Energy in Industry

2007 Report

SUSTAINABLE ENERGY IRELAND
Energy Policy Statistical Support Unit

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Sustainable Energy Ireland (SEI)

Sustainable Energy Ireland was established as Ireland's national energy agency under the Sustainable Energy Act 2002. SEI's mission is to promote and assist the development of sustainable energy. This encompasses environmentally and economically sustainable production, supply and use of energy, in support of Government policy, across all sectors of the economy including public bodies, the business sector, local communities and individual consumers. Its remit relates mainly to improving energy efficiency, advancing the development and competitive deployment of renewable sources of energy and combined heat and power, and reducing the environmental impact of energy production and use, particularly in respect of greenhouse gas emissions.

SEI is charged with implementing significant aspects of government policy on sustainable energy and the climate change abatement, including:

- Assisting deployment of superior energy technologies in each sector as required;
- Raising awareness and providing information, advice and publicity on best practice;
- Stimulating research, development and demonstration;
- Stimulating preparation of necessary standards and codes;
- Publishing statistics and projections on sustainable energy and achievement of targets.

It is funded by the Government through the National Development Plan with programmes part financed by the European Union.

Energy Policy Statistical Support Unit (EPSSU)

SEI has a lead role in developing and maintaining comprehensive national and sectoral statistics for energy production, transformation and end use. This data is a vital input to meeting international reporting obligations, for advising policy makers and informing investment decisions. Based in Cork, EPSSU is SEI's specialist statistics team. Its core functions are to:

- Collect, process and publish energy statistics to support policy analysis and development in line with national needs and international obligations;
- Conduct statistical and economic analyses of energy services sectors and sustainable energy options;
- Contribute to the development and promulgation of appropriate sustainability indicators.

Highlights

Context

- The industry sector in Ireland accounted for 22% (3,478 ktoe) of Ireland's primary energy demand in 2005. The sector was responsible for 22% (10,145 kt CO_2) of Ireland's energy related CO_2 emissions including upstream electricity emissions. Primary energy use in industry has grown by 38% (2.2% per annum on average) between 1990 and 2005.

- From 1990 to 2005 final energy usage in industry grew by 45% while industrial output measured by value added (constant prices) grew by 224%.

- ODEX, an indicator of energy efficiency, shows that over the period 1995 to 2005 there was a 15% improvement in energy efficiency in industry.

- Electricity prices to Irish industry have more than doubled between 2000 and 2006, the largest increase of the EU-15 countries. Oil prices to industry in Ireland were 39% higher in real terms in quarter one 2007 than in the year 2000 while natural gas prices increased by 152% over the same period.

Significance of Energy Expenditure to Industry
Overall

- Just over 93% of industrial GVA was generated by 94% of enterprises who had an energy to direct costs ratio of less than or equal to 4%.

- 97% of industrial enterprises spend 6% or less of their direct costs on energy and these enterprises account for 98% of industry's contribution to GDP.

- Just 11 enterprises had energy spend to cost ratios above 8% and energy to profits ratios above 50%. Of these enterprises, 6 had an energy bill to costs ratio of greater than 10%. These enterprises account for a significant 24% of industrial energy-related CO_2 but are relatively insignificant in terms of contribution to industrial economic output and employment representing 0.4% and 0.5% of each respectively.

- There are 70 enterprises whose energy spend to direct costs represented 10% or more of their cost base. They contributed 0.8% to total industrial GVA, 1.2% to total employment but account for 35% of energy related CO_2 emissions. Of these 70 enterprises, 60 are outside the ETS and account for 2.9% of total industrial CO_2 emissions. The remaining 10 enterprises account for 32% of energy related CO_2 emissions.

Significance of Energy Expenditure to Industry
Emissions Trading Industry (ETS)

- 82% of ETS enterprises spent less than 5% of their direct costs on fuel in 2004. These firms were responsible for 99% of ETS enterprise's contribution to GDP.

- Only 6 ETS enterprises (9.1%) spent more than 10% of their costs on fuel. These 10 enterprises were responsible for 0.2% of total industrial GVA, 0.5% of employment and 15% of CO_2 emissions.

Significance of Energy Expenditure to Industry
Non Emissions Trading Industry

- Half of industrial GVA was generated by 94% of non-ETS enterprises who accounted for 79% of total industrial employment.

- 96% of non-ETS enterprises spent 5% or less of their direct costs on energy. These enterprises accounted for 51% of all industry's contribution to GDP and 81% of industrial employment.

Profiling Analysis of Energy CO_2 for Individual Firms

Out of the enterprises analysed:

- 90% of industrial energy related CO_2 emissions were from 12% of enterprises who accounted for 89% of industrial GVA.

- 60% of emissions were from just 1.2% (52) of enterprises.

- 84 enterprises (2.5%) accounted for 80% of on site energy related CO_2.

Expenditure on Energy, Fuel and Electricity

- Industrial expenditure on energy increased by 51% (3% per annum) over the period 1990 to 2004 and by 6% (2% per annum) between 2001 and 2004.

- Total expenditure by industry on electricity increased by 63% (3.5% per annum) between 1990 and 2004 and by 21% (6.7% per annum) between 2001 and 2004.

- Total expenditure on fossil fuels increased by 34% (2.1% per annum) from 1990 to 2004 however expenditure decreased by 14% (4.7% per annum) between 2001 and 2004.

- The total expenditure on energy in 2004 for industry was €836 million (current prices), of which 65% (56% in 2001) was spent on electricity.

Table of Contents

List of Figures

List of Tables

1 Introduction

The industry sector in Ireland is a significant energy user, accounting for 22% (3,478 ktoe)[1] of Ireland's primary energy demand in 2005. The sector was responsible for 22% (10,145 kt CO_2)[2] of Ireland's energy related CO_2 emissions including upstream electricity emissions. Energy use in industry has grown by 38% (2.2% per annum on average[3]) between 1990 and 2005.

Associated with the levels and growth in the demand for energy and the related environmental impact, there is an imperative for policy makers to develop and implement measures that maximise energy efficiency and renewable energy substitution. To formulate evidence based coherent policies requires timely and comprehensive data and analysis on energy trends and the underlying factors.

This is the third SEI/EPSSU report on industry energy use in Ireland. The initial report, published in October 2003 was the first publication to examine the profile of energy consumption, associated CO_2 emissions and costs across the entire Irish industrial sector. That analysis was based on anonymised source data from the CSO Census of Industrial Production (CIP) for 1998. A subsequent update[4], published in October 2004, examined 2001 data.

This report examines the most recent CIP data for 2004. The analysis benefits greatly from the work of the Energy Statistics Co-ordinating Group, a joint initiative between SEI and CSO to establish and oversee mechanisms for co-operation in order to increase and improve energy statistics in Ireland. Specifically there have been two significant changes in the CIP with respect to energy statistics. Firstly, detailed questions on energy expenditure in 2004 were sent to all enterprises with more than 20 employees (compared with enterprises with an energy bill > €225,000 - increased coverage) and secondly, these detailed energy questions are now included in the CIP on an annual basis (compared with every three years – increased frequency).

In addition, a new feature of this report is a separate analysis of those enterprises that are involved in the Emissions Trading Scheme (ETS) and those that are not.

The focus of the report is on energy and energy-related CO_2 emissions. Other emissions are not considered. Three sub-sectors within the CIP (NACE[5] codes 11, 23 and 40) are part of the energy transformation sector, and thus are not considered to be end use sub-sectors from an energy perspective. These include electricity, steam and gas supply as well as oil and gas extraction. Construction is also excluded as it is not manufacturing industry and is not covered in the CIP. It should also be noted that industrial energy expenditure on transport, recorded in the CIP, has been filtered out for the purposes of the analyses here.

The report is divided into two parts. Part 1 (sections 2 to 5) examines energy usage in industry while part 2 (sections 6 to 8) analyse the significance of energy expenditure.

Specifically, ***section 2*** sets out the recent policy context relating to energy and CO_2 in Irish industry. Relevant energy, CO_2 and energy price trends in industry are outlined in ***section 3.***

Section 4 presents the results of a structural analysis of energy use in industry using the aggregated results of the 1990, 1998, 2001 and 2004 CIP. Using electricity and fuel price information, energy consumption values and associated CO_2 emission values were produced on a sub-sectoral level. In this way it was possible to produce an aggregated profile of energy use in industry by sub-sector.

The remainder of the report is informed by an analysis of CSO micro-data from the 2004 CIP. In order to make a more detailed assessment of the structure of Irish industry in terms of contribution to energy demand and CO_2 emissions, profiling at the level of the firm was undertaken. This work, in the form of profiling analyses, is presented in ***section 5***,

[1] Thousand tonnes of oil equivalent.

[2] Kilo tonnes (kt) are thousands of tonnes.

[3] Throughout the report where annual growth rates are across multiple years they always refer to average annual growth rates.

[4] See http://www.sei.ie/index.asp?locID=71&docID=-1.

[5] The international coding scheme used for classification of sectors and sub-sectors within the economy. See page 63.

and determines the proportions of energy and CO_2 emissions due to, say, the top consuming 10% of companies. Changes that have taken place since 2001 are also discussed.

In ***sections 6, 7 and 8*** the expenditure on energy by firms was related direct costs, as derived from the CIP, in order to enable assessment of each company's sensitivity to energy price changes. In this way the energy bill for a firm is expressed as a proportion of the company's overall costs. The analyses was preformed for three separate industry cohorts; for all industrial firms, for enterprises involved in the ETS and for all non – ETS enterprises .

Finally, **section 9** presents some overall conclusions and outlines the timeframe for further analysis.

Additional sub-sectoral information and analyses, is contained in a separate online Annex to this report. *Energy in Industry 2007 Report –Annex* is available at www.sei.ie by clicking on "Statistics Publications".

Part 1

Profiling Energy Use in Industry

2 Energy and Industry – the Policy Context

The increasing scientific evidence regarding the contribution of energy use to climate change coupled with the growth in energy demand and related emissions have prompted governments and policy makers to respond by introducing policies and measures designed to manage energy more effectively, to move towards less polluting fuels and to mitigate human impact on the environment.

This section briefly identifies the major policy developments that have had an impact on the industry sector since the previous iteration of this report was published in October 2004.

2.1 Energy White Paper –Delivering a Sustainable Energy Future for Ireland

On the 12th March 2007, An Taoiseach Bertie Ahern TD and Noel Dempsey TD, Minister for Communications, Marine and Natural Resources launched the Government's Energy White Paper[6]. The White Paper sets out the energy policy directions and targets for Ireland to 2020.

The following key targets were set:

- 20% savings in energy usage by 2020 in line with EU targets, with a further indicative target of 30%,
- 12% of Ireland's thermal energy requirements to come from renewable sources by 2020,
- 33% of Ireland's electricity consumption to come from renewable sources by 2020 and
- 10% of Ireland's transport energy requirements to come from renewable sources by 2020.

The targets are in line with the EU goals (see 2.4). The White Paper recognises the significant part industry has to play in energy efficiency and management and the Government will continue to support, and expand as necessary, SEI's programmes for industry and business[7]. A target of 400 MW from CHP by 2010 was included with an additional target of at least 800 MW by 2020.

2.2 National Climate Change Strategy 2007 - 2010

The National Climate Change Strategy (NCCS) 2007 - 2012, published on the 2nd April 2007[8] follows on from the first national strategy, published in 2000 and reviewed in 2002. The Strategy details the measures by which Ireland will meet its Kyoto 2008 - 2012 commitment. It also outlines how the measures will position Ireland for the post - 2012 period. The Strategy identifies the areas in which further measures are being researched and developed to enable Ireland to meet the 2020 commitments.

The measures associated with the industry sector are presented in Table 1:

[6] The full text of the White Paper is available at http://www.dcmnr.gov.ie/Energy/Energy+Planning+Division/Energy+White+Paper.htm.

[7] For full details go to http://www.sei.ie/index.asp?locID=158&docID=-1.

[8] Available from http://www.environ.ie/en/PublicationsDocuments/FileDownLoad,1861,en.pdf.

Table 1 NCCS 2007 - 2012 Emissions Reductions in Industry

Measures	Reductions in 2010 (Mt CO_2 equivalent)
Large Industry Energy Network (LIEN)	0.145[9]
Emissions Trading Scheme (ETS)	0.600[10]
F-Gases Regulation	0.024[11]
Commercial Bioheat Programme	0.160
CHP Deployment Programme	0.162
Total	1.173

Source: NCCS 2007 - 2012

It is important to note that the NCCS makes a distinction between on site fuel emissions and emissions associated with the generation and transmission of mains electricity. Both are considered separately.

2.3 The Energy End-use Efficiency and Energy Services Directive

Directive 2006/32/EC[12] of the European Parliament and of the Council on energy end-use efficiency and energy services was signed into law on 5th April 2006. The Directive stipulates that Member States shall adopt and aim to achieve an overall national indicative energy savings target of 9% over the 9 year period from 2008 to the end of 2016. Member States shall submit a first Energy Efficiency Action Plan by 30 June 2007 to describe the measures set to meet the 9% target. The Action Plan will also include an intermediate target covering the third year of application of the Directive.

The target energy savings are referenced against the average primary energy requirement over the most recent five year period for which official data are available. It excludes energy used by enterprises involved in the EU Emissions Trading Scheme (ETS) and aviation and bunker fuels. It was this scoping that prompted separate analysis in this report on enterprises within and outside the ETS. Initial estimates for Ireland suggest that 1,128 ktoe savings are required to meet the 9% target, equivalent to 125.3 ktoe per annum from Jan 2008 – Dec 2016.[13]

2.4 EU Council Presidency Meeting - March 2007

The European Council Presidency met on the 8th / 9th March 2007 and agreed on the need to integrate policies on climate change and energy. The Council committed itself to unilaterally reducing its greenhouse gas emissions to 20% below 1990 levels by 2020. It further endorsed a reduction to 30% below 1990 levels subject to securing agreement on comparable reductions elsewhere.

The Council also adopted an Energy Action Plan based on the European Commissions Communication *An Energy Policy for Europe*[14] that integrates energy policy with these climate change targets. In particular, the European Council

- *stressed the need to increase energy efficiency in the EU so as to achieve the objective of saving 20% of the EU's energy consumption compared to projections for 2020* and

[9] This does not include savings that are included in the ETS.

[10] An overall savings of 3 Mt CO_2 is due from the ETS. Of this 2.4 Mt CO_2 is attributed to the power generation sector. The figure of 0.6 Mt CO_2 in table refers to "on site" savings. These figures were contained in Ireland's National Allocation Plan for the period 2008 - 2012 which was submitted to the European Commission in July 2006.

[11] F-Gases are HFCs, PFCs and SF_6 gases widely used in refrigeration and air conditioning products.

[12] Full details are available at http://ec.europa.eu/energy/demand/legislation/end_use_en.htm.

[13] SEI Response to Green Paper page 29 available at http://www.dcmnr.gov.ie/NR/rdonlyres/54C78A1E-4E96-4E28-A77A-3226220DF2FC/27062/SustainableEnergyIreland.pdf.

[14] Commission of the European Communities, 2007, *An Energy Policy for Europe* available from http://ec.europa.eu/energy/energy_policy/documents_en.htm

- *endorsed a binding target of a 20% share of renewable energies in overall EU energy consumption by 2020 and a binding 10% minimum target to be achieved by all Member States for the share of biofuels in overall EU transport petrol and diesel by 2020.*

The 20% energy efficiency target applies to all sectors, including those involved in the ETS. The reference against which the target savings are set is projected energy requirements in 2020 rather than average historical energy trends. Based on most recent forecasts[15], this would suggest a target for Ireland of 4,046 ktoe by 2020, or 311 ktoe per annum.

In the White Paper Ireland committed to achieving the 20% target by 2020 and set an indicative target of 30% for 2020 to surpass the EU ambition. Ireland has also set sectoral targets for renewable penetration (33% electricity, 12% heat and 10% transport). With respect to GHG emissions reduction, Ireland will establish its target within the context of burden sharing agreement between Member States.[16]

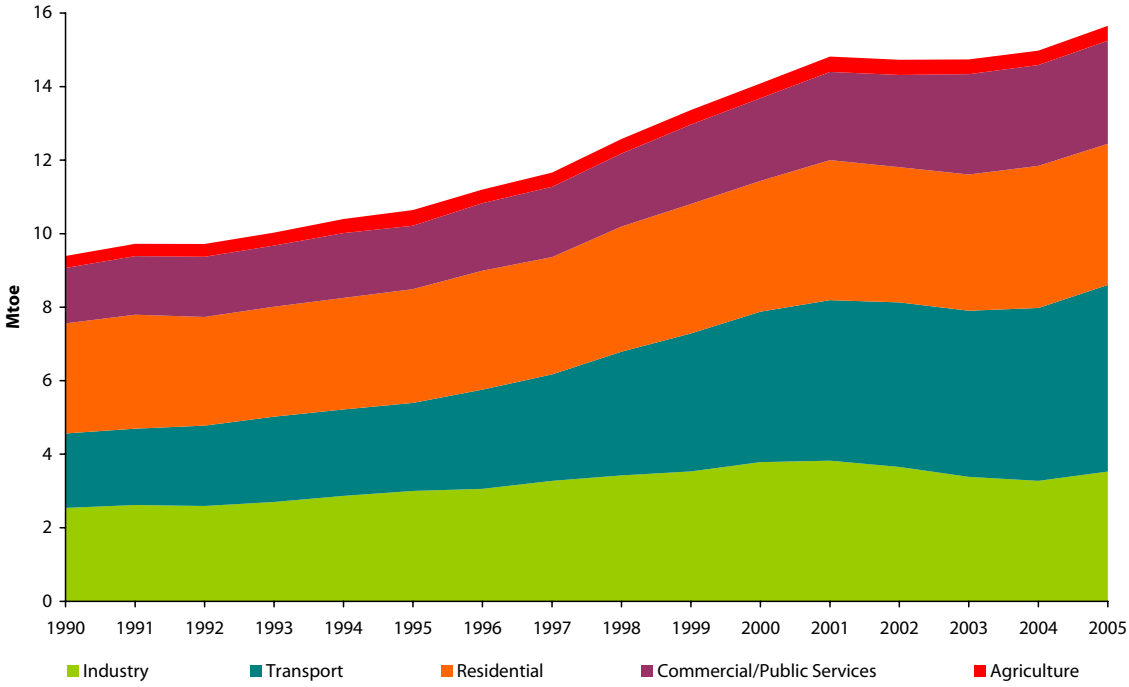
[15] SEI (2007) *Energy in Ireland 1990 – 2005. Trends, issues, forecasts and indicators.* Available from http://www.sei.ie/index.asp?locID=70&docID=-1.

[16] See http://ec.europa.eu/energy/energy_policy/index_en.htm.

3 Energy Trends and Drivers

Figure 1 shows the total primary energy requirement (TPER)[17] by the five principal sectors of the economy in Ireland for the period 1990 to 2005. The average annual growth rate in industrial energy usage during this period was 2.2%, compared with 6.3% for transport, 4.2% for the commercial and public services sector and 1.7% for the residential sector. A more detailed discussion of energy trends in Ireland over the period 1990 to 2005 is available in a separate SEI publication[18].

Figure 1 Total Primary Energy Requirement by Sector 1990 to 2005



Source: SEI

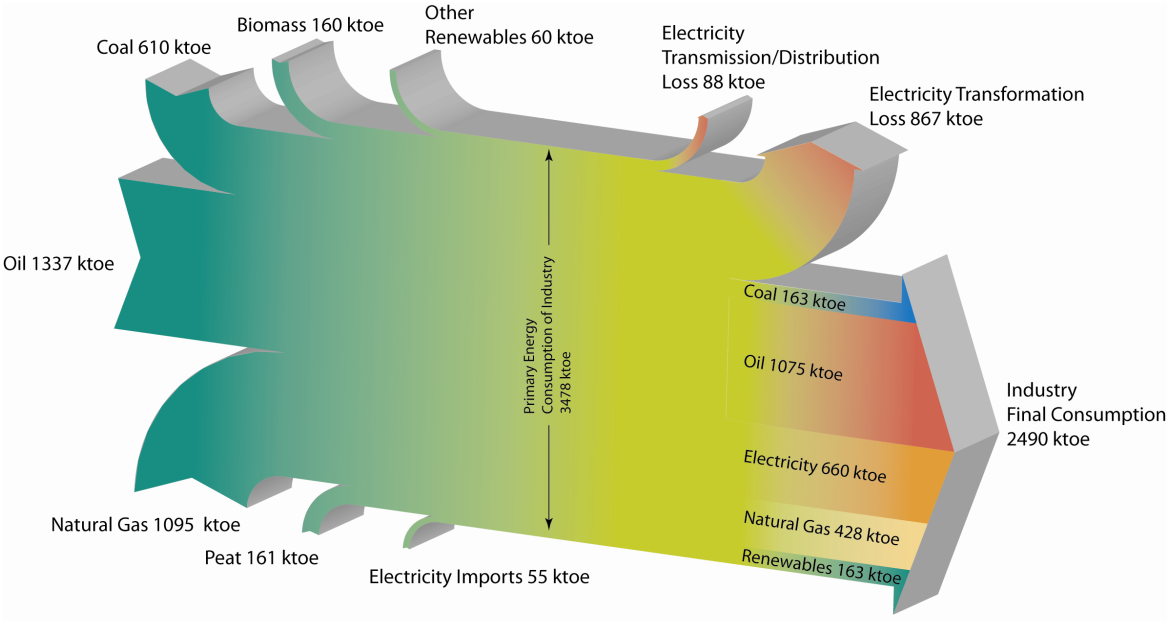
Industry's relative share has fallen as a result of the faster energy demand growth in other sectors. Industry now accounts for 22% of Ireland's primary energy usage, (3.5 Mtoe in 2005) compared with 27% in 1990 (2.5 Mtoe).

Figure 2 shows the energy balance for industry in 2005. Fuel inputs on the left include the upstream fuel used in the generation of electricity for final use in industry.

[17] Primary energy usage includes all the fuels used directly by each sector plus the primary energy used to generate electricity attributed to each sector in proportion to its electricity demand.

[18] SEI (2007) *Energy in Ireland 1990 – 2005. Trends, issues, forecasts and indicators.* Available from http://www.sei.ie/index.asp?locID=70&docID=-1.

Figure 2 Industry's Energy Balance 2005



Note: Some statistical differences and rounding errors exist between inputs and outputs

Source: SEI

The significance of losses due to electricity generation is evident and represents 25% of the primary energy used by industry. Indeed the share of primary energy for industry's electricity requirements (electricity usage plus losses) was just over 46% of the total.

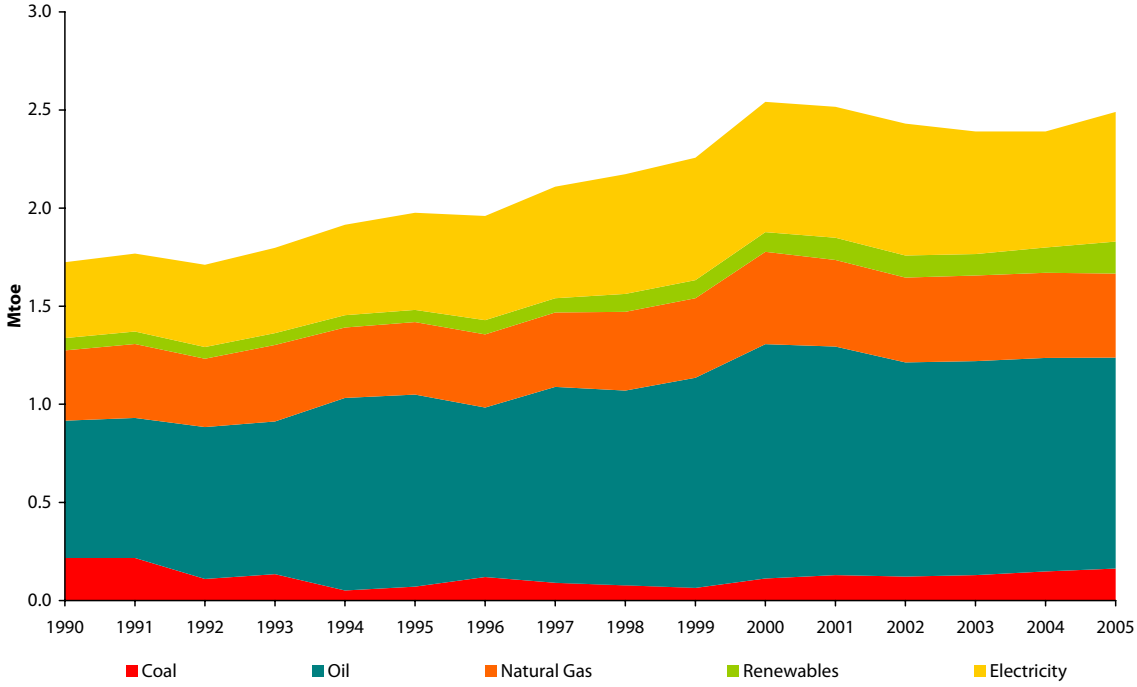
Total final consumption represents the amount of energy for which each sector is billed directly[19]. In the case of industry different sub-sectors use different fuels, depending on the nature of their economic activity. Most sub-sectors have enterprises using gas, oil and electricity. Some also use coal and two sub-sectors use renewable energy (NACE code 20 [wood industry] use biomass and NACE codes 15 -16 [food drink and tobacco] use biogas).

Trends in the consumption of these fuels from 1990 to 2005 are shown in Figure 3 for industry as a whole. Over the period final energy consumption in industry grew by 45% (2.5% per annum on average) while industrial output measured by value added (constant prices)[20] grew by 224% (8.1% per annum). In 2005, oil had the largest share of total fuel usage at 43%.

[19] TFC is essentially TPER less the amount of energy lost in transformation (electricity generation, peat briquetting and oil refining).

[20] Chain linked annually and referenced to year 2004.

Figure 3 Total Final Energy Consumption by Fuel – Industry 1990 to 2005



Source: SEI

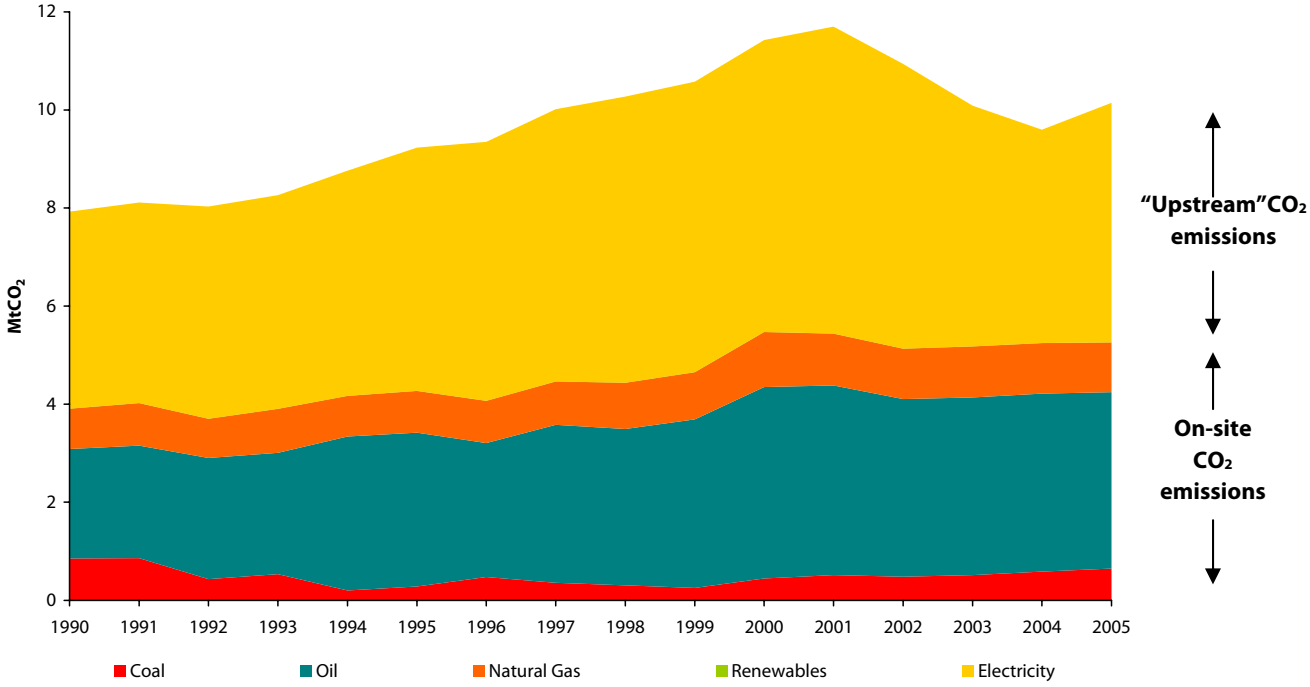
It is the on-site emissions associated with these fuels (excluding electricity) that are used in the National Climate Change Strategy (NCCS) in accordance with IPCC reporting guidelines for the projections and measures associated with energy use in industry. The NCCS treats upstream emissions associated with mains electricity[21] separately and does not attribute them to the individual end user sectors that consume electricity. There are advantages in such an approach from the perspective of targeting specific measures within the electricity supply industry. The associated risk however is that, in decoupling the end user from the source of the pollution arising from their demand, it may reduce the sense of end user responsibility for electricity consumption.

The trend in on-site emissions since 1990 is illustrated in Figure 4. The perspective is different if the upstream emissions associated with electricity consumption in industry are included (also shown in Figure 4).

The trend for all fuels excluding electricity is relatively flat over the period but when the emissions associated with the electricity consumed by industry are included a pronounced increase is evident until 2001. A decrease can be seen for the period 2002 to 2004 (due to reduced CO_2 intensity of electricity generation) but emissions rose again (by 5% in 2005). Total emissions in 2005 were 10.1 Mt an increase of 28% (1.7% per annum) on 1990. Electricity was responsible for 48% of emissions in industry.

[21] In this report the term *electricity* denotes mains electricity, unless otherwise implied. Electricity self-produced by means of plant such as combined heat and power (CHP) will be reflected in a firm's on site fuel consumption. Fuel input to such plant currently represents about 9% of industrial fuel use.

Figure 4 Energy-Related CO_2 Emissions in Industry 1990 to 2005



Source: SEI

The total emissions from industry in 2005 represented 22% of total energy-related CO_2 emissions, a lower share than either the transport (33%) or residential (25%) sectors.

3.1 Industrial Growth and Energy Intensity

Figure 5 and Table 2 show the trend in industrial value added compared with Gross Domestic Product (GDP) growth in Ireland over the period 1990 to 2005, with industry Gross Value Added[22] (GVA) growing at a faster rate than overall GDP albeit from a lower base. However, since 2000 industrial growth has been slower than economic growth and in 2005 industrial GVA grew by 3.4% whereas the economy grew by 5.5%.

In 2005 industry accounted for 32% of GDP (24% in 1990) and 28% of total employment.

Table 2 GDP and Industry GVA - Growth Rates

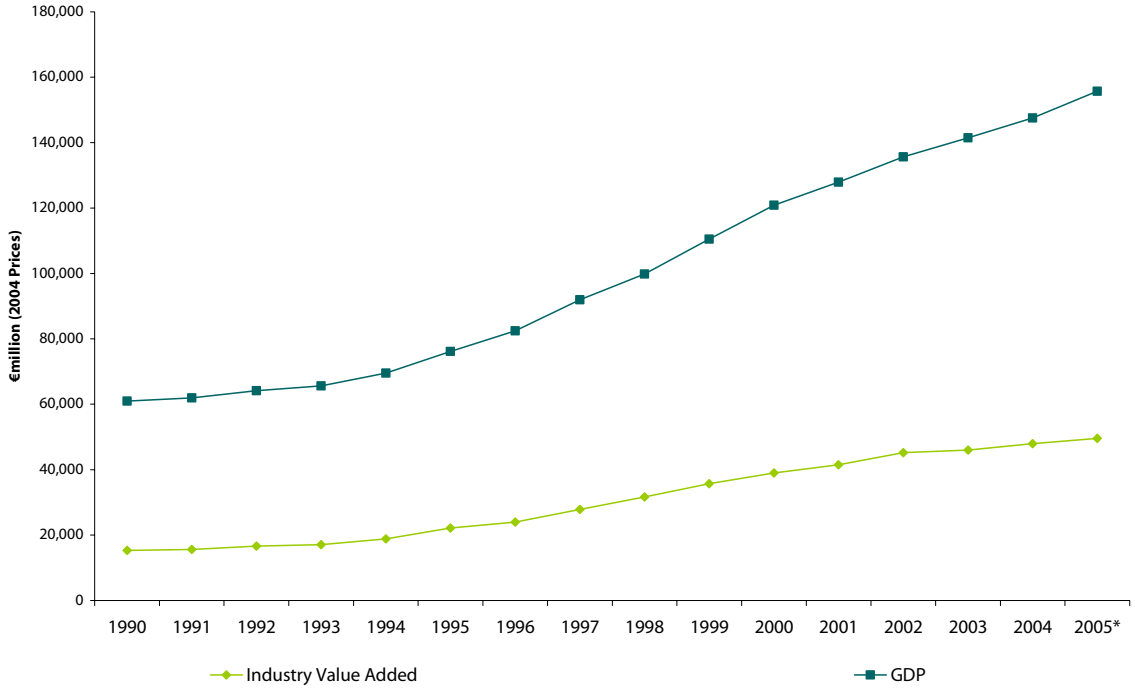
	Growth %	Average Annual Growth Rates %			
	1990 – '05	1990 – '05	1995 – '00	2000 – '05	2005
GDP	156	6.5	10	5.2	5.5
Industry GVA	224	8.1	12	4.9	3.4

Source: Central Statistics Office[23]

[22] GVA is a measure of the extent to which an enterprise has added value to its inputs. At the sectoral level, industrial GVA is a measure of the contribution by industry to economic growth, as measured by GDP.

[23] 1995 to 2005 data are constant 2004 prices. 1990 to 1994 data are estimated by SEI. 2005 data are provisional.

Figure 5 Growth in GDP & Industry's Contribution to GDP 1990 to 2005



Source: Central Statistics Office

Energy intensity is defined as the amount of energy required to produce some functional output (it represents the inverse of energy productivity in general). In the case of industry, the measure of output is usually taken to be GVA. The energy intensity measures the amount of energy required to produce one euro of value added. GVA measured in constant prices is used to remove the influence of inflation.

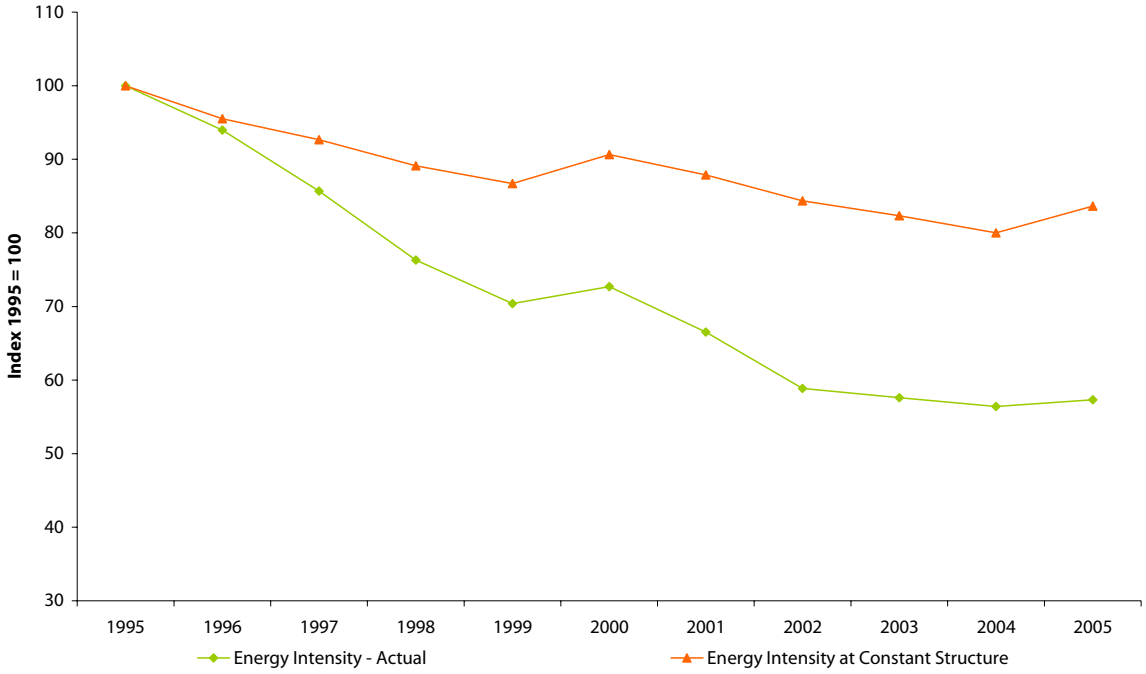
Between 1990 and 2005 the value added of industry grew by 224% whereas industrial final energy consumption grew by only 45%. This resulted in the energy intensity of industry decreasing quite rapidly throughout the decade, as illustrated in Figure 6 (green line) and Table 3. Over the period actual energy intensity fell (indicating an improvement in energy productivity) by 43%.

Table 3 Energy Intensity of Industry –Growth Rates

	Growth %	Average Annual Growth Rates %			
	1995 – '05	1995 – '05	1995 – '00	2000 – '05	2005
Intensity – Actual	-43	-5.4	-6.2	-4.6	1.6
Industry - Constant Structure	-16	-1.8	-1.9	-1.6	4.5

Source: SEI

Figure 6 Index of Energy Intensity of Industry (Actual & at Constant Structure) 1995 to 2005



Source: SEI

Energy intensity in this form is a crude indicator, however, and variation may be a result of many factors such as economic, structural, technical, behavioural issues, or because real energy efficiency gains have been made. To eliminate the effects of structural changes an index of energy intensity at constant 1995 structure [24] is also shown in Figure 6 and Table 3.

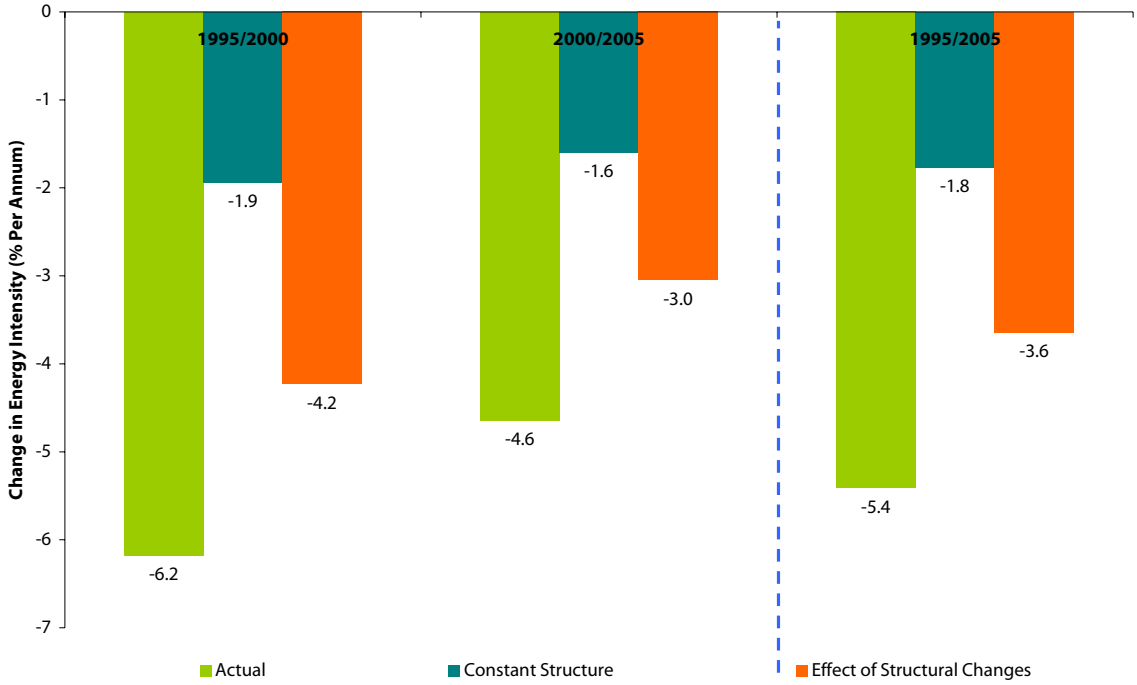
This indicator measures the impact of structural changes in industry by comparing the variations of the actual intensity with that of a fictitious or notional intensity at constant structure (using 1995 structure as a reference). It can be seen that structural changes have had a significant effect but other factors are also responsible for the improvement in energy productivity.

The orange line in Figure 6 represents the evolution of industrial energy intensity had the structure stayed the same as it was in 1995. In actual fact the structure of industry changed, resulting in lower energy intensity. These structural changes were brought about by global economic influences and Irish industrial policy. Over the period, industrial policy concentrated on moving the sector up the value chain to manufacture high value goods such as pharmaceuticals, electronics and value added foodstuffs. This resulted in increased economic efficiencies, contributing to the further reduction in intensity shown in Figure 6.

The contribution of structural changes is examined further in Figure 7 and Table 4. For three periods (1995 to 2000, 2000 to 2005 and 1995 to 2005) the changes in final energy intensity are compared with that of the intensity at constant structure. The difference between the intensities shows the influences of structural changes in the sector.

[24] This section draws on methodology developed under the Odyssee project, a cross European project which maintains and develops a database of energy efficiency indicators. The project includes Irish involvement through SEI/EPSSU. See Bosseboeuf D. et al, 1999, *Energy Efficiency Indicators – The European Experience and* Bosseboeuf D. et al, 2005, *Energy Efficiency Monitoring in the EU-15* both published by ADEME and the European Commission. http://www.odyssee-indicators.org/

Figure 7 Intensity Trends in Industry: The Role of Structural Changes



Source: SEI

It can be seen that structural changes were most influential over the period 1995 to 2000 when structural changes accounted for 4.2% per annum of the reduction in energy intensity.

In other words, changes in the makeup of Irish industry between 1995 and 2000 accounted for 68% of the reduction in industrial energy intensity. Between 2000 and 2005, 65% of the reduction was due to structural changes. The remainder of the change in intensity is due to other effects such as change in fuel mix, quantity effects (economies of scale), other behavioural effects and real efficiency gains.

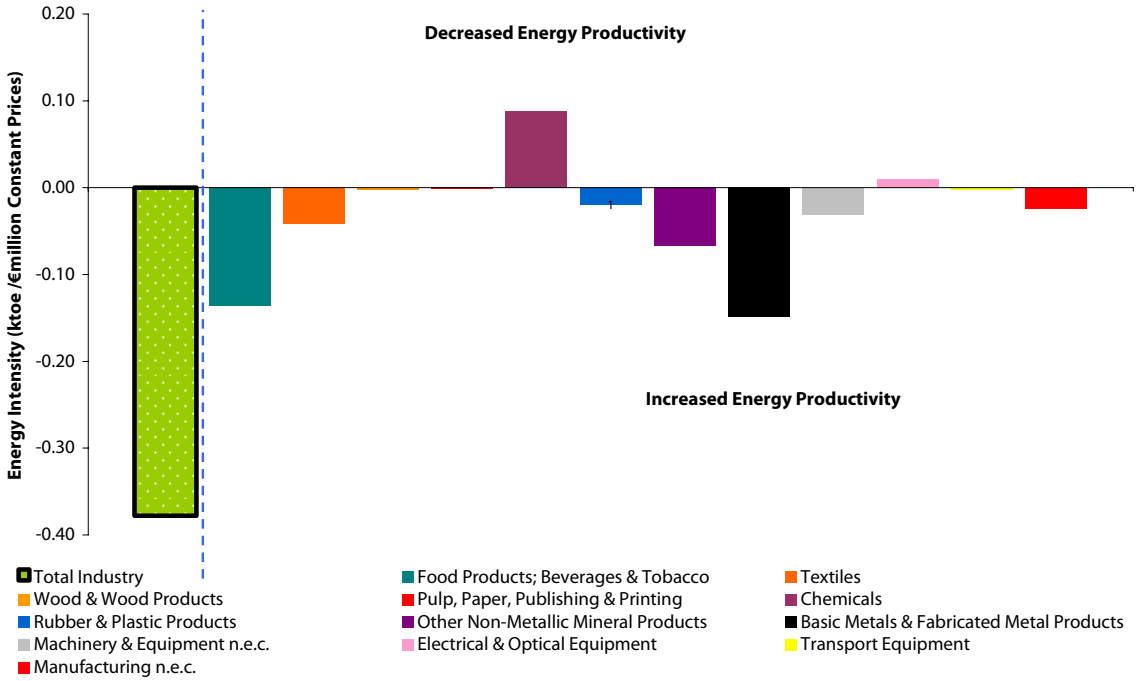
To examine the issue further it is useful to examine the industrial intensity at a sub-sectoral level. Figure 8 and Table 4 show the contribution that each sub-sector in industry made to the overall improvement in energy intensity. Three time periods are again examined in Table 4 .

The total reduction in structural energy intensity is shown to the left of the dotted line in Figure 8 with the contribution of each sub-sector[25] illustrated to the right. Sub-sectors registering a positive energy intensity change imply decreased energy productivity whereas a negative intensity change means increased energy productivity.

From 1995 to 2005 the contribution of the basic metals and the food products sub-sectors were the most significant with basic metals contributing 39% of the total variation due to structural changes and the food sector 36%.

[25] Full definitions of the sub-sectors used can be found on page 63.

Figure 8 Variation in Structural Energy Intensity –Contribution by Sub-Sector 1995 to 2005



Source: SEI

Turning attention to Table 4, it can be seen that for the period 1995 to 2000 food products contributed 56% the total variation due to structural changes and metals 40%. The chemicals, optical and transport equipment sub-sectors increased in energy intensity but this effect was outweighed by the other sub-sectors.

Also, from Table 4, for the period 2000 to 2005 the sub-sectors which contributed most to the overall decrease in energy intensity were basic metals (responsible for 37%) and other non-metallic mineral products (23%).

Table 4 Variation in Structural Energy Intensity –Contribution to Overall Change by Branch

	1995 - 2000	2000- 2005		1995 - 2005
Food Products; Beverages & Tobacco	56%	14%		36%
Textiles	11%	15%		11%
Wood & Wood Products	2%	2%		1%
Pulp, Paper, Publishing & Printing	4%	1%		0%
Chemicals	-35%	-8%		-23%
Rubber & Plastic Products	6%	5%		5%
Other Non-Metallic Mineral Products	12%	23%		18%
Basic Metals & Fabricated Metal Products	40%	37%		39%
Machinery & Equipment n.e.c.	7%	10%		8%
Electrical & Optical Equipment	-6%	-10%		-3%
Transport Equipment	-1%	1%		1%
Manufacturing n.e.c.	3%	10%		6%

Source: SEI

While changes in energy intensity trends due to structural changes can be analysed separately, as shown, the role of other factors affecting energy trends cannot be assessed[26] using such top-down macro-economic indicators. For example energy intensity at constant structure may be affected by:

[26] ADEME, 2005, *Energy Efficiency Monitoring in the EU-15.*

- The spread of energy-efficient technologies and equipment, behaviour and practices;
- Energy substitution in favour of energies with high end-use efficiency (for example electricity or gas).

In order to better understand the trends and to clarify the role of the energy-related factors (efficiency and substitution) an approach focussing on techno-economic effects is required. This also facilitates analysis on the results of specific energy-efficiency policy measures.

A set of energy efficiency indicators have been developed since 1993 through an EU supported project called ODYSSEE (http://www.odyssee-indicators.org/), which includes Irish involvement through SEI/EPSSU. These indicators measure achievements in energy efficiency at the level of the main end-uses and appliances and have been utilised in a parallel project MURE (http://www.isis-it.com/mure/) to assess energy policies and measures.

A more recent development within the ODYSSEE project is the development of aggregated *bottom-up energy efficiency (ODEX) indicators*. ODEX indicators are quite innovative compared to similar indices. They aggregate trends in unit consumption by sub-sector or end-use into one index by sector based on the weight of each sub-sector/end-use in the total energy consumption of the sector.

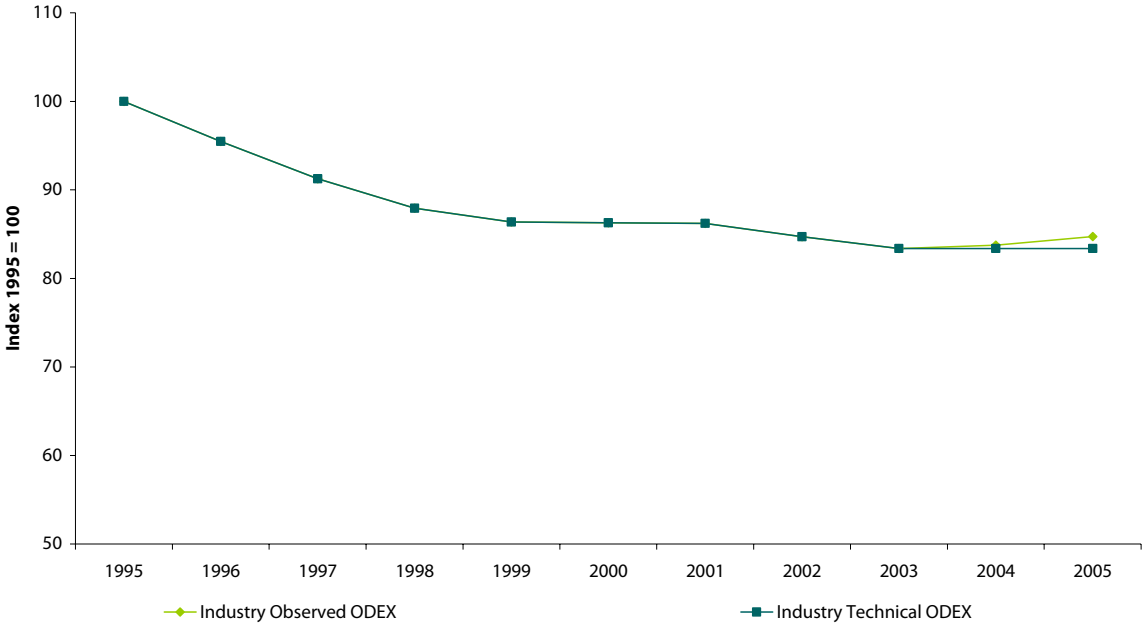
The indices provide an alternative to the usual energy intensities used to assess energy efficiency changes at the sectoral level or at the level of the whole country, as they include effects only related to energy-efficiency and exclude the changes in energy use due to other effects (such as climate fluctuations, changes in economic and industry structures, lifestyle changes etc) at the economy or sectoral level.

For this report, an ODEX indicator for industry in Ireland has been constructed over the period 1995 to 2005 that takes into account twelve industry[27] sub-sectors, as shown in Figure 9. The graph clearly shows the improvements in energy efficiency over the period.

Two indicators are shown in Figure 9. The first ODEX, industry observed, is based on unit consumption expressed in terms of energy used per unit of physical output (where data are available) and production indices for the other branches relative to that in the base year (in this case 1995). It is important to note that, for some branches the trends also include some non-technical changes, especially in the chemical industry as a result of the shift to light chemicals. Data for this sector are currently not available at a sufficiently disaggregated level. It can be seen that the trend decreased from 100 in 1995 to 82.4 in 2004 indicating an improvement in energy efficiency. The trend reversed, for the first time, to 84.7 in 2005. Overall there was a 15% improvement in energy efficiency in industry over this 10 year period.

[27] ODEX indicators have also been developed for the overall economy and for the residential and transport sectors, however these are outside the remit of this report. They will be contained in the forthcoming report: *Energy Efficiency in Ireland*, due for publication by EPSSU in June. A full explanation and methodology for ODEX indicators is available at http://www.odyssee-indicators.org/Indicators/PDF/odex.pdf.

Figure 9 Industry ODEX 1995 to 2005



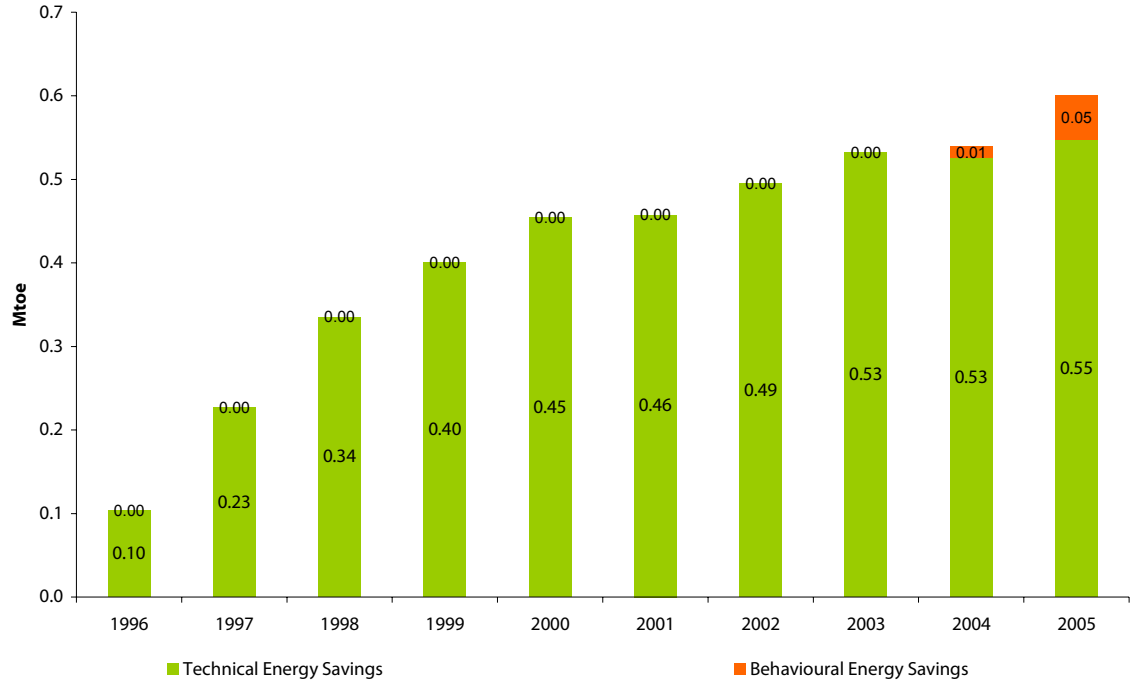
Source: SEI

The second indicator, the technical ODEX, separates out the influence of behavioural factors by separating behavioural and technical changes[28]. The difference between the technical ODEX and the observed ODEX shows the influence of behavioural factors on energy efficiency. It can be seen that for Ireland behavioural effects contributed to energy efficiency in Ireland in 2004 and 2005.

This methodology also allows for the quantification of energy savings as a result of technical and non technical energy efficiency improvements. These are shown in Figure 10. Total energy savings in 2005 were 0.6 Mtoe. The effect of behavioural or non technical changes can be seen from 2004.

[28] Technical efficiency gains arise from the use of more energy efficient technologies whereas behavioural gains are the result of how technologies are used.

Figure 10 Technical and Behavioural Energy Savings in Industry 1996 to 2005



Source: SEI

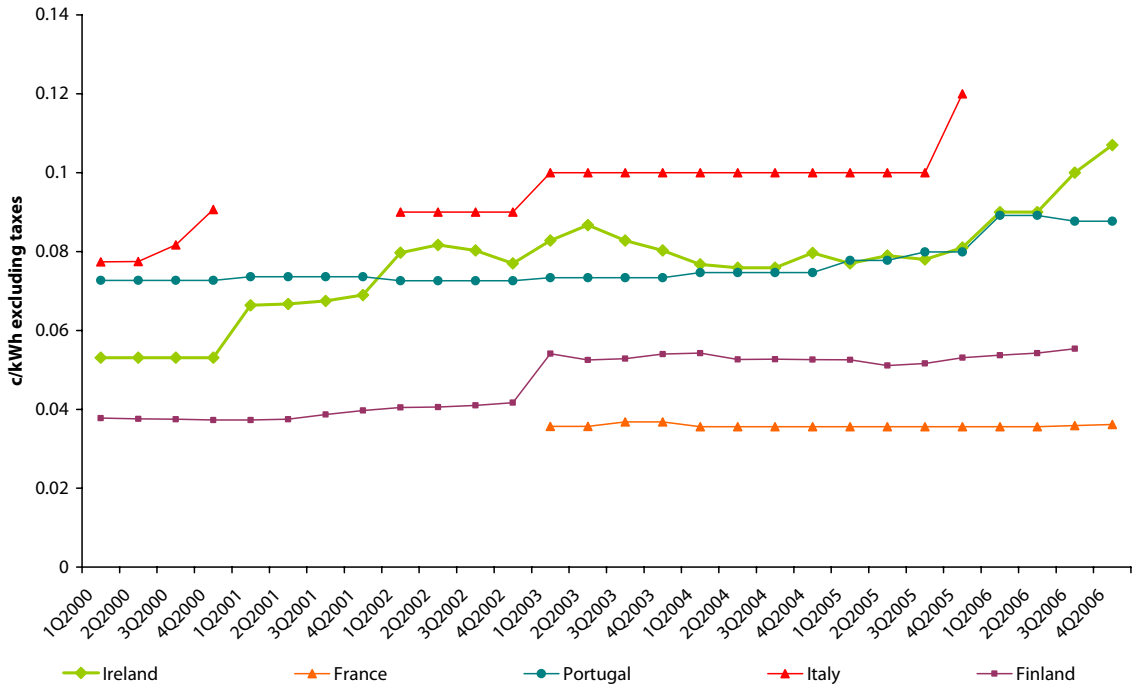
3.2 Energy Prices in Industry

At times of rising or fluctuating energy prices there is considerable interest not only in the actual price being paid for energy but also in comparing the relative cost with other countries. These direct comparisons give some crude perspectives on the effects of energy price changes but don't take account of the weighting of energy in the cost base of the economy.

This section presents comparisons of the cost of energy in various forms with selected EU countries. The source of the data presented here is the International Energy Agency (IEA). Prices are shown in current (nominal) money. Comparisons with other countries in money terms are restricted to euro-zone countries (subject to data availability) to avoid difficulties in adjusting for exchange rates. To avoid too many confusing lines on the graphs and resulting confusion, only a sub-set (Ireland and the countries that experienced the highest and lowest prices) of countries are presented. Relative price increases since 2000, however, are given for all the EU-15 countries in index format in both nominal and real terms[29].

[29] Nominal prices are not adjusted for the effects of inflation whereas real prices are.

Figure 11 Electricity Prices to Industry (Nominal)



Source: Energy Prices & Taxes © OECD/IEA, 2006.

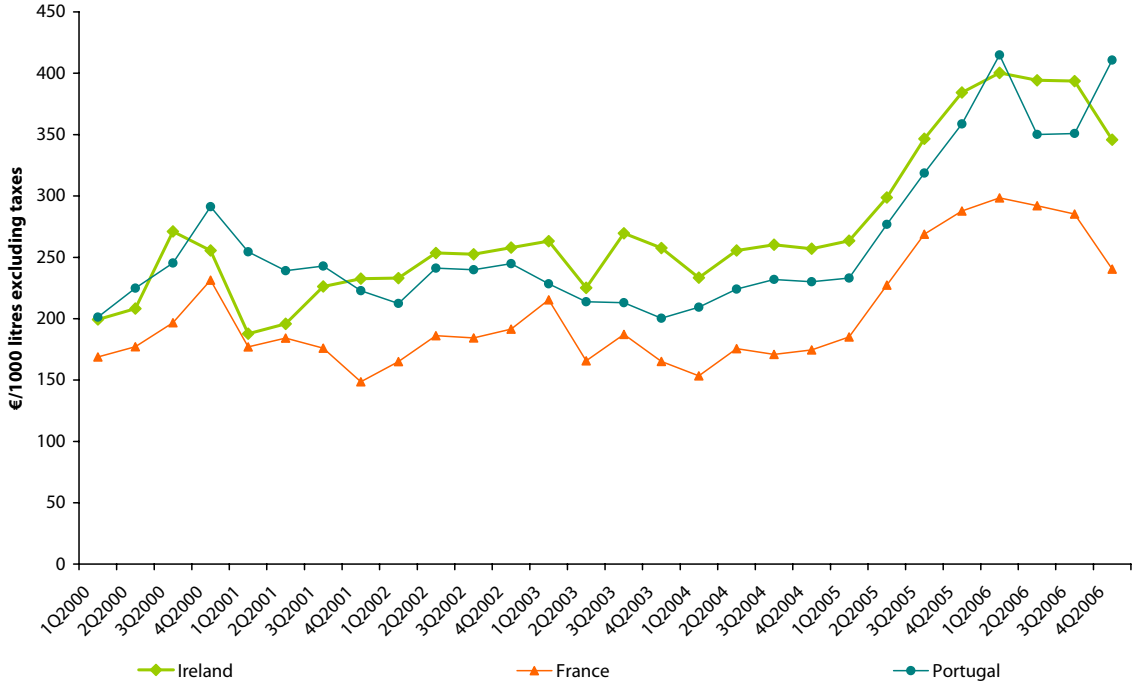
Electricity prices to Irish industry have risen by 123% in real terms between 2000 and quarter four 2006, the largest increase of the EU-15 countries. It can be seen from Figure 11 that Ireland had, at the end 2006, the highest electricity cost to industry in the euro-zone countries.

Table 5 Electricity Price to Industry Increase since 2000

Index 2000 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	**Ireland**	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
4th qtr 2006 (nominal)	159.2	210.9	130.2	115.1	143.0	104.9	156.4	127.4	**201.5**	171.0	158.0	..	120.6	157.5	143.4	175.5
4th qtr 2006 (real)	132.1	184.7	116.3	102.3	139.6	97.1	141.5	104.2	**223.2**	144.6	120.0	..	104.9	132.6	130.6	159.9

Source: Energy Prices & Taxes © OECD/IEA, 2006.

Figure 12 Fuel Oil Prices to Industry (Nominal)



Source: Energy Prices & Taxes © OECD/IEA, 2006.

Figure 12 shows that Portugal as of quarter 1 2007 was the most expensive for oil in industry within the euro-zone countries. Oil prices in Ireland have been the most expensive for much of the 2000 to 2007 period.

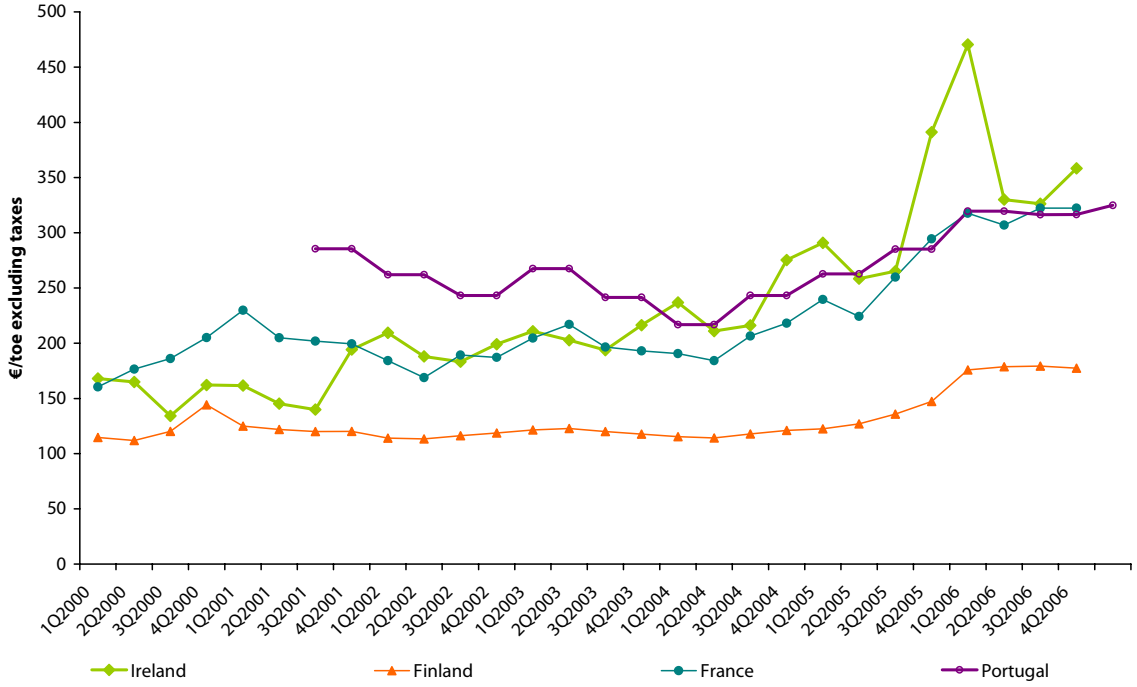
Referring to Table 6 oil prices to industry in Ireland were 39% higher in real terms in quarter one 2007 than in the year 2000. As with electricity this was the largest increase experienced within the EU-15.

Table 6 Oil Price to Industry Increase Since 2000

Index 2000 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	**Ireland**	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
1st qtr 2007 (nominal)	143.9	98.6	125.5	107.8	115.7	119.9	131.0	129.3	**126.0**	122.0	121.5	..	156.6	125.3	124.3	113.9
1st qtr 2007 (real)	110.4	86.7	113.1	95.8	112.9	110.5	118.4	106.6	**139.1**	103.1	91.2	..	136.0	104.8	112.5	103.5

Source: Energy Prices & Taxes © OECD/IEA, 2006.

Figure 13 Natural Gas Prices to Industry (Nominal)



Source: Energy Prices & Taxes © OECD/IEA, 2006.

Figure 13 shows the dramatic increase and subsequent decrease in gas prices to industry since the 3rd quarter of 2005.

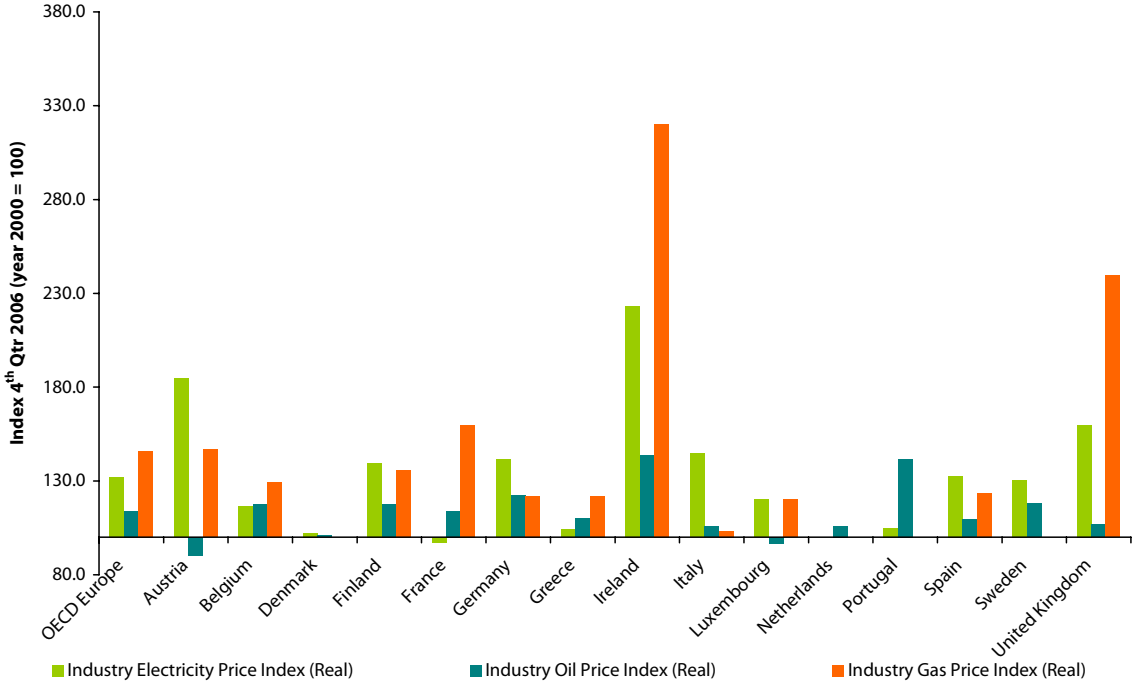
Table 7 Natural Gas Price to Industry Increase Since 2000

Index 2000 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	**Ireland**	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
4th qtr 2006 (nominal)	172.8	167.4	144.9	..	139.0	172.6	134.7	149.3	**227.8**	122.2	158.0	..	..	146.8	..	262.7
4th qtr 2006 (real)	145.9	146.6	129.4	..	135.8	159.8	121.9	122.1	**252.1**	103.3	120.0	..	..	123.6	..	239.4

Source: Energy Prices & Taxes © OECD/IEA, 2006.

With reference to Table 7 (real) natural gas prices to Irish industry increased by 152% since 2000 and had increased by 227% by the first quarter of 2006. The increase in quarter one 2006 was, largely, a result of capacity problems in the UK.

Figure 14 Real Energy Price Change to Industry Since 2000 in EU-15 (Index)



Source: Energy Prices & Taxes © OECD/IEA, 2006.

Figure 14 summarises the data presented in Tables Table 5, Table 6 and Table 7. It emphasises the unique problems (due to supply constraints) experienced by Ireland and the UK with respect to gas prices in industry. It also shows Ireland and Austria experienced the highest increases in electricity prices to industry.

4 Industry Sectoral Profiling on an Aggregated Basis

The analysis in this section is carried out at a sub-sectoral level using aggregated data from CSO's Census of Industrial Production (CIP). The analyses in sections 5 to 8 is based on interrogation of the anonymised data at the level of the individual enterprise.

The CIP comprises two annual censuses carried out by CSO of:

i) All enterprises[30] having three or more persons engaged and being wholly or principally involved in industrial production. There were 4,684[31] such firms (with 235,489 employees) operating in Ireland in 2004 in the NACE (see page 63) sectors covered in this report.

ii) All local units[32] principally engaged in industrial activity, with three or more persons engaged. In 2004, there were 5,142 (239,544 employees) local units known to CSO in NACE sectors 15 - 37.

The CIP seeks a wide range of data from the respondents, for example the selling value of goods, turnover and purchases of materials. Each year one of the questions in the CIP seeks expenditure on energy, but generally in the form of a single question on the total expenditure on electricity and all fuels.

In 1990, 1998, 2001 and 2004, however, the energy expenditure question in the census of industrial enterprises was disaggregated and expenditure on each fuel[33] type was sought. For this reason, the analysis in this report is conducted on the industrial enterprises, rather than on local units. The distinction is important in the context of the National Allocation Plan (NAP) for the Emissions Trading Scheme (ETS), which deals with installations on a site basis.

The focus of this report is on energy and energy-related CO_2 emissions. Other emissions are not considered. Three sub-sectors within the CIP (NACE[34] codes 11, 23 and 40) are part of the energy transformation sector, and thus are not considered to be end use sub-sectors from an energy perspective. These include electricity, steam and gas supply as well as oil and gas extraction. Construction is also excluded as it is not manufacturing industry and is not covered in the CIP. It should also be noted that industrial energy expenditure on transport, recorded in the CIP, has been filtered out for the purposes of the analyses here.

The analysis benefits greatly from the work of the Energy Statistics Co-ordinating Group, a joint initiative between SEI and CSO to establish and oversee mechanisms for co-operation in order to increase and improve energy statistics in Ireland. Since the last SEI industry report[35] there have been two changes with respect to energy questions in the CIP. Firstly, detailed questions on energy expenditure in 2004 were sent to all enterprises with more than 20 employees (compared with enterprises with an energy bill > €225,000 - increased coverage) and secondly, these detailed energy questions are now included in the CIP on an annual basis (compared with every three years – increased frequency).

[30] Defined as the smallest combination of legal units that is an organisational unit producing goods or services, which benefits from a certain degree of autonomy in decision making, especially for the allocation of its current resources (company, partnership, individual proprietorship, etc.), also known as firm or company.

[31] Subsequent sections on industry profiling and ratio analysis deals with slightly different total numbers of enterprises. The profiling analysis excludes a number of enterprises that are classified as being in the energy transformation sector and the ratio analysis excludes a further number of enterprises on the basis that the calculation of the ratios would result in division by zero.

[32] Defined as an enterprise or part thereof situated in a geographically identified place, also known as an industrial site or installation.

[33] The surveyed energy forms or "fuels" relevant to the present analysis were: electricity, natural gas, gas oil, LPG, fuel oil, coal, coke, derived gas, heat, renewable energy and "other".

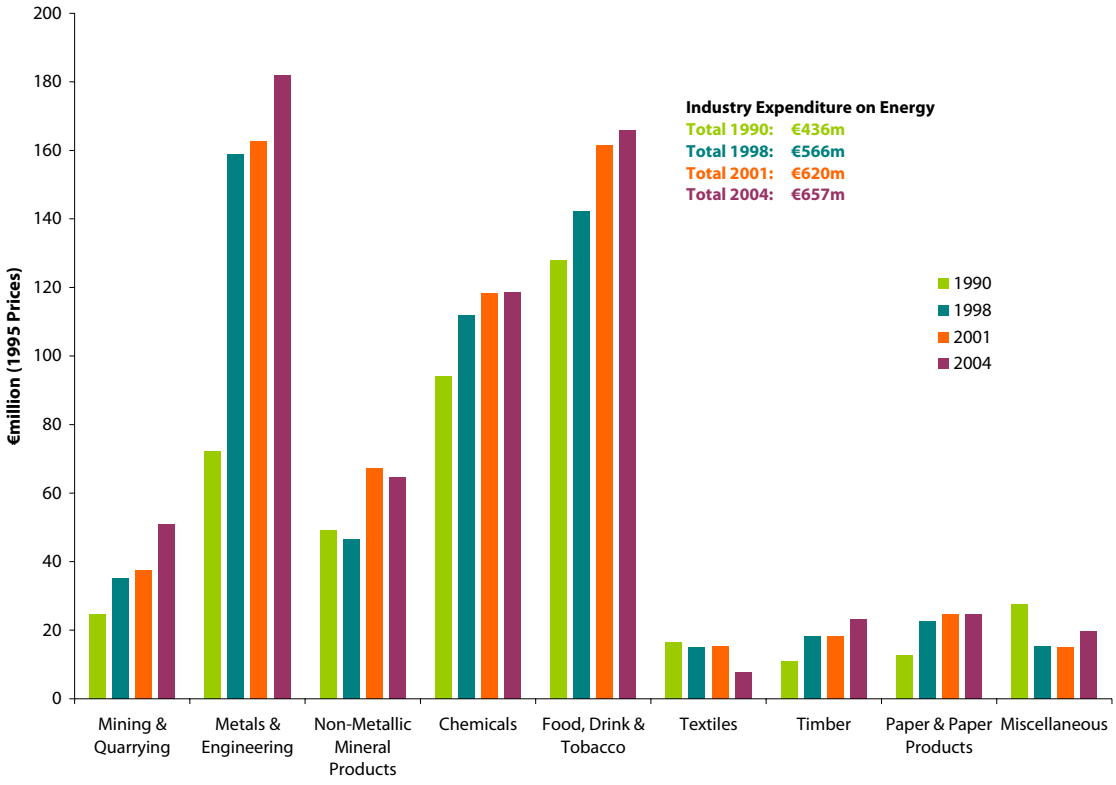
[34] The international coding scheme used for classification of sectors and sub-sectors within the economy. See page 63.

[35] Available from http://www.sei.ie/index.asp?locID=71&docID=-1.

4.1 Energy Expenditure by Sub-Sector

Figure 15 shows changes in energy expenditure across nine individual or clustered sub-sectors (NACE coded) for the years 1990, 1998, 2001 and 2004[36]. For industry as a whole, there was an increase in energy expenditure of 51% (3% per annum on average) over the period 1990 to 2004 and a 6% increase (2% per annum) between 2001 and 2004. The metals and engineering sub-sector (which includes much of the information and communication technology hardware industry) experienced the most dramatic increases in energy expenditure. Expenditure increased by 152% (6.8% per annum) from 1990 to 2004 and by 12% (3.8% per annum) from 2001 to 2004.

Figure 15 Industry Expenditure on Energy 1990, 1998, 2001 and 2004 (1995 Prices)



Source: Central Statistics Office.

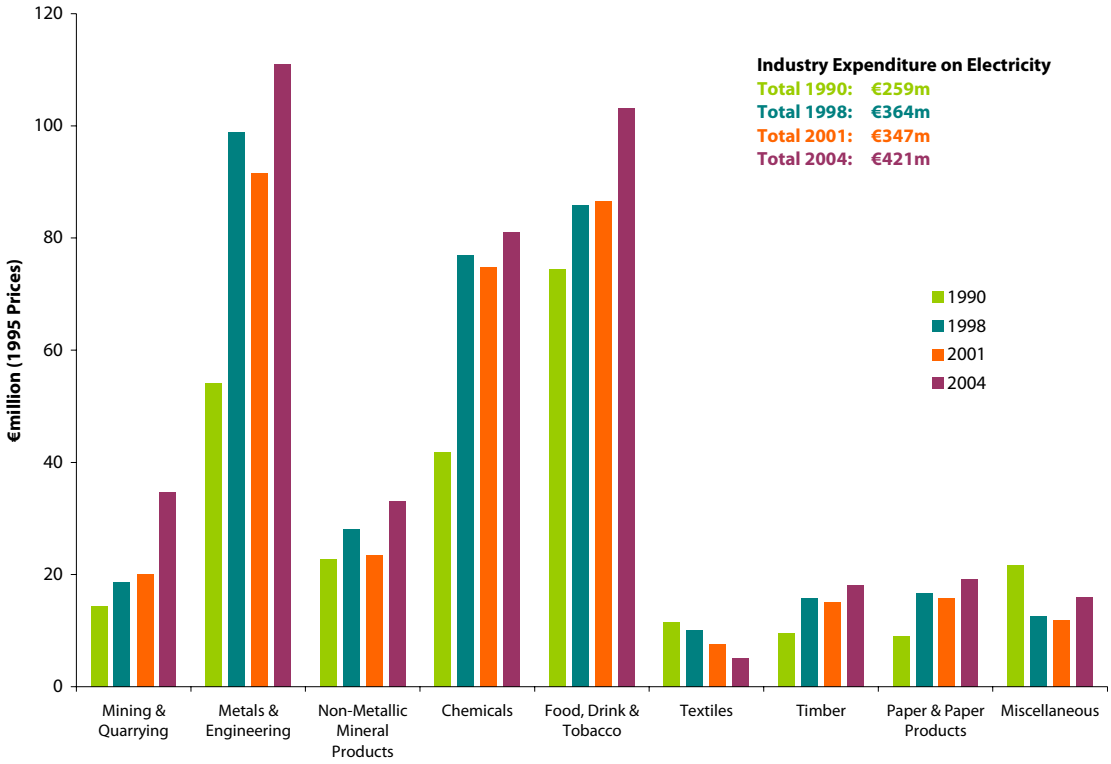
Ireland's buoyant construction market is evident from the increase between 1998 and 2001 in energy expenditure of the non-metallic mineral products (primarily cement production) sub-sector. Expenditure on energy in this sub-sector fell slightly between 1990 and 1998 but grew by almost 44% (13% per annum) between 1998 and 2001. There was a decrease of 3.9% (1.3% per annum) in energy expenditure reported by this sub-sector between 2001 and 2004.

The mining and quarrying sub-sector also recorded significant growth of 106% (5.3% per annum) over the period 1990 to 2004 and energy expenditure increased by 36% from 2001 to 2004 (11% per annum). This sector is primarily involved in the provision of materials for road building and construction industries.

It is also possible to examine the trend in expenditure on electricity and fossil fuels separately.

[36] The values shown are constant 1995 prices. They were converted from current prices by SEI using a deflator of energy prices constructed by the Economic and Social research Institute (ESRI).

Figure 16 Industry Expenditure on Electricity 1990, 1998, 2001 and 2004 (1995 Prices)

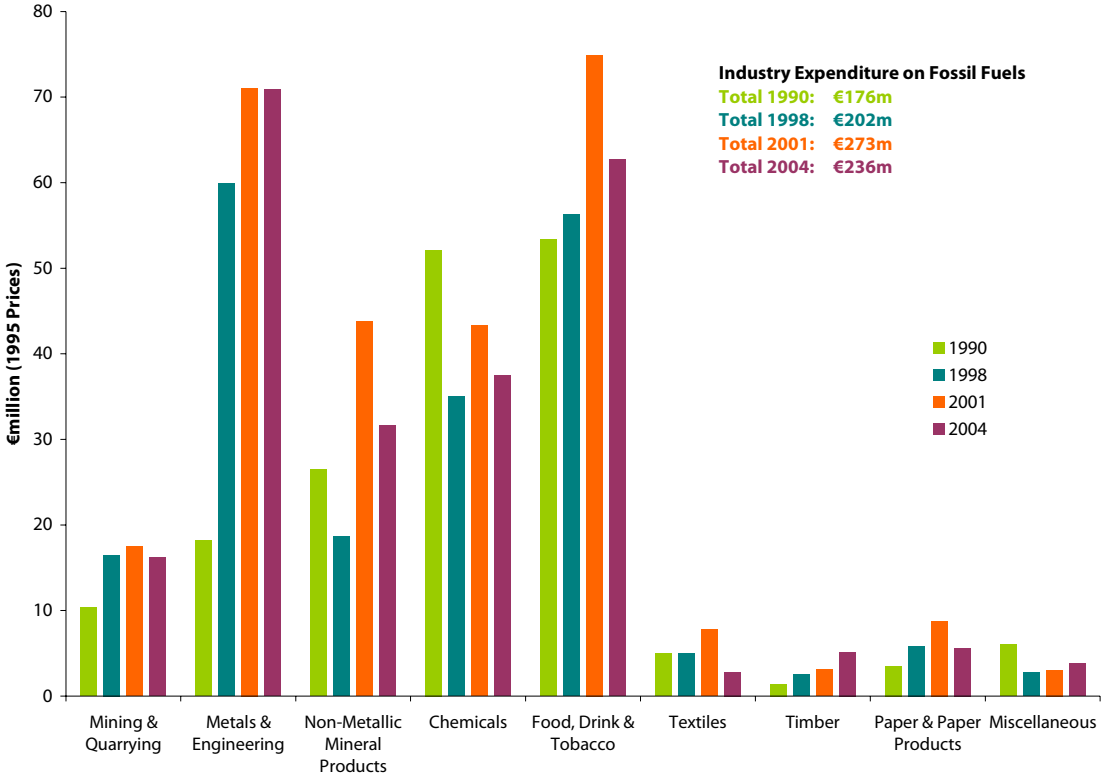


Source: Central Statistics Office.

Figure 16 shows that total expenditure on electricity increased by 63% (3.5% per annum) between 1990 and 2004 and by 21% (6.7% per annum) between 2001 and 2004. The sub-sector with the largest (relative) increase over the period 1990 to 2004 was mining and quarrying which experienced growth of 142% (6.5% per annum). Growth from 2001 to 2004 was 73% (20% per annum).

The largest absolute growth occurred in the metals and engineering sub-sector were expenditure on electricity increased from €54 million in 1990 to €111million in 2004 (an increase of 106% or 5.3% per annum). The decrease in expenditure (57% or 5.8% per annum) by the textile sub-sector is also noticeable in Figure 16.

Figure 17 Industry Expenditure on Fossil Fuels 1990, 1998, 2001 and 2004 (1995 Prices)



Source: Central Statistics Office

Figure 17 shows that total expenditure on fossil fuels increased by 34% (2.1% per annum) from 1990 to 2004 however expenditure decreased by 14% (4.7% per annum) between 2001 and 2004. Over the same period expenditure fell by 64% (29% per annum) in the textile sub-sector.

Figure 18 shows the energy expenditure profile for industry in 2004, across thirteen individual or clustered (NACE coded) sub-sectors, segmented between fuel and electricity contributions. This additional sub-sectoral detail is not available for 1990 therefore the previous figures were not shown in this detail. This and subsequent diagrams also show the number of enterprises for each sub-sector. It should be borne in mind that some enterprises may have several sites.

Figure 18 Industry Expenditure on Energy 2004 (Current Prices)

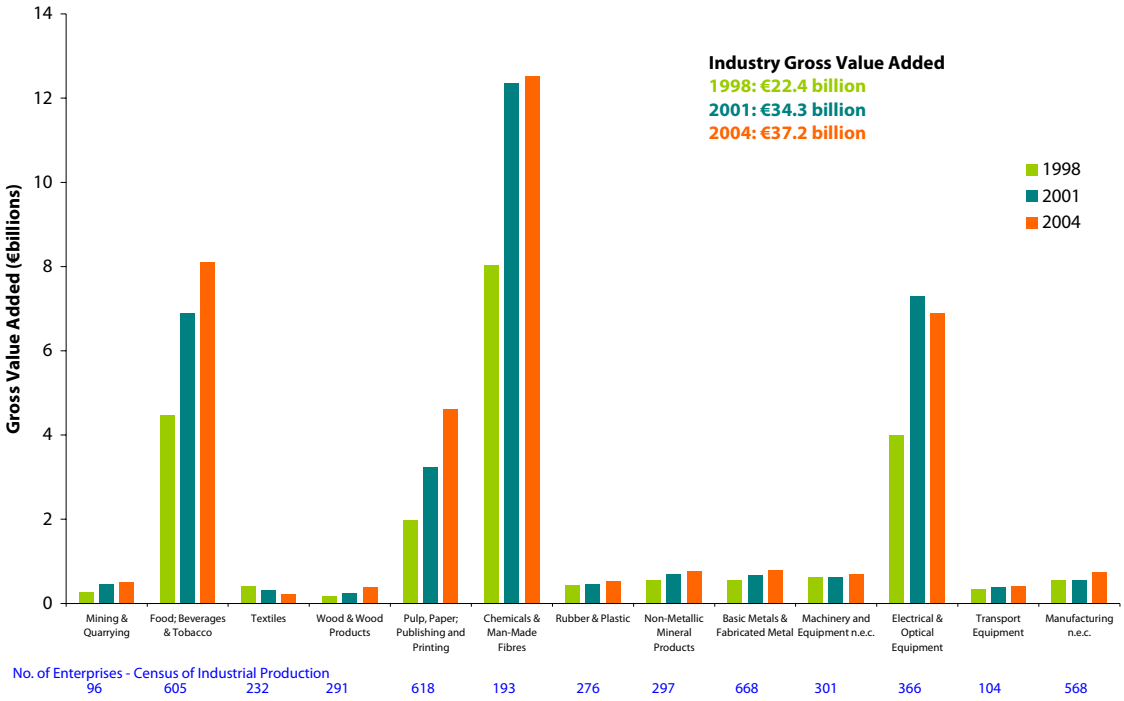
Source: Central Statistics Office.

The total expenditure on energy in 2004 for industry was €836 million in current prices, of which 65% (56% in 2001) was spent on electricity. One sub-sector alone, food, beverages and tobacco accounted for 26% of this bill and spent 75% more on energy than the next highest sub-sector: chemicals. The largest five sub-sectors accounted for 74% (75% in 2001) of industry's energy bill. The three sub-sectors with the highest absolute expenditure, accounting for 53% of industry's energy bill, were in turn: food, drink & tobacco; chemicals; and electrical and optical.

4.2 Sub-Sectoral Contribution to GDP

Figure 19 shows the contribution of individual sub-sectors to Ireland's economic growth levels as measured by Gross Value Added (GVA) which represents industry's contribution to Gross Domestic Product (GDP) for 1998, 2001 and 2004. GVA for industry grew by 53% (15% per annum) from 1998 to 2001 but increased by only 8.5% (2.7% per annum) between 2001 and 2004.

Figure 19 Gross Value Added in Industry 1998, 2001 and 2004 (Current Prices)[37]



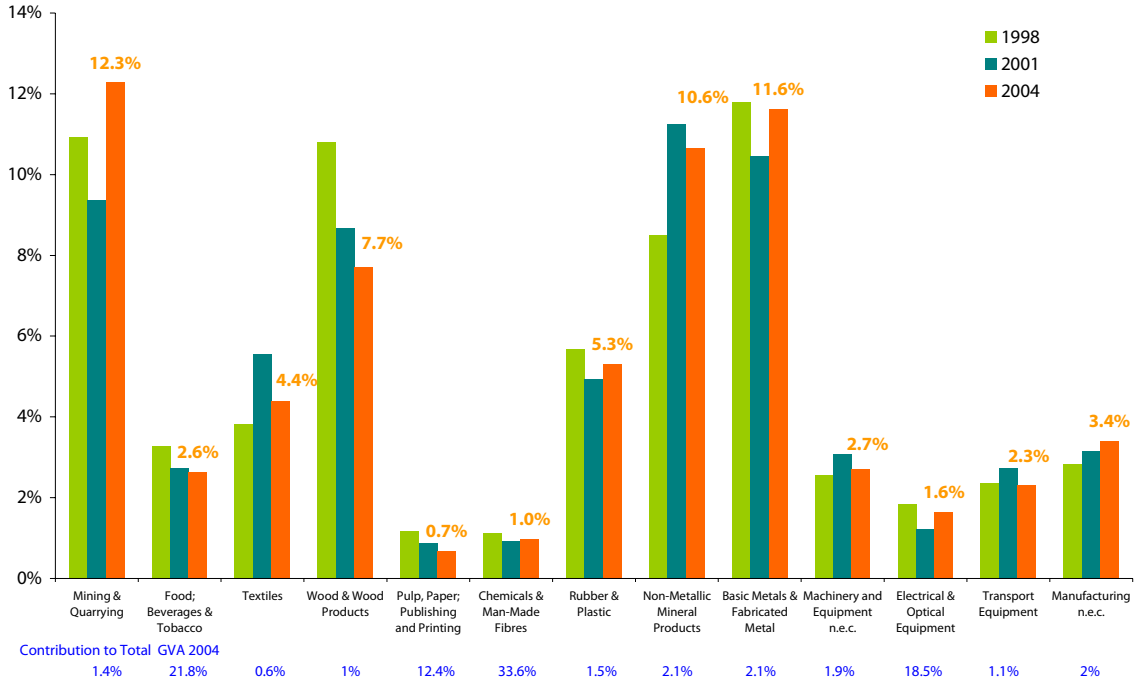
Source: Central Statistics Office.

A second interesting feature is that the three sub-sectors that accounted for 53% of industry's energy bill contributed most to Ireland's GDP, accounting for 75% (77% in 2001) of industrial GVA thereby representing 19% of Ireland's total GDP figure (current prices) for 2004 (23% in 2001).

Figure 20 illustrates the expenditure on energy as a percentage of GVA for each sub-sector for 1998, 2001 and 2004. Percentage values are shown only for 2004. The contribution of each sub-sector to total industry GVA in 2004 is shown at the bottom of the graph. This gives a crude indication of sensitivity of specific sub-sectors to changes in energy prices. It is a limited indicator, however, because the appropriate unit to assess price sensitivity is the individual firm, not at the aggregate level as presented in Figure 20. Significant variations will exist between individual firms.

[37] Note that the total will be difference to industry value added as seen in National Accounts. This arises from the use of different methodologies between that used in the CIP and National Accounts. In addition the energy transformation sector, which includes electricity and oil refining and energy mining and extraction, is not included in this analysis.

Figure 20 Energy Spend as a Percentage of GVA 1998, 2001 and 2004



Source: Based on CSO data.

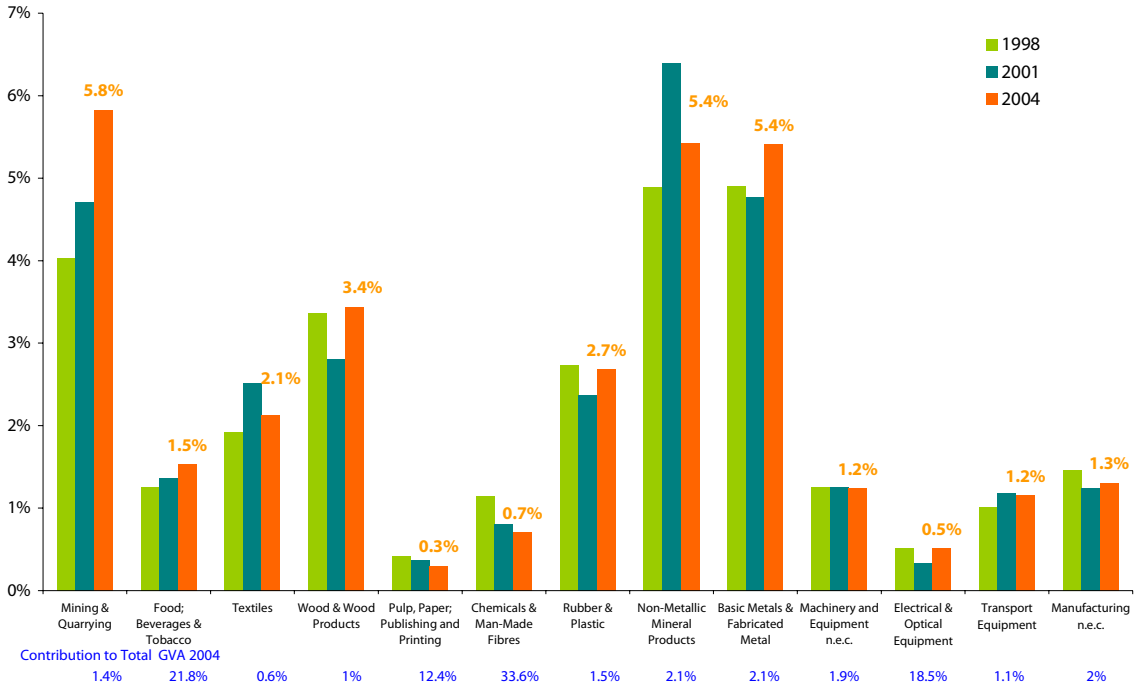
It is evident from Figure 20 that in 2004 only three sub-sectors had an average energy bill to GVA ratio of over 10%, indicating a comparative sensitivity to energy price changes. They were mining and quarrying (12%), basic metals and fabricated metal (12%) and non-metallic mineral products (11%). Combined these three sub-sectors were responsible for 29% of energy expenditure and 5.6% of GVA.

It is interesting to note that the three sub-sectors that contributed most to GVA (manufacture of food products beverages and tobacco, manufacture of chemicals and manufacture of electrical and optical equipment) each had an energy expenditure to GVA intensity of less than 3%.

When analysing a company's sensitivity to price it is pertinent to examine how significant energy expenditure is as a proportion of the overall cost base. This is shown graphically for 1998, 2001 and 2004 in Figure 21. This report only examines the direct costs of producing an enterprise's output. Direct costs are defined as intermediate consumption[38] plus labour costs. Indirect costs such as taxes are excluded.

[38] Defined as the purchases of materials, industrial and non-industrial services and fuel and power less or plus stock changes.

Figure 21 Energy Spend as a Percentage of Direct Costs 1998, 2001 and 2004



Source: Based on CSO data.

The sub-sectors, in 2004, with the highest energy bill as a proportion of direct costs were mining and quarrying (5.8%), basic metals and fabricated metal (5.4%) and non-metallic metal mineral products (5.4%). These sub-sectors may be more susceptible to the negative effects of increases in energy costs. However, even at these levels, energy costs represent a relatively small proportion of total business costs. Combined these sub-sectors were responsible for 29% of energy expenditure and 5.6% of GVA.

Energy expenditure represented 1.1% of direct costs for the sub-sectors as a whole in 2004. Of course, some enterprises will spend a far higher percentage of their direct costs on energy than is suggested by this analysis depending on their individual circumstances. The above should merely be seen as an indication of the overall situation for each sub-sector.

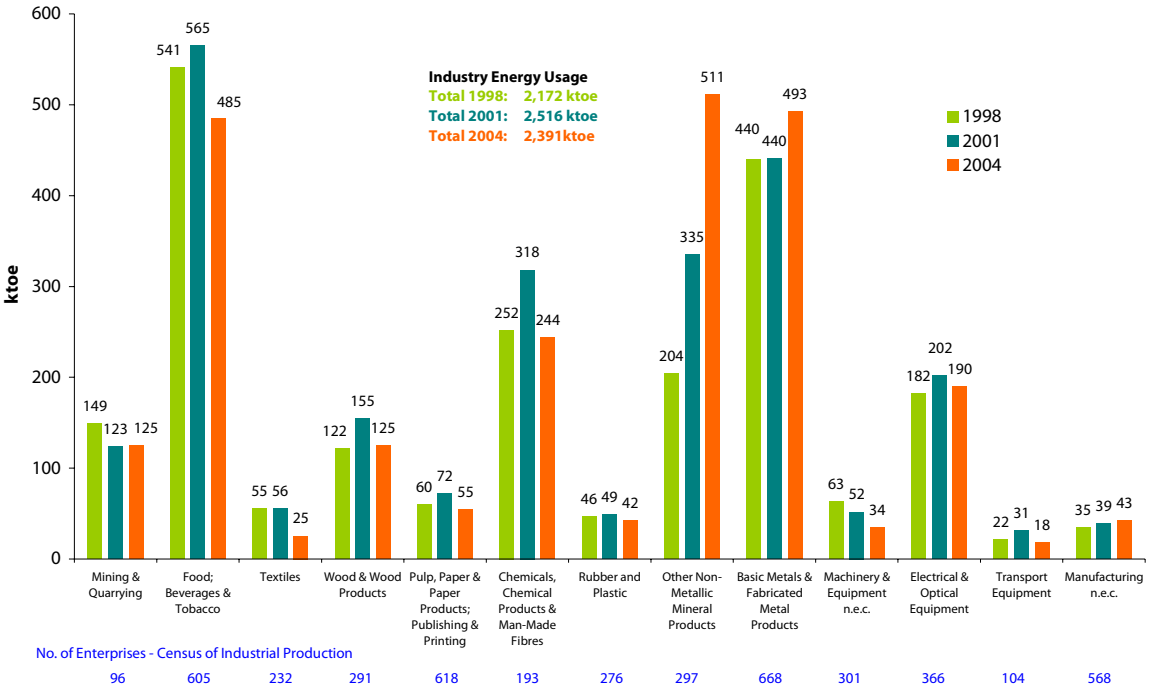
4.3 Energy Consumption by Sub-Sector

Figure 22 shows the final energy consumption for thirteen industry sub-sectors in 1998, 2001 and 2004, expressed in thousands of tonnes of oil equivalent (ktoe). Data are as reported in the national energy balances[39]. Total final energy consumption in 2001 was 2,516 ktoe and in 2004 it was 2,391 ktoe (2,490 ktoe in 2005). The decrease of 5% (1.7% per annum) in energy consumption compares with an energy bill increase of 6% at constant 1995 prices (2% per annum).

The food, drinks and tobacco sector reduced its energy consumption by 14% between 2001 and 2004 while value added (see Figure 19) increased by 18% (current prices), implying a sizeable reduction in energy intensity. The manufacture of other non-metallic mineral products sector increased its energy consumption by 53% while value added increased by 12% indicating a reduction in energy intensity. This sub-sector was the largest energy using sub-sector in 2004 which reflects the strong growth in consumption of cement products in recent years.

[39] National energy balances for the period 1990 to 2006 are available at http://www.sei.ie/index.asp?locID=70&docID=-1.

Figure 22 Industry Energy Usage 1998, 2001 and 2004

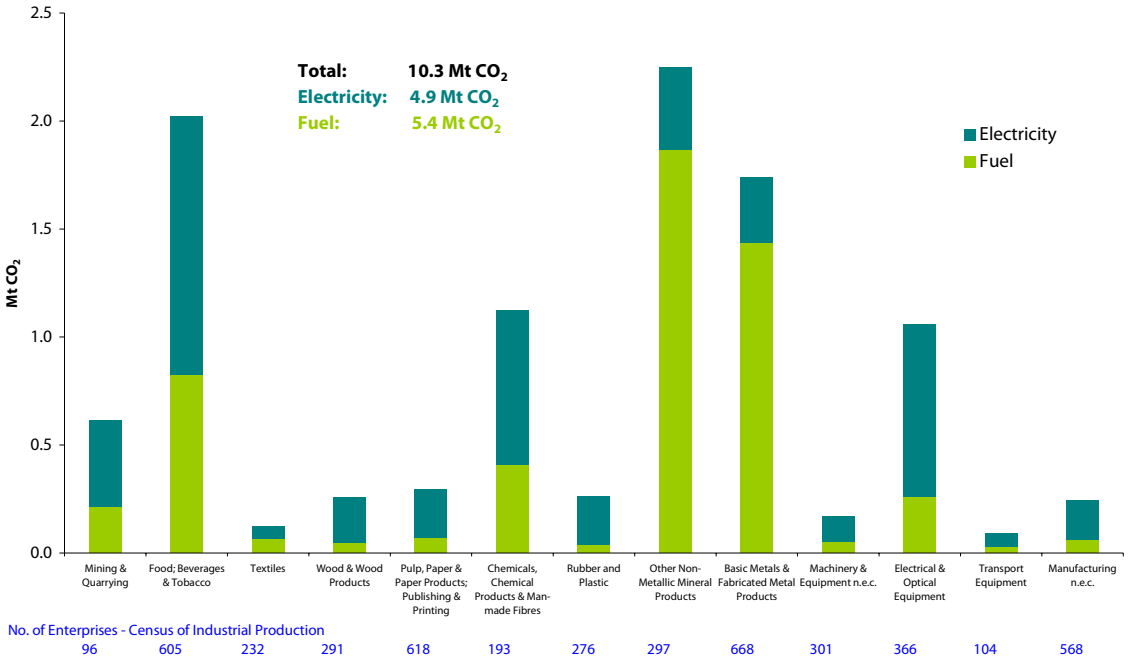


Source: Based on CSO data.

4.4 Energy-Related CO_2 Emissions by Sub-Sector

Figure 23 shows the calculated levels of energy-related CO_2 emissions for the sub-sectors. The conversion factors for each fuel are given on page 66. It is worth reiterating the distinction between this analysis and the National Climate Change Strategy (NCCS) in terms of attributing emissions to the end use sector. In the NCCS the only energy-related CO_2 emissions attributed to industry are those from fuel combusted on site whereas emissions associated with consumed electricity are attributed to the electricity supply sector. In the present analysis the upstream emissions associated with electricity consumed by industry are attributed to industry.

Figure 23 Energy-Related CO_2 Emissions in Industry 2004



Source: Based on CSO data.

According to these calculations, industry was responsible for 10.3 Mt CO_2 emissions in 2004[40], a reduction of 3.9% on 2001. Electricity consumption accounted for 48% (4.9 Mt CO_2) of the total in 2004 (59% in 2001).

Comparing Figure 22 and 23, there is general alignment between the final energy consumption and CO_2 emissions profiles. Where differences do occur, they are due to the weighting of the fuels used by each of the sub-sectors. The reason for this is clear from the emission factors shown on page 66, which show the variation in CO_2 emission factors (or CO_2 intensity) by energy form. In particular, when a large proportion of the energy is electricity or to a lesser extent coal, this will increase the amount of CO_2 emissions relative to the energy consumed.

It is worth noting that the split between emissions associated with electricity and (non-electricity) fuel consumption vary greatly across the sub-sectors of industry. In the case of manufacture of rubber and plastic products, emissions associated with fuel use accounted for just 15% of total energy –related CO_2 in that sub-sector, whereas in the case of the non-metallic minerals sub-sector the figure was 83%.

4.5 Drawing Inferences

Table 8 provides a summary for 2004 of the information detailed in sections 4.2 to 4.4.

[40] There are slight differences in the total industry emissions presented here compared to those shown in section 3. Here emissions are calculated using a bottom up methodology whereas those in section 3 are calculated on a top down basis.

Table 8 Summary of Data from Sections 4.2 to 4.4

	GVA %	Energy Exp. %	Energy Usage %	CO_2 %	Energy Spend as % of GVA	Energy Exp as % of Total Costs	Enterprises %
Chemicals, Chemical Products & Man-Made Fibres	33.6	14.6	9.9	11	1	0.7	4.2
Food; Beverages & Tobacco	21.8	25.5	20	19.7	2.6	1.5	13.1
Electrical & Optical Equipment	18.5	13.2	8	10.3	1.6	0.5	7.9
Pulp, Paper & Paper Products; Publishing & Printing	12.4	3.8	2.2	2.9	0.7	0.3	13.4
Basic Metals & Fabricated Metal Products	2.1	11	20.9	16.9	11.6	5.4	14.5
Other Non-Metallic Mineral Products	2.1	10	21.6	21.9	10.6	5.4	6.4
Manufacturing n.e.c.	2	3	1.8	2.4	3.4	1.3	12.3
Machinery & Equipment n.e.c.	1.9	2.2	1.4	1.7	2.7	1.2	6.5
Rubber and Plastic	1.5	3.5	1.8	2.6	5.3	2.7	6
Mining & Quarrying	1.4	7.5	5.2	6	12.3	5.8	2.1
Transport Equipment	1.1	1.2	0.7	0.9	2.3	1.2	2.3
Wood & Wood Products	1	3.3	5.3	2.5	7.7	3.4	6.3
Textiles	0.6	1.2	1.1	1.2	4.4	2.1	5

Source: Based on CSO data.

On the basis of aggregated data on a sub-sectoral basis across industry, it may appear self evident that energy price increases will most adversely affect the cost competitiveness of those sub-sectors with high ratios of energy in relation to other measures of output or input – such as to GVA or costs - and have a lesser effect on those with low ratios.

It should be noted, however, that these ratios provide an indication of sensitivity based only on the direct price change impacts of energy costs. This excludes the indirect impacts of energy price changes such as inflationary effects, which in turn impact on energy costs. These are also clearly important but fall beyond the scope of this analysis. There also exists the possibility of some distorting factors within some of the derived variables used in the cost sensitivity analyses, for example the exclusion of certain subsidies and the inclusion of indirect taxes within recorded turnover.

The analysis also does not take into account the exposure of companies in certain sub-sectors to international competition effects. While energy price increases will affect companies with high ratios of energy in relation to other measures of output or input, the extent of this impact will however also depend on the ability of the companies to pass through the costs increases to final consumers. This in turn will depend on the level to which companies are exposed to international competition from companies subject to lesser energy price increases.

It must therefore be recognised in seeking to assess the impact of fuel price increases and measures such as emissions trading on the cost base and CO_2 emissions of Irish industry, that the relevant unit of application is the individual firm or site. Aggregated data in this context may have a serious potential to mislead. Moving down one level of disaggregation in the NACE coding will not necessarily address this need. For this reason, SEI developed the necessary protocols with the CSO to allow appropriate access to CIP source data from the 1998, 2001, 2004 and future surveys. This analysis is presented in sections 5, 6, 7 and 8.

Given the caveats, however, from Table 8 it can be seen that the sub-sectors of industry that contribute over 90% of industrial value added spend, in aggregate, 1.5% or less (per sub-sector) of their direct cots on energy. Conversely, 5.6% of industrial value added was generated by 48% of enterprises that spend, in aggregate between 5% and 6% on energy. Part 2 of this report moves beyond this analysis at aggregate level to examine the role of energy in the cost structure of industry at an individual enterprise level.

5 Profiling Analysis of Energy CO_2 for Individual Firms

The Pareto principle suggests that a significant few within a population are responsible for the bulk of the impacts. This is sometimes expressed as the "80/20 rule" where 80% of the effects are caused by 20% of the population. In terms of Irish manufacturing industry it has been shown in previous iterations of this analysis[41] that a small percentage of firms are responsible for a large percentage of total industrial energy consumption and, by implication, related CO_2 emissions. The analysis in this section attempts to quantify this specific profile using newly available 2004 data.

In interpreting these results and those of sections 6, 7 and 8, it should be borne in mind that the data relates to the year 2004 unless otherwise stated (the most recent year for which detailed data are available). It is acknowledged that there have been price changes, closures and new plant openings since then which will affect the results presented here.

The methodology is as follows: using estimated price data for 2004, the anonymised energy expenditure for each firm was converted to energy consumption and subsequently to energy-related CO_2 emissions, using emission factors. The firms were then ranked in descending order in terms of energy-related emissions. The top energy consumers were grouped until their combined emissions reached a meaningful proportion (e.g. 30%) of the total for industry, or of the segment of industry concerned, and sufficiently compounded to maintain confidentiality. The remaining ranked firms were grouped in bands, each representing a further 10% in energy-related emissions.

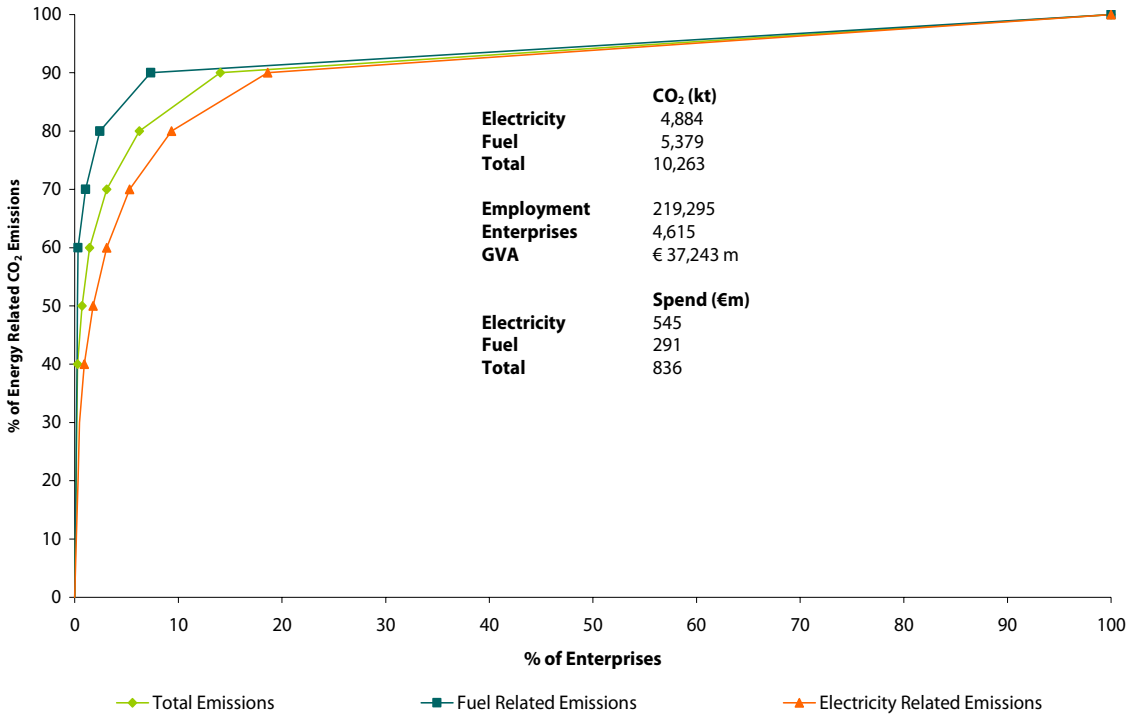
For each band, the associated contribution to industry GVA (total €37.2 billion) and employment (total 219,295) was also determined, and reported in the tables and figures below. To comply with confidentiality requirements, the proportions of firms in each band in respect of these two parameters were reported in percentage terms to a single decimal place; this represented data resolution limits of €37 million GVA and 219 jobs respectively.

[41] See http://www.sei.ie/index.asp?locID=71&docID=-1.

5.1 Profile of Energy CO_2 for all Industrial Firms

Figure 24 shows the results of the profiling analysis on CIP data for 2004 applied to the entire industrial sector.

Figure 24 Profile of Energy CO_2 in Industry 2004



Source: Based on CSO data.

The results are also presented in tabular form in Table 9. The ranges in the left hand column represent these percentage bands of total energy-related CO_2 emissions (or in the case of the middle and lower box, percentage of total fuel-related CO_2 and total electricity-related CO_2 respectively). The second column shows the number of enterprises associated with the respective incremental percentage bands. The third column shows the number of enterprises as a cumulative figure, while columns 4 to 6 respectively show the cumulative percentage of firms, the percentage of industry GVA and employment for the band concerned. For example, from 4,615 enterprises in total, 488 enterprises (or 12%) were responsible for 90% of energy-related CO_2 emissions in industry and thus 4,127 (column 2) enterprises (or 88%) were responsible for the final 10% of energy-related CO_2 emissions.

The profile for the fuel component is steeper than that for the electricity component, as can be seen in Figure 24. This means that fuel consumption in industry is concentrated towards a smaller number of firms than is electricity consumption.

The most striking features of Figure 24 and Table 9 are that, out of 4,615 industrial enterprises:

- 90% of industrial energy related CO_2 emissions were from 12% of enterprises who accounted for 89% of industrial GVA.
- 60% of emissions were from just 1.2% (52) of enterprises.
- 84 enterprises (2.5%) accounted for 80% of on site energy related CO_2.

Table 9 Energy CO_2 Profiling of Industry by Individual Enterprise (2004)

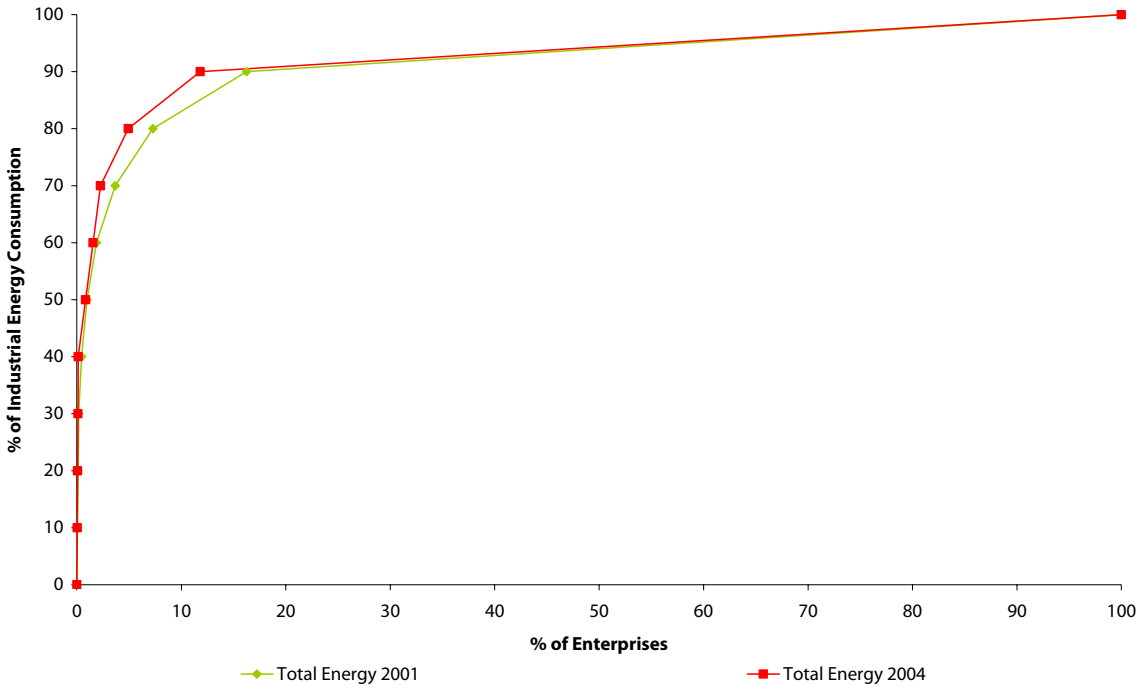
Total Energy - Related CO_2 Emissions	*Number of Enterprises*	*Cumulative Enterprises*	*Cumulative Enterprises %*	*% of Industry GVA*	*% of Industry Employment*
0 - 40%	12	12	0.3%	21.3%	5.2%
40 - 50%	19	31	0.7%	15.6%	7.3%
50 - 60%	33	52	1.2%	14.2%	8.0%
60 - 70%	73	106	2.5%	17.8%	12.7%
70 - 80%	140	213	5.1%	10.7%	13.7%
80 - 90%	348	488	11.7%	9.4%	17.9%
90 - 100%	4127	4615	100.0%	11.0%	35.2%
Fuel Related CO_2 Emissions	***Number of Enterprises***	***Cumulative Enterprises***	***Cumulative Enterprises %***	***% of Industry GVA***	***% of Industry Employment***
0-60%	11	11	0.3%	21.1%	4.4%
60-80%	73	84	2.5%	25.6%	14.0%
80-90%	170	243	7.2%	15.4%	15.7%
90-100%	4372	4615	100.0%	37.9%	65.9%
Electricity Related CO_2 Emissions	***Number of Enterprises***	***Cumulative Enterprises***	***Cumulative Enterprises %***	***% of Industry GVA***	***% of Industry Employment***
0-30%	20	20	0.5%	27.9%	9.4%
30-40%	20	40	0.9%	16.6%	7.4%
40-50%	37	77	1.8%	9.2%	8.6%
50-60%	58	135	3.1%	18.6%	8.7%
60-70%	97	232	5.3%	5.4%	10.1%
70-80%	177	409	9.3%	6.1%	10.9%
80-90%	407	816	18.6%	7.5%	15.6%
90-100%	3799	4615	100.0%	8.7%	29.3%

Source: Based on CSO data.

5.2 Change in Industrial Energy Profile

Figure 25 compares the profile of overall energy consumption in industry for 2001 and 2004. The steeper curve for 2004 suggests increased concentration of energy consumption in a small percentage of enterprises.

Figure 25 Comparison of 2001 and 2004 Industrial Energy Profiles



Source: Based on CSO data.

Just 12% (488) of enterprises accounted for 90% of energy consumption in 2004 compared with 16% (788) enterprises in 2001, demonstrating this increase in concentration of energy consumption.

Part 2

Significance of Energy Expenditure to Industry

6 Significance of Energy Expenditure to Industry – Overall

The cost of energy varies for many reasons such as demand, supply, geo-political conflicts and imposed changes such as taxes, duties and levies. Individual industrial enterprises can be more sensitive to these changes than others just as some industries are, for example, more sensitive to labour costs. Ireland, in recent years, has seen a departure of manufacturing industries that have a high share of labour costs in their cost structure. Examples are the textiles and assembly industries that require significant manual input. When labour costs increased these industries were unable to compete and either closed down or moved to jurisdictions with lower wage rates.

This analysis looks at the cost structure of Irish industry as it relates to energy through the analysis of a series of ratios which profile the share of energy in total costs. These ratios are indicators of sensitivity to energy price changes and relate energy expenditure to direct costs (a measure of a firm's cost base).

The reasoning here is that if an enterprise has a high share of energy costs in its overall cost base then it will be more likely to experience difficulties in a rising energy price scenario. Conversely if the share is low then the enterprise is more likely to be able to weather the effect of increasing energy costs as energy will have a low weighting in its cost structure.

It is hoped that the results presented in this report can be fed into further work exploring indirect impacts of energy price changes such as inflationary effects. The ratios in this section are applied at the level of the individual firm to the complete industrial base of 4,501 enterprises[42].

The ratios have been determined for three streams: for all energy, for fuel only and for electricity only. The analysis also assesses the contribution made to the economy by sections of industry that may be sensitive to energy cost rises in terms of value added and employment. It does this separately for all of industry (the remainder of this section), for enterprises involved in emissions trading (section 7) and also for non-emissions trading enterprises (section 8).

As presented, these ratios may be of assistance to analysts seeking to consider the potential impact of energy cost increases, including those arising from climate change policy instruments, on industry's cost competitiveness. The commentaries, which are by no means exhaustive, are aimed at guiding interpretation of the tables and encouraging further examination.

More detailed ratio analyses are provided at a sub-sectoral basis in a separate Annex to this report. *Energy in Industry 2007 Report –Annex* is available at www.sei.ie by clicking on "Statistics Publications".

One of the key findings is that 98% of industrial Gross Value Added (GVA) in 2004 was generated by industrial enterprises whose energy spend represented 6% or less of their direct costs, unchanged since 2001. Regarding companies involved in the Emissions Trading Scheme (ETS), 99% of their contribution to GDP was accounted for by enterprises who spent 5% or less of their direct costs on fuel.

It is also interesting to note that there are 70 enterprises whose energy spend to direct costs represented 10% or more of their cost base. They contributed 0.8% to total industrial GVA, 1.2% to total employment but accounted for 35% of energy related CO_2 emissions. Of these 70 enterprises, 60 were outside the ETS and accounted for 2.9% of total industrial CO_2 emissions. The remaining 10 enterprises accounted for 32% of energy related CO_2 emissions.

[42] This number excludes the sectors mentioned on page 8. The number varies slightly for some of the ratio analyses, as some of the enterprises were excluded if the denominator of the ratio was zero. This avoids divide by zero errors when interrogating the data.

6.1 Sensitivity of Enterprises to Energy Price Changes

The ratios of energy spend to direct costs[43] show the share of energy expenditure in the expenses incurred by an enterprise in conducting its business. This is a metric that will be well understood in industry and was chosen because any change in the cost of energy would affect an individual enterprise in proportion to the magnitude of the ratio.

The graphs in this section illustrate the data contained in the tables. The horizontal axis shows the cumulative percentage of enterprises in industry ranked from smallest to largest (in terms of the ratio under scrutiny) going from left to right. The green line plots the ratio of total energy costs to direct costs for each enterprise and the scale for this line is along the left-hand axis. The other three lines are for cumulative percentage of industrial gross value added (GVA), employment and CO_2 emissions for the corresponding enterprises and are plotted against the right-hand axis.

To assist in interpreting the graphs, a horizontal red dotted line is drawn at a pre-selected ratio of energy expenditure to direct costs ratio. The pre-selected ratio is chosen where there is significant change in the profile of the ratio. Where this dotted line intersects with the green line (marked on the graph as point 4) a vertical red dotted line is drawn to give the percentages of industrial GVA (marked on the graph as point 1), employment (marked on the graph as point 2) and CO_2 (marked on the graph as point 3) that is accounted for by enterprises with less than or equal to the chosen energy to costs ratio. Approximations of key activity data associated with any chosen ratio can be obtained in a similar manner.

The brief commentaries below relate separately to total energy costs, to fuel costs only (i.e. excluding electricity) and to electricity costs as a ratio of an enterprise's direct costs.

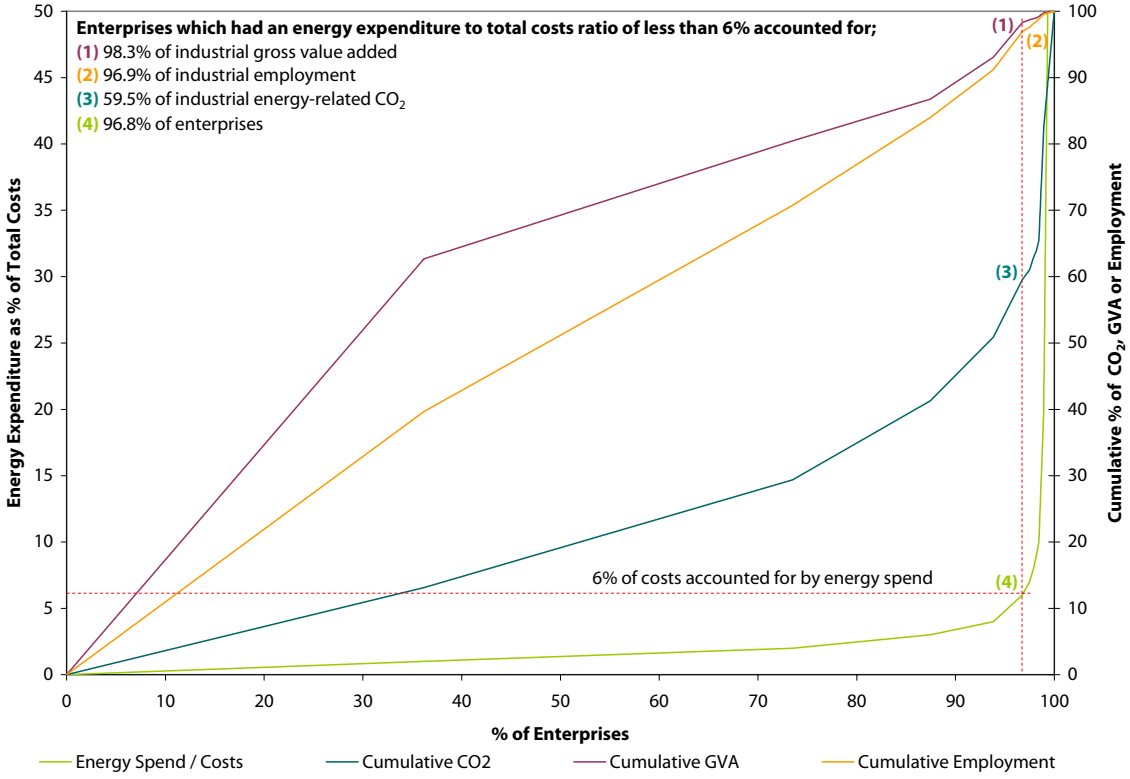
6.1.1 Ratio of Total Energy Expenditure to Direct Costs

Figure 26 graphs the ratio of total energy spend to direct costs against the cumulative percentage of enterprises. The data underpinning Figure 26 is presented in Table 10. What strikes one immediately is the low share of costs that energy accounts for in the majority of enterprises. Just under 97% (4,355) of industrial enterprises spend 6% or less of their direct costs on energy and these enterprises account for 98% of industry's contribution to GDP and 97% of industrial employment.

With regard to industrial energy-related CO_2 emissions these 4,355 enterprises only account for 60%. This means that of the remaining 3.2% (146) of enterprises with energy share of costs of greater than 6% some must be very large emitters. Indeed, Table 10 shows that just 48 enterprises, with cost ratios in the greater than 20% range, accounted for 17% of all industrial energy-related emissions but only accounted for 0.2% of value added and 0.4% of employment. This small number of enterprises accounted for 11% of industry's energy bill.

[43] Direct costs are defined as intermediate consumption (which includes the purchases of materials, industrial and non-industrial services and fuel and power less or plus the change during the year of stocks of materials and fuels) plus labour costs. Indirect costs such as taxes are excluded.

Figure 26 Total Energy Expenditure to Direct Costs Ratio Analysis (2004)



Source: Based on CSO data.

Regarding the changes in the ratio of energy costs to direct costs during the period 2001 and 2004, fewer enterprises fell into the lower ratio categories in general in 2004 compared with 2001. This would suggest that over the period energy became more significant in the cost structure of industry which reflects the fuel price increases.

Table 10 Total Energy Expenditure to Direct Costs Ratio Analysis (2004)

		Cumulative Enterprises		% of Total Industry (Cumulative)			
Energy Spend / Costs	**No. of Enterprises**	**No.**	**%**	**Energy Spend**	**GVA**	**Employment**	**Energy Related CO_2**
0 - 1%	1,629	1,629	36.2%	16.5%	62.7%	39.7%	13.1%
1 - 2%	1679	3,308	73.5%	36.5%	80.5%	70.7%	29.4%
2 - 3%	628	3,936	87.4%	50.9%	86.8%	84.0%	41.3%
3 - 4%	287	4,223	93.8%	62.0%	93.1%	91.2%	50.9%
4 - 6%	132	4,355	96.8%	72.7%	98.3%	96.9%	59.5%
6 - 7%	33	4,388	97.5%	74.5%	98.7%	97.6%	61.0%
7 - 8%	18	4,406	97.9%	76.6%	98.9%	98.2%	62.9%
8 - 9%	13	4,419	98.2%	77.7%	99.0%	98.5%	63.9%
9 - 10%	12	4,431	98.4%	79.6%	99.2%	98.8%	65.5%
10 - 20%	22	4,453	98.9%	88.5%	99.8%	99.6%	82.5%
> 20%	48	4,501	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Based on CSO data.

Some further points from the full profile of industry in Table 10 and shown in Figure 26 are:

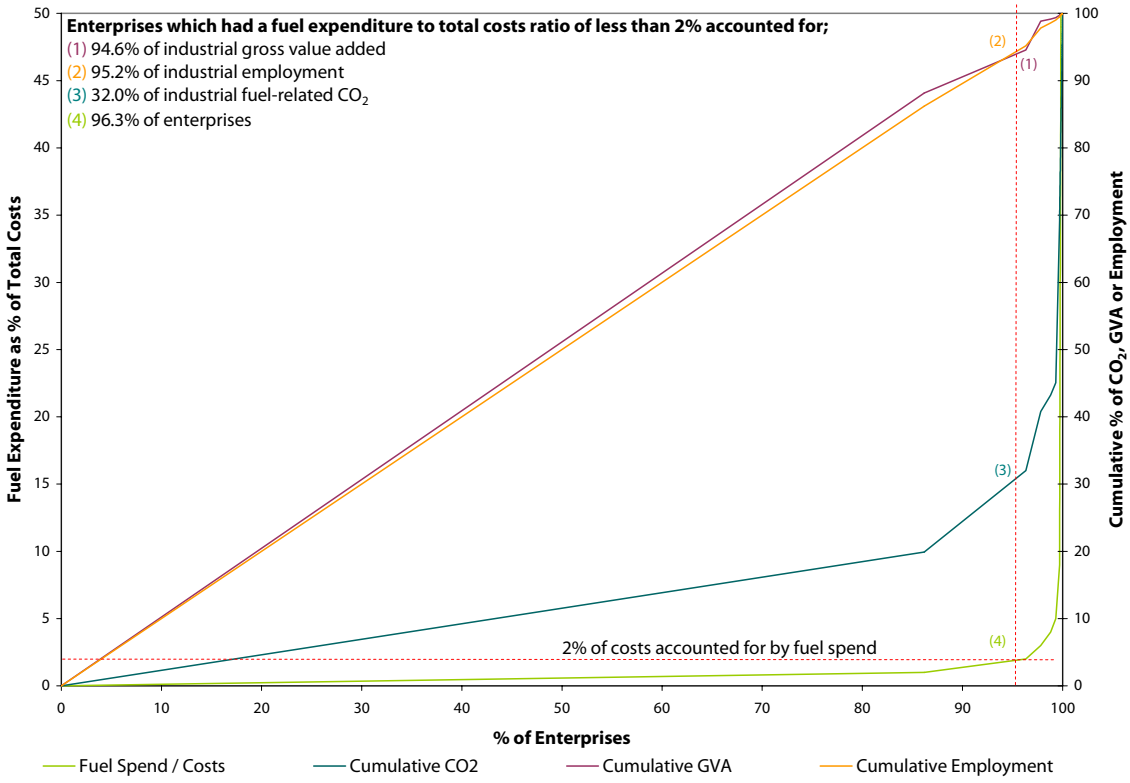
- Just over 93% of GVA was generated by enterprises whose energy spend represents 4% or less of their direct costs.

- Nearly three quarters (74% or 3,308) of all industrial enterprises had an energy to direct costs ratio of less than or equal to 2%. These accounted for 81% of industrial GVA and 71% of industrial employment.
- 98% (4,431) of industrial enterprises had a ratio of less than 10%. They accounted for 99% of industrial GVA.
- A total of 22 enterprises (0.5%) had ratios between 10% and 20%. This group of enterprises accounted for 17% of energy-related CO_2 emitted by all of industry, 0.6% of industrial GVA and 0.8% of industrial employment.
- It is notable that the 48 firms who had the highest ratio (>20%) do not include all of the 12 largest energy consuming firms highlighted in Table 9 (this is clear from the GVA and employment figures). High energy consumption in absolute terms does not in itself denote high sensitivity to energy price changes. Confidentiality constraints prevent further elaboration on the profile for these firms.

6.1.2 Ratio of Fuel Bill to Direct Costs

Figure 27 and Table 11 present the results for the ratio of fuel costs to direct costs, which points to sensitivity to fuel price changes for industrial consumers.

Figure 27 Fuel Expenditure to Direct Costs Ratio Analysis (2004)



Source: Based on CSO data.

Table 11 Fuel Expenditure to Direct Costs Ratio Analysis (2004)

		Cumulative Enterprises		% of Total Industry (Cumulative)			
Fuel Spend / Costs	**No. of Enterprises**	**No.**	**%**	**Fuel Spend**	**GVA**	**Employment**	**Fuel Related CO_2**
0 - 1%	3,879	3,879	86.2%	30.4%	88.2%	86.2%	19.9%
1 - 2%	457	4,336	96.3%	46.6%	94.6%	95.2%	32.0%
2 - 3%	67	4,403	97.8%	60.7%	98.9%	97.8%	40.8%
3 - 4%	44	4,447	98.8%	63.9%	99.1%	98.6%	43.3%
4 - 5%	23	4,470	99.3%	66.4%	99.4%	99.0%	45.1%
5 - 9%	17	4,487	99.7%	74.5%	99.7%	99.5%	69.2%
> 10	14	4,501	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Based on CSO data.

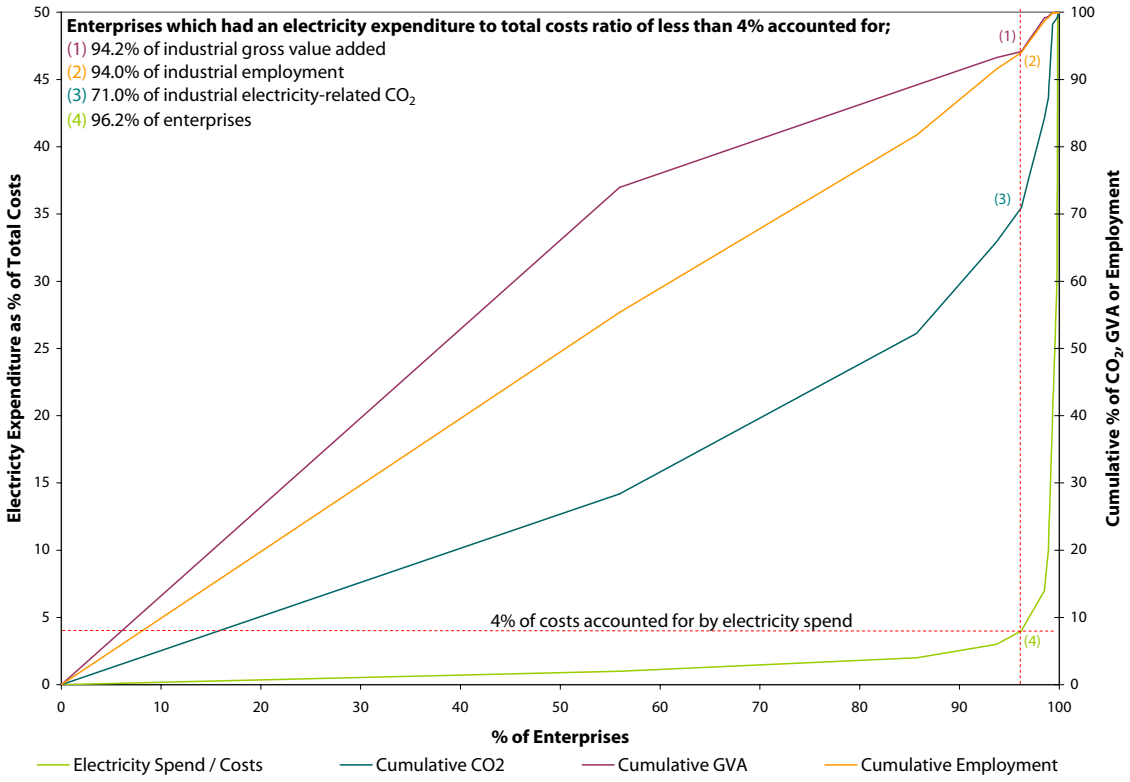
The key features of Figure 27 and Table 11 are:

- Just less than 99% of industrial GVA was generated by enterprises whose fuel spend represented 3% or less of their cost base.
- 96% of enterprises had a share of fuel costs in direct costs of less than 2%. These enterprises accounted for 95% of industrial value added, 95% of industrial employment but only 32% of industrial fuel-related CO_2 emissions.
- The fuel-related CO_2 emissions trace is lower than the energy-related emissions trace (point 3 on Figure 26), indicating the higher concentration of fuel-related emissions among a smaller number of enterprises.
- 88% of industrial GVA was generated by enterprises for which fuel costs represented no more than 1% of their direct costs. These enterprises represented 86% of industrial employment and 20% of fuel-related CO_2.
- For 14 firms the ratio of fuel spend to direct costs was greater than 10%. These firms accounted for 31% of fuel-related CO_2, but just 0.3% of industrial GVA and 0.5% of industrial employment.

6.1.3 Ratio of Electricity Bill to Direct Costs

Figure 28 and Table 12 present the results for the ratio of electricity costs to direct costs, assessing sensitivity to electricity price changes.

Figure 28 Electricity Expenditure to Direct Costs Ratio Analysis (2004)



Source: Based on CSO data.

Table 12 Electricity Expenditure to Direct Costs Ratio Analysis (2004)

		Cumulative Enterprises		% of Total Industry (Cumulative)			
Electricity Spend / OS	**No. of Enterprises**	**No.**	**%**	**Electricity Spend**	**GVA**	**Employment**	**Electricity Related CO_2**
0 - 1%	2,518	2,518	55.9%	28.4%	74.0%	55.4%	28.4%
1 - 2%	1,340	3,858	85.7%	52.3%	89.2%	81.7%	52.3%
2 - 3%	360	4,218	93.7%	65.8%	93.3%	91.5%	65.8%
3 - 4%	112	4,330	96.2%	71.0%	94.2%	94.0%	71.0%
4 - 6%	91	4,421	98.2%	83.6%	99.0%	98.5%	83.6%
6 - 7%	13	4,434	98.5%	84.2%	99.1%	98.7%	84.2%
7 - 10%	18	4,452	98.9%	87.3%	99.4%	99.2%	87.3%
10 - 20%	19	4,471	99.3%	98.2%	100.0%	99.9%	98.2%
20 - 30%	20	4,491	99.8%	99.1%	100.0%	100.0%	99.1%
> 30%	10	4,501	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Based on CSO data.

The key features of Figure 28 and Table 12 are

- 93% of industrial value added was generated by enterprises whose electricity bill represented less than 3% of their direct costs. These enterprises accounted for 92% of industrial employment and 66% of electricity-related CO_2 emissions.
- 80 firms (1.5%) had a ratio to direct costs in excess of 6%, representing 17% of electricity- related CO_2, 1% of industrial GVA and 1.5% of industrial employment.

6.2 Analysis of Enterprises Most Sensitive to Energy Price Change

The ratios presented in sections 6.1 provide useful insights into the sensitivity of individual enterprises to changes in energy prices. The enterprises that are most likely to be adversely affected by increasing energy prices are those with a high energy spend relative to direct costs. This section presents additional analysis of these more highly sensitive enterprises. It also relates levels of expenditure on energy with the profitability of the individual enterprise. Operating surplus (OS), defined as gross value added minus labour costs, is presented as a proxy for profits. Additional energy spend to OS ratios are contained in an online annex entitled *Energy in Industry 2007 Report -Annex*. Go to www.sei.ie and click on "Statistics Publications".

The assumption here is that increases in energy costs will have an impact on operating surplus or profit. The relative magnitude of energy expenditure and operating surplus should provide an indication of the sensitivity of enterprises' profit base to changes in their energy costs.

For the purposes of establishing a threshold for the analysis, only those enterprises with an energy bill to costs ratio greater than 8% and an energy bill to profits ratio greater than 50% were considered. These thresholds appear to act as a reasonable cut-off for analysis of the most sensitive enterprises.

A summary of the results is presented in Table 13. Confidentiality constraints do not allow further disaggregation or the presentation, separately, of fuel and electricity data for this analysis. In each table section, the enterprises are ranked in terms of increasing spend to direct costs ratio and then grouped in appropriate bands. The bands are shown in the left hand column and the number of enterprises in each in the second column. Taking the first row as an example, there were 5 enterprises with an energy bill to profit ratio greater than 50% and whose energy spend represented between 8% and 10% of their direct costs.

The final three columns show the contribution from each band of enterprises to industrial GVA, employment and energy or fuel-related CO_2.

Table 13 Costs Ratio >8% and Profits Ratio >50%

Energy Spend/Costs	***Frequency***	***% of Industrial***		
		GVA	***Employment***	***Energy-related CO_2***
8 – 10%	5	0.1%	0.3%	1.4%
10% >	6	0.4%	0.5%	24%

Source: Based on CSO data.

Table 13 shows that there were only 11 enterprises that had energy to costs ratios above 8% and energy to profits ratios above 50%.

Of these 11 enterprises, there were 6 with an energy bill to costs ratio of greater than 10%. These enterprises accounted for a significant 24% of industrial energy-related CO_2 but were relatively insignificant in terms of contribution to industrial economic output and employment representing 0.4% and 0.5% of each respectively.

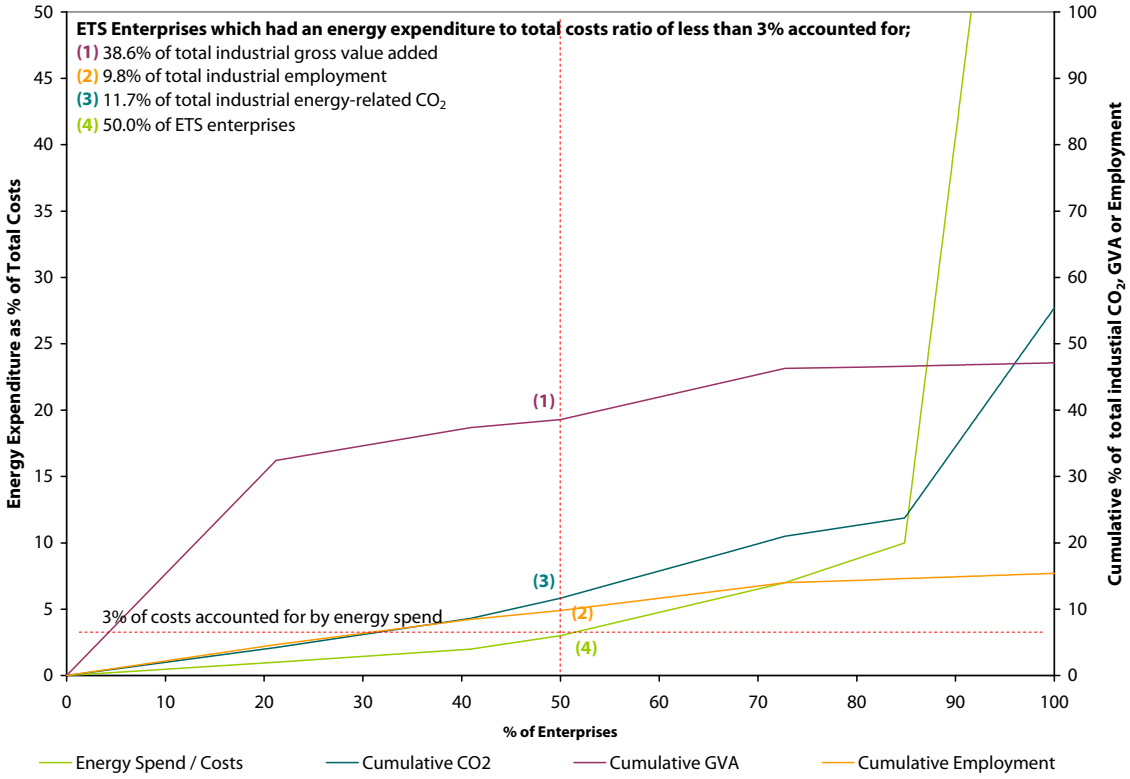
7 Significance of Energy Expenditure to Industry -Emissions Trading

It is possible to examine, for the first time, the cost ratios for those enterprises involved in the Emissions Trading Scheme (ETS). This is important, not least, because these enterprises are faced with additional costs associated with their CO_2 emissions through the ETS. It is also interesting to assess the impact of energy savings separately for these large energy users. It is important to note here that CIP data refers to enterprises while the ETS refers to sites. The distinction is important in the context of the National Allocation Plan (NAP) for the ETS, which deals with installations on a site basis.

7.1 Ratio of Total Energy Expenditure to Direct Costs- Emissions Trading

Figure 29 graphs the total energy spend to direct costs against the cumulative percentage of enterprises. The data underpinning Figure 29 is presented in Table 14. The contrast with the ratio for all of industry as seen in section 6.1.1 is stark. In this case only half of emissions trading industrial enterprises spend 3% or less of their direct costs on energy. These enterprises account for 39% of all industry's contribution to GDP and 9.8% of industrial employment. With regard to industrial energy-related CO_2 emissions the 33 enterprises account for 12%.

Figure 29 Total Energy Expenditure to Direct Costs Ratio Analysis – Emissions Trading (2004)



Source: Based on CSO data.

Table 14 Total Energy Expenditure to Direct costs Ratio Analysis - Emissions Trading (2004)

		Cumulative Enterprises		% of Total Industry (Cumulative)			
Energy Spend / Costs	**No. of Enterprises**	**No.**	**%**	**Energy Spend**	**GVA**	**Employment**	**Energy Related CO_2**
0 - 1%	14	14	21.2%	5.2%	32.4%	4.7%	4.2%
1 - 2%	13	27	40.9%	10.6%	37.4%	8.5%	8.6%
2 - 3%	6	33	50.0%	14.0%	38.6%	9.8%	11.7%
3 - 7%	15	48	72.7%	24.8%	46.3%	14.0%	21.0%
7- 10%	8	56	84.8%	28.1%	46.6%	14.6%	23.7%
> 10%	10	66	100.0%	45.4%	47.1%	15.4%	55.4%

Source: Based on CSO data.

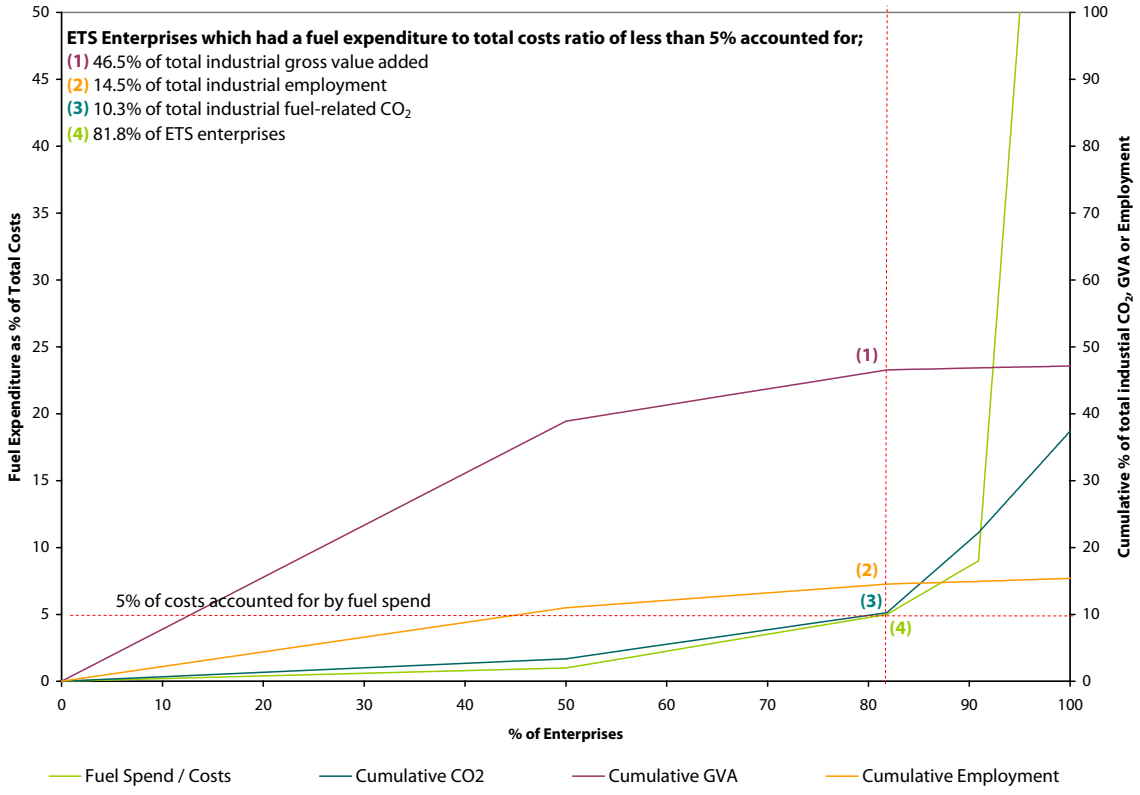
Some further salient points from the full profile of industry in Table 14 and shown in Figure 29 are:

- Nearly three quarters of these enterprises had an energy spend at or less than 7% of their costs. These enterprises accounted for 98% of the ETS enterprise's GVA.
- Only 10 ETS enterprises (15%) spent more than 10% of their costs on energy. These 10 enterprises were responsible for 0.5% of total industry GVA, 0.8% of employment and 32% of total industry CO_2 emissions.
- 14 (21%) enterprises involved in the ETS had an energy spend to direct costs ratio of less than1%. These enterprises accounted for 69% of ETS companies' contribution to GDP.

7.2 Ratio of Fuel Bill to Direct Costs - Emissions Trading

Figure 30 and Table 15 present the results for the ratio of fuel costs to direct costs, which points to sensitivity to fuel price changes for industrial enterprises involved in the ETS. In this case, 82% of ETS enterprises spend 5% or less of their direct costs on energy. These enterprises account for 47% of all industry's contribution to GDP and 15% of industrial employment. The enterprises account for 10% of industrial energy-related CO_2 emissions.

Figure 30 Fuel Expenditure to Direct Costs Ratio Analysis – Emissions Trading (2004)



Source: Based on CSO data.

Table 15 Fuel Expenditure to Direct Costs Ratio Analysis – Emissions Trading (2004)

		Cumulative Enterprises		% of Total Industry (Cumulative)			
Fuel Spend / Costs	**No. of Enterprises**	**No.**	**%**	**Fuel Spend**	**GVA**	**Employment**	**Fuel Related CO_2**
0 - 1%	33	33	50.0%	3.5%	38.9%	11.0%	3.4%
1 - 5%	21	54	81.8%	10.2%	46.5%	14.5%	10.3%
5 - 9%	6	60	90.9%	12.8%	46.9%	14.9%	22.2%
> 10	6	66	100.0%	21.2%	47.1%	15.4%	37.4%

Source: Based on CSO data.

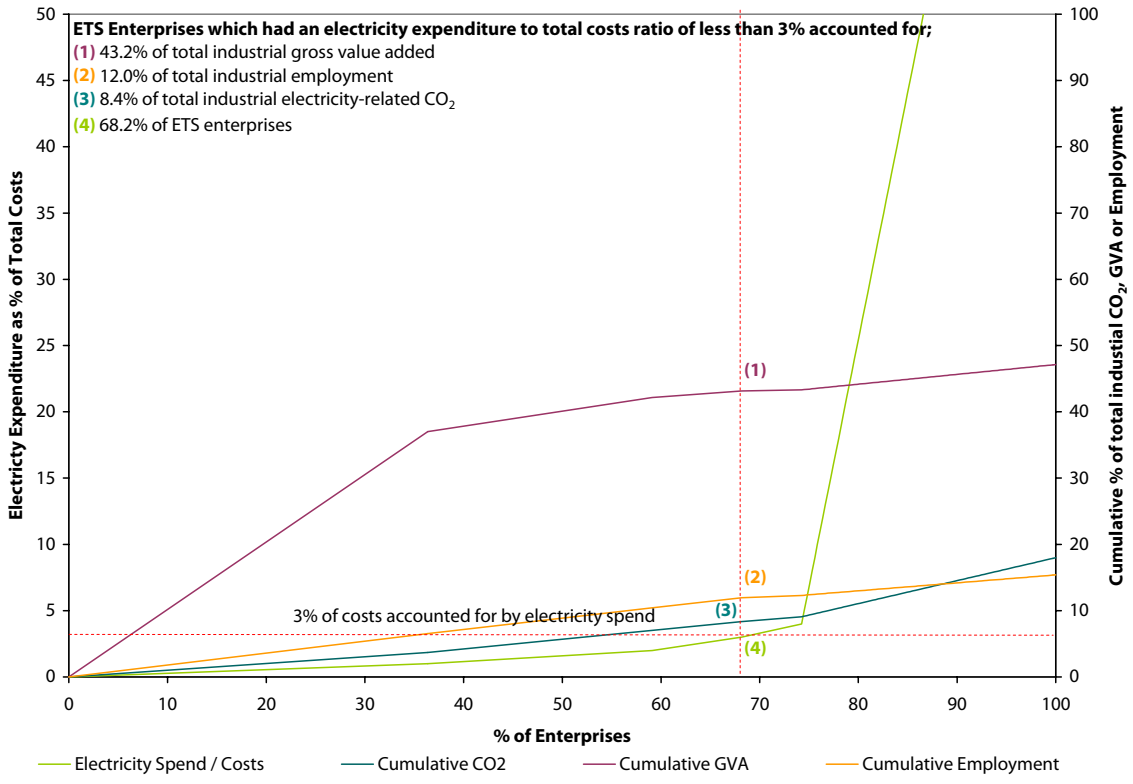
The key features of Figure 30 and Table 15 are:

- 82% of ETS enterprises spent less than 5% of their direct costs on fuel in 2004. These firms were responsible for 99% of ETS enterprise's contribution to GDP.
- Only 6 ETS enterprises (9.1%) spent more than 10% of their costs on fuel. These 10 enterprises were responsible for 0.2% of total industrial GVA, 0.5% of employment and 15% of CO_2 emissions.

7.3 Ratio of Electricity Bill to Direct Costs- Emissions Trading

Figure 31 and Table 16 present the results for the ratio of electricity costs to direct costs, assessing sensitivity to electricity price changes, including those associated with the changing cost of oil, gas and coal.

Figure 31 Electricity Expenditure to Direct Costs Ratio Analysis – Emissions Trading (2004)



Source: Based on CSO data.

Table 16 Electricity Expenditure to Direct Costs Ratio Analysis – Emissions Trading (2004)

		Cumulative Enterprises		% of Total Industry (Cumulative)			
Electricity Spend / OS	**No. of Enterprises**	**No.**	**%**	**Electricity Spend**	**GVA**	**Employment**	**Electricity Related CO_2**
0 - 1%	24	24	36.4%	5.0%	37.0%	6.6%	3.7%
1 - 2%	15	39	59.1%	9.4%	42.2%	10.4%	7.0%
2 - 3%	6	45	68.2%	11.2%	43.2%	12.0%	8.4%
3 - 4%	4	49	74.2%	12.2%	43.3%	12.3%	9.1%
> 4%	17	66	100.0%	24.1%	47.1%	15.4%	18.0%

Source: Based on CSO data.

The key features of Figure 31 and Table 16 are

- 43% of industrial value added was generated by ETS enterprises whose electricity bill represented less than 3% of their direct costs.
- 17 firms (26%) had a ratio to direct costs in excess of 4%, representing 3.8% of industrial GVA, 8.9% of electricity- related CO_2, and 3.1% of industrial employment.

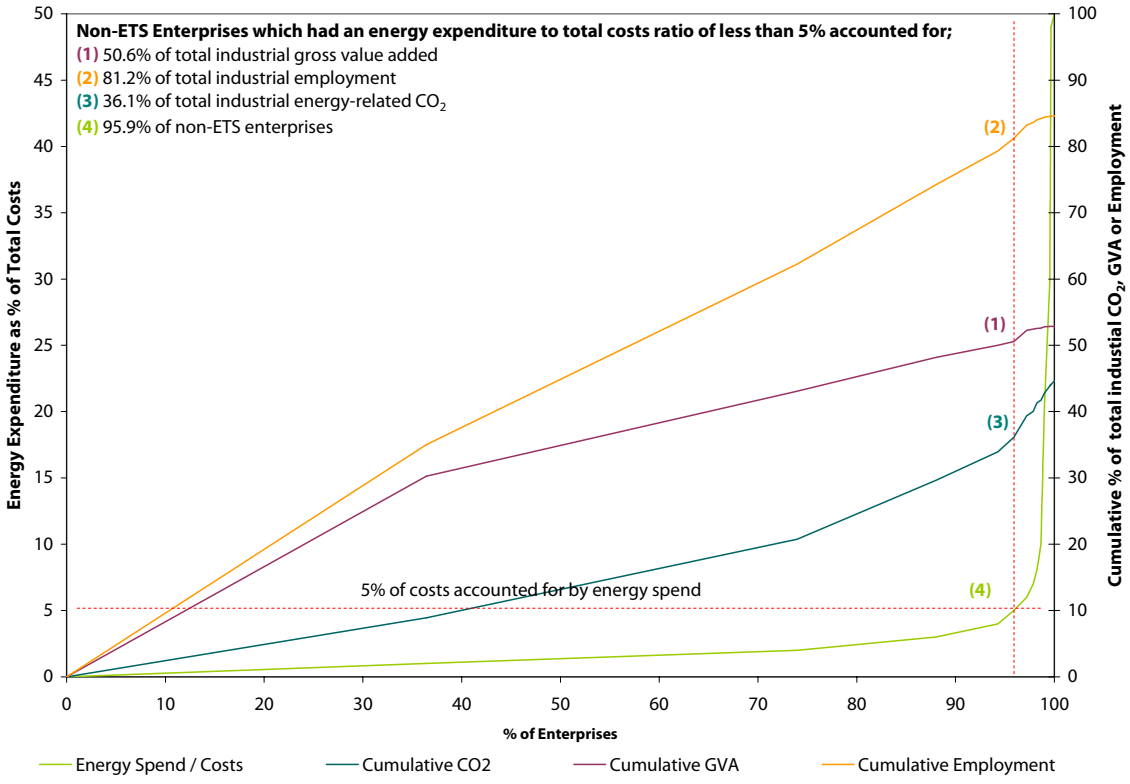
8 Significance of Energy Expenditure to Industry – Non Emissions Trading

The section examines the cost ratios for those enterprises not involved in the Emissions Trading Scheme (ETS). These enterprises will be included in the calculations of energy savings targets for the Energy Services Directive.

8.1 Ratio of Total Energy Expenditure to Direct Costs- Non Emissions Trading

Figure 32 graphs the total energy spend to direct costs against the cumulative percentage of enterprises. The data underpinning Figure 32 is presented in Table 17. As can be seen, 96% of non emissions trading industrial enterprises spent 5% or less of their direct costs on energy. These enterprises accounted for 51% of all industry's contribution to GDP and 81% of industrial employment. With regard to industrial energy-related CO_2 emissions these enterprises accounted for 36%.

Figure 32 Total Energy Expenditure to Direct Costs Ratio Analysis – Non Emissions Trading (2004)



Source: Based on CSO data.

Table 17 Total Energy Expenditure to Direct costs Ratio Analysis – Non Emissions Trading (2004)

		Cumulative Enterprises		% of Total Industry (Cumulative)			
Energy Spend / Costs	**No. of Enterprises**	**No.**	**%**	**Energy Spend**	**GVA**	**Employment**	**Energy Related CO_2**
0 - 1%	1,615	1,615	36.4%	11.3%	30.3%	35.0%	8.9%
1 - 2%	1666	3,281	74.0%	25.9%	43.1%	62.3%	20.7%
2 - 3%	622	3,903	88.0%	36.9%	48.2%	74.2%	29.6%
3 - 4%	279	4,182	94.3%	42.3%	50.0%	79.3%	34.0%
4 - 5%	72	4,254	95.9%	44.9%	50.6%	81.2%	36.1%
5 - 6%	57	4,311	97.2%	48.9%	52.2%	83.2%	39.4%
6 - 7%	29	4,340	97.9%	49.7%	52.5%	83.6%	40.0%
7 - 8%	16	4,356	98.2%	51.0%	52.5%	84.0%	41.3%
8 - 9%	11	4,367	98.5%	51.3%	52.6%	84.1%	41.5%
9 - 10%	8	4,375	98.6%	51.5%	52.6%	84.2%	41.7%
10 - 20%	15	4,390	99.0%	52.6%	52.8%	84.4%	42.8%
20 - 30%	25	4,415	99.5%	53.7%	52.8%	84.5%	43.9%
30 - 50%	20	4,435	100.0%	54.6%	52.9%	84.6%	44.6%

Source: Based on CSO data.

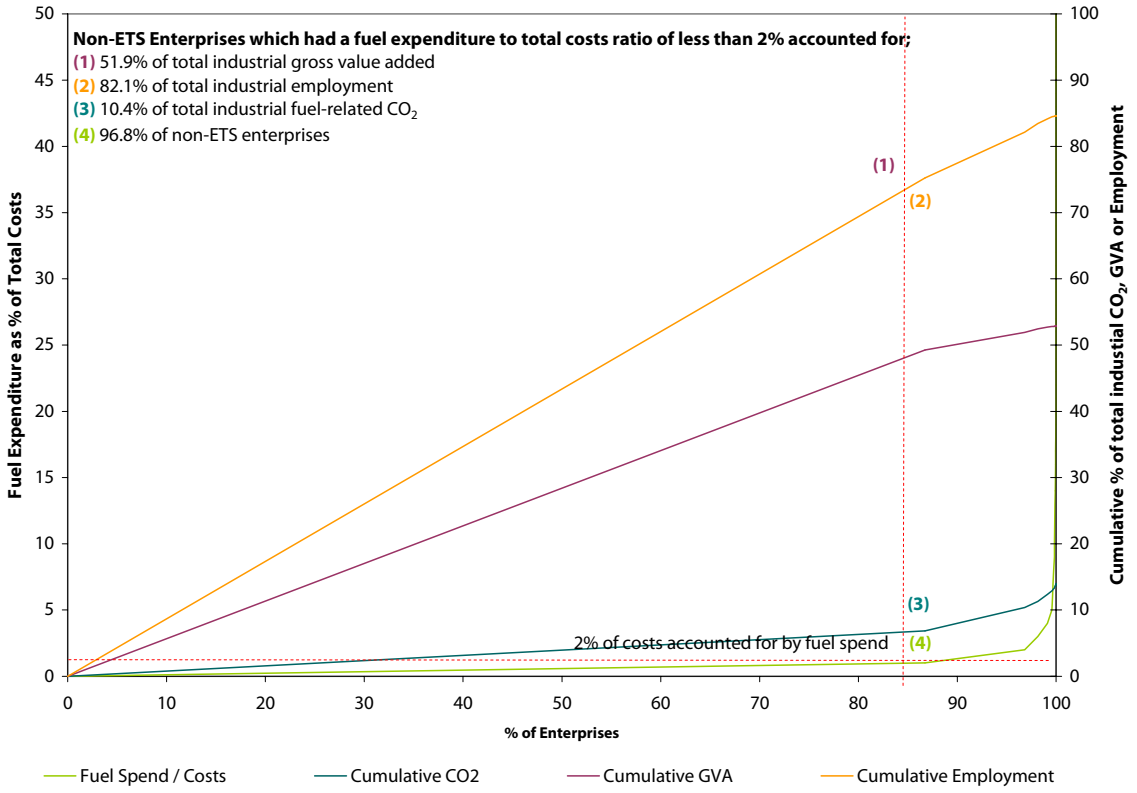
Some further points from Table 17 and shown in Figure 32 are:

- Half of industrial GVA was generated by 94% of non-ETS enterprises.
- Only 60 non-ETS enterprises (1%) spent more than 10% of their costs on energy. These 60 enterprises were responsible for 2.9% of total CO_2 emissions, 0.4% of employment and 0.3% of industry GVA.

8.2 Ratio of Fuel Bill to Direct Costs – Non Emissions Trading

Figure 33 and Table 18 present the results for the ratio of fuel costs to direct costs, which points to sensitivity to fuel price changes for industrial enterprises not involved in the ETS.

Figure 33 Fuel Expenditure to Direct Costs Ratio Analysis – Non Emissions Trading (2004)



Source: Based on CSO data.

Table 18 Fuel Expenditure to Direct Costs Ratio Analysis – Non Emissions Trading (2004)

		Cumulative Enterprises		Cumulative % of Total Industry			
Fuel Spend / Costs	**No. of Enterprises**	**No.**	**%**	**Fuel Spend**	**GVA**	**Employment**	**Fuel Related CO_2**
0 - 1%	3,846	3,846	86.7%	7.0%	49.3%	75.2%	6.9%
1 - 2%	448	4,294	96.8%	10.6%	51.9%	82.1%	10.4%
2 - 3%	59	4,353	98.2%	11.5%	52.4%	83.5%	11.3%
3 - 4%	43	4,396	99.1%	12.5%	52.7%	84.2%	12.4%
4 - 5%	20	4,416	99.6%	13.0%	52.8%	84.5%	12.9%
5 - 9%	11	4,427	99.8%	13.2%	52.8%	84.6%	13.3%
10 - 20%	8	4,435	100.0%	13.6%	52.9%	84.6%	14.0%

Source: Based on CSO data.

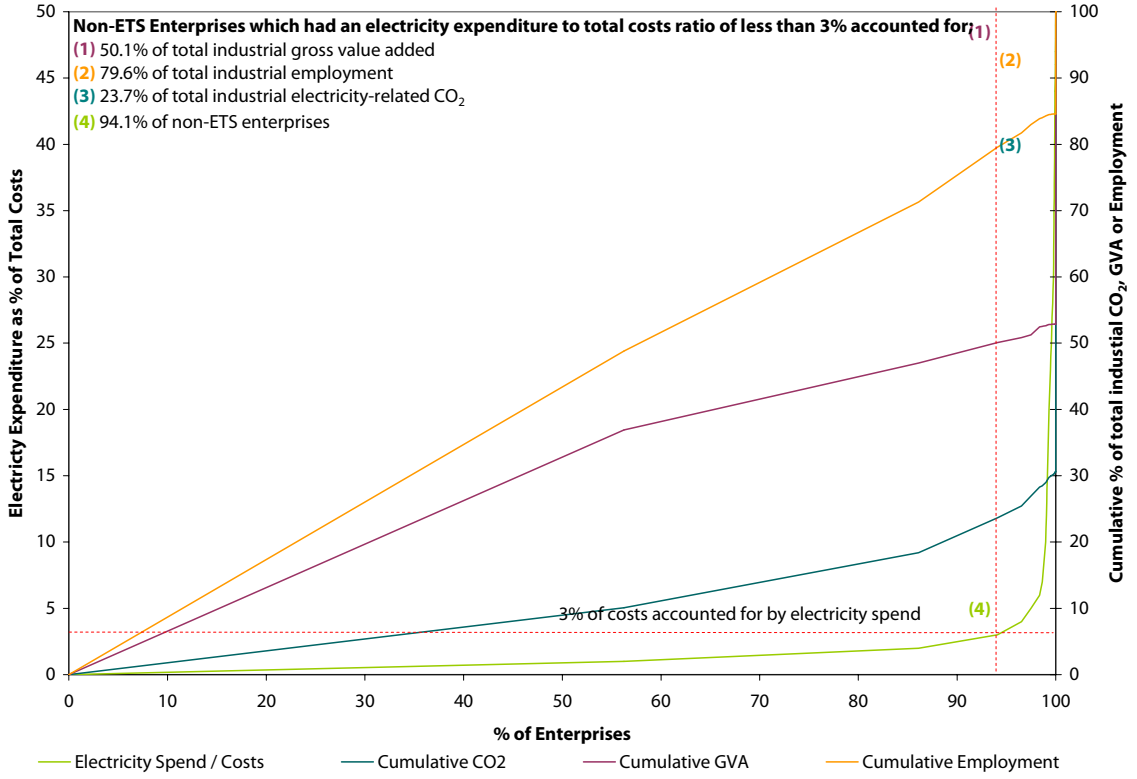
The key features of Figure 33 and Table 18 are:

- 97% of non-ETS enterprises had a fuel expenditure to direct costs ratio of less than 2%. They accounted for; 52% of total industrial GVA, 82% of total industrial employment and 10% of total industrial fuel-related CO_2.
- Only 8 non-ETS enterprises (0.2%) spent more than 20% of their costs on fuel. These 8 enterprises were responsible for 0.7% of total CO_2 emissions, 0.04% of employment and 0.03% of industry GVA.

8.3 Ratio of Electricity Bill to Direct Costs - Non Emissions Trading

Figure 34 and Table 19 present the results for the ratio of electricity costs to direct costs, assessing sensitivity to electricity price changes, including those associated with the changing cost of oil, gas and coal.

Figure 34 Electricity Expenditure to Direct Costs Ratio Analysis – Non Emissions Trading (2004)



Source: Based on CSO data.

Table 19 Electricity Expenditure to Direct Costs Ratio Analysis – Non Emissions Trading (2004)

		Cumulative Enterprises		% of Total Industry (Cumulative)			
Electricity Spend / OS	**No. of Enterprises**	**No.**	**%**	**Electricity Spend**	**GVA**	**Employment**	**Electricity Related CO_2**
0 - 1%	2,494	2,494	56.2%	13.5%	36.9%	48.8%	10.1%
1 - 2%	1,325	3,819	86.1%	24.6%	47.0%	71.3%	18.4%
2 - 3%	354	4,173	94.1%	31.7%	50.1%	79.6%	23.7%
3 - 4%	108	4,281	96.5%	34.1%	50.8%	81.7%	25.4%
4 - 5%	43	4,324	97.5%	36.1%	51.2%	83.0%	26.9%
5 - 6%	38	4,362	98.4%	37.9%	52.5%	83.9%	28.3%
6 - 7%	12	4,374	98.6%	38.2%	52.5%	84.0%	28.5%
7 - 10%	16	4,390	99.0%	38.8%	52.6%	84.3%	29.0%
10 - 20%	15	4,405	99.3%	39.9%	52.8%	84.5%	29.8%
20 - 30%	20	4,425	99.8%	40.5%	52.9%	84.6%	30.2%
30 - 50%	10	4,435	100.0%	41.1%	52.9%	84.6%	30.6%

Source: Based on CSO data.

The key features of Figure 34 and Table 19 are

- 94% of non-ETS enterprises had an electricity expenditure to direct costs ratio of less than 3%. These enterprises accounted for; 50% of total industrial GVA, 80% of total industrial employment and 24% of total industrial electricity-related CO_2.
- 10 firms (0.2%) had a ratio to direct costs in excess of 50%, representing 0.4% of electricity- related CO_2, 0.01% of industrial GVA and 0.03% of industrial employment.

9 Conclusions and Next Steps

This report is presented as a discussion document, acting as a window to further exploration, rather than providing a set of answers to certain questions relating to current climate change policy options for application in industry.

It provides an update and extension of the analysis published in 2003 (based on 1998 data), and 2004 (based on 2001 data) using more recently available (2004) data. From the CIP survey related to 2004 there have been two significant changes in the CIP with respect to energy statistics. Firstly, detailed questions on energy expenditure in 2004 were sent to all enterprises with more than 20 employees (as opposed to enterprises with an energy bill > €225,000). Secondly, these detailed energy questions are now included in the CIP on an annual basis and as a result this analysis can be updated annually. The next update will be published in 2008 and will examine data for 2005.

One of the key findings of the report is that 98% of industrial Gross Value Added (GVA) in 2004 was generated by industrial enterprises whose energy spend represented 6% or less of their direct costs.

The analysis also found that there were 70 enterprises whose energy spend to direct costs represented 10% or more of their cost base. They contributed 0.8% to total industrial GVA, 1.2% to total employment but accounted for 35% of energy related CO_2 emissions. Of these 70 enterprises, 60 were outside the ETS and accounted for 2.9% of total industrial CO_2 emissions. The remaining 10 enterprises accounted for 32% of energy related CO_2 emissions.

Additional analysis is available in an online annex entitled *Energy in Industry 2007 Report -Annex*. Go to www.sei.ie and click on "Statistics Publications".

Comments from the energy, environment, enterprise and economic policy community are most welcome.

The Census of Industrial Production Data report arising from collaborative work being carried out by CSO and SEI, under the auspices of the Energy Statistics Co-ordinating Group, which seeks to facilitate improved collection and analysis of energy statistics. SEI gratefully acknowledges the co-operation of the CSO in providing access to the anonymised source data that made this analysis possible.

Data Sources

Central Statistics Office

Department of Communication Marine & Natural Resources

International Energy Agency

Glossary of Terms

Carbon Dioxide (CO_2): A compound of carbon and oxygen formed when carbon is burned. Carbon dioxide is one of the main greenhouse gases. Units used in this report are *t* CO_2 – tonnes of CO_2, *kt* CO_2 – kilo-tonnes of CO_2 (10^3 tonnes) and *Mt* CO_2 – mega-tonnes of CO_2 (10^6 tonnes).

Carbon Intensity (kg CO_2/kWh): This is the amount of carbon dioxide that will be released per kWh of energy of a given fuel. For most fossil fuels the value of this is constant, however in the case of electricity it will depend on the fuel mix used to generate the electricity and also on the efficiency of the technology employed. Renewable sources of electricity generation, such as hydro and wind, have zero carbon intensity.

Energy Intensity: The amount of energy used per unit of activity. Examples of activity used in this report are gross domestic product (GDP), value added, number of households, employees etc. Where possible, the monetary values used are in constant prices. When this is the case the intensity is displayed as "€xx" where xx is the base year. So for instance in the case of final intensity the units are *kgoe/€95 – kilograms of oil equivalent per euro in constant 1995 prices*.

Energy Units:

- **joule (J):** Joule is the international (S.I.) unit of energy.
- **kilowatt hour (kWh):** The conventional unit of energy that electricity is measured and charged for commercially.
- **tonne of Oil Equivalent (toe):** This is a conventional standardized unit of energy and is defined on the basis of a tonne of oil having a net calorific value of 41686 kJ/kg. A related unit is the *kilogram of oil equivalent (kgoe)*, where 1 kgoe = 10^{-3} toe.

Gross and Net Calorific Value (GCV & NCV): The gross calorific value (GCV) gives the maximum theoretical heat release during combustion, including the heat of condensation of the water vapour produced during combustion. This water is produced by the combustion of the hydrogen in the fuel with oxygen to give H_2O (water). The net calorific value (NCV) excludes this heat of condensation because it cannot be recovered in conventional boilers. For natural gas, the difference between GCV and NCV is about 10%, for oil it is approximately 5%.

Gross Domestic Product: The gross domestic product represents the total output of the economy over a period.

Structural Effect: As it affects energy intensity, structural change is a change in the shares of activity accounted for by the energy consuming sub-sectors within a sector. For instance, in industry the structural effect caused by the change in emphasis of individual sub-sectors such as pharmaceuticals, electronics, textiles, steel etc in their contribution to gross domestic product.

Total Final Consumption (TFC): This is the energy used by the final consuming sectors of industry, transport, residential, agriculture and tertiary. It excludes the energy sector such as electricity generation and oil refining etc.

Total Primary Energy Requirement (TPER): This is the total requirement for all uses of energy, including energy used to transform one energy form to another (e.g. burning fossil fuel to generate electricity) and energy used by the final consumer.

Value Added: Value added is an economic measure of output. The value added of industry, for instance, is the additional value created by the production process through the application of labour and capital. It is defined as the value of industry's output of goods and services less the value of the intermediate consumptions of goods (raw materials, fuel, etc) and services.

NACE Classification

Section A Agriculture, hunting and forestry

01	Agriculture hunting and related service activities
02	Forestry logging and related service activities

Section B Fishing

05	Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing

Section C Mining and quarrying

10	Mining of coal and lignite; extraction of peat
11	Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction, excluding surveying
12	Mining of uranium and thorium ores
13	Mining of metal ores
14	Other mining and quarrying

Section D Manufacturing

15	Manufacture of food products and beverages
16	Manufacture of tobacco products
17	Manufacture of textiles
18	Manufacture of wearing apparel; dressing and dyeing of fur
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
21	Manufacture of pulp, paper and paper products
22	Publishing, printing and reproduction of recorded media
23	Manufacture of coke, refined petroleum products and nuclear fuel
24	Manufacture of chemicals and chemical products
25	Manufacture of rubber and plastic products
26	Manufacture of other non-metallic mineral products
27	Manufacture of basic metals
28	Manufacture of fabricated metal products, except machinery and equipment
29	Manufacture of machinery and equipment n.e.c.
30	Manufacture of office machinery and computers
31	Manufacture of electrical machinery and apparatus n.e.c.
32	Manufacture of radio, television and communication equipment and apparatus
33	Manufacture of medical, precision and optical instruments, watches and clocks
34	Manufacture of motor vehicles, trailers and semi-trailers
35	Manufacture of other transport equipment
36	Manufacture of furniture; manufacturing n.e.c.
37	Recycling

Section E Electricity, gas and water supply

40	Electricity, gas, steam and hot water supply
41	Collection, purification and distribution of water

Section F Construction

45	Construction

Section G Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods

50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel
51	Wholesale trade and commission trade, except of motor vehicles and motorcycles

52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods

Section H Hotels and restaurants

55	Hotels and restaurants

Section I Transport, storage and communication

60	Land transport; transport via pipelines
61	Water transport
62	Air transport
63	Supporting and auxiliary transport activities; activities of travel agencies
64	Post and telecommunications

Section J Financial intermediation

65	Financial intermediation, except insurance and pension funding
66	Insurance and pension funding, except compulsory social security
67	Activities auxiliary to financial intermediation

Section K Real estate, renting and business activities

70	Real estate activities
71	Renting of machinery and equipment without operator and of personal and household goods
72	Computer and related activities
73	Research and development
74	Other business activities

Section L Public administration and defence; compulsory social security

75	Public administration and defence; compulsory social security

Section M Education

80	Education

Section N Health and social work

85	Health and social work

Section O Other community, social and personal service activities

90	Sewage and refuse disposal, sanitation and similar activities
91	Activities of membership organisations n.e.c.
92	Recreational, cultural and sporting activities
93	Other service activities

Section P Private households with employed persons

95	Private households with employed persons

Section Q Extra-territorial organisations and bodies

99	Extra-territorial organisations and bodies

Table 20 lists the thirteen grouped NACE classifications used by CSO to aggregate sub-sectors for energy expenditure in 2004 (and in previous iterations of the CIP).

Table 20 NACE classifications used in 2004 CIP

NACE codes	Description
10 - 14	Mining and quarrying
15 - 16	Manufacture of food products, beverages and tobacco
17 - 18	Manufacture of textiles and textile products
20	Manufacture of wood and wood products
21 - 22	Manufacture of pulp, paper and paper products; publishing and printing
24	Manufacture of chemicals, chemical products and man-made fibres
25	Manufacture of rubber and plastic products
26	Manufacture of other non-metallic mineral products
27 - 28	Manufacture of basic metals and fabricated metal products
29	Manufacture of machinery and equipment n.e.c.
30 - 33	Manufacture of electrical and optical equipment
34 - 35	Manufacture of transport equipment
36 - 37, 19, 23	Manufacturing n.e.c.

Emission Factors

	t CO_2/TJ (NCV)	g CO_2/kWh (NCV)
Liquid Fuels		
Motor Spirit (Gasoline)	70.0	251.9
Jet Kerosene	71.4	257.0
Other Kerosene	71.4	257.0
Gas/Diesel Oil	73.3	263.9
Residual Oil	76.0	273.6
LPG	63.7	229.3
Naphta	73.3	264.0
Petroleum Coke	100.8	362.9
Solid Fuels and Derivatives		
Coal	94.6	340. 6
Milled Peat	116.7	420.0
Sod Peat	104.0	374.4
Peat Briquettes	98.9	355.9
Gas		
Natural Gas	56.8	204.5
Electricity (2005)	176.8	636.5

References

Bosseboeuf D. et al, 1999, *Energy Efficiency Indicators – The European Experience*. Published by ADEME and the European Commission.

Bosseboeuf D. et al, 2005, *Energy Efficiency Monitoring in the EU-15*. Published by ADEME and the European Commission. Available from http://www.odyssee-indicators.org/Publication/publications.php.

Central Statistics Office, Various Years, *Census of Industrial Production*. Available from www.cso.ie

Commission of the European Communities, 2007, *An Energy Policy for Europe.* Available from http://ec.europa.eu/energy/energy_policy/documents_en.htm

Environmental Protection Agency, 2006, *National Allocation Plan 2008-2012*. Available from http://www.epa.ie/downloads/pubs/air/etu/

European Union, 2006, *Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services.* Available from http://ec.europa.eu/energy/demand/legislation/end_use_en.htm.

Government of Ireland, 2007, *Energy White Paper 2007 Delivering a Sustainable Energy Future for Ireland the Energy Policy Framework 2007 – 2020*. Available from http://www.dcmnr.gov.ie/Energy/Energy+Planning+Division/Energy+White+Paper.htm.

Government of Ireland, 2007, *National Climate Change Strategy 2007-2012*. Available from http://www.environ.ie/en/PublicationsDocuments/FileDownLoad,1861,en.pdf.

Odyssee, 2006, *Introduction and Definition to ODEX Indicators.* Available from http://www.odyssee-indicators.org/Indicators/PDF/odex.pdf.

Sustainable Energy Ireland, 2003, *Profiling energy consumption and CO_2 emissions in industry – Sensitivity to carbon taxation and emissions trading*. Available from http://www.sei.ie/index.asp?locID=71&docID=-1

Sustainable Energy Ireland, 2004, *Profiling energy consumption and CO_2 emissions in industry – 2004 Update*, Available from http://www.sei.ie/index.asp?locID=70&docID=-1

Sustainable Energy Ireland, 2006, *Response to Green Paper Towards a Sustainable Energy Future for Ireland.* Available from http://www.dcmnr.gov.ie

Sustainable Energy Ireland, 2006, *Energy in Ireland – Trends, issues, forecasts and indicators. 1990 – 2005*. Available from http://www.sei.ie/index.asp?locID=70&docID=-1.

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NDP
National Development Plan 2007 - 2013

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