kWh) within the metals sector (CCL)

Fuel	**Total consumption (ktoe)**	**Fuel mix**	**CCL (p/kWh)**	**Weighted average kWh price (p)**
Coal	33	0.01	0.170	0.002
Heavy oil	48	0.02	0.075	0.002
Gas oil	85	0.03	0.075	0.002
Electricity	1,535	0.49	0.441	0.216
Gas	1,443	0.46	0.154	0.071
			Total	**0.293**

The food and drink sector

15.50 The food and drink sector accounted for 11.5% of the energy consumed within industry in 2005 and Figure 15.11 shows the trend in energy use in the food and drink sector between 1990 and 2005. This shows that energy consumption has been very consistent in recent years, varying from 3.86Mtoe in 1999 to 3.82Mktoe in 2005.

Figure 15.11: The trend in energy consumption in the food and drink sector



Quantification of energy savings

15.51 The recent Defra study on resource efficiency in the food and drink sector reported short to medium term energy savings potential of 12% (see Table 15.20)[1]. The savings figures were calculated by analysing the energy consuming processes (boilers and steam, refrigeration, pumps, fans etc) within each manufacturing sector. A savings opportunity was then applied to each process. This was then aggregated to obtain an overall savings figure for each manufacturing sector.

[1] Scoping studies to identify opportunities for improving resource use efficiency and for reducing waste through the food production chain. AEA Energy & Environment for Defra, February 2007.

Table 15.20: Energy efficiency, food and drink sector

Industry by SIC codes	Manufacturing sector	Total primary (TWh)	Total savings potential (TWh)	Sectoral savings potential (S-M)%	Saving of F&D industry
15.1. Meat processing & production	Meat	2.788	0.424	15.2	0.7
	Poultry	2.169	0.270	12.5	0.4
	Renderers	1.239	0.153	12.4	0.2
15.2. Fish products	Fish processing	1.342	0.113	8.4	0.2
15.3. Fruit & vegetables	Fruit & vegetables	3.201	0.317	9.9	0.5
15.4. Oils & fats	Oils & fats	1.859	0.177	9.5	0.3
15.5. Dairy products	Dairy	4.337	0.521	12.0	0.8
	Ice cream	2.685	0.400	14.9	0.6
15.6. Grain milling & production	Milling & products	4.337	0.195	4.5	0.3
15.7 Animal feeds	Animal feed	3.098	0.325	10.5	0.5
	Pet foods	2.478	0.379	15.3	0.6
15.8. Other food products	Bakery	6.196	0.929	15.0	1.5
	Ambient food	4.337	0.521	12.0	0.8
	Sugar manufacture	6.196	0.781	12.6	1.3
	Confectionery	3.098	0.452	14.6	0.7
15.9. Beverages	Spirits	2.788	0.218	7.8	0.4
	Brewing	3.718	0.497	13.4	0.8
	Malting	1.859	0.194	10.4	0.3
	Soft drinks	0.929	0.126	13.6	0.2
	Total	**58.654**	**6.992**	**12.0**	**12.0**

15.52 The 12% energy savings opportunity appears to show that very little has changed since the Carbon Trust study in 2003, which estimated the savings potential from short to medium term opportunities at 12.5% (Table 15.21).

Table 15.21: Savings opportunities for food and drink sector

Sector	Carbon impact in MtC	Cost effective carbon savings (% of total impact)			
		Improvements in operational practices	Retrofitting	New plant	Total savings opportunity
Food & drink	3.51	8.5	4	4	17

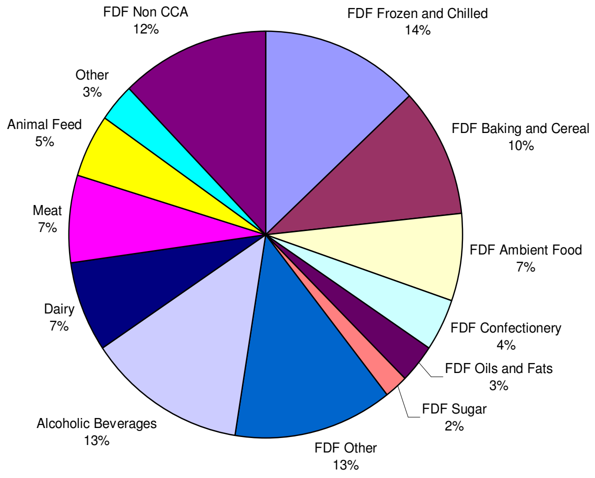
Source: Adapted from Industrial energy efficiency fact base and market assessment. Future Energy Solutions for the Carbon Trust. August 2003. NB: short to medium term savings is made up of improvements in operational practices and retrofitting.

15.53 Using the energy intensity figure for food and drink shown in Table 4.3 (-0.8/4.6) it can be seen that energy intensity in the food and drink sector improved by 17% over the period 1990 to 2005, representing an annual improvement of 1.2%. Projecting these savings forward, using the Carbon Trust figure as the baseline it would be anticipated that current savings opportunity would be nearer 7.7% (12.5% - 4 x 1.2%). It was therefore considered necessary to verify this data.

15.54 The Climate Change Agreements (CCAs) can be used as a start point to estimate the change in savings opportunity, using the 2003 Carbon Trust study as a baseline, since the food and drink sector contains a significant number of energy intensive companies. The assumption is that companies undertake the short to medium term savings opportunities, i.e. the quick win low-cost / no-cost opportunities, before committing capital and investing in new plant. The Food and Drink Federation (FDF) report that the CCA administered by FDF covered 1082 sites in 2004 and accounted for approximately 50% of the total energy use within the food and drink manufacturing sector (Figure 15.12). Additional CCA agreements include red meat, beer, malt and dairy and hence the majority of energy consumed in the sector is covered by a CCA. The FDF report[1]:
"As a significant proportion of food and drink manufacturing sites also participate in ETS schemes, FDF estimate that almost 99% of the sector's energy use is covered by one or other of the schemes"

[1] Defra / FDF study on environmental impacts of the food and drink industry. Final report October 2004.

Figure 15.12[1]: Total energy use in food and drink sector



15.55 Table 15.22 shows the change in specific energy consumption made between 2002 and 2006, as reported in the CCA returns for TP1 and TP3. The analysis shows that 9 out of 11 product groups made significant energy efficiency improvements.

[1] Defra / FDF study on environmental impacts of the food and drink industry. Final report October 2004.

Table 15.22: The change in specific energy consumption within the 11 food and drink sector Climate Change Agreements[1]

Organisation	Product group	Specific Energy Consumption (SEC)			Change in SEC (%)
		Units	2002 (TP1)	2006 (TP3)	
NAMB/SAMB	Master bakers	kWh/£k	1,493.8	1,268.0	-15.1
BBPA	Brewing	kWh/hl	59.5	51.5	-13.4
Dairy UK	Dairy	kWh/t	458.7	419.5	-8.5
British Egg Products Ass'n	Eggs	kWh/kg	0.8	0.8	-6.5
FDF	Various	kWh/t	944.1	892.4	-5.5
Malsters Ass'n of GB	Malt	kWh/t	1,263.3	1,162.1	-8.0
British Poultry Council	Poultry	kWh/t	624.5	587.0	-6.0
BMPA	Red meat	kWh/t	681.6	722.5	6.0
UKRA	Renderers	kWh/t	853.0	911.8	6.9
The Spirits Energy Efficiency Company	Spirits	kWh/lpa	7.5	6.7	-11.6
AIC (formerly UKASTA)	Animal feed	kWh/t	158.3	143.4	-9.4

15.56 Table 15.23 shows the impact these savings have on the overall savings opportunity identified within the 2003 Carbon Trust study. The analysis shows that the savings opportunity has dropped from 12.5% in 2002 to 5.5%.

Table 15.23: Energy savings opportunity for CCA food and drink companies

Product group	Energy savings opportunity (%)			Primary energy consumption (2006) (TWh)	Energy savings opportunity (£M)
	2002	Change in SEC 2002 to 2006	2006		
Master bakers	15.0	-15.1	0	1.325	0
Brewing	13.4	-13.4	0	2.913	0
Dairy	12.0	-8.5	3.5	4.169	146
Eggs	12.0	-6.5	5.5	0.081	4
Various	12.0	-5.5	6.5	32.559	2,116
Malt	10.4	-8.0	2.4	1.707	41
Poultry	12.5	-6.0	6.5	1.892	123
Red meat	15.2	6.0	15.2	1.950	296
Renderers	12.4	6.9	12.4	1.724	214
Spirits	7.8	-11.6	0	3.047	0
Animal feed	10.5	-9.4	1.1	3.031	33
			Total	**54.398**	**2,974**

[1] Climate Change Agreement. Results of the third target period assessment. July 2007. AEAT for Defra.

15.57 One concern is the allocation of zero short to medium term savings opportunity in three of the product groups. The bakers and brewing sectors are particularly questionable since Table 15.22 shows these to account for 2.3% of the overall 12% savings opportunity projected for the whole sector. The British Beer and Pub Association (BBPA) report that the specific energy consumption (MJ/hl) in the brewing sector has improved by 54% in the last 30 years (Figure 15.13). In addition, the variation in performance across the sector has also reduced significantly (Table 15.24). Andy Tighe of the BBPA explains that[1]:

"The standard deviation of the SEC has got smaller over time indicating reducing opportunities for improvement, but there is still a wide variation in the SEC due to the very significant economies of scale between largest and smallest. The shape of the curve is highly skewed at the lower end and of course the Industry SEC is a weighted average. Many, particularly smaller, breweries date back 100s of years and the buildings they are housed in often mean there are also limitations and restrictions in relation to achieving further savings".

[1] Andy Tighe, BBPA personal communication May 2006.

Figure 15.13: Specific energy consumption of the UK brewing sector 1976 to 2006[1]

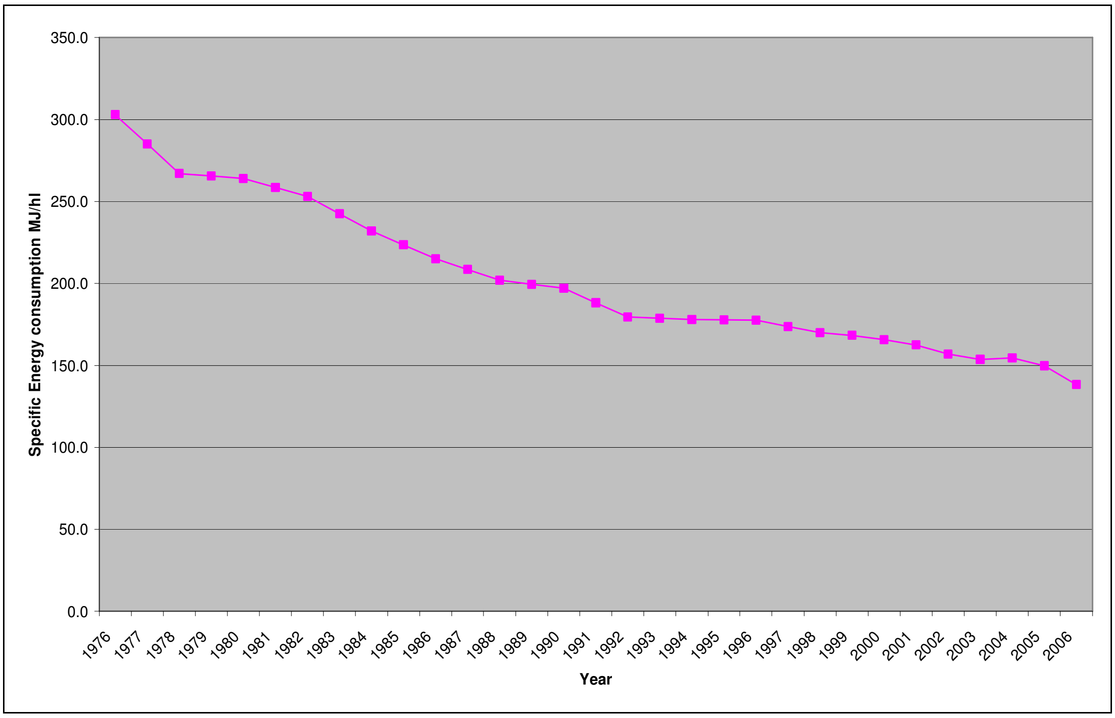


Table 15.24: The performance of the brewing sector 1998 to 2005[2]

Measure	1998	2000	2003	2005
SEC (Mean)	1.7	1.66	1.54	1.5
SEC (Std. deviation)	1.33	1.05	1.11	1.01

15.58 This is considered strong evidence in support of the allocation of zero savings opportunity to these three subsectors.

15.59 To gross up to sector level it was considered appropriate to use the 5.5% savings opportunity across the whole sector. The BERR reported that the energy consumption within the sector in 2005 was 3,820ktoe, which equates to 44.312TWh. The savings opportunity is therefore 2.437TWh.

[1] The British Brewing Sector. Thirty years of environmental improvement 1976 to 2006. The British Beer and Pub Association. May 2007.

[2] Andy Tighe, BBPA, Personal Communication May 2007.

Valuation of energy savings

15.60 Multiplying the total energy savings opportunity of 2.427TWh by 2.99p/kWh (Table 15.25) generates a savings opportunity within the food and drink sector of £72 million.

Table 15.25: Summary of energy price (p/kWh) within the food and drink sector

Fuel	Total consumption (ktoe)	Fuel mix	Fuel price (p/kWh)	Weighted average kWh price (p)
Coal	17	0.00	0.626	0.00
Heavy oil	40	0.01	2.0987	0.02
Gas oil	283	0.07	2.957	0.22
Electricity	1,071	0.28	5.85	1.64
Gas	2,408	0.63	1.746	1.10
			Total	**2.99**

15.61 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.26. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £5 million, making the estimated total savings for the sector £77 million.

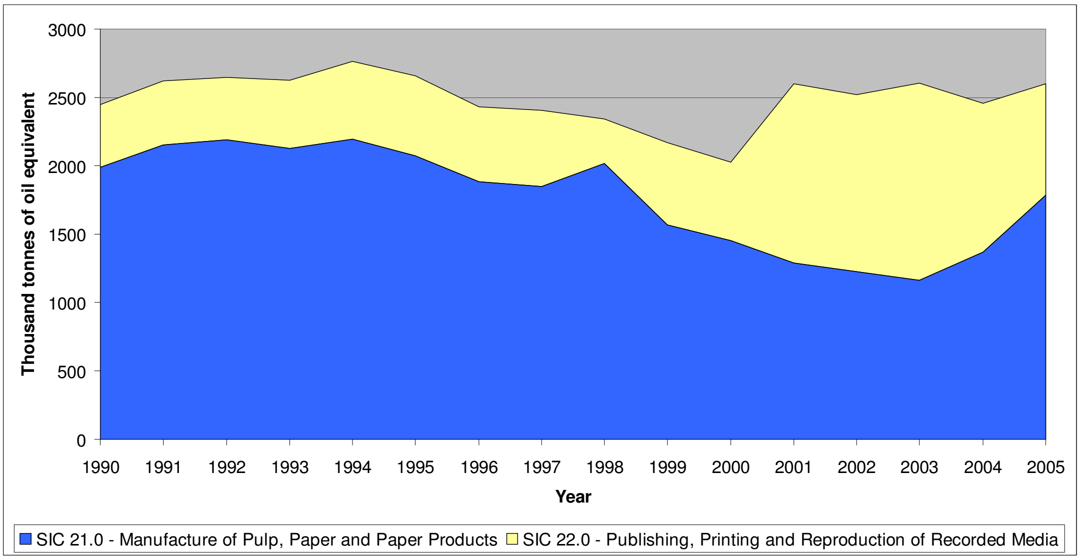
Table 15.26: Summary of energy price (p/kWh) within the food and drink sector (CCL)

Fuel	Total consumption (ktoe)	Fuel mix	CCL (p/kWh)	Weighted average kWh price (p)
Coal	17	0.00	0.170	0.00
Heavy oil	40	0.01	0.075	0.001
Gas oil	283	0.07	0.075	0.005
Electricity	1,071	0.28	0.441	0.123
Gas	2,408	0.63	0.154	0.097
			Total	**0.226**

The paper, printing and publishing sector

15.62 This sector accounted for 7.8% of the energy consumed within the industrial sector in 2005 and Figure 15.14 shows the trend in energy consumption in the paper, printing and publishing sector between 1990 and 2005. This shows that up until 2000 the publishing and printing sector had a stable energy consumption whereas the pulp and paper sector peaked in 1994 before a steady reduction. However, since 2000 energy consumption in the printing sector has shown more dramatic fluctuations although the overall energy consumption within the sector has remained relatively static over the past five years.

Figure 15.14: The trend in energy consumption in the paper, printing and publishing sector



Quantification of energy savings

15.63 Table 15.27 shows the estimates of energy savings opportunity for the sector from the Carbon Trust 2003 report. This shows the short and medium term savings opportunity to equate to 8.4% in 2002. Table 4.3 shows that energy intensity increased by 13% in the paper and printing sector between 1990 and 2005. Therefore, it would be assumed that the 8.4% energy savings opportunity still remains.

Table 15.27: Energy savings opportunity in the paper and printing sector 2002

Sector	Carbon impact (MtC)	Cost effective carbon savings (% of total impact)			
		Improvements in operational practices	Retrofitting	New plant	Total savings opportunity
Paper & printing	1.66	2.4	6.0	6.6	15.1

Source: Adapted from Industrial energy efficiency fact base and market assessment. Future Energy Solutions for the Carbon Trust. August 2003. NB: short to medium term savings is made up of improvements in operational practices and retrofitting.

15.64 Both the paper and printing sectors have CCAs. The CCA for the paper sector is managed by the Confederation of Paper Industries (CPI). The returns from the third target period show that in terms of SEC CCA companies improved by 9.3% between 2002 and 2006 (Table 15.28). This implies that the 8.4% short to medium term savings shown in Table 15.27 would have been realised since 2002.

Table 15.28: Results from the CCA TP3 paper sector returns[1]

	TP1 (2002)	TP2 (2004)	TP3 (2006)
Primary energy consumption (TWh)	28.596	27.216	22.856
Production output (Mt)	6.4	6.4	5.6
Specific energy consumption (kWh/t)	4,476	4,280	4,060

15.65 Based on the energy intensity analysis shown in Table 15.27 it is assumed that the energy savings opportunity for non-CCA companies operating in the paper sector remains at 8.4%. Table 15.29 shows the estimated savings opportunity from the paper sector.

Table 15.29: Summary of energy savings opportunity within the paper sector

	Secondary energy consumed (TWh)	Energy savings opportunity	
		%	TWh
CCA	13.942	0	0
Non-CCA	6.829	8.4	0.574
Total	**20.771**	**2.8**	**0.574**

[1] Climate Change Agreement. Results of the third target period assessment. July 2007. AEAT for Defra.

15.66 The CCA for the printing sector is operated by the British Printing Industries Federation (BPIF). Table 15.30 shows the results of the 2006 (TP3) returns. This shows that a significant increase in production output (21%) had a subsequent impact on the SEC (a 4.2% increase). It is therefore assumed that the 8.4% savings opportunity shown in Table 15.27 remains for the printing sector.

Table 15.30: Results from the CCA TP3 printing sector returns[1]

	TP1 (2002)	TP2 (2004)	TP3 (2006)
Primary energy Consumption (TWh)	2.848	3.441	3.595
Production output (Mm^2)	49,030	56,462	59,371
Specific energy consumption (kWh/m^2)	0.05809	0.06095	0.060557

15.67 The savings opportunity within this sector as a whole is summarised in Table 15.31.

Table 15.31: Summary of energy savings opportunity within the paper sector

Subsector	**Secondary energy consumed (TWh)**	**Energy savings opportunity**	
		%	**TWh**
Paper	20.771	2.8	0.574
Printing	9.467	8.4	0.795
Total	**30.238**	**4.5**	**1.369**

Valuation of energy savings

15.68 Applying a standard energy price of 3.6p/kWh (Table 15.32) to the estimated energy savings opportunity in Table 15.31 the savings opportunity from the paper and printing sector is estimated at £49 million.

[1] Climate Change Agreement. Results of the third target period assessment. July 2007. AEAT for Defra.

Table 15.32: Summary of energy price (p/kWh) within the paper sector

Fuel	Total consumption (ktoe)	Fuel mix	Fuel price (p/kWh)	Weighted average kWh price (p)
Coal	98	0.04	0.626	0.02
Heavy oil	31	0.01	2.0987	0.03
Gas oil	56	0.02	2.957	0.06
Electricity	1,183	0.45	5.85	2.66
Gas	1,233	0.47	1.746	0.83
			Total	**3.60**

15.69 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.33. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £4 million, making the estimated total savings for the sector £53 million.

Table 15.33: Summary of energy price (p/kWh) within the paper sector (CCL)

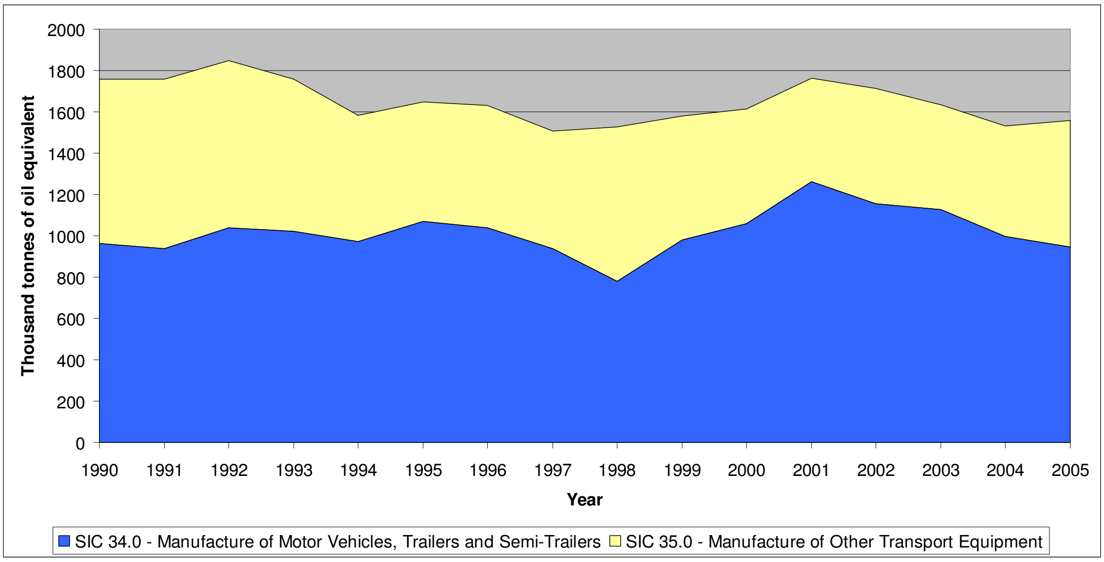
Fuel	Total consumption (ktoe)	Fuel mix	CCL (p/kWh)	Weighted average kWh price (p)
Coal	98	0.04	0.1695	0.007
Heavy oil	31	0.01	0.07544	0.001
Gas oil	56	0.02	0.07544	0.002
Electricity	1,183	0.45	0.441	0.198
Gas	1,233	0.47	0.154	0.072
			Total	**0.280**

The manufacture of vehicles sector

15.70 This sector accounted for 4.6% of the energy consumed within the industrial sector in 2005.

15.71 Figure 15.15 shows the trend in energy consumption in the vehicles sector between 1990 and 2005. This shows energy consumption to have fluctuated over the period with the manufacture of motor vehicles, trailers and semi-trailers accounting for approximately 60% and other transport equipment the remaining 40%.

Figure 15.15: The trend in energy consumption in the vehicles sector



Quantification of energy savings

15.72 The Carbon Trust study in 2003 did not classify the savings opportunity from the vehicles sector separately. Instead it was classified under the general heading of "engineering" with an estimated short and medium term savings opportunity of 16.1% (Table 15.34).

Table 15.34: Energy savings in the vehicles sector 2002

Subsector	Carbon impact (MtC)	Cost effective carbon savings (% of total impact)			
		Improvements in operational practices	Retrofitting	New plant	Total savings opportunity
Engineering	4.22	11.4	4.7	2.8	19.0

Source: Adapted from Industrial energy efficiency fact base and market assessment. Future Energy Solutions for the Carbon Trust. August 2003. NB: short to medium term savings is made up of improvements in operational practices and retrofitting.

15.73 Table 4.3 shows that energy intensity in the vehicles sector improved by 20% between 1990 and 2005 representing an annual improvement of 1.3%. This would therefore suggest that 5.3% of the savings opportunity would have been realised between 2002 and 2006, leaving 10.8% remaining.

15.74 The SMMT manage a CCA for the vehicles sector and Table 15.35 shows the results reported for 2006. This shows that the specific energy consumption (kWh/vehicle) improved by 9.4% between 2002 and 2006; an annual improvement of 2.35% and implying that 6.7% of the opportunity estimated in 2002 would remain.

Table 15.35: Results from the CCA TP3 vehicles sector returns[1]

	TP1 (2002)	TP2 (2004)	TP3 (2006)
Energy consumption (TWh)	4.799	5.069	4.352
Production output (million vehicles)	1.7	1.9	1.7
Specific energy consumption (kWh/vehicle)	2,809	2,704	2,545

15.75 However, the Society of Motor Manufacturers and Traders (SMMT) reported in 2004[2] that the UK vehicle manufacturers improved energy efficiency by 17.5% since 1995; an annual improvement of 1.94% per annum over the period. More importantly, the SMMT report concluded that UK facilities have already invested in the best available technology and hence there is limited scope for further improvements in energy efficiency.

[1] Climate Change Agreement. Results of the third target period assessment. July 2007. AEAT for Defra.

[2] www.smmt.co.uk/articles/article.cfm?articleid=8292 accessed July 2007.

15.76 It is therefore considered appropriate to assign a minimal 2% short to medium term savings opportunity to SIC 34.1 (The manufacture of motor vehicles) and to apply the 6.7% savings opportunity to the rest of the sector.

Table 15.36: Summary of energy savings opportunity within the vehicles sector

Subsector	**Secondary energy consumed (TWh)**	**Energy savings opportunity**	
		%	**TWh**
Motor vehicles	7.292	2.0	0.146
Other	10.839	6.7	0.726
Total	**18.131**	**4.0**	**0.872**

Valuation of energy savings

15.77 Applying the standard energy price of 3.14p/kWh (Table 15.30) to the estimated savings opportunity shown in Table 15.36 the estimated savings opportunity within the vehicles sector is £27 million.

Table 15.37: Summary of energy price (p/kWh) within the vehicles sector

Fuel	**Total consumption (ktoe)**	**Fuel mix**	**Fuel price (p/kWh)**	**Weighted average kWh price (p)**
Coal	38	0.02	0.626	0.02
Heavy oil	20	0.01	2.0987	0.03
Gas oil	119	0.08	2.957	0.23
Electricity	501	0.32	5.85	1.88
Gas	880	0.56	1.746	0.99
			Total	**3.14**

15.78 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.38. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £2 million, making the estimated total savings for the sector £29 million.

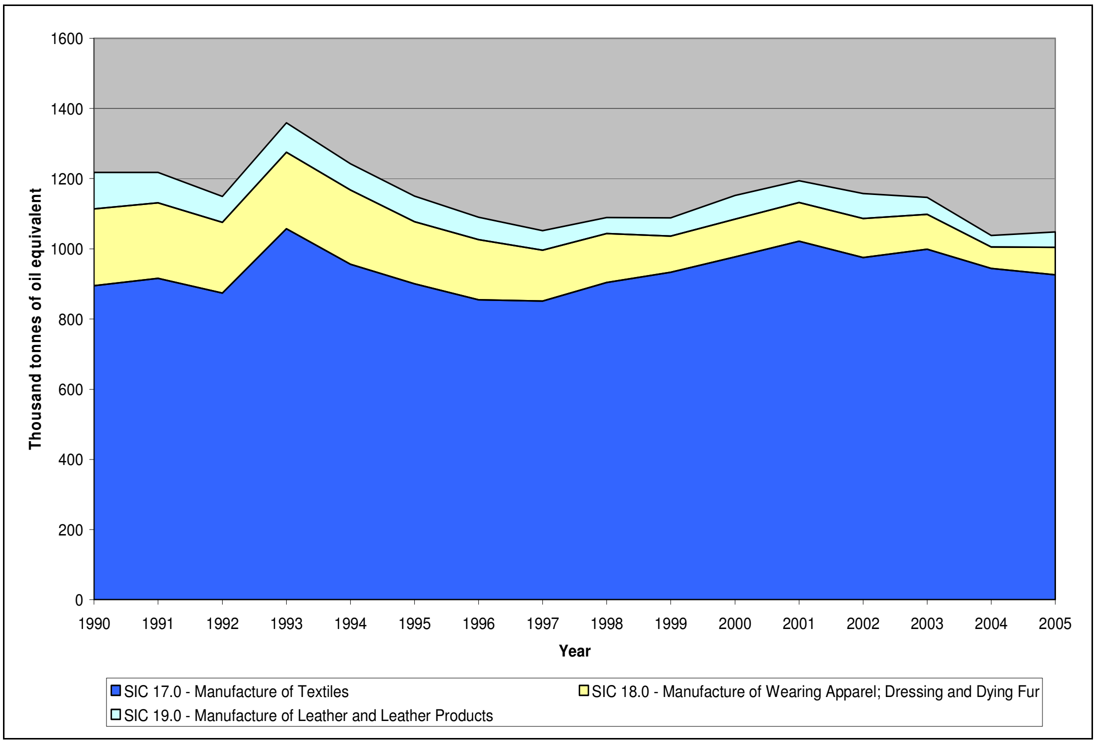
Table 15.38: Summary of energy price (p/kWh) within the vehicles sector (CCL)

Fuel	**Total consumption (ktoe)**	**Fuel mix**	**CCL (p/kWh)**	**Weighted average kWh price (p)**
Coal	38	0.02	0.1695	0.003
Heavy oil	20	0.01	0.07544	0.001
Gas oil	119	0.08	0.07544	0.006
Electricity	501	0.32	0.441	0.141
Gas	880	0.56	0.154	0.086
			Total	**0.237**

The textiles sector

15.79 The textiles sector accounted for 3.1% of the energy consumed within the industrial sector in 2005 and Figure 15.16 shows the trend in energy consumption in the textiles sector between 1990 and 2005. This shows that energy consumption has fluctuated over the period with SIC 17.0 (The manufacture of textiles) dominating; accounting for 92% of the sector's energy consumption in 2005.

Figure 15.16: The trend in energy consumption in the textiles sector



Quantification of energy savings

15.80 Table 15.39 shows that the 2003 Carbon Trust study estimated the short and medium term energy savings opportunity from the textiles sector to be 8.0%.

Table 15.39: Energy savings opportunity in the textiles sector 2002

Sector	**Carbon impact (MtC)**	**Cost effective carbon savings (% of total impact)**			
		Improvements in operational practices	**Retrofitting**	**New plant**	**Total savings opportunity**
Textiles	1.00	6.0	2.0	2.0	10.0

Source: Adapted from Industrial energy efficiency fact base and market assessment. Future Energy Solutions for the Carbon Trust. August 2003. NB: short to medium term savings is made up of improvements in operational practices and retrofitting.

15.81 The energy intensity data shown in Table 4.3 shows that the textile industry has performed worse in terms of energy intensity over the period 1990 to 2005 with the energy intensity increasing by 66%, i.e. an annual increase of 4.4%. A major cause of this increase is likely to be the significant drop in output resulting in the below capacity running of plant.

15.82 There are two CCAs for the textiles sector, the first focuses on textile manufacture (Table 15.40) and the second on leather manufacturing

15.83 The specific energy consumption (SEC) has been calculated in this study using the energy consumption and output figures from the CCA returns (Table 15.40). This shows that an improvement in SEC of 37% was achieved between 2002 and 2006. This clearly contradicts the energy intensity trends discussed above and suggests that no short or medium term savings remain.

15.84 Table 15.41 shows a 16.3% reduction in specific energy consumption, which again implies the short to medium term savings will have been realised.

Table 15.40: Results from the CCA TP3 textiles sector returns[1]

	TP1 (2002)	TP2 (2004)	TP3 (2006)
Primary energy consumption (TWh)	3.141	2.435	1.750
Production output (mixed units, millions)	791	771	700
Specific energy consumption (kWh/unit)	3.97	3.16	2.50

Table 15.41: Results from the CCA TP3 leather sector returns[2]

	TP1 (2002)	TP2 (2004)	TP3 (2006)
Primary energy consumption (TWh)	0.187	0.187	0.115
Production output (Mm^2)	18	17	13
Specific energy consumption (kWh/m^2)	10.45	11.08	8.75

15.85 Since the CCA data contradicts the energy intensity analysis by showing that significant energy efficiency savings have been made, it is assumed that it is the non-CCA companies that have not achieved energy savings. The 8%

[1] Climate Change Agreement. Results of the third target period assessment. July 2007. AEAT for Defra.

[2] Climate Change Agreement. Results of the third target period assessment. July 2007. AEAT for Defra.

saving shown in Table 15.39 is therefore applied to the non-CCA companies. Table 15.42 shows the summary of savings.

Table 15.42: Summary of energy savings opportunity within the textiles sector

Subsector	**Secondary energy consumed (TWh)**	**Energy savings opportunity**	
		%	**TWh**
CCA	1.283	0	0
Non-CCA	10.381	8	0.831
Total	**11.664**	**7.1**	**0.831**

Valuation of energy savings

15.86 Applying the standard energy price of 2.97p to the estimated savings opportunity shown in Table 15.43 the estimated savings opportunity within the textiles sector is £25 million.

Table 15.43: Summary of energy price (p/kWh) within the textiles sector

Fuel	**Total consumption (ktoe)**	**Fuel mix**	**Fuel price (p/kWh)**	**Weighted average kWh price (p)**
Coal	50	0.05	0.626	0.03
Heavy oil	9	0.01	2.0987	0.02
Gas oil	101	0.10	2.957	0.29
Electricity	292	0.28	5.85	1.65
Gas	586	0.56	1.746	0.99
			Total	**2.98**

15.87 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.44. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £2 million, and the estimated total savings for the sector £27 million.

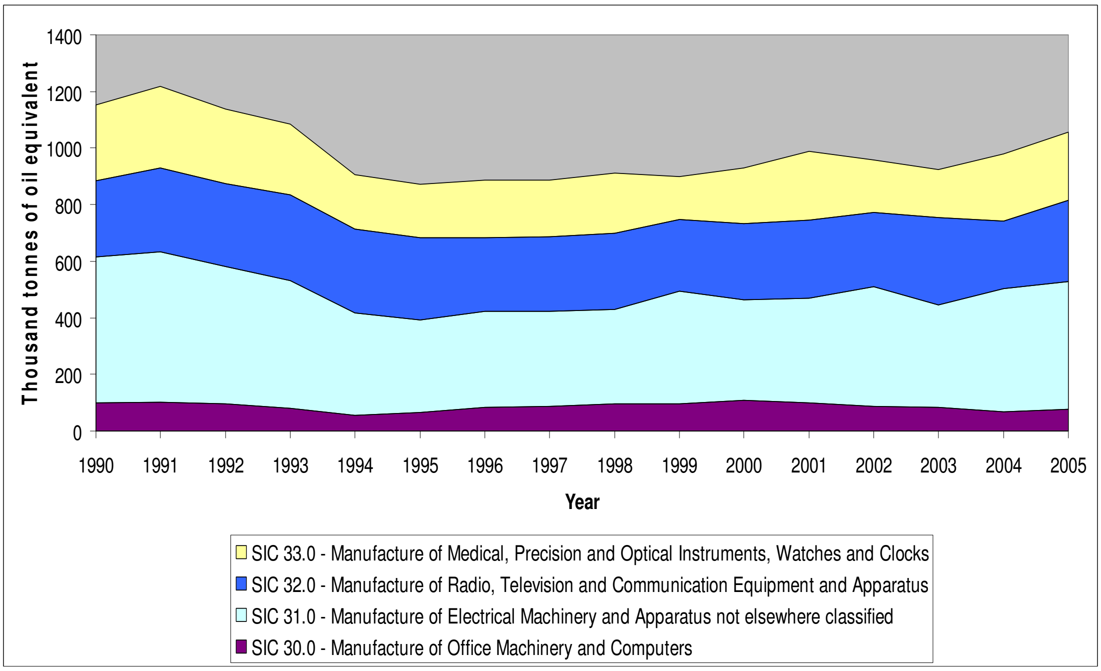
Table 15.44: Summary of energy price (p/kWh) within the textiles sector (CCL)

Fuel	**Total consumption (ktoe)**	**Fuel mix**	**CCL (p/kWh)**	**Weighted average kWh price (p)**
Coal	50	0.05	0.1695	0.008
Heavy oil	9	0.01	0.07544	0.001
Gas oil	101	0.10	0.07544	0.008
Electricity	292	0.28	0.441	0.123
Gas	586	0.56	0.154	0.086
			Total	**0.226**

The electrical engineering sector

15.88 The electrical engineering sector accounted for 3.1% of the energy consumed within the industrial sector in 2005 and Figure 15.17 shows the trend in energy consumption in the electrical engineering sector between 1990 and 2005.

Figure 15.17: The trend in energy consumption in the electrical engineering sector



Quantification of energy savings

15.89 The Carbon Trust study in 2003 did not classify the savings opportunity from the electrical engineering sector separately. Instead it was classified under the general heading of "engineering" with an estimated short and medium term savings opportunity of 16.1% (Table 15.45).

Table 15.45: Energy savings in the engineering sector 2002

Subsector	Carbon impact (MtC)	Cost effective carbon savings (% of total impact)			
		Improvements in operational practices	Retrofitting	New plant	Total savings opportunity
Engineering	4.22	11.4	4.7	2.8	19.0

Source: Adapted from Industrial energy efficiency fact base and market assessment. Future Energy Solutions for the Carbon Trust. August 2003. NB: short to medium term savings is made up of improvements in operational practices and retrofitting.

15.90 The energy intensity data shown in Table 4.3 shows that energy intensity within the electrical engineering sector improved by 31% between 1990 and 2005, an annual improvement of 2.1%. It would therefore be anticipated that an 8.3% improvement would have taken place between 2002 and 2006, reducing the savings opportunity shown in Table 15.45 to 7.8%.

15.91 There is one CCA for the electrical engineering sector focusing on semiconductors. The target for the sector is expressed as a ratio of target year performance to base year performance. Table 15.46 shows that between 2002 and 2006 a 62% improvement in the SEC was achieved. This clearly overwhelms the 16.1% short to medium term savings opportunity identified in 2002 and hence a savings opportunity of zero will be applied to the CCA companies.

Table 15.46: Results from the CCA TP3 semiconductor sector returns[1]

	TP1 (2002)	TP2 (2004)	TP3 (2006)
Primary energy consumption (TWh)	1.985	2.225	2.371
Ratio (target year performance to base year)	0.8897	0.5394	0.2666
SEC improvement on base year (%)	11	46	73

15.92 A review of ENWORKS and Envirowise 2005 and 2006 survey data showed average identified energy savings of 7.1% within the electrical engineering sector (Table 15.47) in line with the 7.8% estimate discussed above. Since this 7.1% represents actual identified opportunities it is considered the most robust estimate and hence is applied to all non-CCA companies in the sector.

Table 15.47: A summary of case study findings in the electrical engineering sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Electrical engineering	28	7.1	10.7	0.59

15.93 Table 15.48 shows the summary of energy savings within the electrical engineering sector.

[1] Climate Change Agreement. Results of the third target period assessment. July 2007. AEAT for Defra.

Table 15.48: Summary of energy savings opportunity within the electrical engineering sector

Subsector	Secondary energy consumed (TWh)	Energy savings opportunity	
		%	TWh
CCA	1.221	0	0
Non-CCA	8.257	7.14	0.590
Total	**9.478**	**6.2**	**0.590**

Valuation of energy savings

15.94 Applying the standard energy price of 4.26p/kWh (Table 15.49) to the estimated savings opportunity shown in Table 15.48 (0.59TWh) the estimated savings within the electrical engineering sector is £25 million.

Table 15.49: Summary of energy price (p/kWh) within the electrical engineering sector

Fuel	Total consumption (ktoe)	Fuel mix	Fuel price (p/kWh)	Weighted average kWh price (p)
Coal	3	0.00	0.626	0.00
Heavy oil	7	0.01	2.0987	0.01
Gas oil	29	0.03	2.957	0.08
Electricity	638	0.60	5.85	3.53
Gas	380	0.36	1.746	0.63
			Total	**4.26**

15.95 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.50. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £2 million, making the estimated total savings for the sector £27 million ± 10.7%.

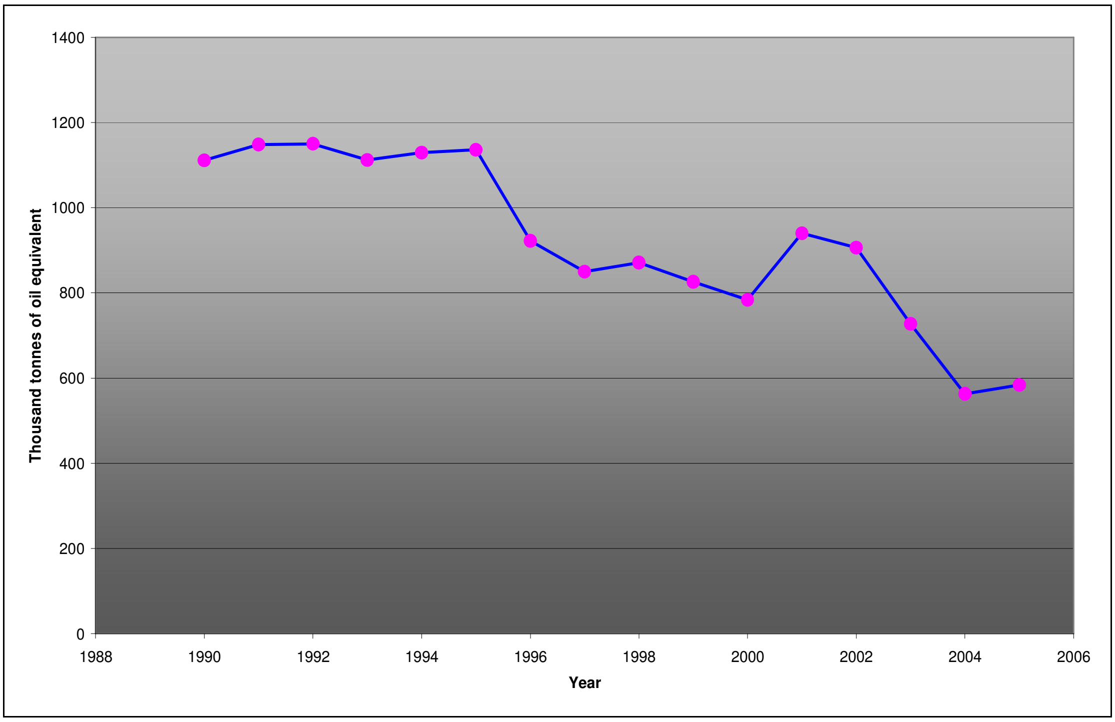
Table 15.50: Summary of energy price (p/kWh) within the electrical engineering sector (CCL)

Fuel	Total consumption (ktoe)	Fuel mix	CCL (p/kWh)	Weighted average kWh price (p)
Coal	3	0.00	0.1695	0.00
Heavy oil	7	0.01	0.07544	0.001
Gas oil	29	0.03	0.07544	0.002
Electricity	638	0.60	0.441	0.264
Gas	380	0.36	0.154	0.055
			Total	**0.322**

The construction sector

15.96 The construction sector accounted for 1.7% of the energy consumed within the industrial sector in 2005 and Figure 15.18 shows the trend in energy consumption in the construction sector between 1990 and 2005. This shows that energy consumption has reduced dramatically.

Figure 15.18: Energy consumption in the construction sector



Source: BERR.

Quantification of energy savings

15.97 In 2003 the Carbon Trust reported[1] that the short and medium term energy savings from the group of sectors comprising of construction, timber products and furniture equated to 13.2%, Table 15.51. The energy intensity data shown in Table 4.3 indicates that the construction industry as improved by 54% between 1990 and 2005 representing an annual improvement of 3.6%. Therefore, it would be anticipated that during the period from 2002 (base year for the Carbon Trust report) to 2006 an improvement of 14.4% would have taken place, which would suggest that the 13.2% savings opportunity has been realised.

Table 15.51: Energy savings in the chemicals sector 2003

Subsector	Carbon impact (MtC)	Cost effective carbon savings (% of total impact)			
		Improvements in operational practices	Retrofitting	New plant	Total savings opportunity
Other (construction, timber and furniture products)	4.93	7.5	5.7	5.7	18.9

Source: Adapted from Industrial energy efficiency fact base and market assessment. Future Energy Solutions for the Carbon Trust. August 2003.

15.98 However, these findings are not in agreement with those of the construction industry. The major construction company, Taylor Woodrow, report[2] that they cannot attribute such significant savings to energy efficiency activities undertaken in the industry over the four year period. In addition, Table 15.52 shows the energy savings that have been identified in the Envirowise FastTrack case studies since 2005 and the anecdotal evidence from Taylor Woodrow; it is assumed that a 12.4% opportunity remains. This shows the average savings opportunity was 12.4%. Based on the evidence from the FastTrack case studies, the 2005 value shown in Figure 15.18 (563ktoe) was converted to kWh (6.53TWh). Applying 12.4% then gives an estimated savings opportunity of 0.81TWh.

Table 15.52: A summary of case study findings in the construction sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Construction	38	12.4	11.9	0.74

[1] Industrial energy efficiency fact base and market assessment. Future Energy Solutions for the Carbon Trust. August 2003.

[2] Jon May, Taylor Woodrow, Personal Communication. May 2007.

Valuation of energy savings

15.99 Applying a cost factor of 3.28p/kWh (Table 15.53) to the 0.81TWh, the savings opportunity is estimated at £26m.

Table 15.53: Summary of energy price (p/kWh) within the construction sector

Fuel	**Total consumption (ktoe)**	**Fuel mix**	**Fuel price (p/kWh)**	**Weighted average kWh price (p)**
Coal	0	0.00	0.626	0.00
Heavy oil	17	0.03	2.0987	0.06
Gas oil	173	0.30	2.957	0.88
Electricity	166	0.28	5.85	1.66
Gas	228	0.39	1.746	0.68
			Total	**3.28**

15.100 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.54. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £2 million, making the estimated total savings for the sector £28 million ± 11.9%.

Table 15.54: Summary of energy price (p/kWh) within the construction sector (CCL)

Fuel	**Total consumption (ktoe)**	**Fuel mix**	**CCL (p/kWh)**	**Weighted average kWh price (p)**
Coal	0	0.00	0.1695	0.00
Heavy oil	17	0.03	0.07544	0.002
Gas oil	173	0.30	0.07544	0.023
Electricity	166	0.28	0.441	0.123
Gas	228	0.39	0.154	0.060
			Total	**0.208**

Grossing up of energy savings opportunity within the industrial sector

15.101 The nine subsectors detailed above account for 83% of secondary energy consumption within the industrial sector. To gross up the data to take account of the savings opportunity within the remaining 17% the mean energy savings within these nine sectors was used. Table 15.55 summarises the energy savings and shows mean savings of 4.8%.

Table 15.55: Summary of energy savings opportunity within the nine focus subsectors of the industrial sector

Subsector	**Secondary energy consumed (TWh)**	**Estimated energy savings**	
		%	**TWh**
Coke, refined petroleum products and nuclear fuel	106.449	2.0	2.129
Chemicals	97.360	7.0	6.770
Metals	46.737	4.4	2.034
Food & drink	44.312	5.5	2.427
Paper	30.238	4.5	1.369
Vehicles	18.131	4.0	0.726
Textiles	11.664	7.1	0.831
Electrical engineering	9.478	6.2	0.590
Construction	6.530	12.4	0.810
Total	**370.899**	**4.76**	**17.686**

15.102 Table 15.56 shows the estimated savings from the remaining subsectors when applying the mean energy savings opportunity of 4.76%.

Table 15.56: Summary of energy savings opportunity within the other subsectors of the Industrial sector

Subsector	**Secondary energy consumed (TWh)**	**Estimated energy savings**	
		%	**TWh**
Other non-metallic mineral products	26.249	4.76	1.249
Manufacturing nec	21.167	4.76	1.008
Wood	10.990	4.76	0.523
Machinery & equipment nec	7.711	4.76	0.367
Mining & quarrying	5.827	4.76	0.277
Total	**71.944**	**4.76**	**3.424**

Valuation of energy savings

15.103 Using the BERR fuel mix data and the mean fuel prices the energy cost per kWh (p/kWh) was derived for each subsector. This was then multiplied by the estimated energy savings to derive the energy savings opportunity (£), Table 15.57.

Table 15.57: Summary of energy savings opportunity (£) within the other subsectors of the Industrial sector

Subsector	**Energy price (p/kWh)**	**Estimated energy savings**	
		TWh	**£M**
Other non-metallic mineral products	2.26	1.249	28
Manufacturing nec	3.28	1.008	33
Wood	3.32	0.523	17
Machinery & equipment nec	3.72	0.367	14
Mining & quarrying	3.93	0.277	11
	Total	**3.424**	**103**

15.104 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.58 for the five additional subsectors. The estimated additional savings is £7 million, making the estimated total savings for the sector £110 million.

Table 15.58: Summary of energy savings opportunity (£) within the other subsectors of the Industrial sector (CCL)

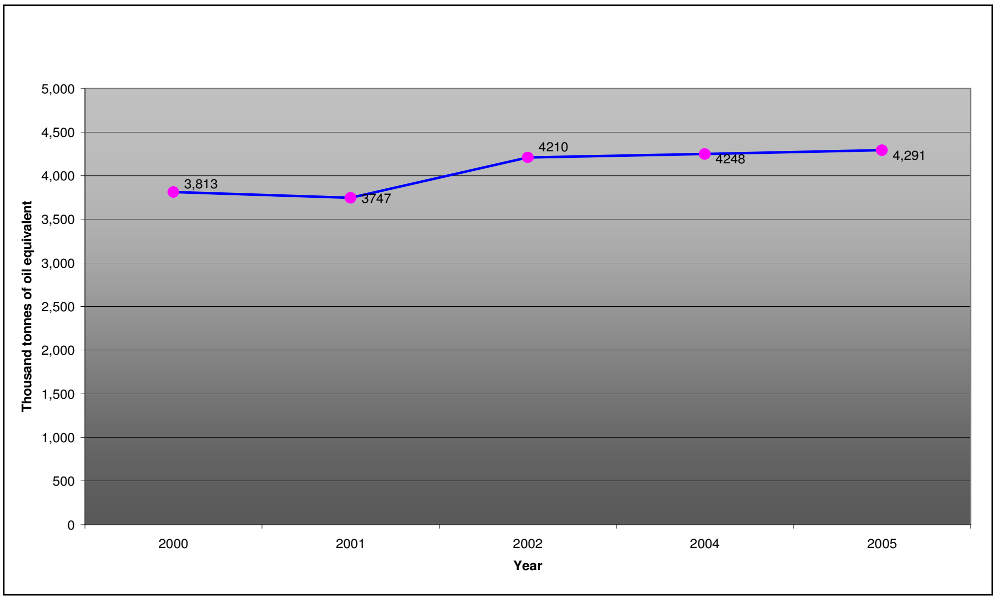
Subsector	**CCL (p/kWh)**	**Estimated energy savings**	
		TWh	**£M**
Other non-metallic mineral products	0.215	1.249	3
Manufacturing nec	0.145	1.008	1
Wood	0.174	0.523	1
Machinery & equipment nec	0.280	0.367	1
Mining & quarrying	0.263	0.277	1
	Total	**3.424**	**7**

The commercial, public administration and agricultural sector

Retail

15.105 This sector accounted for 22.8% of the energy consumed within the commercial and public administration sectors in 2005 and Figure 15.19 shows that energy consumption increased by 12.5% in the sector between 2000 and 2005.

Figure 15.19: Energy consumption in the retail sector



Source: BERR

Quantification of energy savings

15.106 The Carbon Trust estimates that energy savings of up to 20% across the sector are possible with the biggest areas of energy savings potential being heating, lighting, refrigeration and, in the larger stores, air conditioning[1]. Potential interventions include:

- **Lighting:** Staff "switch off" policy to turn lights off in staff areas when not used; ensure light timers match trading hours; reduce the number of lights that are used for display and use natural lighting where possible, only turn on lights during low light at the beginning and end of the day. Replace old inefficient lights with modern alternatives

[1] www.carbontrust.co.uk/energy/startsaving/sectorselector/retailandwholesale_20_1.htm Accessed July 2007.

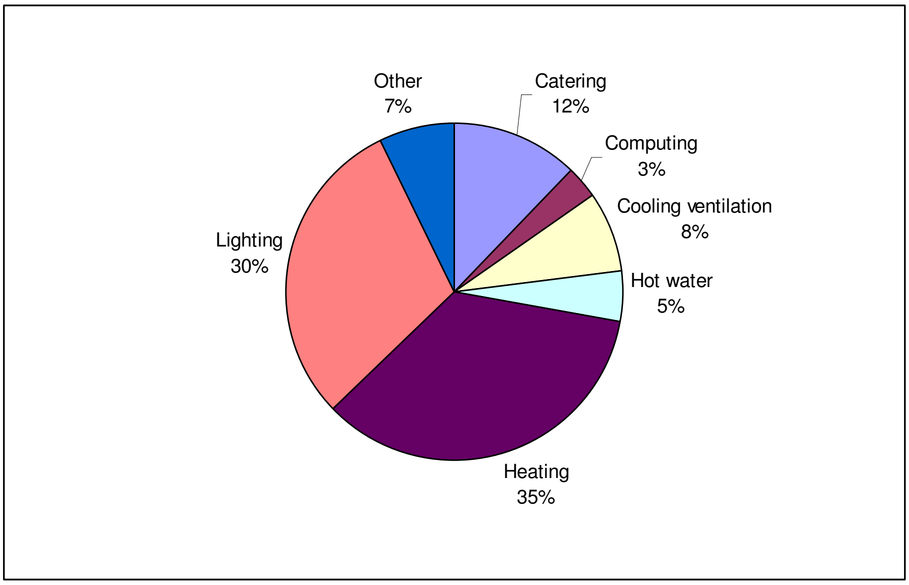
- **Heating ventilation and air conditioning:** Turn off redundant boilers in summer months. In colder months lower the temperature of the store, customers can feel uncomfortable in hot stores. Ensure that the air conditioning and heating a correctly set, ensure that they are not operating outside of opening hours; initiate regular maintenance regimes.

- **Refrigeration:** Ensure that chilling cabinets are correctly filled, over/incorrectly filled cabinets require more energy to operate; install night blinds; setup regular maintenance regimes.

- Accurately measure the energy consumption from the building, this way targets can be set for energy efficiency savings.

15.107 Figure 15.20 shows that lighting and heating alone account for 65% of energy consumption from the retail sector and hence represent the two most significant opportunities.

Figure 15.20: A breakdown of energy use within the retail sector



Source: BERR

15.108 A review of Envirowise and ENWORKS surveys undertaken in the retail sector in 2005 and 2006 showed average energy savings of 11.3% (Table 15.59). The discrepancy between the 20% savings opportunity suggested by the Carbon Trust and the 11.3% found within the Envirowise and ENWORKS surveys is likely to be in the interpretation of savings opportunity. The Carbon Trust reports all cost effective savings opportunities, which can include significant capital expenditure, whereas the savings identified within this study are based on surveys which focused on short to medium term low-cost / no-cost savings. The 11.3% savings opportunity is therefore considered the most relevant for this study. Since the retail sector consumed 49.9TWh (4,291ktoe) of energy in 2005 the saving equates to 5.6TWh.

Table 15.59: A summary of case study findings in the retail sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Retail	66	11.3	9.3	0.8

Valuation of energy savings

15.109 Based on an energy price of 2.31p/kWh (Table 15.60) the savings of 5.6TWh equates to a savings opportunity of £130 million.

Table 15.60: Summary of energy price (per kWh) within the retail sector

Fuel	Total consumption (ktoe)	Fuel mix	Fuel price (p/kWh)	Weighted average kWh price (p)
Electricity	279	0.14	5.85	0.80
Gas	1,758	0.86	1.746	1.51
			Total	**2.31**

15.110 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.61. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £11 million and the estimated total savings for the sector £141 million ± 9.3%.

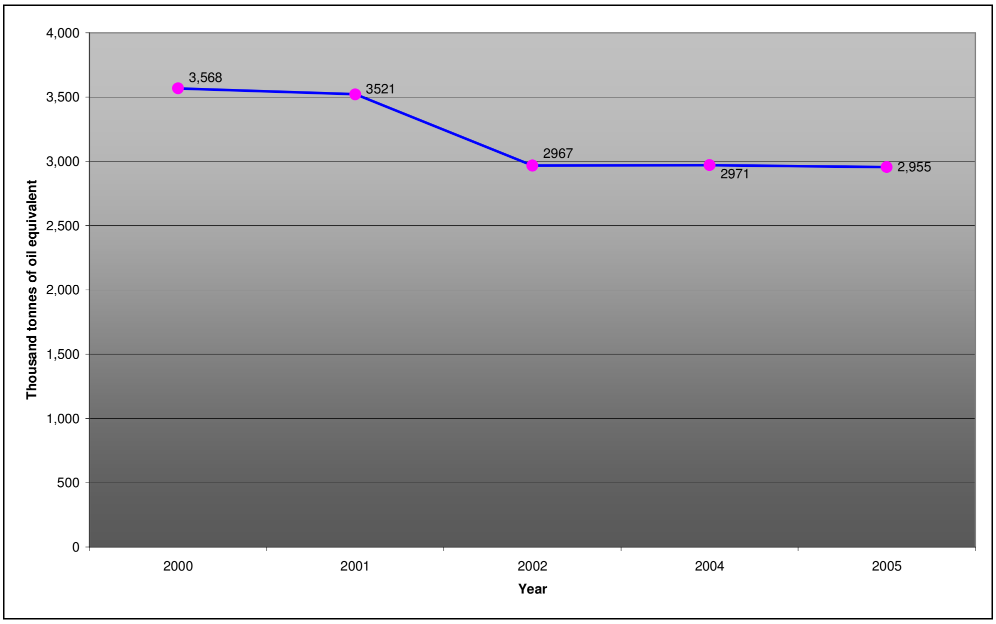
Table 15.61: Summary of energy price (per kWh) within the retail sector (CCL)

Fuel	Total consumption (ktoe)	Fuel mix	CCL (p/kWh)	Weighted average kWh price (p)
Electricity	279	0.14	0.441	0.062
Gas	1,758	0.86	0.154	0.132
			Total	**0.194**

The hotels and catering sector

15.111 This sector accounted for 15.7% of the energy consumed within the commercial and public administration sectors in 2005 and Figure 15.21 shows that energy consumption reduced by 17% in the sector between 2000 and 2005.

Figure 15.21: Energy consumption in the hotels and catering sector



Quantification of energy savings

15.112 The Carbon Trust estimates that energy savings of up to 20% are possible across the sector[1]. However, much like the retail sector the review of FastTrack case studies undertaken by Envirowise and the ENWORKS surveys puts the low-cost / no-cost savings opportunity lower at 12.9% (Table 15.62). Since the hotel and catering sector consumed 34.4TWh (2,955ktoe) of energy in 2005 it is estimated that the savings opportunity of 12.9% equates to 4.4TWh.

Table 15.62: A summary of case study findings in the hotels and catering sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Hotels and Catering	62	12.9	12.7	0.55

[1] www.carbontrust.co.uk/energy/startsaving/sectorselector/hospitalityhotelsandrestaurants_14_1.htm Accessed July 2007.

Valuation of energy savings

15.113 Based on an energy price of 2.28p/kWh (Table 15.63) the energy savings is £101 million.

Table 15.63: Summary of energy price (per kWh) within the hospitality sector

Fuel	Total consumption (ktoe)	Fuel mix	Fuel price (p/kWh)	Weighted average kWh price (p)
Electricity	694	0.13	5.85	0.77
Gas	4,610	0.87	1.746	1.52
			Total	**2.28**

15.114 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.64. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £8 million and the estimated total savings for the sector £109 million ± 12.7%.

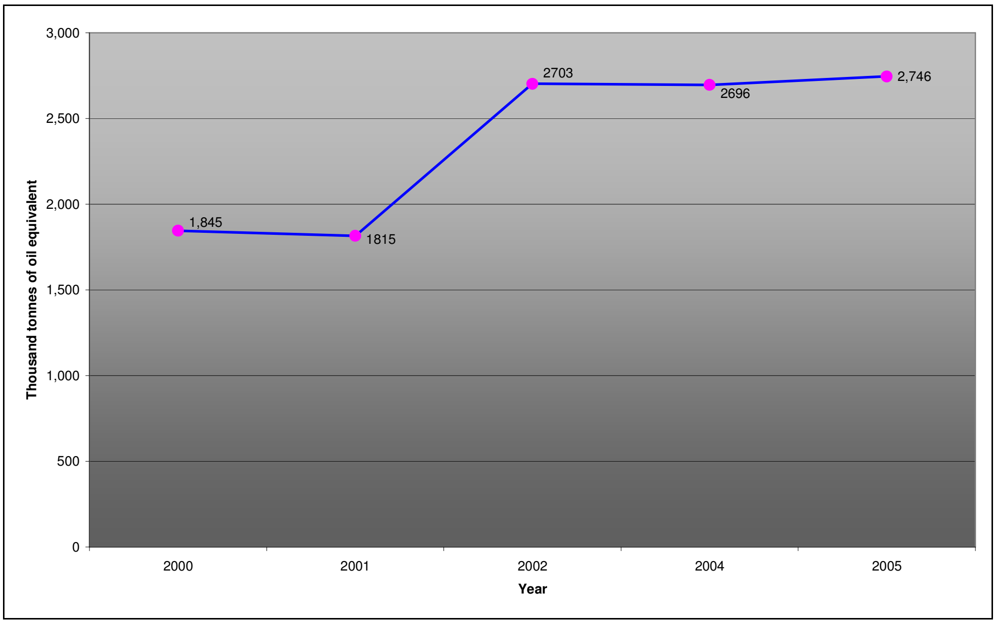
Table 15.64: Summary of energy price (per kWh) within the hospitality sector (CCL)

Fuel	Total consumption (ktoe)	Fuel mix	CCL (p/kWh)	Weighted average kWh price (p)
Electricity	694	0.13	0.441	0.057
Gas	4,610	0.87	0.154	0.134
			Total	**0.191**

Warehousing

15.115 Warehousing accounted for 14.6% of the energy consumed within the commercial and public administration sectors in 2005 and Figure 15.22 shows that energy consumption within the sector increased by 49% between 2000 and 2005.

Figure 15.22: Energy consumption in the warehousing sector



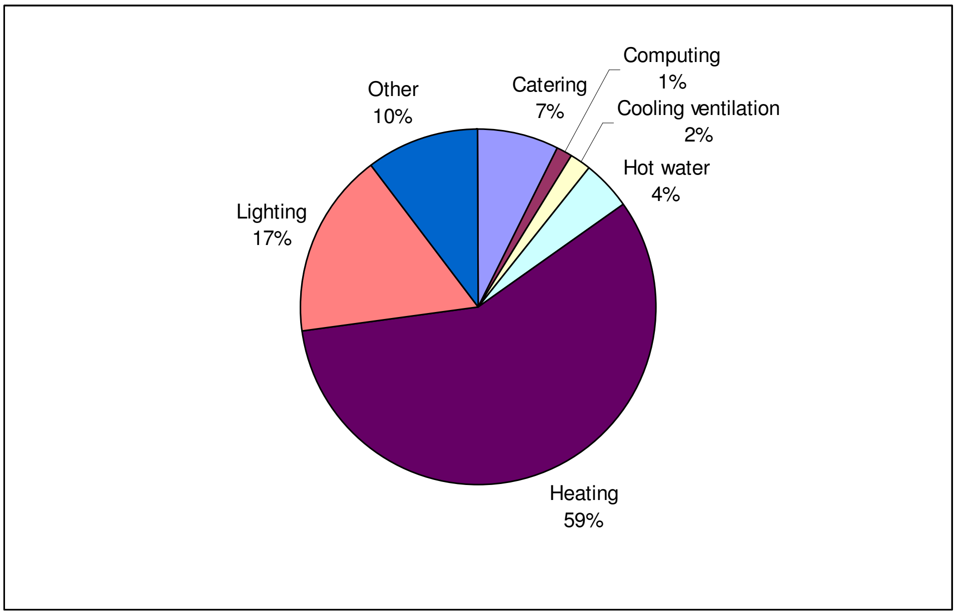
Quantification of energy savings

15.116 The review of FastTrack surveys undertaken by Envirowise and ENWORKS surveys puts the low-cost / no-cost savings opportunity from warehousing at 9.5% (Table 15.65). Heating and lighting were cited as the two most significant energy savings opportunities within the surveys and Figure 15.23 shows these two energy uses to account for 76% of the energy consumed by warehousing. Since warehousing used 31.94TWh (2,746ktoe) of energy in 2005 the saving equates to 3.034TWh.

Table 15.65: A summary of case study findings in the Warehousing sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Warehousing	14	9.5	7.5	0.91

Figure 15.23: A breakdown of energy use within the warehousing sector



Valuation of energy savings

15.117 Applying an energy price of 2.35p/kWh (Table 15.66) to the estimated saving of 3.0TWh the savings opportunity is £71 million ± 7.5%.

Table 15.66: Summary of energy price (per kWh) within the warehousing sector

Fuel	**Total consumption (ktoe)**	**Fuel mix**	**Fuel price (p/kWh)**	**Weighted average kWh price (p)**
Electricity	318	0.15	5.85	0.86
Gas	1,835	0.85	1.746	1.49
			Total	**2.35**

15.118 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.67. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £6 million and the estimated total savings for the sector £77 million ± 7.5%.

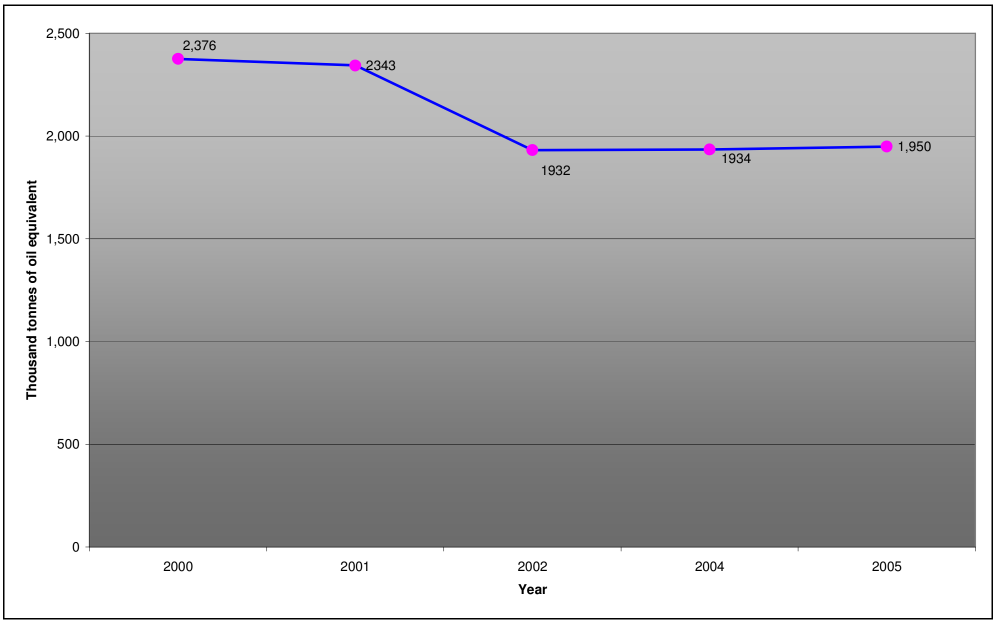
Table 15.67: Summary of energy price (per kWh) within the warehousing sector (CCL)

Fuel	**Total consumption (ktoe)**	**Fuel mix**	**CCL (p/kWh)**	**Weighted average kWh price (p)**
Electricity	318	0.15	0.441	0.066
Gas	1,835	0.85	0.154	0.131
			Total	**0.197**

Commercial offices

15.119 Commercial offices accounted for 10.4% of the energy consumed within the commercial and public administration sectors in 2005. Figure 15.24 shows that the energy consumed in commercial offices reduced by nearly 18% (17.9%) between 2000 and 2005 due to the significant step change in 2002.

Figure 15.24: Energy consumption in commercial offices



Quantification of energy savings

15.120 The Carbon Trust estimates that the savings opportunity from business activities (office based) is up to 20%[1]. Surveys undertaken by Envirowise and ENWORKS have identified average low-cost / no-cost energy savings of 17.4% (Table 15.68) which equates to a saving of 3.9TWh.

15.121 Three primary areas where these savings can be realised are:

- **Heating & Cooling:** Set the radiator thermostat to 1°C lower; ensure radiators are not blocked by furniture or files; keep doors and windows closed in air-conditioned areas; turn the heating off overnight**.**
- **Lighting:** Try to use as much natural light as possible; switch off lights when the room is not in use; ensure that lights are the last to leave in

[1] www.carbontrust.co.uk/energy/startsaving/sectorselector/businessactivities_3 _1.htm Accessed July 2007.

the evenings is responsible for turning off all lights, purchase energy saving light bulbs where possible.

- **IT Equipment:** Ensure monitors enter standby rather than use screen savers and the computer powers down when not in use, turn off all office equipment overnight; switch off computer screens when away from your desk (especially during lunch and meetings); reduce the number of printers in the office through sharing.

Table 15.68: A summary of case study findings in the commercial office sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Commercial offices	84	17.4	15.9	0.79

Valuation of energy savings

15.122 Based on an energy price of 2.36p/kWh (Table 15.69) the savings opportunity of 3.9TWh equates to £93 million.

Table 15.69: Summary of energy price (per kWh) within the commercial sector

Fuel	Total consumption (ktoe)	Fuel mix	Fuel price (p/kWh)	Weighted average kWh price (p)
Electricity	563	0.15	5.85	0.87
Gas	3,214	0.85	1.746	1.49
			Total	**2.36**

15.123 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.70. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £8 million and the estimated total savings for the sector £101 million ± 15.9%.

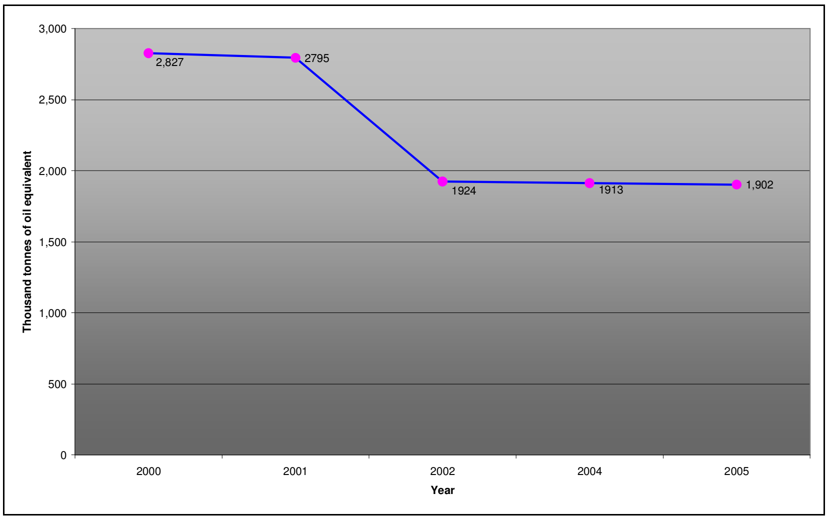
Table 15.70: Summary of energy price (per kWh) within the commercial sector (CCL)

Fuel	Total consumption (ktoe)	Fuel mix	CCL (p/kWh)	Weighted average kWh price (p)
Electricity	563	0.15	0.441	0.066
Gas	3,214	0.85	0.154	0.131
			Total	**0.197**

Education

15.124 Education accounted for 10.1% of the energy consumed within the commercial and public administration sectors in 2005 and Figure 15.25 shows that energy consumption reduced by nearly one third (32.7%) between 2000 and 2005.

Figure 15.25: Energy consumption in the education sector



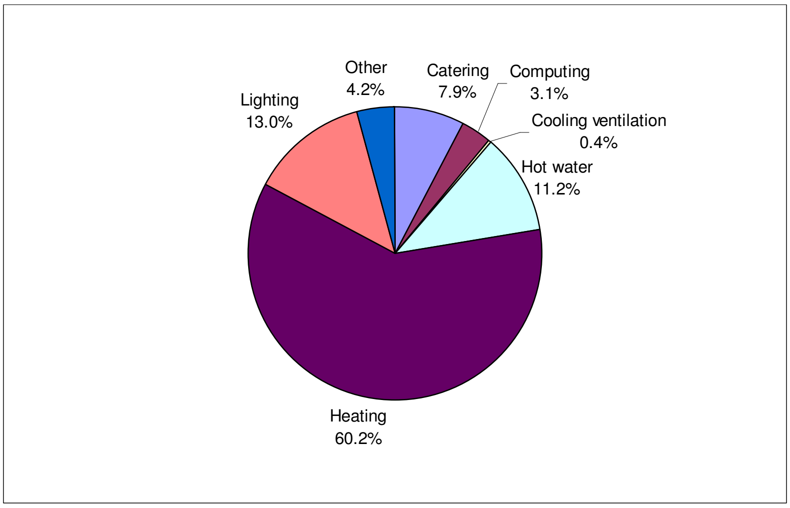
Quantification of energy savings

15.125 The Carbon Trust estimates that schools can make energy savings of 5% at no cost[1] and that higher and further education could make savings of 20% using simple low-cost / no-cost techniques and technologies[2]. Figure 15.26 shows that heating, lighting and hot water represent the significant areas of opportunity, accounting for 84.4% of energy use.

[1] www.carbontrust.co.uk/energy/startsaving/sectorselector/schools_21_1.htm Accessed July 2007.

[2] www.carbontrust.co.uk/energy/startsaving/sectorselector/higherandfurthereducation_8_1.htm Accessed July 2007.

Figure 15.26: A breakdown of energy use within the education sector



Valuation of energy savings

15.126 The Carbon Trust values the 5% energy savings opportunities from schools at £20 million and the 20% from higher and further education at £40 million making a combined savings opportunity of £60 million or 10% of the energy consumed in the education sector.

15.127 Alternatively, using the 2005 energy consumption of 22.1TWh (1,902ktoe) the 10% energy savings equates to 2.212TWh which, based on a standard energy price of 2.17p/kWh (Table 15.71) equates to a saving of £48 million.

Table 15.71: Summary of energy price (per kWh) within the education sector

Fuel	**Total consumption (ktoe)**	**Fuel mix**	**Fuel price (p/kWh)**	**Weighted average kWh price (p)**
Electricity	319	0.10	5.85	0.61
Gas	2,756	0.90	1.746	1.56
			Total	**2.17**

15.128 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.72. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £4 million and the estimated total savings for the sector £52 million. This shows an £8 million difference compared with the £60 million Carbon Trust estimate. Two potential reasons for this are the possible use of different baselines (expenditure on energy in the sector) and rounding errors. For consistency, the £52 million will be the valuation used in this report.

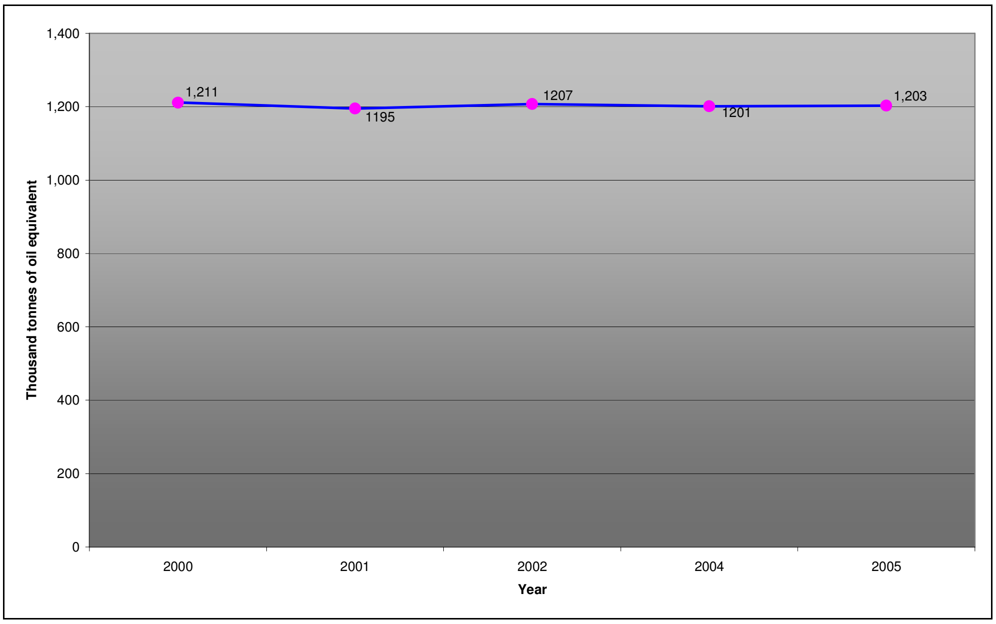
Table 15.72: Summary of energy price (per kWh) within the education sector (CCL)

Fuel	**Total consumption (ktoe)**	**Fuel mix**	**CCL (p/kWh)**	**Weighted average kWh price (p)**
Electricity	319	0.10	0.441	0.044
Gas	2,756	0.90	0.154	0.139
			Total	**0.183**

Government

15.129 Government activities accounted for 6.4% of the energy consumed within the commercial and public administration sectors in 2005. Figure 15.27 shows that energy consumption in the sector remained steady between 2000 and 2005, with a very slight reduction of less than 1% (0.66%).

Figure 15.27: Energy consumption in Government



Quantification of energy savings

15.130 The Carbon Trust estimates the energy savings opportunities to be 18%[1] within local government and 21.6% for central government[2].

15.131 The Office of Government Commerce (OGC) has made slightly lower estimates stating that the Government can reduce energy use by 10% through behavioural change and a further 5% through the use of more energy efficient products and services[3], giving a slightly lower estimate of 15%.

15.132 Based on the 2005 energy consumption of 13.99TWh (1,203 ktoe) the 15% savings cited by the OGC the savings opportunity is 2.10TWh.

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[1] www.carbontrust.co.uk/energy/startsaving/sectorselector/localgovernment_13_1.htm Accessed July 2007.

[2] www.carbontrust.co.uk/energy/startsaving/sectorselector/centralgovernment_12_1.htm Accessed July 2007.

[3] The Energy Challenge: Energy Review Report 2006. BERR. July 2006.

Valuation of energy savings

15.133 The Carbon Trust states that for local government:

"It is estimated that savings of up to 18% across the sector are possible totalling over £19 million each year"

15.134 However, the Carbon Trust has not estimated the financial savings opportunity in central government.

15.135 Applying an energy price of 2.21p/kWh (Table 15.73) to the savings estimate for the whole sector of 2.099TWh the savings opportunity equates to £46.3 million. Since the Carbon Trust estimate for an 18% reduction in energy saving in local government is £19 million a 15% reduction would equate to 15.8%. This would leave £30.5 million of the £46.3 million savings opportunity within central government.

Table 15.73: Summary of energy price (per kWh) within the government sector

Fuel	Total consumption (ktoe)	Fuel mix	Fuel price (p/kWh)	Weighted average kWh price (p)
Electricity	226	0.11	5.85	0.66
Gas	1,783	0.89	1.746	1.55
			Total	**2.21**

15.136 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.274. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £4 million (£3,904,140) and the estimated total savings for the sector £50 million.

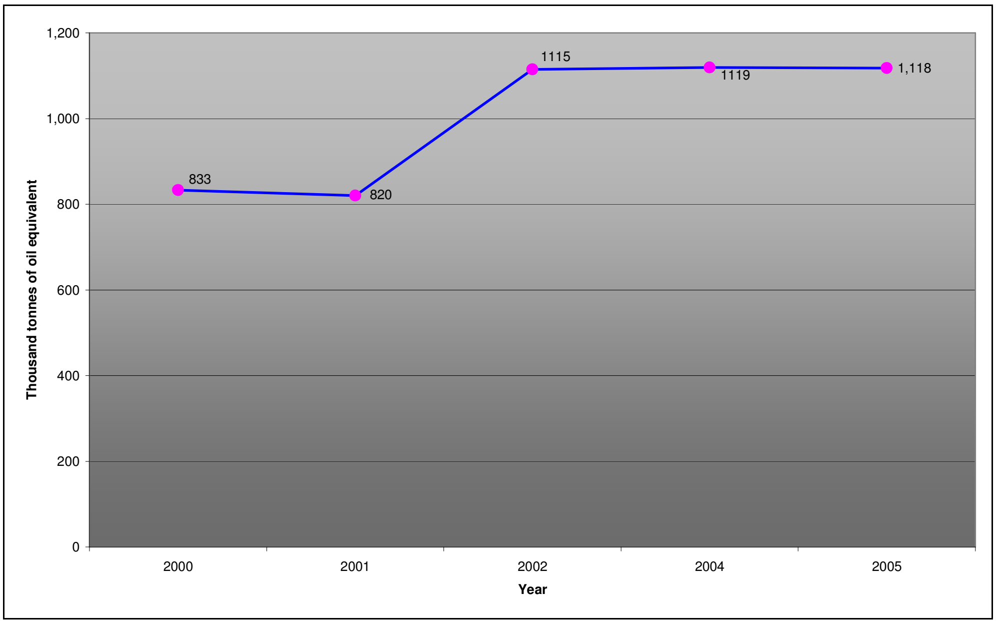
Table 15.74: Summary of energy price (per kWh) within the government sector (CCL)

Fuel	Total consumption (ktoe)	Fuel mix	CCL (p/kWh)	Weighted average kWh price (p)
Electricity	226	0.11	0.441	0.049
Gas	1,783	0.89	0.154	0.137
			Total	**0.186**

Sports and leisure

15.137 This sector accounted for 5.9% of the energy consumed within the commercial and public administration sectors in 2005. Figure 15.28 shows that energy consumption in this sector increased by 34% between 2000 and 2005 with a major increase between 2001 and 2002 being the significant cause.

Figure 15.28: Energy consumption in the sports and leisure sector

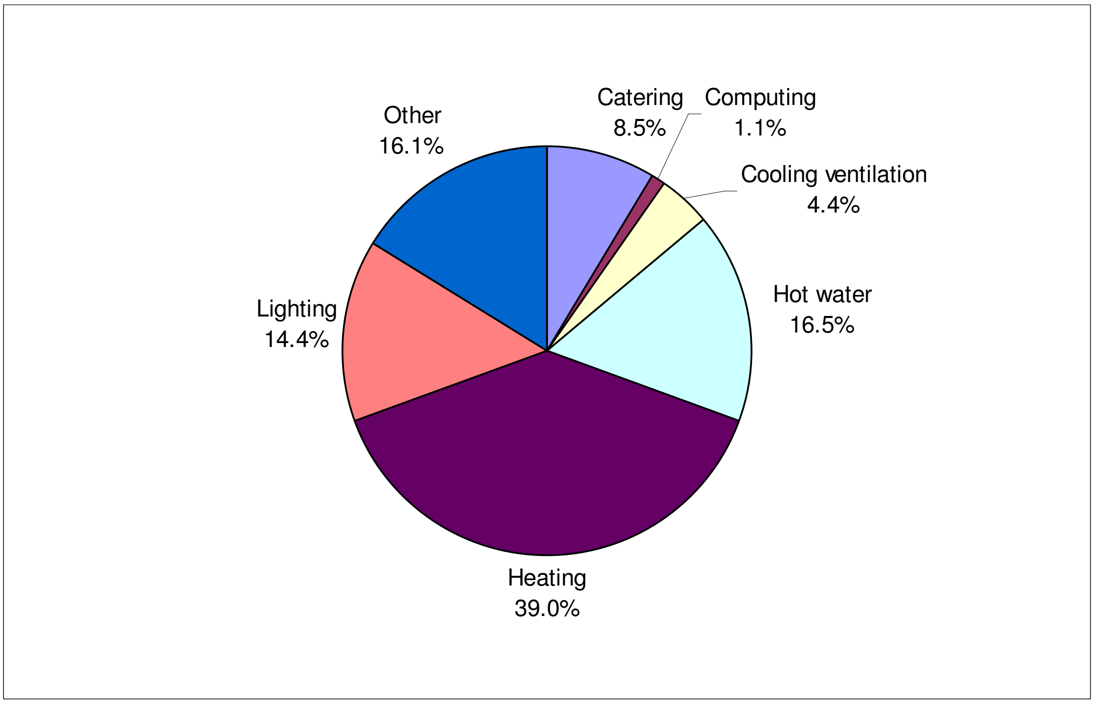


Quantification of energy savings

15.138 The Carbon Trust estimates the energy savings opportunity within the sports and leisure sector to be 10% through savings on heating, lighting, ventilation and air-conditioning[1]. Figure 15.29 shows heating, lighting and ventilation to account for 57.8% of energy consumed within the sector. Hot water is also a significant energy use accounting for 16.5% of energy use.

[1] www.carbontrust.co.uk/energy/startsaving/sectorselector/sportsandleisure_22_1.htm Accessed July 2007.

Figure 15.29: A breakdown of energy use within the sports and leisure sector



15.139 A review of the energy savings opportunities identified by Envirowise and ENWORKS in 2005 and 2006 values the low-cost / no-cost savings at 7.4% (Table 15.75), slightly below the Carbon Trust valuation.

Table 15.75: A summary of case study findings in the sports and leisure sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Sports and leisure	18	7.4	5.4	0.96

15.140 Applying the 7.4% saving to the 2005 energy consumption figure of 13TWh (1,118ktoe) gives a saving opportunity of 0.962TWh.

Valuation of energy savings

15.141 Applying an energy price of 2.54p/kWh (Table 15.76) to the savings opportunity of 0.962TWh generates a savings opportunity of £24.4 million.

Table 15.76: Summary of energy price (per kWh) within the sports and leisure sector

Fuel	Total consumption (ktoe)	Fuel mix	Fuel price (p/kWh)	Weighted average kWh price (p)
Electricity	1,975	0.19	5.85	1.13
Gas	8,290	0.81	1.746	1.41
			Total	**2.54**

15.142 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.77. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £2 million and the estimated total savings for the sector £26 million ± 5.4%.

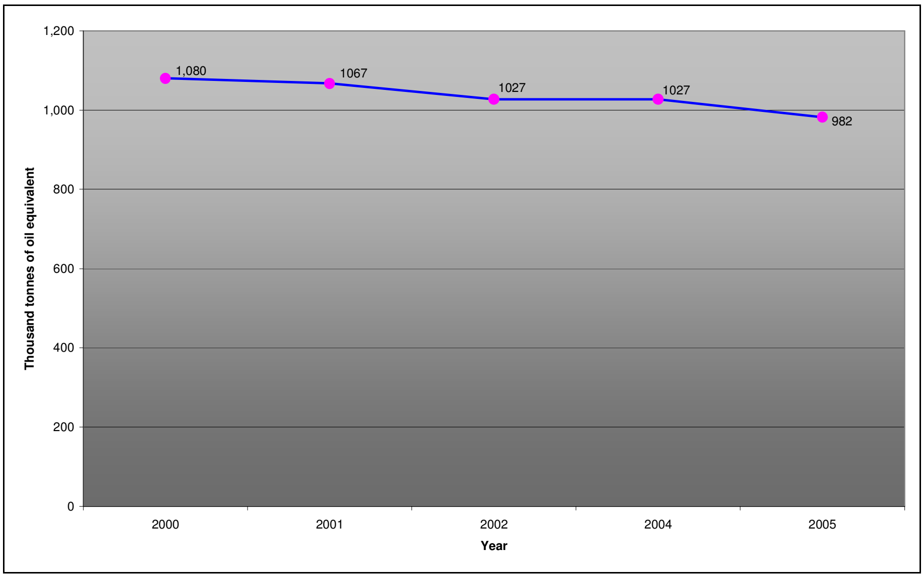
Table 15.77: Summary of energy price (per kWh) within the sports and leisure sector (CCL)

Fuel	Total consumption (ktoe)	Fuel mix	CCL (p/kWh)	Weighted average kWh price (p)
Electricity	1,975	0.19	0.441	0.084
Gas	8,290	0.81	0.154	0.125
			Total	**0.209**

Health

15.143 Health accounted for 5.2% of the energy consumed within the commercial and public administration sector in 2005. Figure 15.30 shows that a steady reduction in energy consumption has taken place between 2000 and 2005, equating to a 9% drop in energy use.

Figure 15.30: Energy consumption in the health sector



Quantification of energy savings

15.144 The Carbon Trust reports that[1]:

"the sector uniquely has mandatory energy targets for new and existing buildings which seek to deliver a 15% reduction in energy consumption from 2001 - 2010. Potentially 35% savings are achievable from primary care buildings and 20% savings from hospital buildings"

15.145 The 15% reduction across the nine year period equates to an annual reduction of 1.67% and hence assuming the savings will be made on an incremental basis the remaining opportunity is estimated to be 6.67%.

15.146 Based on the 2005 energy consumption within the sector of 11.4TWh (982 ktoe), a saving of 6.67% equates to 0.76TWh.

[1] www.carbontrust.co.uk/energy/startsaving/sectorselector/healthcare_15_1.htm Accessed July 2007.

Valuation of energy savings

15.147 Applying an energy price of 2.15p/kWh (Table 15.78) to the 0.76TWh savings opportunity provides an estimated savings of £16 million.

Table 15.78: Summary of energy price (per kWh) within the health sector

Fuel	Total consumption (ktoe)	Fuel mix	Fuel price (p/kWh)	Weighted average kWh price (p)
Electricity	152	0.10	5.85	0.57
Gas	1,402	0.90	1.746	1.58
			Total	**2.15**

15.148 The additional savings associated with reductions in CCL payments is derived by calculating the average CCL payment (p/kWh); this is shown in Table 15.79. Multiplying this by the energy savings opportunity values the savings from reduced CCL payments at £1 million, making the estimated total savings for the sector £17 million.

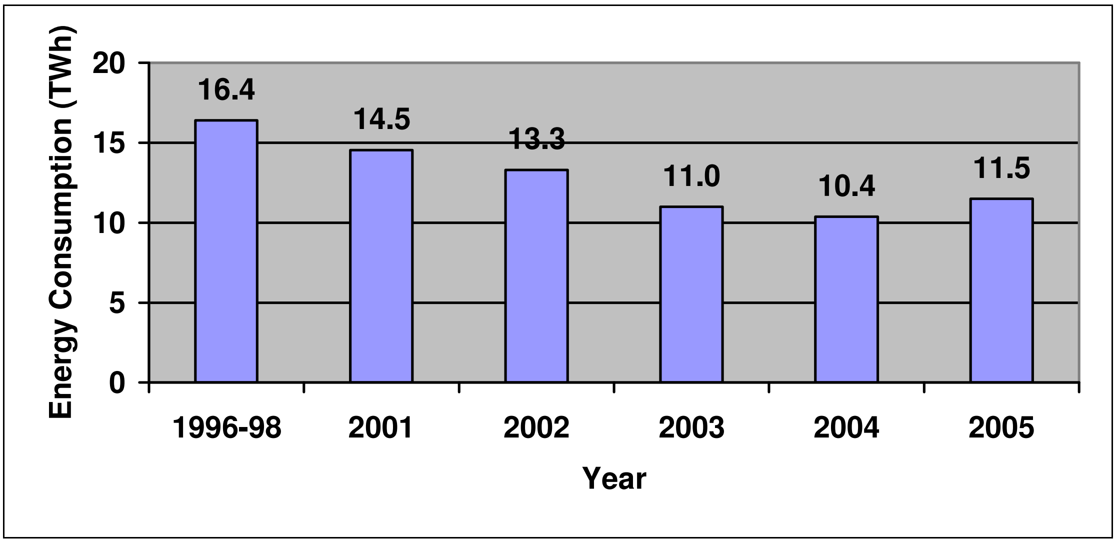
Table 15.79: Summary of energy price (per kWh) within the health sector (CCL)

Fuel	Total consumption (ktoe)	Fuel mix	CCL (p/kWh)	Weighted average kWh price (p)
Electricity	152	0.10	0.441	0.044
Gas	1,402	0.90	0.154	0.139
			Total	**0.183**

The agriculture sector

15.149 Figure 15.31 shows the direct energy consumed within the agriculture sector. This shows that energy consumption has dropped steadily since 1996/98 with the exception of 2005 which saw a slight increase.

Figure 15.31: Direct energy consumption in the agriculture sector[1]



Quantification of energy savings

15.150 Figure 15.32 shows a breakdown of the energy use in the sector. The Carbon Trust reports that there are big energy savings to be made in all five categories shown resulting in an estimated potential energy saving of 20%.

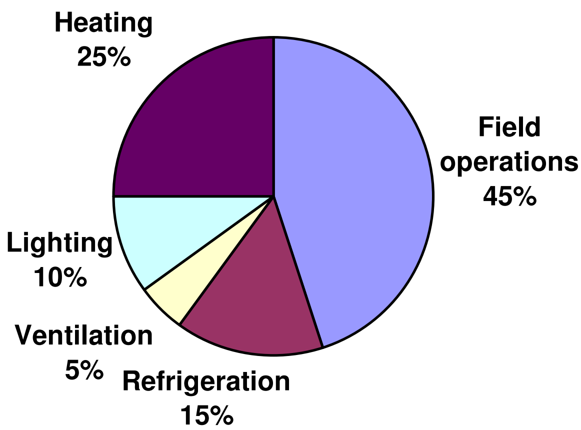
15.151 The Environment Agency[2] stressed that it feels that 20% is in the right region but noted that although the savings fall under the general category of low-cost / no-cost savings, they would be very difficult to realise from a practical perspective.

15.152 Based on the energy consumption of 11.5TWh in 2005 (Figure 15.31) the 20% savings equate to 2.3TWh.

[1] Agriculture in the United Kingdom 2006, Defra

[2] Jane James. Environment Agency. Personal communication. August 2007.

Figure 15.32: A breakdown of energy consumption in the agriculture sector[1]



Valuation of energy savings

15.153 Applying an energy price of 2.32p/kWh to the savings opportunity of 2.3TWh gives an estimated savings of £53 million.

15.154 The fuel mix within the agriculture sector could not be identified. Hence the mean value in the other sectors analysed within this report was used to allocate a CCL reduction value. Assuming the CCL equates to 2.8% of the energy cost in the agriculture sector the additional savings is £1.5 million. The total savings is therefore £54.5 million.

[1] www.carbontrust.co.uk/energy/startsaving/sectorselector/agricultureandhorticulture_2_1.htm Accessed July 2007.

Grossing up of energy savings opportunity within commerce, public administration and agriculture

15.155 The nine subsectors detailed above account for 91% of secondary energy consumption within this sector. To gross up the data to take account of the savings opportunity within the remaining 9% the mean energy savings within these nine sectors was used. Table 15.80 summarises the energy savings and shows mean savings of 11.2%.

Table 15.80: Summary of energy savings opportunity within the eight focus subsectors of the industrial sector

Subsector	**Secondary energy consumed (TWh)**	**Estimated energy savings**	
		%	**TWh**
Retail	49.904	11.3	5.639
Hotel & catering	34.367	12.9	4.433
Warehouses	30.340	10.0	3.034
Commercial offices	39.460	10.0	3.946
Education	22.120	10.0	2.212
Government	13.990	15.0	2.099
Sport & leisure	13.000	7.4	0.962
Health	11.400	6.7	0.762
Agriculture	11.400	20.0	2.280
Total	**225.981**	**11.2**	**25.367**

15.156 The secondary energy consumed by the “other” sectors not included in the detailed analysis equates to 6.619TWh. Therefore, using the mean energy saving of 11.2% results in an estimated saving of 0.74TWh. Applying the mean energy price within the sector of 2.32p/kWh the estimated savings opportunity is £17 million.

The transport sector

15.157 Table 15.81 shows the analysis of the change in energy use within the transport sector between 1990 and 2005. This shows that over the period there was a 25% increase in transport activity (output). Air represents the most significant growth area increasing by 78% and accounting for 46% of the overall growth in transport over the period. Road passenger transport grew by 20% accounting for 29.7% of the overall sector growth; however, improvements in car efficiencies counteracted the increase in output in this area, i.e. intensity improved by -3.9 Mtoe cancelling out the 3.8 Mtoe increase in output[1]. Road goods transport represents the most significant concern since activity or output grew by 17.5% at the same time intensity increased by 11.7%, equating to an overall increase in energy use of 29.2%. This study focuses on identifying the energy savings opportunity in this area, which accounts for 68% of the total energy consumed by industry and the service sector (Figure 4.8).

Table 15.81: Factors affecting changes in transport energy use between 1990 and 2005

Transport activity	Energy consumption (Mtoe)			Cause (Mtoe)	
	1990	2005	Change between 1990 and 2005	Change in output	Change in intensity
Road passenger transport	26.8	26.9	-0.1	3.8	-3.9
Road goods transport	12.0	15.5	3.7	2.4	1.3
Rail	1.1	1.4	0.3	0.4	-0.1
Air	7.3	13.9	6.5	5.7	0.8
Water	1.4	1.4	0.0	0.1	-0.1
All transport sectors	48.6	59.1	10.4	12.3	-1.9

Source: BERR

15.158 EU ministers agreed a strategy on energy efficiency in transport at the Energy and Transport Council meeting on 8th June 2007. The strategy sets five priorities[2]:

[1] The Future of Transport – White Paper reports that the fuel efficiency of new cars in the UK has been improving by around 1 to 2 per cent a year.

[2] Ends Report 389/ June 2007

- to improve energy efficiency in all transport modes
- to increase the use of alternative and renewable fuels
- to increase the use of more efficient vehicles
- to design measures to shape consumer behaviour
- to promote integrated transport planning.

Quantification of energy savings

15.159 The 2002 Energy Review[1] valued the economic potential for energy saving within the transport sector at 35% or £4.7 billion. The Intergovernmental Panel on Climate Change reported in May 2007[2] that within the EU:
"Road vehicle efficiency might be improved by 5 to 20% through strategies such as eco-driving styles, increased load factors, improved maintenance, in-vehicle technological aids, more efficient replacement tyres, reducing idling and better traffic management and route choice"

15.160 The Freight Best Practice Programme, run by the Department for Transport, wants operators to consider strategies such as[3]:

- minimising demand
- virtual delivery
- de-massing (material selection, design)
- size minimisation (material selection, design, packaging etc)
- source location (closer better)
- modal choice
- consolidation (just because you own a big truck don't use it for a half a load, a consolidator might be cheaper)

[1] The Energy Review: Performance and Innovation Unit 2002.

[2] IPCC Fourth Assessment Report, Working Group 3. May 2007.

[3] Roger Worth and Ian Turner, Department for Transport. Personal Communication. June 2007.

- equipment (match your truck specification to suit your underlying contract not your ego)
- routing (if you must use your truck then optimise the route and backloads etc using IT)
- training (you've got the right vehicle, schedule and route but use it all correctly)
- management information (KPIs will help operators identify improvement and outsourcing opportunities).

15.161 The programme website freightbestpractice.co.uk shows numerous examples of savings opportunity for example:

- the 'Save It' video – field trials with a range of operators adopting the quick win practices shown in the video showed savings ranging from 7% to 15%.
- the Yearsley case study demonstrates improvements in fuel consumption of 11.7%
- the 'Testing Times Trucks' case study shows an improvement in fuel consumption of 8% through the use of more energy efficient tyres.

15.162 In addition, the Transport Energy Best Practice Programme (TEBP)[1] funded by the Department for Transport reported that with reference specifically to road freight movements that:
"On average companies saved 6.2% on their fuel costs. The problem is that the lack of penetration of the marketplace left the Transport Best Practice Programme making little impact on the overall marketplace"

15.163 Based on these and the other energy efficiency case studies, the savings opportunity within the transport sector (road freight) is estimated to be 11% or 1,712ktoe (19.91TWh).

[1] Transport Energy Best Practice Programme. Freight Market Audit. For the Department for Transport by AEAT 24/02.06.

Valuation of energy savings

15.164 It is estimated from the BERR data[1] that DERV accounts for 97% of road freight fuel and petrol 3%. Table 15.82 summarises the savings opportunity and shows that the overall savings opportunity is estimated at £2,017 million.

Table 15.82: Summary of savings opportunity within the transport sector

Fuel	**Energy savings opportunity**			
	ktoe	**Ml[2]**	**£/l[3]**	**£M**
DERV	1,661	1,998	0.976	1,952
Petrol	51	69	0.941	65
Total	**1,712**	**2,067**	**0.976**	**2,017**

[1] http://stats.berr.gov.uk/energystats/ecuk2_6.xls Accessed August 2007

[2] Based on conversion factors; Derv fuel = 1,203 litres per tonne and petrol = 1,361 litres per tonne. Source BERR.

[3] Transport Statistics Great Britain 2006: Energy and the Environment – Data tables. www.dft.gov.uk/transtat

16 Appendix 8: Detailed analysis of water savings opportunities

The industrial sector

Manufacture of chemicals, chemical products and man-made fibres; Manufacture of rubber and plastic products

Background

16.1 In 2004, this sector accounted for 20% of the total cost of water supplied to the industrial sector and 9.8% of total non-household expenditure on water. Figure 16.1 shows the trend in the cost of water supplied to this sector. This shows the same trend as seen in Figure 5.4, with costs increasing significantly since 2000. Likewise, Figure 16.2 shows that the trend continues even when GVA (output) is taken into consideration.

Figure 16.1: The cost of water in the chemicals sector

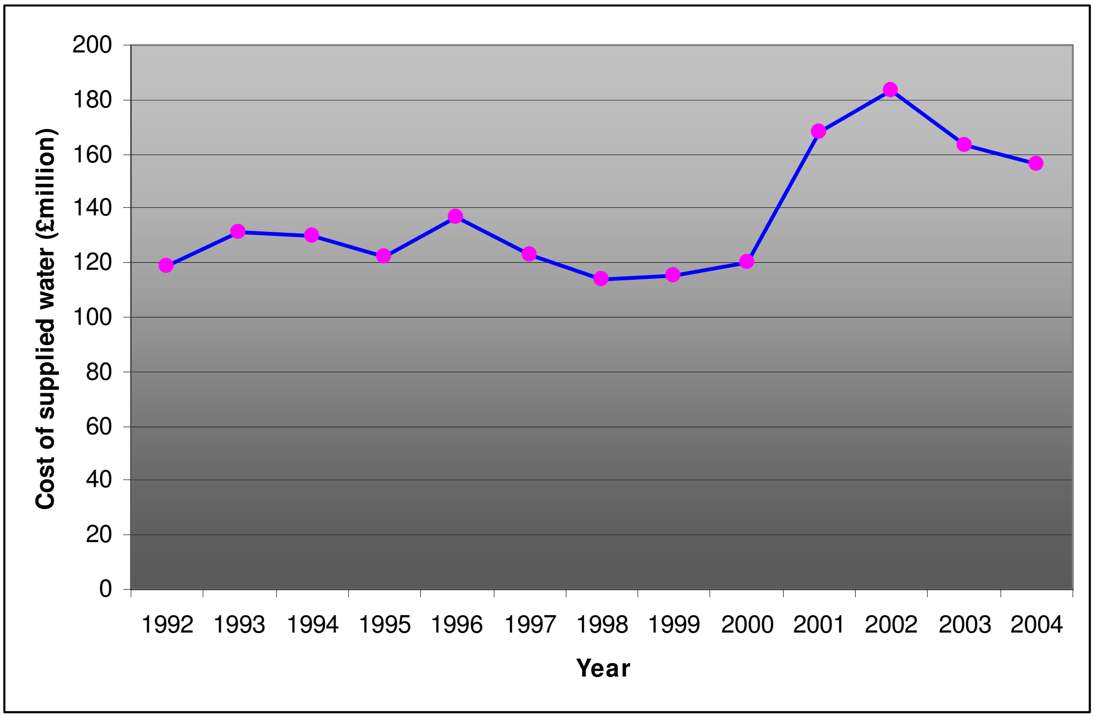
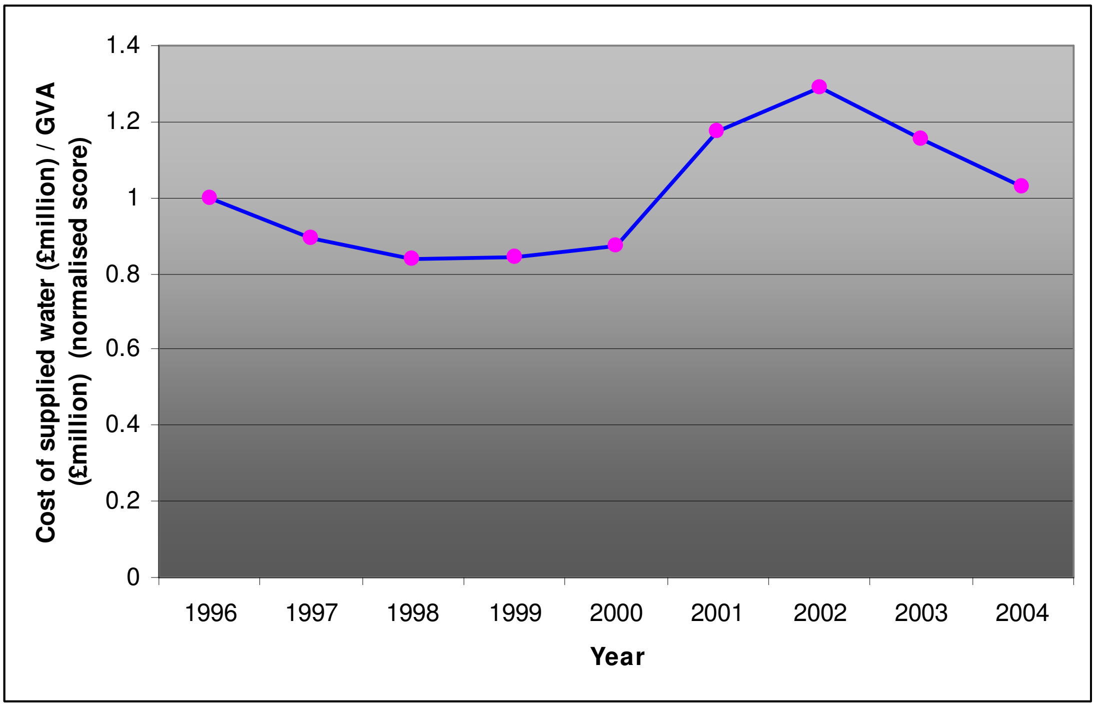


Figure 16.2: Spend / GVA on water in the chemicals sector



16.2 Table 16.1 shows the breakdown of the cost of water supplied to this sector as detailed in the ABI input-output tables. Unfortunately, the product group accounting for 57.1% of expenditure is extremely broad and hence does not direct focus to any particular "significant" activities.

Table 16.1: A breakdown of the cost of water supplied to the chemicals sector

Product group	**Cost of supplied water (2004) (£M)**	**% of supplied water**
Industrial gases, dyes & pigments; other inorganic basic chemicals; other organic basic chemicals; fertilisers & nitrogen compounds; plastics & synthetic rubber in primary forms	89.0	57.1
Plastic products	18.4	11.8
Pharmaceuticals, medicinal chemicals & botanical products	16.1	10.3
Other*	32.5	20.8
Total	**156**	**100**

*Other= Soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations; Other chemical products; Paints, varnishes and similar coatings, printing ink and mastics; Rubber products; Man-made fibres; Pesticides and other agro-chemical products

Quantification of water savings potential

16.3 The Envirowise FastTrack and ENWORKS surveys undertaken since 2005 within the chemicals sector were reviewed to determine the water savings potential. Table 16.2 shows average savings potential of 8.1%. The R^2 value of 0.745 is sufficiently high to assume that this savings opportunity is across all sizes of business. NB: based on the findings from the analysis of waste where it was found that it is the better performing companies that are currently contacting the delivery bodies for assistance, it is assumed that this savings opportunity is achievable across the whole of the sector.

Table 16.2: A summary of case study findings in the chemical sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Chemical	44	8.1	20.1	0.75

Valuation of water savings

16.4 The chemicals sector spent £156 million on water in 2004 and hence the water savings opportunity of 8.1% equates to £12.6 million. Table 16.3 shows the projection of the cost of water to 2006. It is estimated that the cost of water will have increased to £167.3 million and hence the savings potential within the sector is £13.6 million.

Table 16.3: An estimate of the cost of water supplied to the chemicals sector in 2006

Product group	Cost of supplied water (2006 projected) (£M)	% of supplied water
Industrial gases, dyes & pigments; other inorganic basic chemicals; other organic basic chemicals; fertilisers & nitrogen compounds; plastics & synthetic rubber in primary forms	98.9	59.1
Plastic products	19.7	11.8
Pharmaceuticals, medicinal chemicals & botanical products	15.5	9.3
Other*	33.2	19.8
Total	**167.3**	**100**

*Other= as Table 16.1.

16.5 Defra reports that the expenditure on wastewater treatment within the chemicals sector was £313 million and hence, assuming the 8.1% savings opportunity will provide an equivalent wastewater saving, the estimated wastewater saving is £25 million.

16.6 The overall water savings opportunity is therefore valued at £38.9 million ± 20.1%.

Manufacture of food products, beverages and tobacco

Background

16.7 The food and drink sector spent £155 million on water in 2004, equating to 20% of the total spend on water within the industrial sector or 9.8% of the total non-household expenditure on water. Figure 16.3 shows the trend in the cost of water supplied to this sector. This shows the same trend as seen in Figure 5.4 for the total industrial sector and Figure 16.1 for the chemical sector. This trend is also evident in Figure 16.4 when GVA (output) is taken into consideration.

Figure 16.3: The cost of water in the food sector

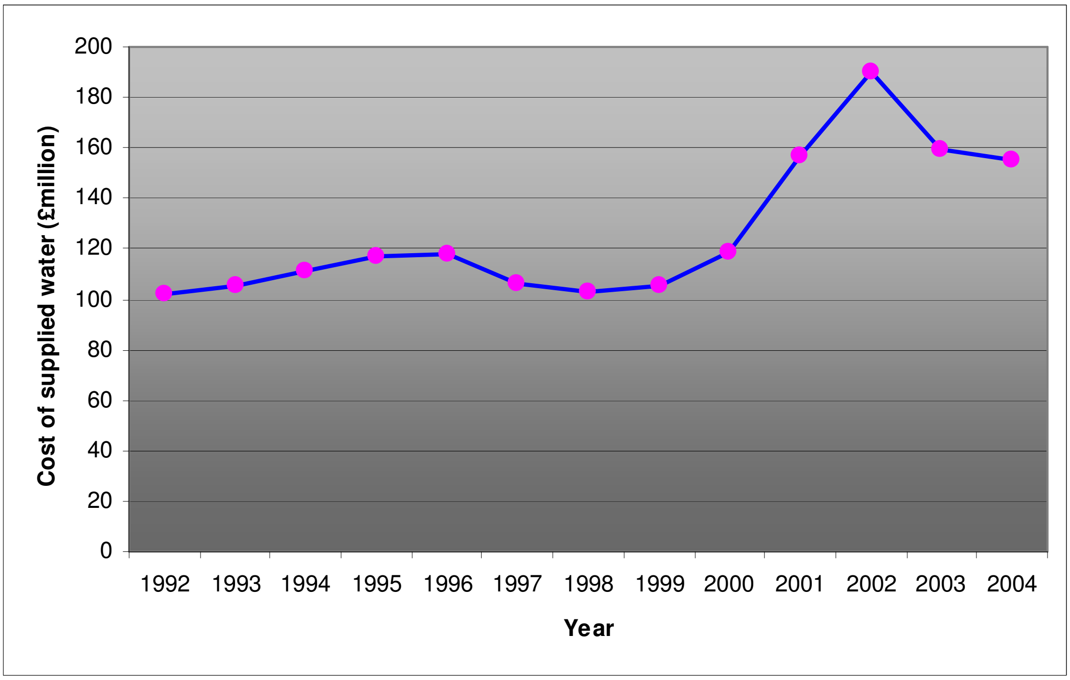
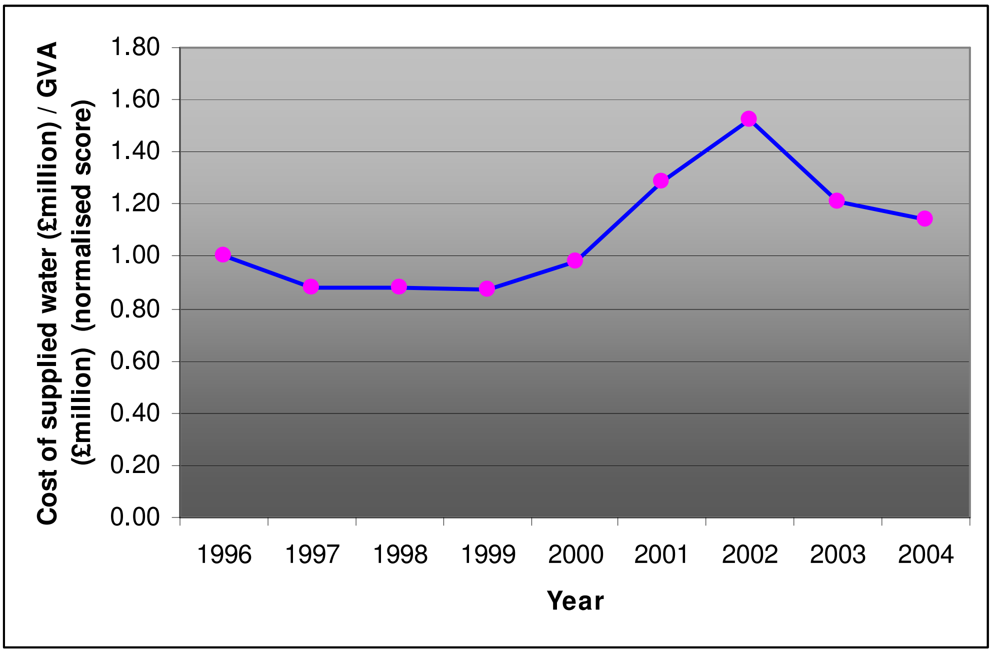


Figure 16.4: Spend / GVA on water in the food sector



16.8 Table 16.4 shows the breakdown of the cost of water supplied to this sector with the top three activities accounting for 63.5% of the sectors expenditure on water. These therefore represent the first area that should be focused on in any water reduction initiative in this sector since they have the greatest economic incentive to reduce their expenditure on water. The table also shows a distinct difference in the ranking when compared against the findings from studies focusing on consumption. For example, in the 2001 Envirowise report[1] the food and drink sector is split between six categories (Table 16.5) and water usage in the meat sector accounted for 2.3% of total water used, as opposed to 21.2% of water cost as seen in Table 16.4.

[1] EN368 – A review of water use in industry and commerce, Envirowise 2001.

Table 16.4: A breakdown of the cost of water supplied to the food sector in 2004

Product group	Cost of supplied water (2004) (£M)	% of supplied water
Bread & biscuits; sugar; cocoa; other food products	36.0	23.2
Production, processing & preserving of meat & meat products	32.9	21.2
Alcoholic beverages; production of mineral water & soft drinks	29.7	19.1
Processing & preserving of fish & fish products; fruit & vegetables	20.0	12.9
Vegetable & animal oils & fats	13.6	8.8
Other*	22.9	14.8
Total	**155.1**	**100**

*Other= Dairy products; Grain mill products, starches & starch products; Prepared animal feeds; Tobacco

Table 16.5: Water usage by food and drink sector in 2001

Subsector	Estimated volume (million m^3)	% of total
Dairies	39.0	12.7
Breweries	35.2	11.4
Soft drinks	27.5	8.9
Distilleries	25.9	8.4
Meat	7.2	2.3
Other	172.7	56.2
Total	**307.5**	**100**

Valuation of water savings

16.9 Defra, through their Food Industry Sustainability Strategy (FISS) Champions Group on water reported savings potential within the food and drink sector of £60 million based on a savings opportunity of 20% on a water bill of £300 million[1].

16.10 Table 16.6 shows the projection of the cost of supplied water in 2006 using the 2004 input-output table data (Table 16.4). This values the current expenditure on water within the food sector at £171.3 million, which is well below the estimate within the FISS study of £300 million. However the £300

[1] Report for the Food Industry Sustainability Strategy Champions Group on water Defra May 2007.

million cost of water includes the cost of waste water disposal and hence the £60 million savings represents total savings as opposed to simply the savings from water supply. Using the £171.3 million as the cost of water supplied to the sector the 20% saving is estimated at £34 million.

Table 16.6: An estimate of the cost of water supplied to the food sector in 2006

Product group	**Cost of supplied water (2006 projected) (£M)**	**% of supplied water**
Bread & biscuits; sugar; cocoa; other food products	39.6	23.1
Production, processing & preserving of meat & meat products	36.3	21.2
Alcoholic beverages; production of mineral water & soft drinks	28.6	16.7
Processing & preserving of fish & fish products; fruit & vegetables	22.1	12.9
Vegetable & animal oils & fats	17.7	10.3
Other*	27.0	15.8
Total	**171.3**	**100**

*Other= as Table 16.4

16.11 This 20% savings opportunity cannot be regarded as applicable uniformly across all the subsectors of the food and drink sector. For example, the British Beer & Pub Association (BBPA) reports total water usage of 28 million cubic metres in 2006[1], a reduction of 7.2 million cubic metres from the 2001 estimates shown in Table 16.5. This results from a reduction in the volume of beer being produced in the UK and the rationalisation that has taken place in the sector; with the number of non-micro breweries reducing from 140 in 1976 to 52 in 2006. Figure 16.5 shows that the specific water consumption in the brewing sector has reduced by 43% over 30 years and by 11.6% since 2001. In addition, Table 16.7 shows that the standard deviation has also reduced from 3.16 in 1998 to 2.27 in 2005. This is a strong indication that the brewing sector as a whole has taken up resource efficiency and hence most of the quick win opportunities in the sector may well have been realised.

[1] The British Brewing Industry. Thirty years of environmental improvement 1976 – 2006. The British Beer & Pub Association, March 2007.

Figure 16.5: Reduction in water consumption, brewing sector

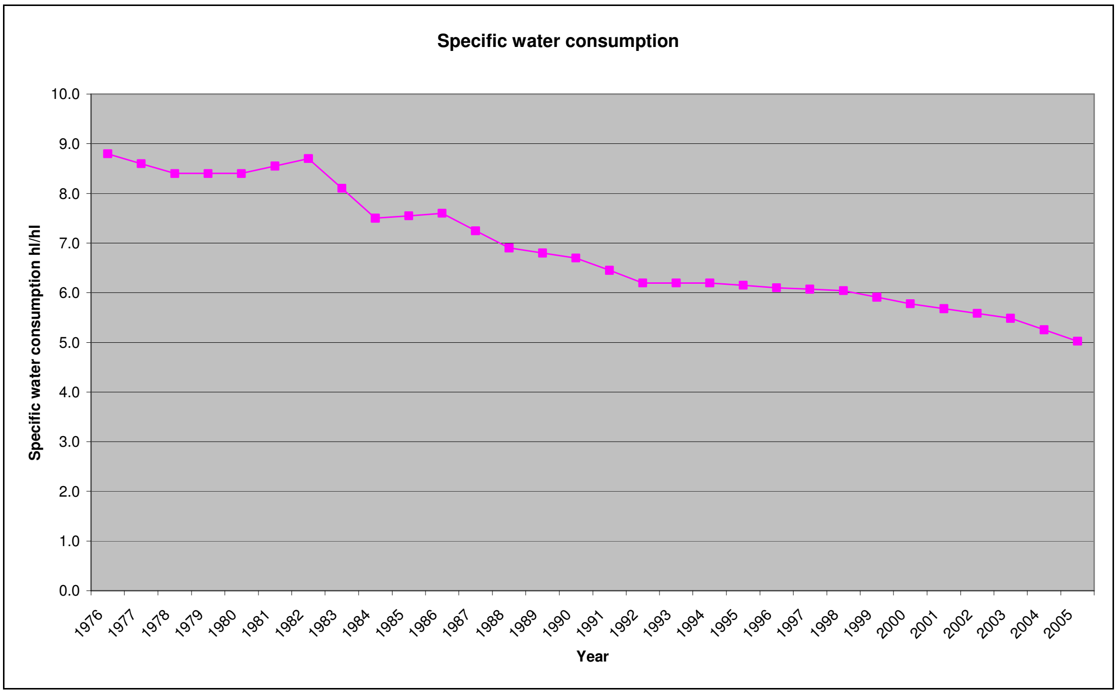


Table 16.7: Variation in waster consumption, brewing sector

Specific water consumption	1998	2000	2003	2005
Mean	6.04	5.78	5.49	5.03
Standard deviation	3.16	2.53	2.68	2.27

Source: Andy Tighe, British Beer & Pub Association Personal Communication.

16.12 The distilling sector is very similar. SEPA report[1] that 30 to 40 million cubic metres of water is used within the Scottish malt distilling industry for cooling and 2 to 3 million cubic metres within the mashing process. The water used for cooling purposes is returned unchanged apart from some uplift in temperature; normally to its original watercourse. According to SEPA: *"The industry uses the water it requires for its production, no more, no less, and there is little scope for reducing usage. Cooling water is often recycled before being discharged. There is therefore not much scope for reduction in or more efficient use of water. Major capital investment would be required for the installation of cooling towers, which could not be justified either on economic or environmental grounds"*

[1] An economic analysis of water use in the Scotland river basin district. Summary report. Scottish Whisky distilling industry. SEPA 2004. www.sepa.org.uk/publications/wfd/html/economics_scotland/annex1e.html

Manufacture of basic metals and fabricated metal products

Background

16.13 This sector spent £95.7 million on water in 2004, equating to 13.5% of the total spend on water within the industrial sector. Figure 16.6 shows the trend in the expenditure on water supplied to this sector. This shows the cost of water supplied to the industry has been steadily rising since 2000. This trend is also evident in Figure 16.7 when GVA (output) is taken into consideration.

Figure 16.6: The cost of water in the basic metals sector

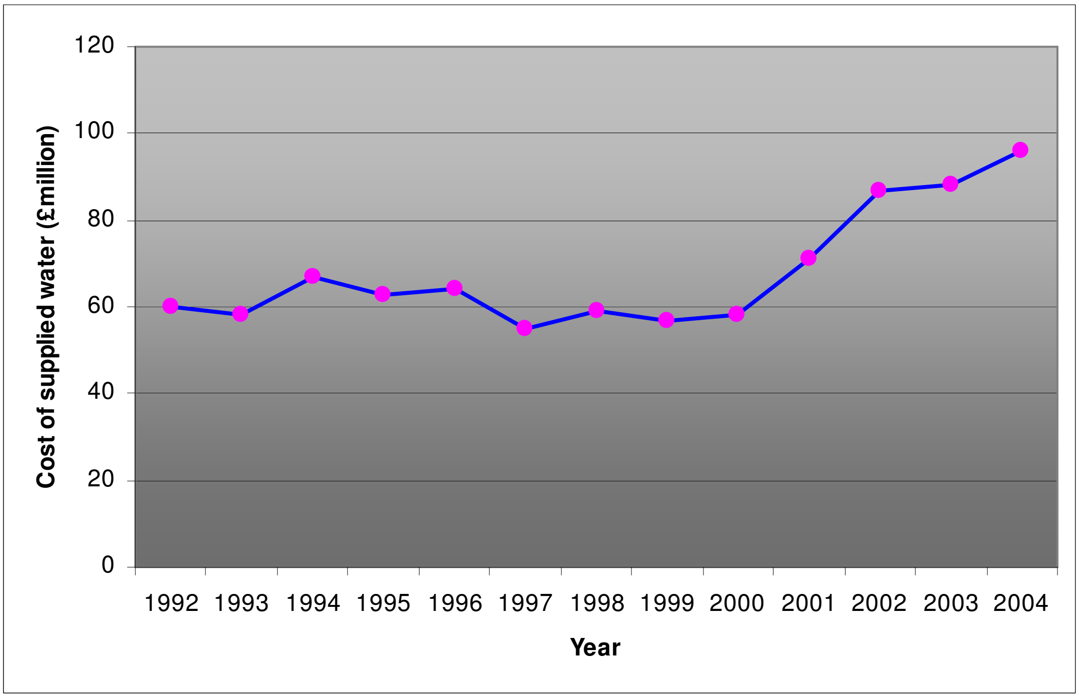
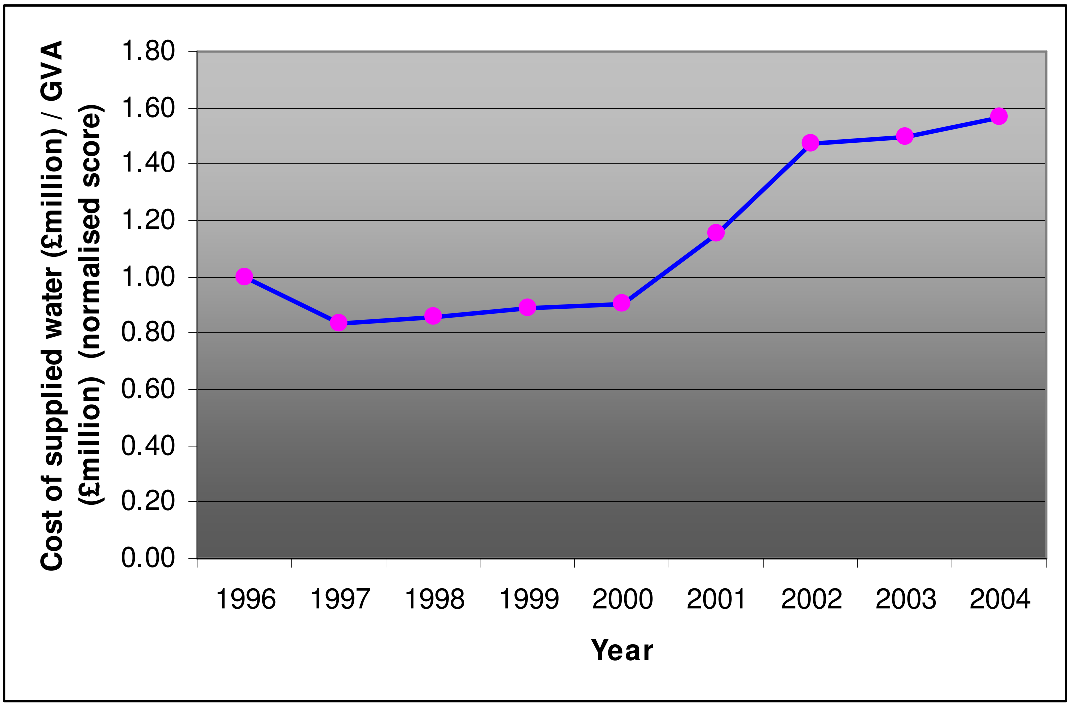


Figure 16.7: Spend/GVA on water in the basic metals sector



16.14 Table 16.8 shows the breakdown of the cost of water and this shows three sub groups to account for 80% of the total cost of water.

Table 16.8: A breakdown of the cost of water supplied to the basic metals sector in 2004

Product group	**Cost of supplied water (2004) (£M)**	**% of supplied water**
Basic iron and steel and of ferro-alloys; manufacture of tubes and other first processing of iron and steel	40.6	42.4
Forging, pressing, stamping and roll forming of metal; powder metallurgy; treatment and coating of metals	23.4	24.4
Basic precious and non-ferrous metals	12.6	13.2
Other*	19.1	20.0
Total	**95.7**	**100**

*Other= Other fabricated metal products; Structural metal products; Casting of metals; Tanks, reservoirs and containers of metal; manufacture of central heating radiators and boilers; manufacture of steam generators; Cutlery, tools and general hardware

16.15 Envirowise FastTrack data for this sector heavily focuses on SIC 28: Manufacture of fabricated metal products, except machinery and equipment. Many of the case studies focused on the facility type savings such as the fitting of cistern displacement devices and optimising the use of automatic flushing control systems, i.e. the non-industrial process type water uses.

Based on the compilation of data from the FastTrack surveys an average of 44% saving in water use can be made in this area (Table 16.9).

Table 16.9: A summary of case study findings in the fabricated metal products sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Fabricated metal products	19	44	18.7	0.81

16.16 An alternative source of data was the water companies who kindly provided the consumption data from their individual accounts. The standard deviation and mean of this data was calculated and from this a savings allocation was determined based on a methodology used by CIRIA in the estimate of water savings opportunity in offices and hotels[1]. This assumes the savings opportunity equates to one decile (10% of 6 standard deviations[2]). Table 16.10 shows the results of this analysis. This shows that the average savings opportunity is 7%.

Table 16.10: Estimated savings opportunity in the basic metals sector

Subsector	Mean (m^3)	Standard Deviation (m^3)	1 Decile (SD x 6 / 10) (m^3)	Savings Opportunity (1 Decile / Mean x 100%)
Basic Metals	11,551	1,360	817	7%

Valuation of water savings

16.17 The valuation has been split into two parts, the first focusing on the savings in the water used in non-industrial processes and the second on the overall savings opportunity.

Non-industrial process savings

16.18 To gain an estimate of the potential savings across the whole sector based on non-industrial process type water uses, the following assumption is used "*water use in industrial buildings can be compared with consumption patterns found in offices when industrial processes are not taken into account*"[3].

[1] CIRIA (2006) Water Key Performance Indicators and benchmarks for Offices and Hotels

[2] In the CIRIA study the upper quartile, i.e. the top 25% in terms of water efficiency, was classified as best practice.

[3] Transforming existing buildings: The Green Challenge. Final Report, March 2007. RICS and Cyril Sweett.

16.19 Based on the Annual Business Inquiry (ABI) employment data for 2005, 406,000 people were employed under SIC DJ. The Office of Government Commerce (OGC) produced the "Watermark study" in May 2003 which quantified the water savings opportunity in offices. The OGC estimate that a typical office worker uses 9.3m^3/person/year and that best practice is approximately 6.4m^3/person/year, i.e. a savings opportunity of 31%. Although this report is rather old other, more recent, sources, show that these estimated percentage savings are still valid. For example, CIRIA[1] reported in 2006 that the water savings opportunity in offices is 33%. Therefore, for SIC DJ, approximately £1.2m or 1.3% of expenditure on water can be saved through the reduction of non industrial process water savings.

16.20 Defra reports that the expenditure on wastewater treatment within the basic metals sector was £64 million and hence assuming the 1.3% savings opportunity will provide an equivalent wastewater savings the estimated wastewater savings is £0.8 million.

16.21 The water savings opportunity from non-industrial processes is therefore valued at £2 million.

Total savings

16.22 Based on the estimated savings of 7% and an expenditure on water of £95.7 million, the savings opportunity is valued at £6.7 million, with an associated £4.5 million savings in wastewater (£64 million x 7%).

16.23 The overall water savings opportunity is therefore £11 million ± 18.7%.

[1] CIRIA C657. Water Key Performance Indicators and benchmarks for offices and hotels. London, 2006.

Electricity, gas and water supply

16.24 The electricity, gas and water supply sector spent £70 million on water in 2004, equating to 8.8% of the expenditure on water by the industrial sector and 4.4% of the total non-household expenditure on water. Figure 16.8 shows the trend in the cost of water supplied to this sector. Although expenditure has increased since 2000 the increase is not as significant as seen in other industrial sectors. When GVA (output) is taken into consideration expenditure on water in 2004 can be seen to be close to its 1997 lowest, Figure 16.9.

Figure 16.8: The trend in water expenditure in the electricity, gas and water supply sector

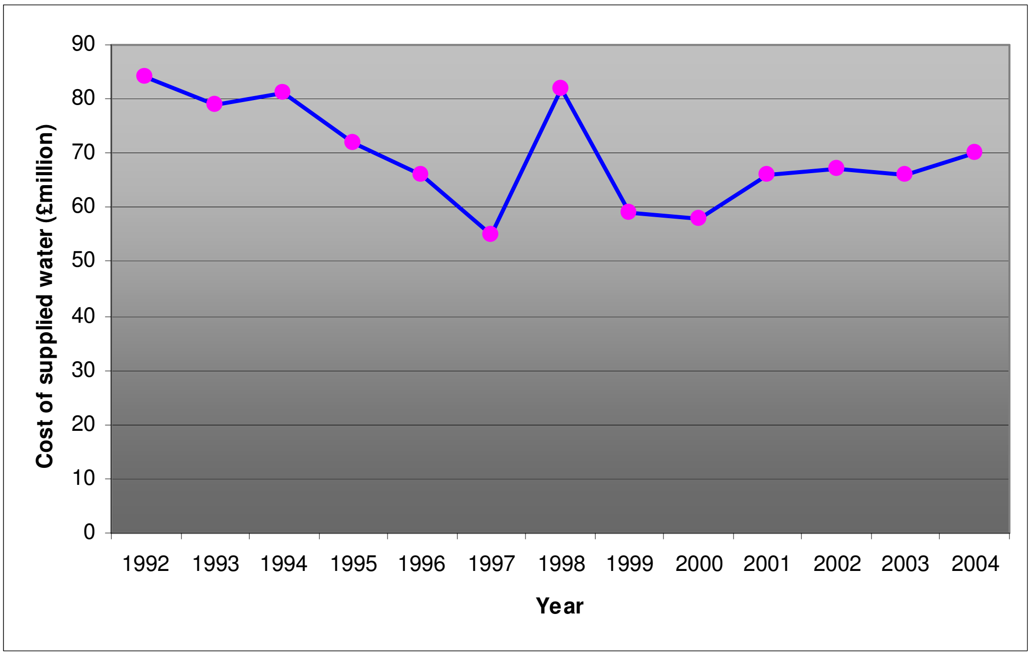
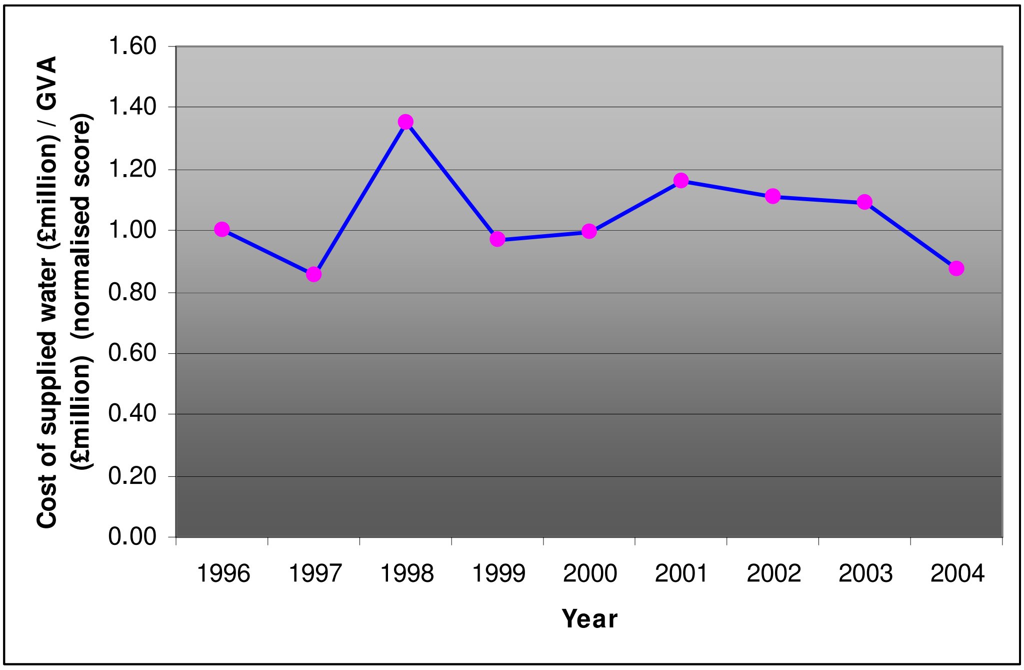


Figure 16.9: The trend in water expenditure / GVA in the electricity, gas and water supply sector



16.25 Table 16.11 shows the breakdown of expenditure on water by subsector. This shows that the production and distribution of electricity and collection, purification and distribution of water account for 76.9% of the total expenditure on water and hence will be the focus of this section.

Table 16.11: Breakdown of cost of supplied water in the gas electricity and water supply subsector

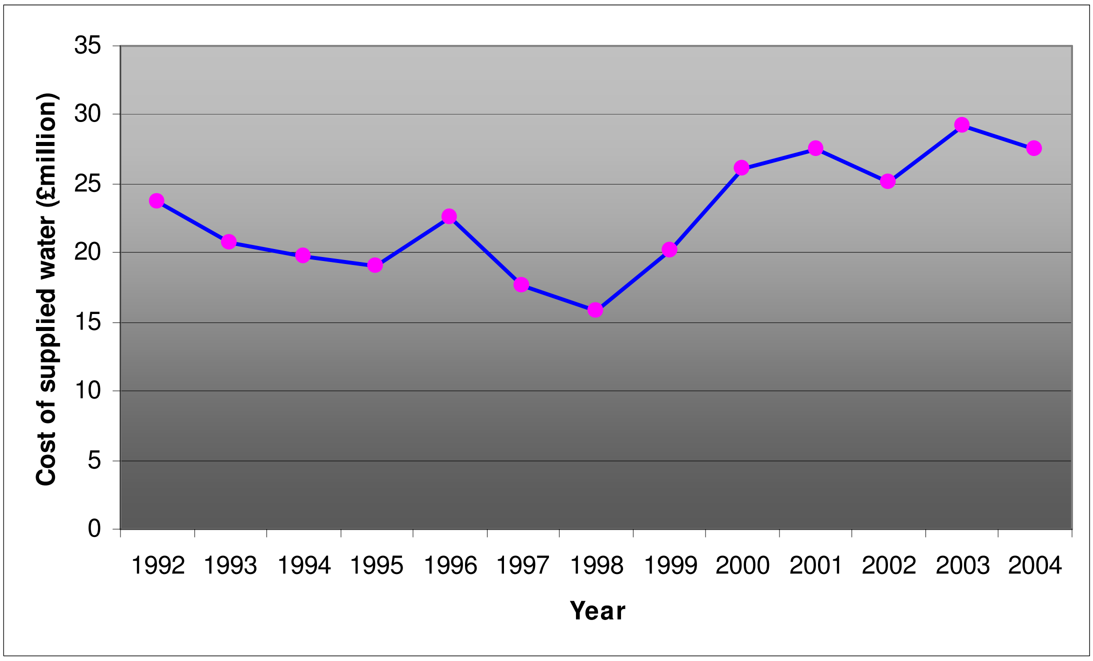
Product group	Cost of supplied water (2004) (£M)	% of supplied water
Production & distribution of electricity	27.5	39.4
Collection, purification & distribution of water	26.2	37.5
Other*	16.1	23.1

*Other= Gas; Distribution of gaseous fuels through mains; Steam and hot water supply

Production and distribution of electricity

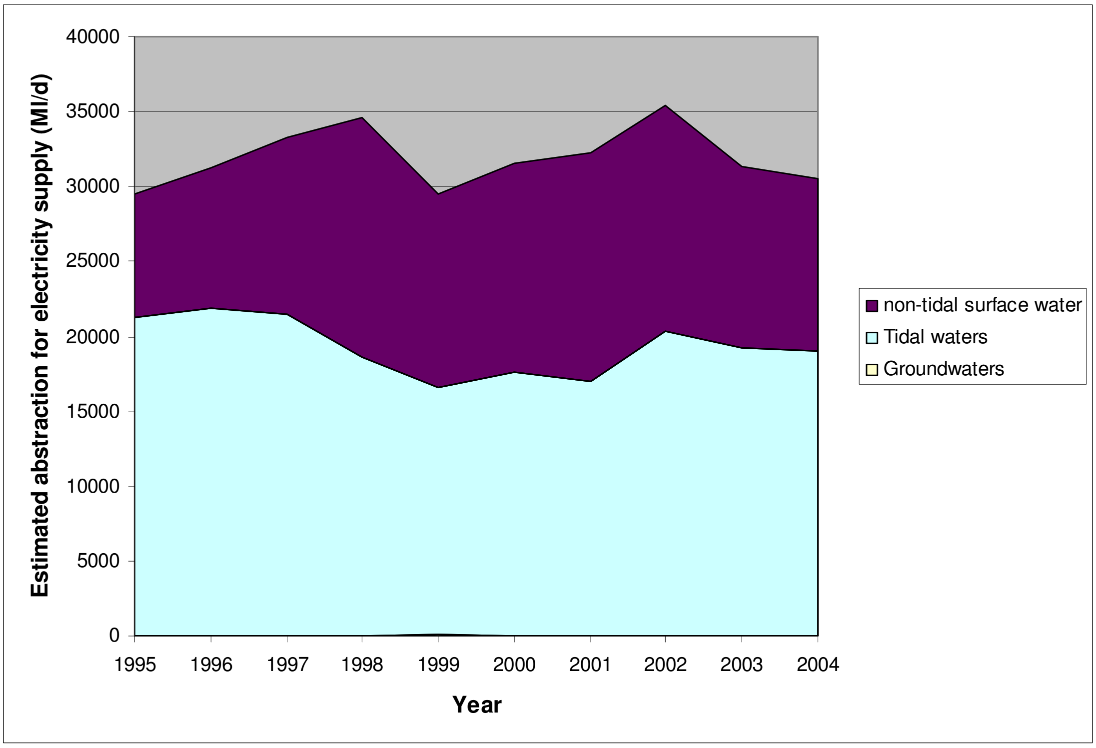
16.26 Figure 16.10 shows the trend in the expenditure on water by the electricity sector. This shows that the expenditure on water has increased significantly since 1998, which is in line with other industrial sectors and the cited price increases for water.

Figure 16.10: The trend in water expenditure in the production and distribution of electricity



16.27 Figure 16.11 shows the breakdown of types of water used. This shows that tidal water and non-tidal surface water are the two main forms of water used with groundwater consumption not registering on the chart.

Figure 16.11: Estimated abstraction from all surface and groundwater for electricity supply: 1995-2004 (England and Wales)



Source: Environment Agency
Source publication: e-Digest of Environmental Statistics, Published November 2006
Department for Environment, Food and Rural Affairs
http://www.defra.gov.uk/environment/statistics/index.htm

16.28 Much of the water used in power stations is in the cooling process and hence low-cost tidal water and non-tidal surface water can be used. This water, used in the cooling process, is returned to its original source. A proportion is lost to the atmosphere as water vapour from power stations with cooling towers[1].

16.29 E.ON report net water use in their power stations has reduced significantly over the past 10 years (Figure 16.12) with the move from the more inefficient coal fired power stations to modern Combined Cycle Gas Turbines (CCGT) being a major factor. In addition, the Pollution Prevention and Control (PPC) Regulation, which implements the European Directive (EC/96/91) on Integrated Pollution Prevention and Control (IPPC) is also cited by E.ON has being a driver for reducing water use. Defra reports that[2]:

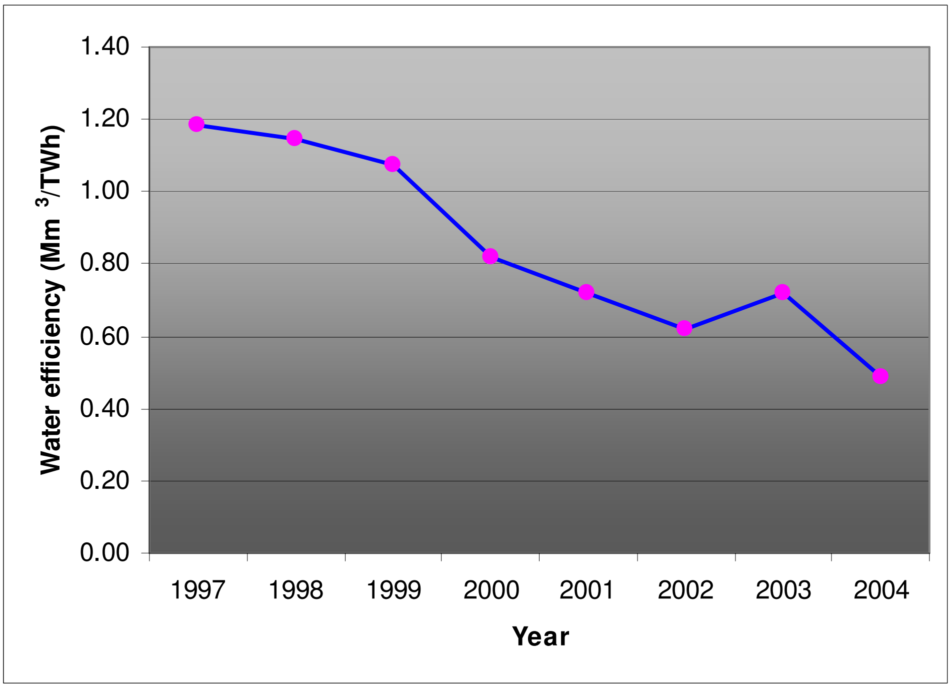
[1] www.eon-uk.com Accessed August 2007.

[2] Mid term review of the UK's implementation of the Pollution Prevention and Control Regulations. April 2007. Defra.

"IPPC can act as a regulatory driver of this process [improvements in resource efficiency] through the standard permit requirement to set up raw materials, water consumption and waste generation monitoring programmes and action plans".

16.30 Assuming that such significant reductions are representative of the industry, it is assumed that few low-cost / no-cost water savings opportunities remain. It is therefore estimated that the savings opportunity would be less than 2%. It is also estimated, based on the trend in expenditure, that £28 million was spent on water by the electricity sector in 2006. Therefore the savings opportunity is £0.6 million.

Figure 16.12: Net water use per unit of useful product supplied: 1997-2004



Source: http://www.eon-uk.com/

16.31 Water use from offices represents a potential area of opportunity and E.ON report that:

"like any other business with office-based operations, our staff and buildings also use a significant amount of potable water. In 2005 our offices, including the Power Technology Centre, used some 111,000 cubic metres of water, as calculated from our utility bill".

16.32 Table 16.12 shows that the water uses in offices by Scottish and Southern Energy and rwenpower increased significantly in 2006.

Table 16.12: Water use in offices by Scottish and Southern Energy and Enpower

Company	2001	2002	2003	2004	2005	2006
Scottish & Southern	99,207	109,355	93,120	90,334	88,652	108,564
rwenpower		51,858	52,179	57,409	57,640	66,108

Source: www.scottish-southern.co.uk, www.rwenpower.com,

16.33 It was not possible to determine the total water uses from offices in this sector. E.ON report that they have an 11% share in the UK power generation sector[1] and hence it is assumed that the water usage within the offices in this sector, based on the E.ON 111,000 cubic metres estimate, is 1 million cubic metres.

16.34 CIRIA report that savings of 33% can be achieved by moving from typical office practice to best practice, which in this case equates to a saving of 336,364 cubic metres. Based on an average cost of £1 per cubic metre as estimated from water company 2006/07 online water pricelists the savings opportunity is valued at £336,364.

Collection, purification and distribution of water

16.35 Figure 16.13 shows the trend in the expenditure on water by the water sector. This shows that, with the exception of one spike in 1998 that the expenditure on water has followed a downward trend.

16.36 A reduction in leakage rates can be regarded as a significant reason for this reduction and Figure 16.14 shows how leakage rates in terms of both distribution and supply pipe losses have gone down since 1992/3. This shows that significant reductions were made in the 1990s and have remained consistent ever since.

[1] http://www.eon.com/en/downloads/ConferenceCall_cmd_050629_charts_golby.pdf

Figure 16.13: The trend in expenditure on water in the water sector

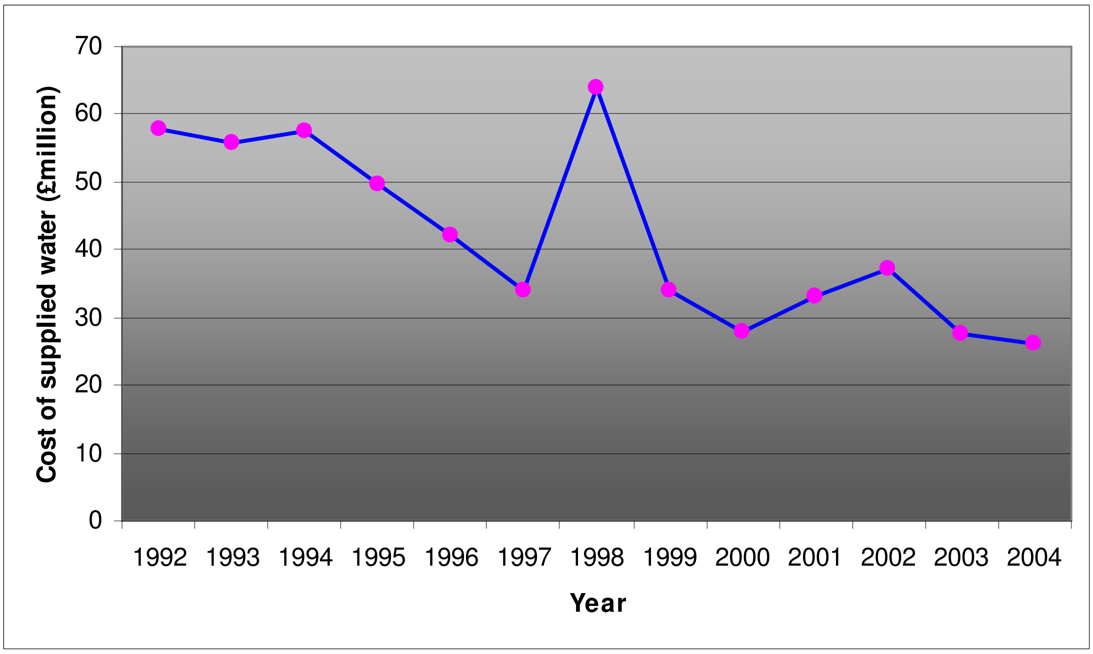
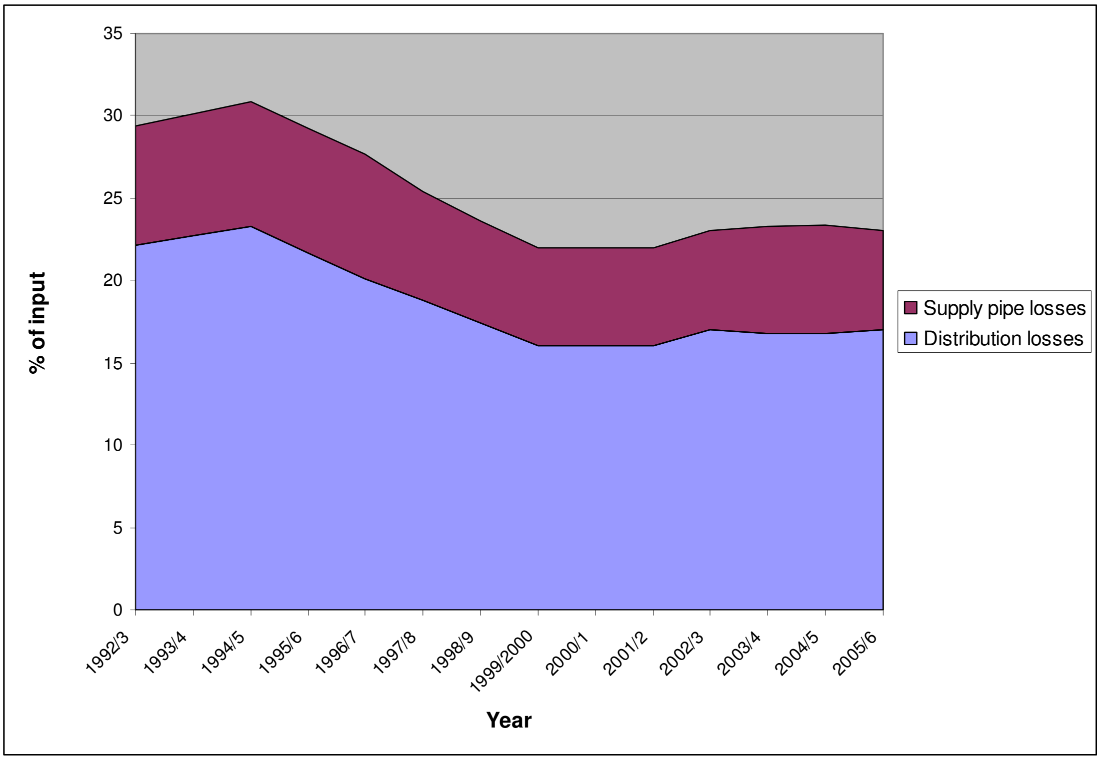


Figure 16.14: Distribution and supply pipe leakage 1992/3-2005/6



Source: Ofwat
Source publication: e-Digest of Environmental Statistics, Published January 2007
Department for Environment, Food and Rural Affairs
http://www.defra.gov.uk/environment/statistics/index.htm

16.37 It is reported that most water companies are now operating at their Economic Level of Leakage (ELL) [1]. This is the leakage at which it would cost more for a water company to reduce its leakage further than to produce water from an alternative source and balances the needs of consumers and the environment. However, Figure 16.14 shows that the current leakage rate of 23% is slightly higher than the low of 22% in 2000/1 and 2001/2. Assuming that 22% represents best practice (optimum ELL) then it is assumed that a 4.4% savings opportunity is achievable.

16.38 Projecting the 2004 expenditure on water forward to 2006 it is estimated that the water industry would spend £20.6 million on water (supply) and hence a saving of 4.4% equates to £0.9 million.

16.39 The water savings opportunity within this sector is therefore valued at £0.6 million from the electricity supply sector and £0.9 million from the water supply sector which totals £1.5 million or 2.1%.

16.40 Defra reports that the expenditure on wastewater treatment within this sector was £23 million and hence assuming the 2.1% savings opportunity will provide an equivalent wastewater savings the estimated wastewater savings is £0.5 million.

16.41 The overall water savings opportunity is therefore valued at £2 million.

[1] www.sustainable-development.gov.uk/data-resources/documents/sdiyp2007_a6.pdf Accessed September 2007

Manufacture of transport equipment

16.42 This sector spent £63 million on water in 2004, accounting for 8.9% of the expenditure on water in the industrial sector or 4% of total non-household expenditure. Figure 16.15 shows the trend in the cost of supplied water to this sector and again this shows an industry that has been significantly affected by the rise in the price of water since 2000. Figure 16.16 shows that the trend continues even when GVA (output) is taken into consideration.

Figure 16.15: The trend in water expenditure in the transport equipment sector

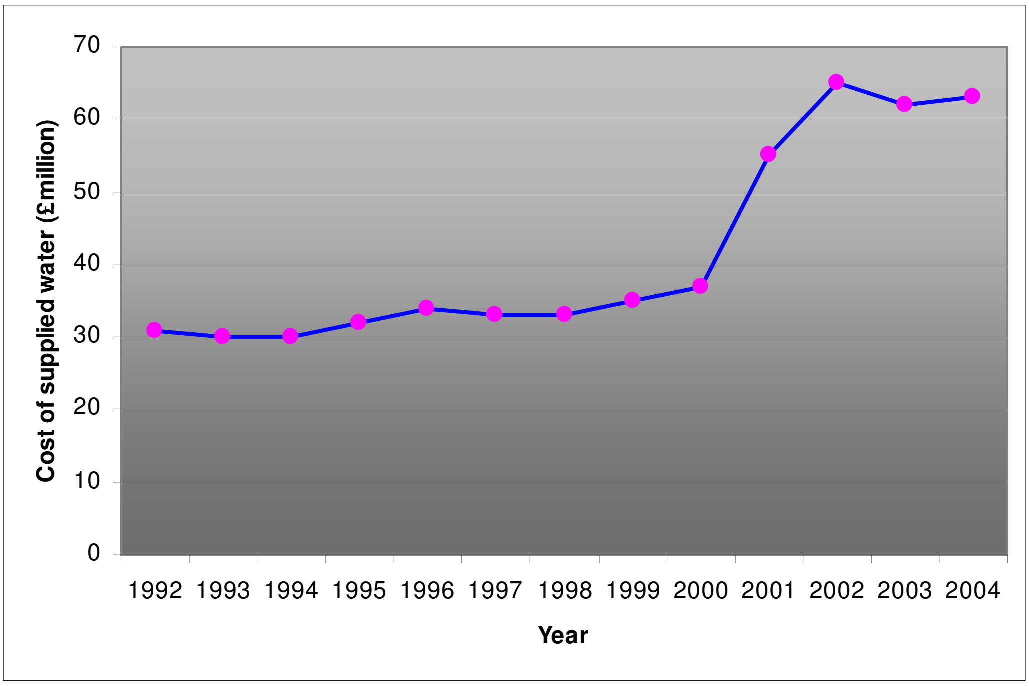
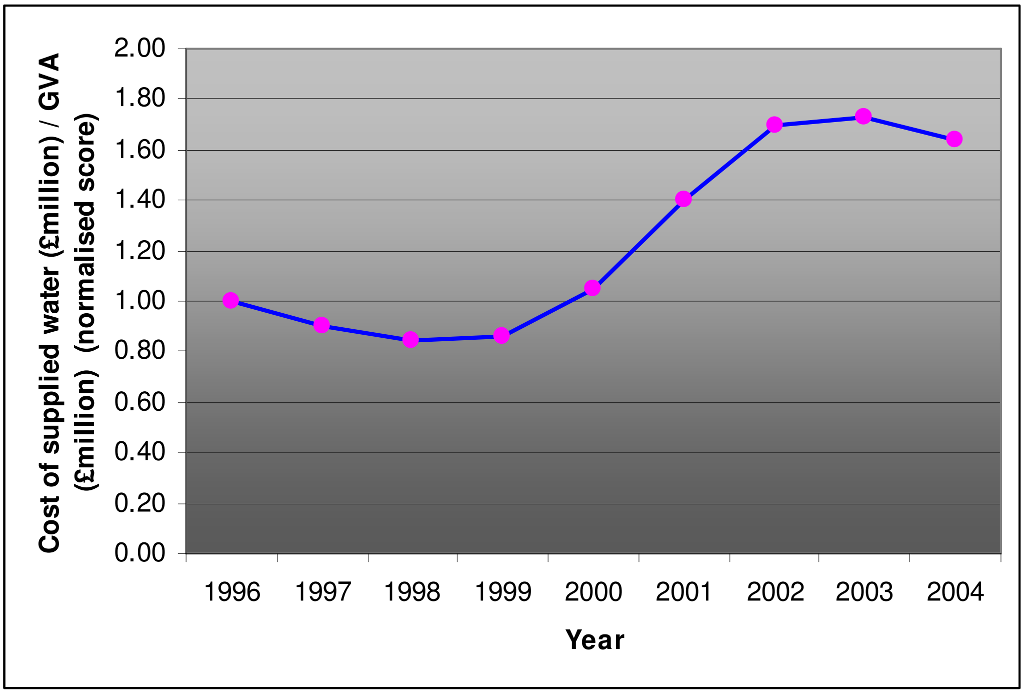


Figure 16.16: The trend in water expenditure / GVA in the transport equipment sector



16.43 Table 16.13 shows the breakdown of the cost of water supplied to this sector with the manufacture of motor vehicles accounting for nearly three-quarters of the sectors expenditure on water.

Table 16.13: A breakdown of the cost of water supplied to the transport equipment sector in 2004.

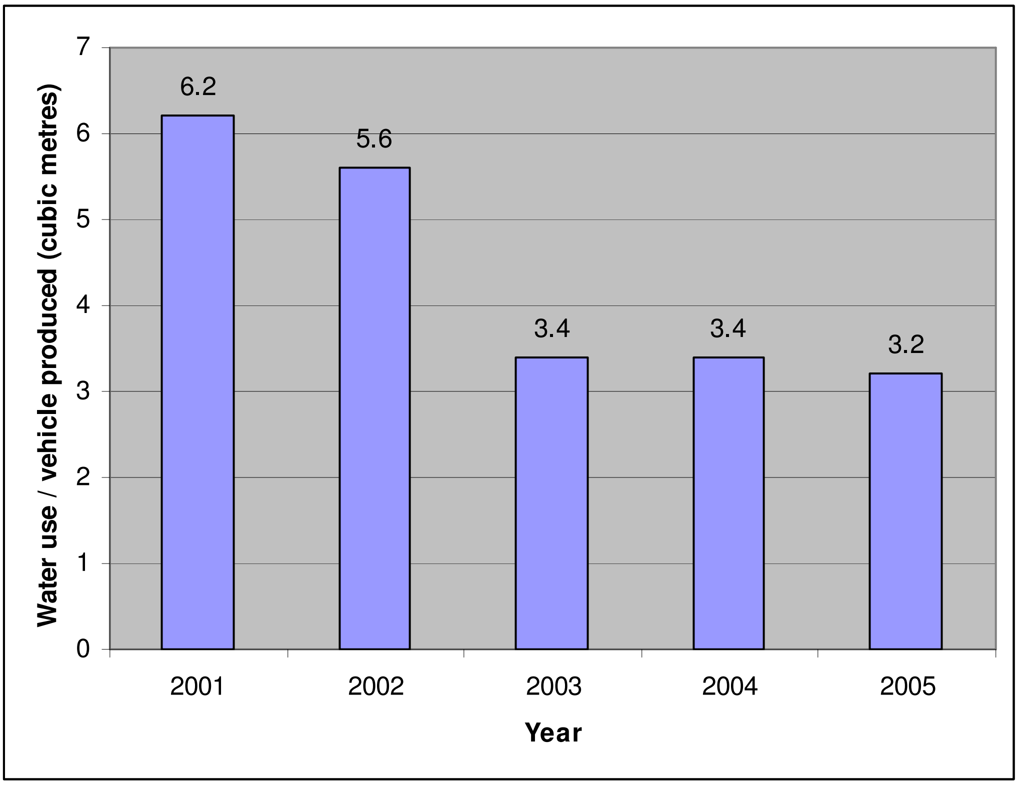
Product group	Cost of supplied water (2004) (£M)	% of supplied water
Motor vehicles, trailers & semi-trailers	46.7	74.1
Aircraft & spacecraft	10.2	16.2
Other*	6.1	9.7

*Other= Building and repairing of ships and boats; Other transport equipment

16.44 The automotive sector has made significant inroads into reducing specific water consumption. Figure 16.17 shows that between 2001 and 2005 water use per vehicle produced reduced by 51.6%[1].

[1] http://www.smmt.co.uk/downloads/motorfacts.pdf Accessed September 2007

Figure 16.17: The trend in specific water use in the automotive sector



16.45 Additionally, individual companies report significant savings, for example BMW report that at their Mini plant in Oxford specific water consumption has been reduced by 25% over a three year period[1]. Toyota Motor Manufacturing (UK) Ltd reports[2] that total water consumption on site dropped from 679,000 to 554,000 cubic metres per year, a reduction of 18%, at a time when production increased. Fords report that it is developing a new environmentally friendly anticorrosion technology that cuts water use in automotive paint shops by almost half and reduces sludge production by 90%[3].

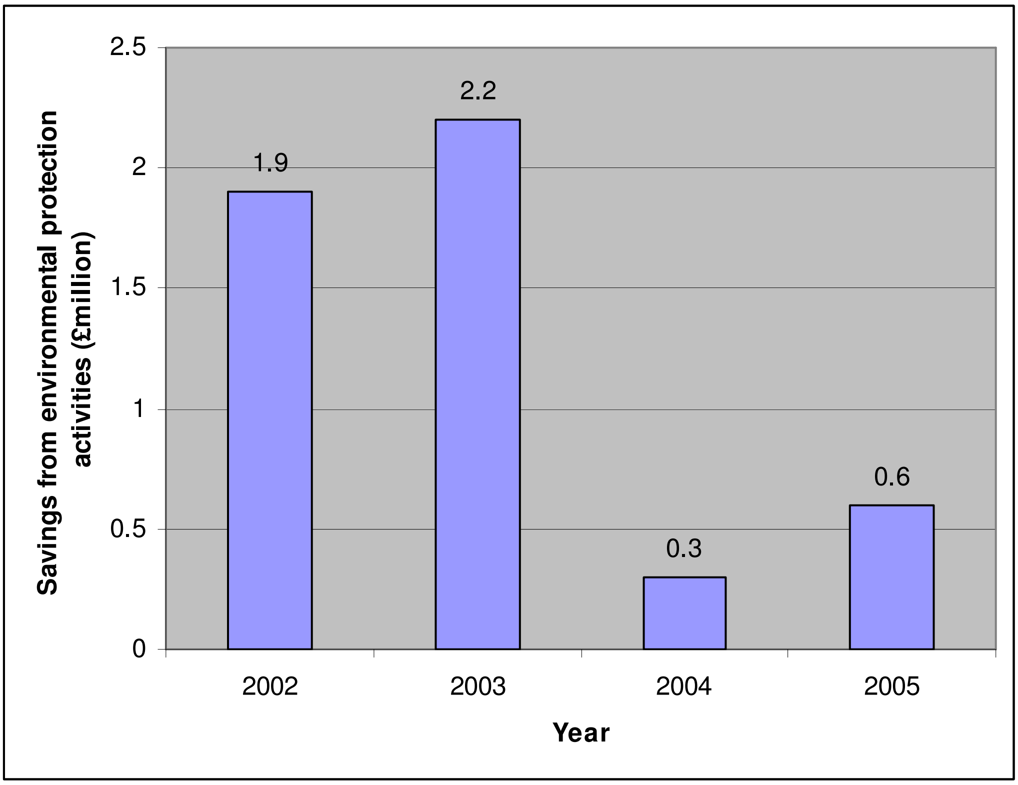
16.46 Figure 16.18 shows the income and savings from environmental activities undertaken within this sector. This shows that between 2002 and 2005 annual savings of £5 million were realised.

[1] http://www.smmt.co.uk/articles/article.cfm?articleid=11508 Accessed September 2007.

[2] http://www.environment-agency.gov.uk/commondata/acrobat/wea2007_final_1727685.pdf Accessed August 2007.

[3] http://www.just-auto.com/article.aspx?id=92336 Accessed August 2007.

Figure 16.18: Expenditure on water based environmental protection activities in the automotive sector



16.47 The low-cost / no-cost savings opportunity in this sector is assumed to be very low due to the level of water savings activity the sector has already undertaken. An arbitrary figure of 2% is assigned to reflect that even the low investment savings opportunity can form part of a continual improvement process, i.e. new low-cost / no-cost opportunities will arise. Table 16.14 shows the projected expenditure on water in 2006. A 2% savings opportunity therefore equates to £1.3 million.

Table 16.14 A breakdown of the cost of water supplied to the transport equipment sector projected to 2006

Product group	**Cost of supplied water (2006 projected) (£M)**	**% of supplied water**
Motor vehicles, trailers & semi-trailers	48.3	72.7
Aircraft & spacecraft	10.8	16.3
Other*	7.3	11.0
Total	**66.4**	**100**

*Other= as Table 16.13

16.48 Defra reports that the expenditure on wastewater treatment within this sector was £32 million and hence, assuming the 2% savings opportunity will provide an equivalent wastewater saving, the estimated wastewater saving is £0.7 million.

16.49 The overall water savings opportunity is therefore valued at £2 million.

Manufacture of pulp, paper and paper products; Publishing and printing

16.50 This sector spent £57 million on water in 2004, accounting for 7.2% of the expenditure on water in the industrial sector. Figure 16.19 shows the trend in the cost of water supplied to this sector and again this shows an industry that has been significantly affected by the rise in the price of water since 2000. Figure 16.20 shows that the trend continues even when GVA (output) is taken into consideration.

Figure 16.19: The trend in water expenditure in the pulp, paper et al sector

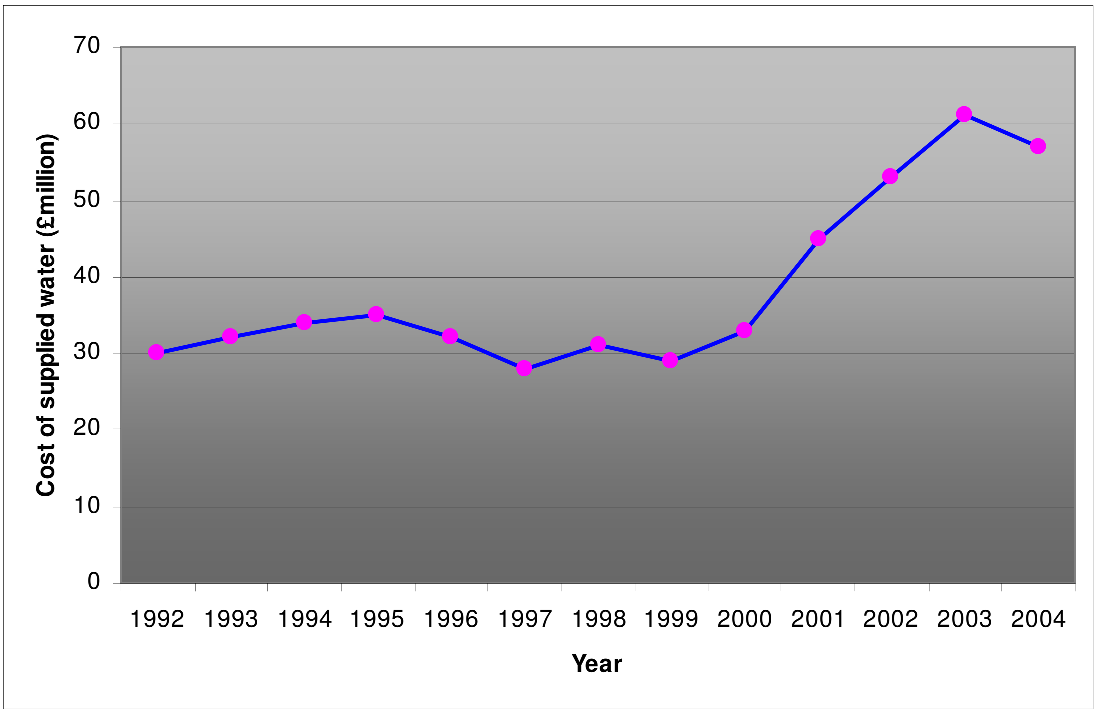
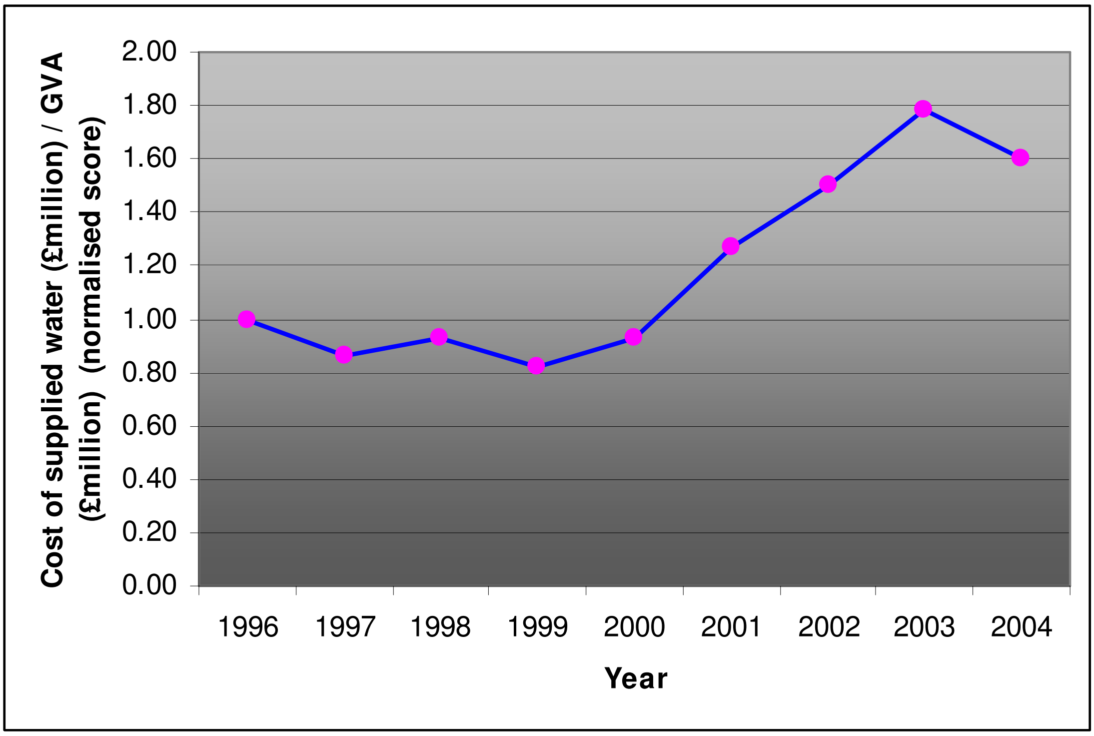


Figure 16.20: The trend in water expenditure in the pulp, paper et al sector



16.51 Table 16.15 shows the breakdown of the cost of water supplied with the two main categories accounting for 80.9% of total expenditure on water in this sector.

Table 16.15: A breakdown of the cost of water supplied to the paper et al sector

Product group	**Cost of supplied water (2004) (£M)**	**% of supplied water**
Publishing, printing and reproduction of recorded media	27.0	47.7
Manufacture of articles of paper and paperboard	18.8	33.2
Other*	10.8	19.1

*Other= Manufacture of pulp, paper and paperboard

16.52 The Envirowise FastTrack data focused mainly on SIC 22: Publishing, printing and reproduction of recorded media, which Table 16.15 shows accounted for 47.7% of the total expenditure on water. The case studies focused predominantly on the non industrial process type water savings that can be made in water used for non-industrial process. Table 16.16 shows that the average estimated saving was 33%.

Table 16.16: A summary of case study findings in the publishing sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Publishing	13	33	27.2	0.66

16.53 An alternative source of data was provided by the water companies. The standard deviation and mean of this data was calculated and from this a savings allocation was determined based on a methodology used by CIRIA in the estimate of the water savings opportunity in offices and hotels[1]. This assumes the savings opportunity equates to one decile (10% of 6 standard deviations[2]). Table 16.17 shows the results of this analysis. This shows that the average savings opportunity is 10.7% in pulp and paper and 12% in printing.

Table 16.17: Estimated savings opportunity in the paper and printing subsector

Subsector	Mean (m^3)	Standard Deviation (m^3)	1 Decile (SD x 6 / 10) (m^3)	Savings Opportunity (1 Decile / Mean x 100%)
Pulp and paper manufacture	15,138	2,711	1,626	10.7%
Printing	2,190	442	265	12.0%

Valuation of water savings

16.54 The valuation has been split into two parts, the first focusing on the savings in the water used in non-industrial processes and the second the overall savings opportunity.

Non-industrial process savings

16.55 To gain an estimate of the potential savings across the whole sector based on non-industrial process type water uses, the following assumption is used : "*water use in industrial buildings can be compared with consumption patterns found in offices when industrial processes are not taken into account*"[3].

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[1] CIRIA (2006) Water Key Performance Indicators and benchmarks for Offices and Hotels

[2] In the CIRIA study the upper quartile, i.e. top 25% businesses by water efficiency, was classified as best practice.

[3] Transforming existing buildings: The Green Challenge. Final Report, March 2007. RICS and Cyril Sweett.

16.56 Based on the Annual Business Inquiry employment data for 2005, 408,000 people were employed under SIC DE. The OGC "Watermark study" data, estimates that a typical office worker uses 9.3m^3/person/year and that best practice is approximately 6.4m^3/person/year. Using this estimate for SIC DE, approximately £1.2m or 2.1% of the expenditure on water can be saved through reduction in personal use. It is not possible to estimate water savings on processes due to insufficient case study data.

16.57 Table 16.18 shows the projected water usage in 2006. A saving of 2.1% equates to £1.2 million based on these figures.

Table 16.18 A breakdown of the cost of water supplied to the transport equipment sector projected to 2006.

Product group	Cost of supplied water (£million) (2006 projected)	% of supplied water
Publishing, printing and reproduction of recorded media	23.8	41.8
Manufacture of articles of paper and paperboard	18.1	31.8
Other*	15.0	26.4
Total	**56.9**	**100**

*Other= as above

16.58 Defra reports that the expenditure on wastewater treatment within this sector was £44 million in 2005[1] and hence, assuming the 2.1% savings opportunity will provide an equivalent wastewater saving, the estimated wastewater saving is £0.9 million.

16.59 The water savings opportunity in non-industrial process use is therefore valued at £2.1 million.

Total Savings

16.60 Based on the expenditure on water within the two subsectors shown in Table 16.18 the estimated savings for the entire sector is 11.4%. Given expenditure on water of £56.9 million the savings opportunity is therefore estimated at £6.5 million, with an associated £5 million savings in wastewater (£44 million x 11.4%). This gives an overall water savings opportunity of £11.5 million for the paper publishing and printing subsector.

[1] http://www.defra.gov.uk/environment/statistics/envsurvey/expn2005/index.htm

The construction sector

16.61 The construction sector spent £13 million on water in 2004, accounting for 0.8% of the total expenditure on water by non-households. Much of the water is used for incorporation into products such as concrete or for cleaning down equipment.

16.62 Envirowise FastTrack surveys were used to quantify the level of savings opportunity and the results can be seen in Table 16.19. Many of the surveys focused on good housekeeping measures such as leak detection and rectification, the use of spray nozzles and raising awareness, e.g. not leaving hose pipes running. The R^2 value of 0.7791 shows a strong relationship and the line equation shows that on average a 12% saving on water can be achieved.

Table 16.19: A summary of case study findings in the construction sector

Subsector	Sample Size	Mean Savings (%)	Standard Error (%)	Coefficient of Determination
Construction	32	12	17.8	0.78

16.63 The savings opportunity is therefore valued at £1.56 million.

16.64 Unfortunately, Defra do not report the expenditure on wastewater within the construction sector, therefore the national average expenditure on water was applied. Based on the ratio of supplied water to wastewater of 1:0.625[1] and the fact that wastewater costs, on average, 45% of the cost of supplied water[2] the wastewater savings are estimated at £0.44 million, i.e. water savings (£1.56 million) multiplied by the wastewater factor (45% x 62.5% = 28%)

16.65 The estimated water savings from this sector is therefore £2 million ± 17.8%.

[1] Envirowise water study 2007.

[2] Estimated from water company 2006/07 price tariffs.

Grossing up to sector level

16.66 The analysis in the industrial sector has shown that in many subsectors the main focus of case studies and surveys has been placed on identifying water savings opportunities in non-industrial process use, e.g. the fitting of cistern displacement devices and optimised use of automatic flushing control systems. Following this focus Table 16.20 shows the savings opportunity in the subsectors not covered in the detailed analysis. The savings are based on the OGC "Watermark study" estimates. This shows that £3.6 million water savings can be made from these sectors through simple non-industrial process related interventions.

Table 16.20: summary of water savings in non industrial process uses

SIC	Description	Employment (2005) (000)	Water spend (£M)	Savings opportunity	
				(£M)	% of total water savings
C	Mining and quarrying	65	17.9	0.19	1.1
DB	Manufacture of textiles and textile products	127	31.0	0.37	1.2
DC	Manufacture of leather and leather products	9	0.4	0.03	6.5
DD	Manufacture of wood and wood products	84	7.0	0.24	3.5
DF	Manufacture of coke, refined petroleum products and nuclear fuel	23	21.1	0.07	0.3
DI	Manufacture of other non-metallic mineral products	113	25.2	0.33	1.3
DK	Manufacture of machinery and equipment not elsewhere classified	286	48.6	0.83	1.7
DL	Manufacture of electrical and optical equipment	338	48.7	0.98	2.0
DN	Manufacturing not elsewhere classified	193	23.0	0.56	2.4
	Total	**1,238**	**223**	**3.6**	**1.6**

16.67 Table 16.21 shows the expenditure on wastewater by each of these sectors and the estimated savings opportunity based on the figures shown in Table 16.20. Assuming that the savings in supplied water will have an equivalent impact on wastewater the wastewater saving is estimated at £3 million.

Table 16.21: Summary of water savings in the “other” sectors

SIC	Description	Expenditure on wastewater (£M)	Water savings opportunity (%)	Wastewater savings opportunity (£M)
C	Mining and quarrying	51	1.1	0.6
DB	Manufacture of textiles and textile products	25	1.2	0.3
DC	Manufacture of leather and leather products			
DD	Manufacture of wood and wood products	4	3.5	0.1
DF	Manufacture of coke, refined petroleum products and nuclear fuel	104	0.3	0.3
DI	Manufacture of other non-metallic mineral products	15	1.3	0.2
DK	Manufacture of machinery and equipment not elsewhere classified	47	1.7	0.8
DL	Manufacture of electrical and optical equipment	11	2.0	.02
DN	Manufacturing not elsewhere classified	18	2.4	0.4
	Total	**275**	**1.1**	**3.0**

16.68 The overall savings opportunity in non-industrial process water use for these sectors is therefore estimated to be £6.6 million.

16.69 Detailed case studies focusing on total water use, including in-process water savings, have been undertaken in a number of these subsectors. For example, it is estimated that water efficiency improvements can be made in the textiles and leather products industries, leading to possible savings of between 20 – 50% on water and effluent charges[1]. The types of interventions cited include the re-use of water in cleaning or cooling operations. It is considered highly likely that significant savings can be made through in-process water savings. However, since the data on in-process water savings in these subsectors is extremely sparse, the mean water savings opportunity from the subsectors focused on in this study was used.

[1] http://www.accepta.com/industry_water_treatment/water_efficiency_textile_industry.asp

16.70 Table 16.22 shows the seven industrial sectors focused on in this study. The mean savings from these sectors was 11.3% (based on £65.6 million savings out of a total expenditure of £578 million). Applying this percentage to the expenditure on water of £223 million in the "other" subsectors gives a saving of £25 million, with an associated saving on wastewater of £31 million (£275 million x 11.3%). The total savings opportunity is therefore valued at £56 million.

Table 16.22: Summary of the water savings identified for the industrial sector

Subsector	**Cost of supplied water (2004) (£M)**	**Water savings (£M)**
Manufacture of chemicals, chemical products & man-made fibres; Manufacture of rubber & plastic products	156	13.6
Manufacture of food products, beverages & tobacco	155	34.3
Manufacture of basic metals & fabricated metal products	96	6.7
Electricity, gas & water supply	70	1.3
Manufacture of transport equipment	63	6.5
Manufacture of pulp, paper & paper products; Publishing & printing	57	1.6
Construction	13	1.6
Total	**578**	**65.6**

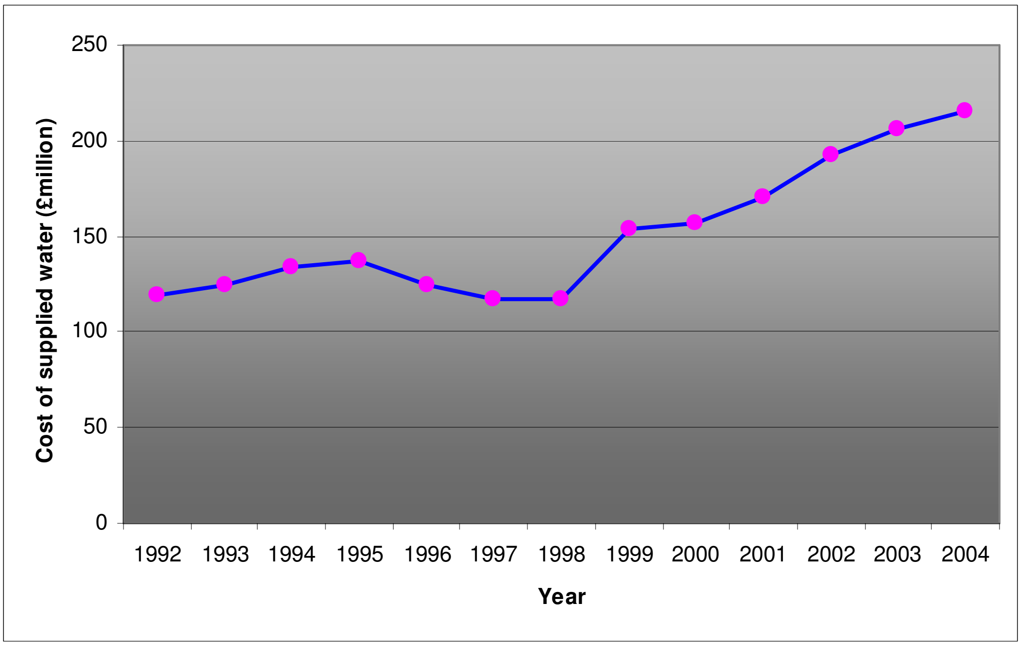
The service sector

Public administration and defence; compulsory social security

16.71 This sector was identified as being that with the highest expenditure on water in the UK, spending £216 million in 2004 and accounting for 13.6% of total expenditure on water by non-household sectors.

16.72 Figure 16.21 shows that the expenditure on water has increased significantly since 1998 and this is in line with the increases in the cost of water described earlier.

Figure 16.21: The trend in water expenditure in the public administration sector



16.73 The "Watermark study" produced by OGC in May 2003 quantified the water savings opportunity in many of the activities included in this sector. Table 16.23 shows the savings opportunities cited in the study as being achievable when moving from current "typical" practice to best practice. Although this report is rather old other, more recent, sources, show that these estimated percentage savings are still valid. For example, CIRIA[1] reported in 2006 that the water savings opportunity in offices is 33%, i.e. typical water consumption in cubic metres per square metre is 0.6 and best practice use is 0.4.

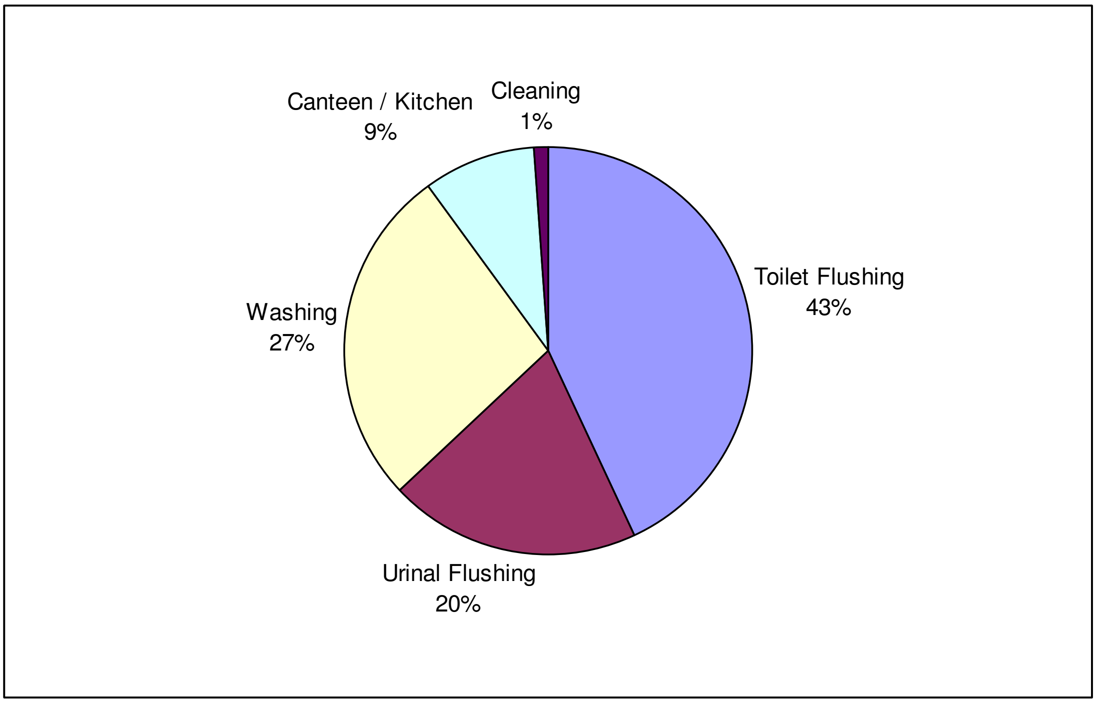
[1] CIRIA C657. Water Key Performance Indicators and benchmarks for offices and hotels. London, 2006.

Table 16.23: Estimated water savings in commercial activities

Activity	Estimated savings (%)
Prisons	22
Offices	31
Defra labs	20
Courts	20-35
Museums	45
Public lavatories	44
Police stations	32
Libraries	37
Community centres	47
Fire	38

16.74 A DTI / CIRIA report in February 2006 showed that toilet and urinal flushing in offices typically accounts for 63% of all water use (Figure 16.22) and hence significant savings can be made through improvements in automatic flushing control systems such as altering the timing of flushing in line with use, and the installation of cistern displacement devices (e.g. Hippos of Saveaflush) which reduce the water used per flush.

Figure 16.22: An analysis of water use in offices[1]



[1] Key Performance Indicators for water use in offices. February 2006. DTI / CIRIA.

16.75 For the purpose of this study it is assumed that the savings opportunity of 30% for “offices” (Table 16.23) represents the average for this sector. This assumption is made on the basis that water consumption in offices, as described in Figure 16.22, is typical of water uses in the other activities within this sector.

16.76 Given the total expenditure of £216 million referred to above, the savings opportunity in the sector therefore equates to £67 million.

16.77 Assuming that wastewater savings are 28% of supplied water savings, as described in the valuation of water savings in the construction sector, the wastewater savings are valued at £19 million.

16.78 The total estimated water saving opportunity from this sector is therefore £86 million.

Health and social work

16.79 The expenditure on water by this sector in 2004 was £122 million or 7.7% of total expenditure by non-household sectors. Figure 16.23 shows that expenditure on water has been gradually creeping up, increasing by 10% between 1993 and 2004. However, Figure 16.24 shows that, when GVA is taken into consideration, relative expenditure on water has gone down for seven consecutive years between 1998 and 2004.

Figure 16.23: The trend in water expenditure in health and social work

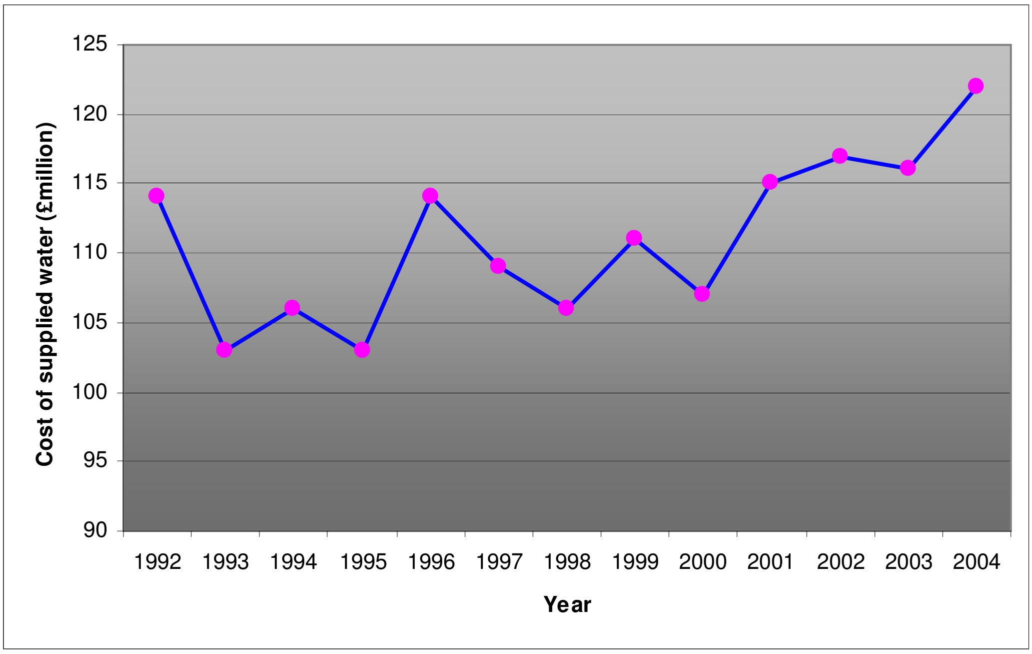
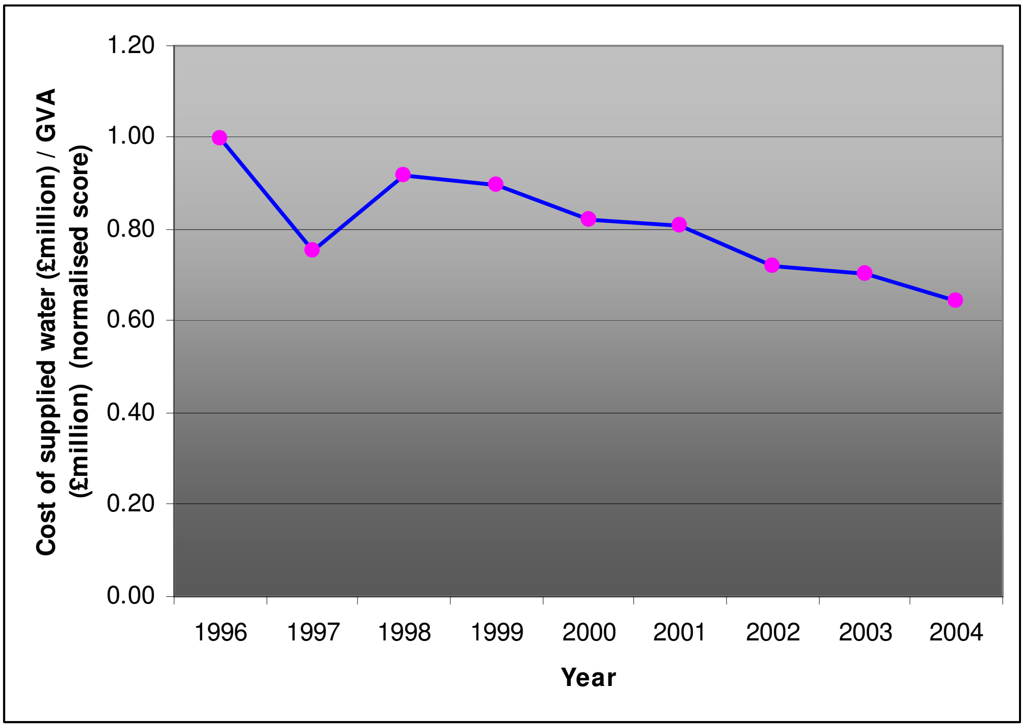


Figure 16.24: The trend in expenditure on water / GVA in the health and social work sector



16.80 Table 16.24 shows the expenditure on water by subsector. This shows that human health and veterinary activities accounted for the majority (71.5%) of sector spend on water in 2004.

Table 16.24: Expenditure on water by subsector in the health and social work sector in 2004

Product group	Cost of supplied water (2004) (£M)	% of supplied water
Human health & veterinary activities	87.2	71.5
Social work activities	34.8	28.5

16.81 The OGC ""Watermark study" in 2003 estimated the savings opportunity from hospitals to be between 17% and 23%. Thames Water reports that a recent survey of three hospitals showed that 15-30% of annual water use was due to leakage[1] and hence better resource monitoring could give rise to significant savings. Gwent Healthcare Trust reports water savings opportunities of 18.3% based on the savings identified at the County Hospital[2].

[1] http://www.thameswater.co.uk/UK/region/en_gb/content/Section_Homepages/Right_Image_000067.jsp?SECT=Right_Image_000031

[2] http://www.swig.org.uk/AMR_MickMerrick.pdf

16.82 Based on these analyses it is assumed that the savings opportunity in this sector equates to 20%. Table 16.25 shows the projection of the expenditure on water to 2006. This shows expenditure at £118.8 million and hence the savings opportunity is estimated at £23.8 million.

Table 16.25: Projected expenditure on water by subsector in the health and social work sector in 2006

Product group	Cost of supplied water (2006 projected) (£M)	% of supplied water
Human health & veterinary activities	86.7	73.0
Social work activities	32.1	27.0
Total	**118.8**	**100.0**

16.83 Assuming that wastewater savings are 28% of supplied water savings, as described in the valuation of water savings in the construction sector, the wastewater savings are valued at £6.6 million.

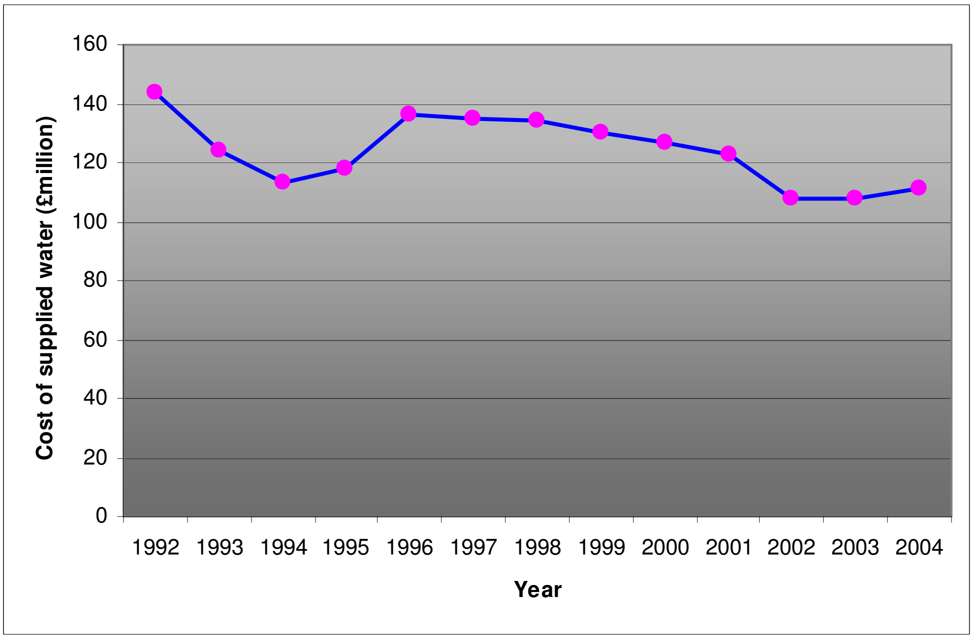
16.84 The estimated water saving opportunity from this sector is therefore £30 million.

Education

16.85 The Education sector spent £111 million on water in 2004 accounting for 7% of total expenditure on water by non-household sectors.

16.86 Figure 16.25 shows that expenditure on water dropped by 19% between 1996 and 2004.

Figure 16.25: The trend in water expenditure in the education sector



16.87 Examples of the types of savings interventions that were cited in case studies in this area include the following:[1]

- For schools (based on the interventions undertaken at the Christchurch Junior Replacement School – Dorset): installation of a monsoon rainwater recycling system; single warm water percussion taps within the children's WC area; the installation of drinking fountains; the installation of 6 litre WC cisterns; the installation of urinal flushing.

- For universities (based on the interventions made at the University of Derby): fitting of urinal sensor controls; fitting of water displacers; installation of induction shower heads; fitting of tap restrictors.

[1] http://216.239.59.104/search?q=cache:Kc6LtKnl2E0J:www.environment-agency.gov.uk/commondata/105385/wea_2003_full__886767.pdf+nissan+production+plant+water+saving&hl=en&ct=clnk&cd=3&gl=uk Accessed September 2007.

16.88 The OGC "Watermark study" in 2003 estimated that 28-29% savings could be achieved in primary schools 29-31% in secondary schools and 35% in higher and further education establishments. Additional studies have suggested that:

- careful water management, together with an effective education programme, can reduce water use by two-thirds[1]
- a carefully managed water saving programme, where schools review their use of water on a regular basis and monitor their daily consumption figures, can cut consumption by as much as 50% and may save schools up to £5,000 per annum[2]

16.89 A £30,000 water saving project was completed in March 2006 in thirty schools and annual consumption dropped by 59% as a result. The project consisted of; fitting electronic urinal controls that only flush when toilets are in use, and only carry out a cleaning cycle during the night, at weekends and during school holidays and converting conventional screw down taps to push down taps[3].

16.90 Based on these analyses it is assumed that a 28% savings opportunity could be achieved, equating to a financial saving of £31 million.

16.91 Using the wastewater factor of 28% the wastewater savings are valued at £9 million.

16.92 The estimated water saving opportunity from this sector is therefore £40 million.

[1] http://www.eco-schools.org.uk/howto/primary/6/6_4.htm

[2] http://www.thinkleadership.org.uk/water.cfm

[3] http://216.239.59.104/search?q=cache:Nj8BMT9YEfgJ:wdccmis.west-dunbarton.gov.uk/CMISWebPublic/Binary.ashx%3FDocument%3D4349+water+savings+in+sport+centres&hl=en&ct=clnk&cd=36&gl=uk

Other community, social and personal service activities

16.93 This sector spent £75 million on water in 2004 accounting for 4.7% of total expenditure on water by non-household sectors.

16.94 Figure 16.26 shows that expenditure on water has been steadily increasing since 1997. Conversely, Figure 16.16.27 shows that when GVA is taken into consideration water expenditure per GVA has fallen steadily since 1996.

Figure 16.26: The trend in water expenditure within the other community et al sector

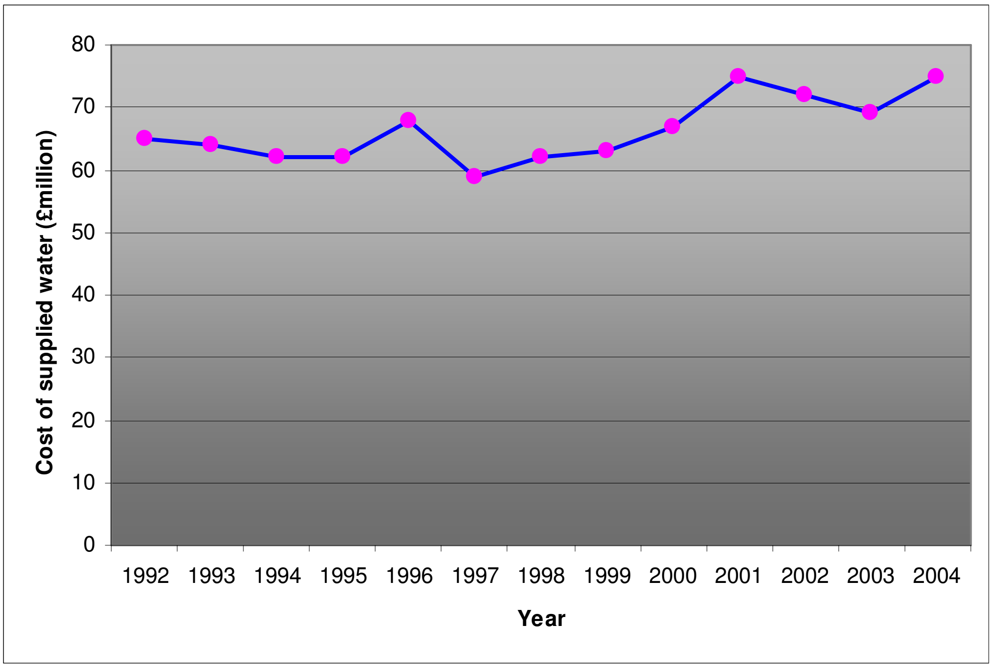
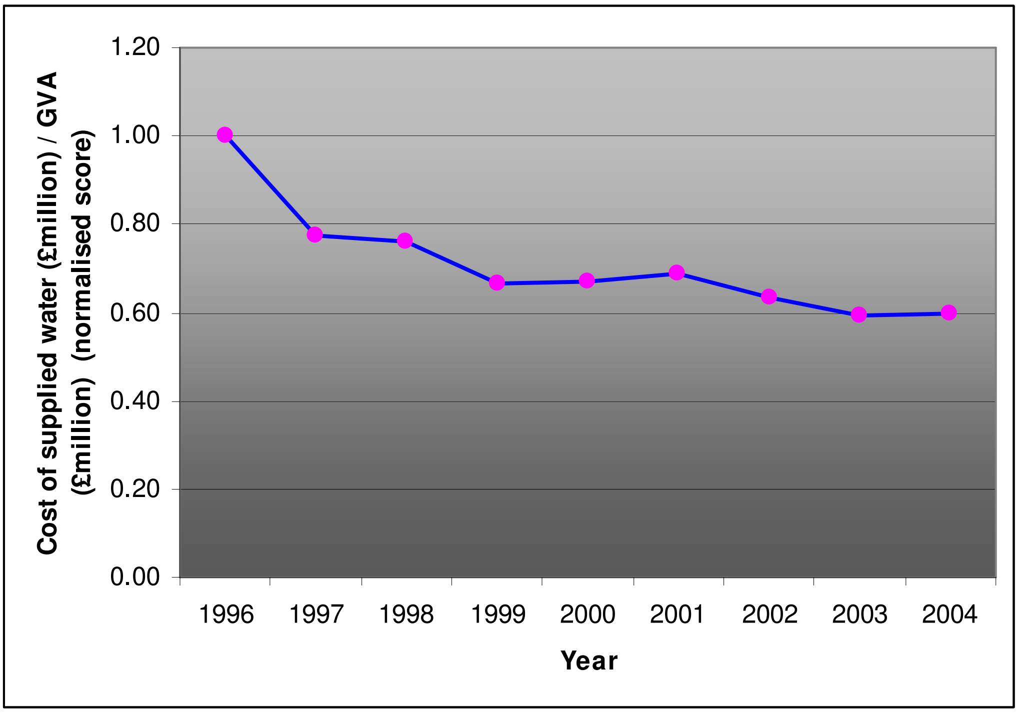


Figure 16.16.27: The trend in water expenditure / GVA within the other community et al sector



16.95 Table 16.26 shows the expenditure on water by subsector. This shows that recreational, cultural and sporting activities accounted for 59% of the sector spend on water in 2004. This was another sector covered in the OGC "Watermark study" and it was estimated that savings of 21% were possible. The survey data from ENWORKS and the Envirowise FastTrack surveys undertaken since 2005 verifies this savings opportunity. Unfortunately, no data could be found on the savings opportunity within "sewage and refuse disposal".

Table 16.26: Expenditure on water by subsector

Product group	**Cost of supplied water (2004) (£M)**	**% of supplied water**
Recreational, cultural & sporting activities	44.3	59.2
Sewage & refuse disposal, sanitation & similar activities	25.5	34.1
Other*	5.0	6.7

*Other= Other service activities; Activities of membership organisations nec

16.96 It is assumed that the “other” sector shown in Table 16.26 can realise similar savings to that of the recreational, cultural and sporting activities. However, the sewage and refuse disposal sector is too diverse to assume similar savings opportunities. Therefore the savings opportunity is valued on the two subsectors which make up 65.9% of the sectors spend on water. Based on a projected 2006 expenditure by the two subsectors of £49.5 million the savings opportunity is estimated at £10 million.

16.97 Using the wastewater factor of 28% the wastewater savings are valued at £3 million.

16.98 The estimated water saving opportunity from this sector is therefore £13 million.

Real estate, renting and business activities

16.99 This sector spent £38 million on water in 2004 accounting for 2.4% of total expenditure on water by non-household sectors.

16.100 Figure 16.28 shows that expenditure on water has been steadily increasing since 1997. However, Figure 16.29 shows that when GVA is taken into consideration water expenditure per GVA has fallen steadily since 1996.

Figure 16.28: The trend in water expenditure in the real estate et al sector

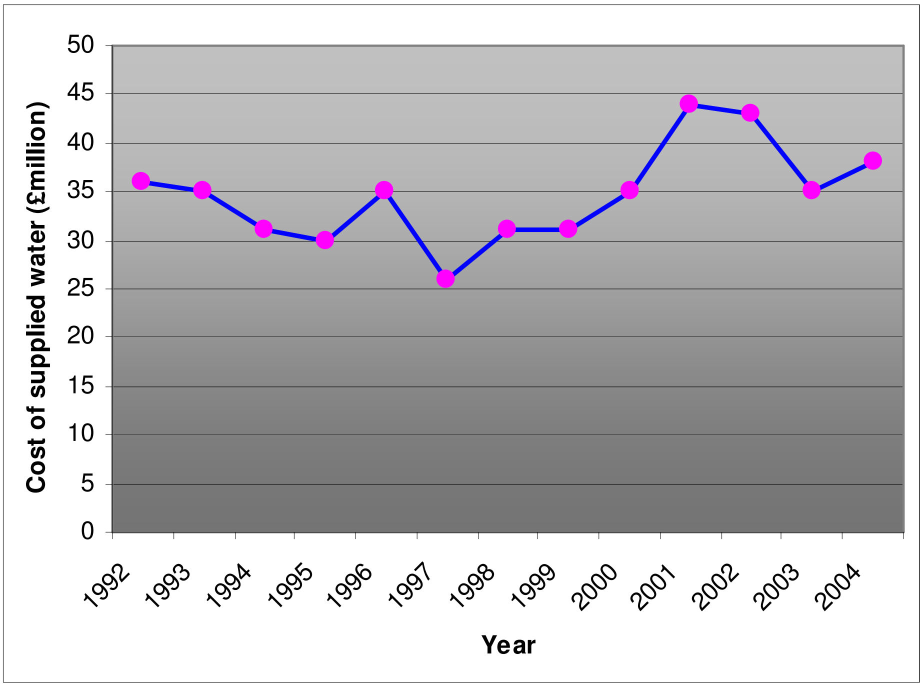
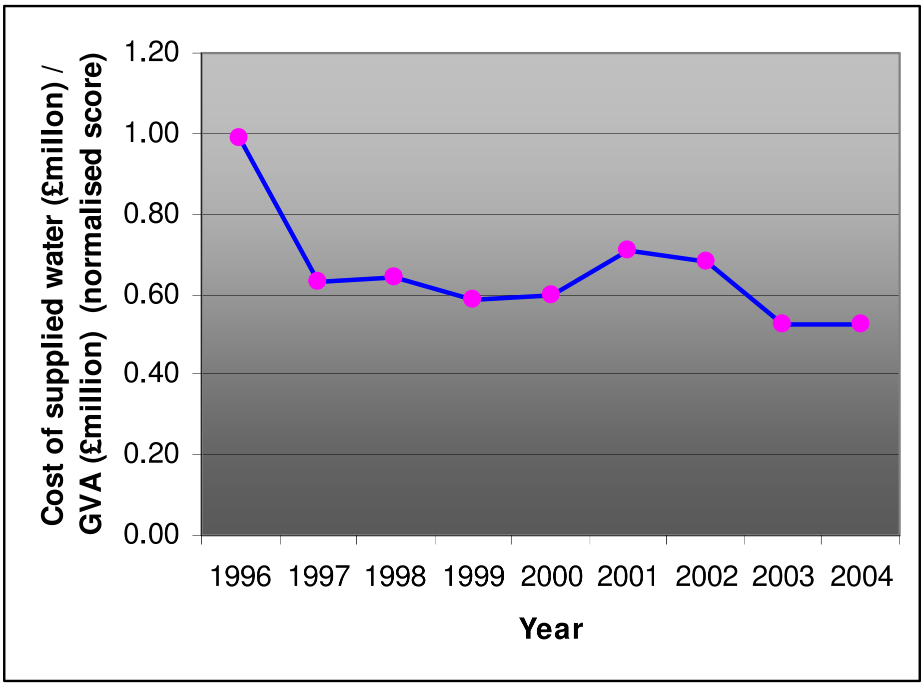


Figure 16.29: The trend in water expenditure / GVA in the real estate et al sector



16.101 Table 16.27 shows the expenditure on water by subsector. This shows that no one significant subsector stands out. However, the list of activities indicates that many can be regarded as office based and hence it is possible to apply a broad savings estimate across the whole sector. Based on the analysis shown in the "public administration" section on savings opportunities in offices it is assumed that a 31% saving can be achieved.

16.102 Table 16.28 shows the projected expenditure by this sector in 2006 which estimates expenditure at £39 million. A 31% saving would therefore result in savings of £12.2 million.

16.103 Using the wastewater factor of 28.125% the wastewater savings are valued at £3.4 million.

16.104 The estimated water saving opportunity from this sector is therefore £16 million.

Table 16.27: Expenditure on water by subsector in the real estate et al sector, 2004

Product group	**Cost of supplied water (2004) (£M)**	**% of supplied water**
Other business services	10.7	28.5
Renting of machinery & equipment without operator & of personal & household goods	7.0	18.7
Legal activities; Accounting, book-keeping & auditing activities; Tax consultancy; Market research & public opinion polling; Business & management consultancy activities; Management activities	5.5	14.7
Research & development	4.9	13.0
Architectural & engineering activities & related technical consultancy; Technical testing & analysis	3.9	10.4
Other*	5.5	14.7

*Other = Advertising; Computer & related activities; Letting of dwellings, including imputed rent; Real estate activities with own property; Letting of own property, except dwellings; Real estate activities on a fee or contract basis

Table 16.28: Projected expenditure on water by subsector in the real estate et al sector, 2004

Product group	**Cost of supplied water (2006 projected) (£M)**	**% of supplied water**
Other business services	11.4	29.1
Renting of machinery & equipment without operator & of personal & household goods	7.0	17.9
Legal activities; Accounting, book-keeping & auditing activities; Tax consultancy; Market research & public opinion polling; Business & management consultancy activities; Management activities	5.3	13.5
Research & development	5.0	12.7
Architectural & engineering activities & related technical consultancy; Technical testing & analysis	4.2	10.7
Other*	6.3	16.1
Total	**39.2**	**100**

*Other = as Table 16.27

Hotels and restaurants

16.105 This sector spent £11 million on water in 2004 accounting for 0.7% of total expenditure on water by non-household sectors.

16.106 Figure 16.30 shows that expenditure on water has increased since 2000 which appears to reflect the same trend as seen in many of the industrial sectors where a price increase has had a significant impact. However, Figure 16.31 shows that when GVA is taken into consideration water expenditure per GVA was at its lowest in 2004.

Figure 16.30: The trend in water expenditure in the hotels and catering sector

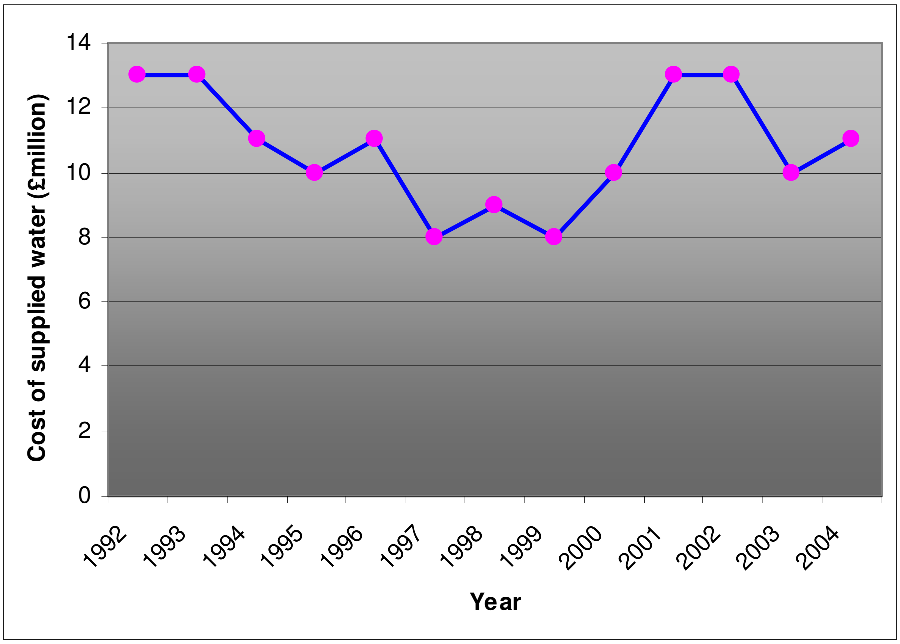
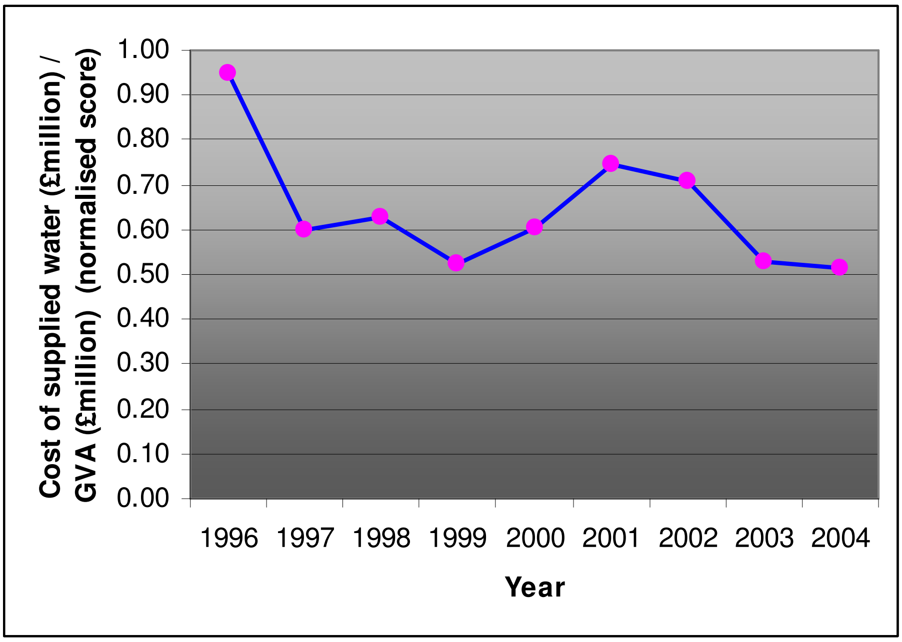


Figure 16.31: The trend in water expenditure / GVA in the hotels and catering sector



16.107 Work undertaken by Cosmopolitan Hotels was typical of the type of water saving interventions identified in a literature survey. This included[1]:

- the fitting of push taps in public restrooms, preventing taps being left on
- flow restrictors fitted on all tap outlets reducing consumption but not compromising guest or user comfort;
- sensor activated flushing in gent's urinals eliminating unnecessary flushing frequencies.

16.108 CIRIA report that water savings of 50% can be achieved by moving to current best practice[2]. The Environment Agency undertook a similar study entitled "Water efficiency & benchmarking project" in the hotel sector[3]. This demonstrated average water-efficiency savings of 33%. A review of Envirowise FastTrack surveys showed savings opportunities nearer the Environment Agency estimates and hence it was considered appropriate to use the 33% savings opportunity for this valuation. The savings opportunity is therefore estimated at £3.6 million. It is considered to be reasonable to base

[1] http://www.greentourism.org.uk/CosmopolitanHotels.html Accessed August 2007.

[2] CIRIA C657. Water key performance indicators and benchmarks for offices and hotels. CIRIA, London 2006.

[3] http://www.environment-agency.gov.uk/subjects/waterres/286587/1332197/746671/995746/?lang=_e

this calculation on the 2004 expenditure of £11 million due to the levelling out of costs at this time.

16.109 Using the wastewater factor of 28 % the wastewater savings are valued at £1.0 million.

16.110 The estimated water saving opportunity from this sector is therefore £4.6 million.

Grossing up to sector level

16.111 Much as in the case of the industrial sector the focus of most of the case studies and surveys undertaken on water savings in the service sector has focused on non industrial process type intervention and hence this is reflected in the method used to gross up the savings to sector level.

16.112 Table 16.29 shows the savings opportunity in each of the subsectors, assuming based on the findings from the OGC “Watermark study” that there is a savings opportunity of 2.9m^3/person/year for each employee in each subsector. The savings opportunity is estimated at £23.1 million.

Table 16.29: Projection of non industrial process type water savings in the “other” sectors

SIC	Description	Employment (2005) (000)	Water spend (£M)	Savings opportunity	
				(£M)	% of total water savings**
G	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods	5,089	64.9	14.8	22.7
I	Transport, storage and communication	1,624	24.1	4.7	19.5
J	Financial intermediation	1,240	NA	3.6	NA
	Total	**7,953**	**89***	**230.1**	**21.9***

*Note this figure excludes financial intermediation (SIC J) due to the lack of water spend data for this sector

**Based on data from OGC “Watermark study” the theoretical maximum savings achievable, if the entire industry is office based, through simple non process specific water savings is approximately 35%

16.113 Unlike the industrial sector most of the water used in the service sector can be classified as non industrial process type water uses and hence the estimates in Table 16.29 can be regarded as total water supply savings.

16.114 Table 16.30 shows the estimated wastewater and total savings from these three subsectors when applying the wastewater factor of 28%. The wastewater savings opportunity is estimated at £6.5 million and the total savings opportunity for the three subsectors is estimated at £29.5 million.

Table 16.30: Projection of non industrial process type water savings, including waste water costs, in the “other” sectors

SIC	Description	Estimated water savings (£M)	Estimated wastewater savings (£M)	Total estimated savings (£M)
G	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods	14.8	4.2	18.9
I	Transport, storage and communication	4.7	1.3	6.0
J	Financial intermediation	3.6	1.0	4.6
	Total	**23.1**	**6.5**	**29.5**

The agricultural sector

Quantification of savings potential

16.115 Defra has recently completed a comprehensive study investigating the opportunities for water savings within this sector. The aim of the study was to identify new and existing areas of research and knowledge transfer that will create opportunities for reducing water use in English and Welsh agriculture[1]. The study estimated the annual water use in the sector at 308 million m^3 and the savings potential at 99 million m^3, i.e. a savings potential of 32% (Table 16.31).

Table 16.31: The estimated savings potential in the agriculture sector

Sector	Total water withdrawals (million m^3 $year^{-1}$)	Potential savings in water withdrawals (million m^3 $year^{-1}$)
Crop spraying	0.2	NIL
Field crops: potato	75	30 (40%)
Field crops: vegetables	34	13 (40%)
Field crops: fruit	8	2-4 (40%)
Field crops: cereals	1.5	Low
Field crops: sugar beet	4.6	Low
Protected crops	13	5 (40%)
Hardy nursery stock	50	38 (75%)
Washing of produce	3.1	< 1
Livestock: cattle	82	9 (50% of wash water)
Livestock: sheep	17	< 1
Livestock: poultry	12	< 1
Livestock: pigs	8	< 1
Total	**308.4**	**99**

Valuation of water savings

16.116 Taking the annual cost of water at £118 million and the savings opportunity at 32% it is estimated that the savings potential is £38 million.

16.117 Due to the nature of the water savings in this sector no wastewater savings are applied.

[1] Defra research project final report for WU0101 – Opportunities for reducing water use in Agriculture. Warwick HRI, University of Warwick and ADAS for Defra 2007.

17 Appendix 9: Detailed analysis of regional savings opportunities

North East

Waste

Table 17.1: Top ten waste savings opportunity sectors (£M)

Sector	Total savings (£M)
Food products; beverages & tobacco	34
Retail	16
Chemicals, chemical products & man-made fibres; rubber & plastic products	11
Construction	6
Manufacture of machinery & equipment et al	6
Travel agents et al	5
Hotels & catering	3
Other (other non-metallic minerals; wood & wood products; textiles & leather; manufacture of machinery nec; agriculture)	2
Education	2
Energy supply	2

Energy

Table 17.2: Top ten energy savings opportunity sectors (£M)

Sector	Total savings (£M)
Transport	73
Chemicals, chemical products & man-made fibres; rubber & plastic products	9
Retail	5
Coke, refined petroleum products & nuclear fuel	4
Hotels & catering	4
Other - mining & quarrying; wood & wood products; other non-metallic mineral products; machinery & equipment nec; manufacturing nec	4
Food products; beverages & tobacco	3
Basic metals; fabricated metal products except machine equipment	3
Commercial offices	2
Education	2

Water

Table 17.3: Top ten water savings opportunity sectors (£M)

Sector	Total savings (£M)
Public admin & other services	4.5
Food products, beverages & tobacco	2.4
Chemicals, chemical products & man-made fibres; rubber & plastic products	1.8
Education	1.6
Health & social work	1.3
Agriculture	1.0
Other (Commercial)	1.0
Basic metals; fabricated metal products except machine equipment	0.4
Real estate	0.4
Pulp, paper & paper products; publishing, printing & reproduction of rec media	0.2

North West

Waste

Table 17.4: Top ten waste savings opportunity sectors (£M)

Sector	Total savings (£M)
Food products; beverages & tobacco	114
Retail	54
Chemicals, chemical products & man-made fibres; rubber & plastic products	33
Construction	22
Travel agents et al	22
Manufacture of machinery & equipment et al	18
Hotels & catering	7
Other (other non-metallic minerals; wood & wood products; textiles & leather; manufacture of machinery nec; agriculture)	7
Energy supply	6
Education	6

Energy

Table 17.5: Top ten energy savings opportunity sectors (£M)

Sector	Total savings (£M)
Transport	224
Chemicals, chemical products & man-made fibres; rubber & plastic products	26
Retail	16
Coke, refined petroleum products & nuclear fuel	13
Hotels & catering	11
Other - mining & quarrying; wood & wood products; other non-metallic mineral products; machinery & equipment nec; manufacturing nec	11
Food products; beverages & tobacco	10
Commercial offices	9
Basic metals	9
Warehousing	8

Water

Table 17.6: Top ten water savings opportunity sectors (£M)

Sector	Total savings (£M)
Public admin & other services	8.5
Food products, beverages & tobacco	8.0
Chemicals, chemical products & man-made fibres; rubber & plastic products	5.4
Education	4.3
Health & social work	3.2
Other (Commercial)	3.2
Agriculture	2.8
Real estate	1.5
Basic metals; fabricated metal products except machine equipment	1.2
Pulp, paper & paper products; publishing, printing & reproduction of rec media	1.0

Yorkshire and the Humber

Waste

Table 17.7: Top ten waste savings opportunity sectors (£M)

Sector	Total savings (£M)
Food products; beverages & tobacco	95
Retail	41
Chemicals, chemical products & man-made fibres; rubber & plastic products	23
Construction	18
Travel agents et al	14
Manufacture of machinery & equipment et al	14
Other (other non-metallic minerals; wood & wood products; textiles & leather; manufacture of machinery nec; agriculture)	7
Hotels & catering	6
Education	4
Energy supply	3

Energy

Table 17.8: Top ten energy savings opportunity sectors (£M)

Sector	Total savings (£M)
Transport	174
Chemicals, chemical products & man-made fibres; rubber & plastic products	18
Retail	12
Other	11
Hotels & catering	9
Food products; beverages & tobacco	9
Basic metals	9
Commercial offices	6
Warehousing	6
Education	4

Water

Table 17.9: Top ten water savings opportunity sectors (£M)

Sector	Total savings (£M)
Public admin & other services	8.1
Food products, beverages & tobacco	6.7
Chemicals, chemical products & man-made fibres; rubber & plastic products	3.8
Education	3.3
Agriculture	2.8
Other (Commercial)	2.5
Health & social work	2.3
Basic metals; fabricated metal products except machine equipment	1.1
Real estate	1.0
Pulp, paper & paper products; publishing, printing & reproduction of rec media	0.7

East Midlands

Waste

Table 17.10: Top ten waste savings opportunity sectors (£M)

Sector	Total savings (£M)
Food products; beverages & tobacco	60
Retail	35
Chemicals, chemical products & man-made fibres; rubber & plastic products	22
Construction	18
Manufacture of machinery & equipment et al	15
Travel agents et al	13
Other (other non-metallic minerals; wood & wood products; textiles & leather; manufacture of machinery nec; agriculture)	7
Hotels & catering	4
Education	4
Mining & quarrying	3

Energy

Table 17.11: Top ten energy savings opportunity sectors (£M)

Sector	Total savings (£M)
Transport	169
Chemicals, chemical products & man-made fibres; rubber & plastic products	18
Other	10
Retail	10
Basic metals; fabricated metal products except machine equipment	7
Hotels & catering	7
Commercial offices	6
Food products; beverages & tobacco	5
Warehousing	5
Education	4

Water

Table 17.12: Top ten water savings opportunity sectors (£M)

Sector	Total savings (£M)
Public admin & other services	9.3
Food products, beverages & tobacco	4.2
Chemicals, chemical products & man-made fibres; rubber & plastic products	3.7
Education	3.3
Agriculture	2.7
Health & social work	2.2
Other (Commercial)	2.1
Basic metals; fabricated metal products except machine equipment	1.0
Real estate	0.9
Pulp, paper & paper products; publishing, printing & reproduction of rec media	0.8

West Midlands

Waste

Table 17.13: Top ten waste savings opportunity sector (£M)

Sector	Total savings (£M)
Food products; beverages & tobacco	59
Retail	44
Chemicals, chemical products & man-made fibres; rubber & plastic products	25
Construction	20
Manufacture of machinery & equipment et al	18
Travel agents et al	18
Other (other non-metallic minerals; wood & wood products; textiles & leather; manufacture of machinery nec; agriculture)	7
Hotels & catering	6
Education	5
Energy supply	4

Energy

Table 17.14: Top ten energy savings opportunity sectors (£M)

Sector	Total savings (£M)
Transport	191
Chemicals, chemical products & man-made fibres; rubber & plastic products	20
Basic metals; fabricated metal products except machine equipment	14
Other	13
Retail	12
Hotels & catering	9
Commercial offices	8
Coke, refined petroleum products & nuclear fuel	7
Warehousing	6
Food products; beverages & tobacco	5

Water

Table 17.15: Top ten water savings opportunity sectors (£M)

Sector	Total savings (£M)
Public admin & other services	7.8
Food products, beverages & tobacco	4.1
Chemicals, chemical products & man-made fibres; rubber & plastic products	4.1
Education	3.5
Agriculture	3.0
Other (Commercial)	2.6
Health & social work	2.3
Basic metals; fabricated metal products except machine equipment	2.0
Real estate	1.2
Pulp, paper & paper products; publishing, printing & reproduction of rec media	0.8

East

Waste

Table 17.16: Top ten waste savings opportunity sectors (£M)

Sector	Total savings (£M)
Food products; beverages & tobacco	65
Retail	46
Construction	29
Manufacture of machinery & equipment et al	27
Chemicals, chemical products & man-made fibres; rubber & plastic products	24
Travel agents et al	23
Other (other non-metallic minerals; wood & wood products; textiles & leather; manufacture of machinery nec; agriculture)	7
Hotels & catering	6
Education	5
Energy supply	4

Energy

Table 17.17: Top ten energy savings opportunity sectors (£M)

Sector	Total savings (£M)
Transport	207
Chemicals, chemical products & man-made fibres; rubber & plastic products	19
Retail	12
Other	12
Commercial offices	10
Hotels & catering	9
Warehousing	8
Basic metals; fabricated metal products except machine equipment	8
Pulp, paper & paper products; publishing, printing & reproduction of recorded media	6
Food products; beverages & tobacco	6

Water

Table 17.18: Top ten water savings opportunity sectors (£M)

Sector	Total savings (£M)
Public admin & other services	7.8
Food products, beverages & tobacco	4.6
Chemicals, chemical products & man-made fibres; rubber & plastic products	3.9
Education	3.8
Agriculture	3.1
Other (Commercial)	2.8
Health & social work	2.6
Real estate	1.6
Pulp, paper & paper products; publishing, printing & reproduction of rec media	1.3
Basic metals; fabricated metal products except machine equipment	1.1

London

Waste

Table 17.19: Top ten waste savings opportunity sectors (£M)

Sector	Total savings (£M)
Food products; beverages & tobacco	71
Retail	65
Travel agents et al	49
Construction	22
Manufacture of machinery & equipment et al	17
Chemicals, chemical products & man-made fibres; rubber & plastic products	15
Hotels & catering	10
Education	5
Paper, publishing & printing	5
Energy supply	3

Energy

Table 17.20: Top ten energy savings opportunity sectors (£M)

Sector	Total savings (£M)
Transport	160
Commercial offices	21
Retail	19
Hotels & catering	16
Warehousing	14
Chemicals, chemical products & man-made fibres; rubber & plastic products	12
Pulp, paper & paper products; publishing, printing & reproduction of rec media	12
Government	10
Other	8
Sport & leisure	8

Water

Table 17.21: Top ten water savings opportunity sectors (£M)

Sector	Total savings (£M)
Public admin & other services	11.5
Food products, beverages & tobacco	4.9
Education	4.1
Other (Commercial)	4.1
Health & social work	3.9
Real estate	3.3
Pulp, paper & paper products; publishing, printing & reproduction of rec media	2.7
Chemicals, chemical products & man-made fibres; rubber & plastic products	2.6
Hotels & catering	0.7
Other (Industry)	0.6

South East

Waste

Table 17.22: Top ten waste savings opportunity sectors (£M)

Sector	Total savings (£M)
Food products; beverages & tobacco	70
Retail	68
Travel agents et al	43
Construction	41
Manufacture of machinery & equipment et al	40
Chemicals, chemical products & man-made fibres; rubber & plastic products	31
Hotels & catering	10
Education	7
Other (other non-metallic minerals; wood & wood products; textiles & leather; manufacture of machinery nec; agriculture)	7
Energy supply	5

Energy

Table 17.23: Top ten energy savings opportunity sectors (£M)

Sector	Total savings (£M)
Transport	306
Chemicals, chemical products & man-made fibres; rubber & plastic products	25
Retail	19
Commercial offices	19
Hotels & catering	15
Other	14
Warehousing	12
Basic metals; fabricated metal products except machine equipment	11
Pulp, paper & paper products; publishing, printing & reproduction of recorded media	9
Coke, refined petroleum products & nuclear fuel	7

Water

Table 17.24: Top ten water savings opportunity sectors (£M)

Sector	Total savings (£M)
Public admin & other services	11.7
Education	5.4
Chemicals, chemical products & man-made fibres; rubber & plastic products	5.1
Food products, beverages & tobacco	4.9
Health & social work	4.1
Other (Commercial)	4.1
Agriculture	2.9
Real estate	2.9
Pulp, paper & paper products; publishing, printing & reproduction of rec media	2.0
Basic metals; fabricated metal products except machine equipment	1.5

South West

Waste

Table 17.25: Top ten waste savings opportunity sectors (£M)

Sector	Total savings (£M)
Food products; beverages & tobacco	84
Retail	44
Construction	25
Travel agents et al	19
Chemicals, chemical products & man-made fibres; rubber & plastic products	19
Manufacture of machinery & equipment et al	18
Other (other non-metallic minerals; wood & wood products; textiles & leather; manufacture of machinery nec; agriculture)	11
Hotels & catering	7
Education	5
Mining & quarrying	5

Energy

Table 17.26: Top ten energy savings opportunity sectors (£M)

Sector	Total savings (£M)
Transport	178
Chemicals, chemical products & man-made fibres; rubber & plastic products	15
Retail	13
Hotels & catering	11
Other	10
Commercial offices	8
Agriculture	8
Food products; beverages & tobacco	8
Basic metals	7
Warehousing	6

Water

Table 17.27: Top ten water savings opportunity sectors (£M)

Sector	Total savings (£M)
Public admin & other services	7.2
Food products, beverages & tobacco	5.9
Agriculture	5.5
Education	3.5
Chemicals, chemical products & man-made fibres; rubber & plastic products	3.2
Other (Commercial)	2.6
Health & social work	2.6
Real estate	1.3
Pulp, paper & paper products; publishing, printing & reproduction of rec media	1.0
Basic metals; fabricated metal products except machine equipment	0.9

Wales

Waste

Table 17.28: Top ten waste savings opportunity sectors (£M)

Sector	Total savings (£M)
Food products; beverages & tobacco	48
Retail	22
Chemicals, chemical products & man-made fibres; rubber & plastic products	13
Construction	11
Other (other non-metallic minerals; wood & wood products; textiles & leather; manufacture of machinery nec; agriculture)	8
Manufacture of machinery & equipment et al	7
Travel agents et al	7
Hotels & catering	4
Energy supply	3
Education	3

Energy

Table 17.29: Top ten energy saving opportunity sectors (£M)

Sector	Total savings (£M)
Transport	97
Chemicals, chemical products & man-made fibres; rubber & plastic products	11
Retail	7
Agriculture	6
Hotels & catering	6
Other	5
Food products, beverages & tobacco	4
Coke, refined petroleum products & nuclear fuel	4
Basic metals	3
Commercial offices	3

Water

Table 17.30: Top ten water savings opportunity sectors (£M)

Sector	Total savings (£M)
Public admin & other services	5.5
Agriculture	4.3
Food products, beverages & tobacco	3.3
Education	2.3
Chemicals, chemical products & man-made fibres; rubber & plastic products	2.2
Health & social work	1.8
Other (Commercial)	1.3
Basic metals; fabricated metal products except machine equipment	0.5
Real estate	0.5
Pulp, paper & paper products; publishing, printing & reproduction of rec media	0.3

Scotland

Waste

Table 17.31: Top ten waste savings opportunity sectors (£M)

Sector	Total savings (£M)
Food products; beverages & tobacco	110
Retail	37
Construction	17
Travel agents et al	15
Chemicals, chemical products & man-made fibres; rubber & plastic products	12
Manufacture of machinery & equipment et al	12
Other (other non-metallic minerals; wood & wood products; textiles & leather; manufacture of machinery nec; agriculture)	10
Mining & quarrying	9
Energy supply	6
Hotels & catering	6

Energy

Table 17.32: Top ten energy savings opportunity sectors (£M)

Sector	Total savings (£M)
Transport	166
Retail	12
Food products; beverages & tobacco	10
Hotels & catering	10
Chemicals, chemical products & man-made fibres; rubber & plastic products	10
Coke, refined petroleum products & nuclear fuel	9
Other	8
Agriculture	7
Commercial offices	7
Warehousing	6

Water

Table 17.33: Top ten water savings opportunity sectors (£M)

Sector	Total savings (£M)
Public admin & other services	14.6
Food products, beverages & tobacco	7.7
Agriculture	5.1
Education	4.3
Health & social work	3.2
Other (Commercial)	2.3
Chemicals, chemical products & man-made fibres; rubber & plastic products	2.0
Real estate	1.0
Basic metals; fabricated metal products except machine equipment	0.7
Pulp, paper & paper products; publishing, printing & reproduction of rec media	0.6

Northern Ireland

Waste

Table 17.34: Top ten waste savings opportunity sectors (£M)

Sector	Total savings (£M)
Food products; beverages & tobacco	47
Retail	16
Construction	10
Other (other non-metallic minerals; wood & wood products; textiles & leather; manufacture of machinery nec; agriculture)	8
Chemicals, chemical products & man-made fibres; rubber & plastic products	7
Travel agents et al	4
Manufacture of machinery & equipment et al	3
Mining & quarrying	2
Hotels & catering	2
Energy supply	1

Energy

Table 17.35: Top ten energy savings opportunity sectors (£M)

Sector	Total savings (£M)
Transport	73
Agriculture	6
Chemicals, chemical products & man-made fibres; rubber & plastic products	6
Retail	5
Food products; beverages & tobacco	4
Other	4
Hotels & catering	3
Basic metals; fabricated metal products except machine equipment	2
Commercial offices	2
Warehousing	2

Water

Table 17.36: Top ten water savings opportunity sectors (£M)

Sector	Total savings (£M)
Agriculture	4.5
Food products, beverages & tobacco	3.3
Public admin & other services	2.6
Chemicals, chemical products & man-made fibres; rubber & plastic products	1.2
Other (Commercial)	0.9
Health & social work	0.7
Basic metals; fabricated metal products except machine equipment	0.3
Real estate	0.2
Education	0.2
Other (Industry)	0.2

Nobel House
17 Smith Square
LONDON SW1P 3 JR

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