Energy in Ireland 1990–2003

Trends, issues and indicators

SUSTAINABLE ENERGY IRELAND

Energy Policy Statistical Support Unit

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Energy Policy Statistical Support Unit

Sustainable Energy Ireland

Sustainable Energy Ireland (SEI) is Ireland's national energy agency. Established on May 1st 2002 under the Sustainable Energy Act 2002, SEI has a mission 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. 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 the Green Paper on Sustainable Energy and the National Climate Change Strategy as provided for in the National Development Plan.

SEI manages programmes aimed at:

- 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.

SEI is responsible for advising Government on policies and measures on sustainable energy; implementing programmes agreed by Government and stimulating sustainable energy policies and actions by public bodies, the business sector, local communities and individual consumers.

Energy Policy Statistical Support Unit

Sustainable Energy Ireland 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, meeting international reporting obligations and informing investment decisions. Based in Cork, the Energy Policy Statistical Support Unit 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 – the year 2003

- The decoupling of energy and emissions growth from economic growth that began in 2002 continued in 2003. Economic growth, as measured by Gross Domestic Product (GDP), grew by 3.7% in 2003, energy consumption remained flat at 0.2% growth and energy-related emissions fell by 2.1%.
- The factors contributing to this decoupling include:
    - It was the first full year of operation of two high efficiency electricity generation plant;
    - An increase in the share of natural gas in the fuel mix for electricity generation;
    - A decrease in the consumption of energy in industry coupled with an increase in the share of natural gas in the fuel mix of industry.
- Natural gas was the only fuel that increased in Ireland's primary energy supply in 2003. Its use increased by 10.5% compared with declining consumption for all the other fuels. Natural gas accounts for 25% of TPER but oil remains the dominant fuel with a share of 54%.
- While primary energy requirement grew by only 0.2% in 2003, total final consumption (TFC) grew by 2.3%. This was achieved mainly as a result of the improved electricity generation efficiency.
- The primary energy intensity of Ireland's economy fell by 5.8% in 2003, indicating an improvement in the energy productivity of the economy.
- Provisional figures indicate that total greenhouse gas (GHG) emissions fell to 25% above 1990 levels in 2003 (down from 29% above in 2002 and 31% above in 2001). Energy-related (excluding international air transport) CO_2 emissions fell by 1.3% in 2003.
- The share of GHG emissions from energy-related activities was 66% in 2003 compared to an EU average of 80%.
- Transport energy-related CO_2 emissions reached the same level (25%) as residential in 2003.
- There was a 9% decrease in renewable energy production in 2003, as a result of a 35% reduction in hydro energy in 2003 compared to 2002. Renewable energy accounted for 4.4% of gross electricity consumption in 2003.
- Electricity from CHP accounted for 2.4% of electricity generation in 2003.
- Ireland's energy import dependency reached 89% in 2003, up from 65% in 1990. Imported oil and gas accounted 76% of TPER in 2003.
- Electricity prices to Irish industry have risen by 29% between 2000 and 2004. In January 2004 Ireland ranked 4th most expensive for this category of electricity consumption and was 27% above the EU average.
- 3 Mtoe or 20% of TPER is lost in the transformation of primary energy into electricity. It should be noted however that this compares favourably with 2002 when 22% of TPER was lost in electricity transformation.
- The commercial and public services sector replaced industry as the largest electricity consuming sector in 2003.

Electricity Generation

- The efficiency of electricity supply in 2003 increased by three percentage points to 40%.
- Primary energy required to generate Ireland's electricity demand fell by 4% in 2003 in spite of a 2.1% increase in final electricity consumption.
- The carbon intensity of electricity fell for the second year in a row dropping by 9.3% in 2003. In 2003, 651 g CO_2 was associated with every kWh of electricity consumed in aggregate. This compares with 925 g CO_2/kWh required in 1990.
- Natural gas now accounts for 47% of fuel used in electricity generation. The amount of oil used dropped by 37% in 2003 compared with 2002.
- Net imports of electricity amounted to 100 ktoe in 2003.

Industry

- Energy consumption in industry fell by 1% in 2003. This reduction was in part due to closures such as Irish Fertilizer Industries in 2002. The 24% increase in coal consumption in industry is notable in this context.
- Oil remains the dominant fuel with a share of 34% of final energy consumption in industry.
- Electricity is the second most dominant fuel (on a final basis) in industry at a share of 29%. It experienced the largest reduction in consumption in the industrial sector in 2003 of 10% compared with the other fuels.

Transport

- Transport energy grew by 123% over the period 1990 – 2003. Growth in 2003 was 1.2%, which was down on the 3.3% in 2002 and the average annual rate of 6.9% between 2000 and 2002.
- The share of diesel consumption in transport was up one percentage point to 45% in 2003.
- Private car ownership rose to 379 cars per 1000 of population in 2003 from 370 in 2002.
- Cars in the 1.7 – 1.9 litre range experienced the highest growth over the 1990 – 2003 period increasing by 478%. Cars with engines greater than 1.9 litre experienced the second highest growth (290%).

Residential

- Energy consumption in the residential sector increased by 3.4% in 2003. However, when climate corrected this increase was 2.5%.
- The energy consumption per household increased by 1.2% in 2003 but when this is climate corrected the increase is 0.3%. Fossil fuel consumption per household increased by 1.7% while electricity consumption per household fell by 0.3%.
- Natural gas consumption in the residential sector increased by 13% in 2003 whereas the consumption of coal, peat and briquettes declined.
- Energy-related CO_2 emissions from the residential sector fell by 1.9% mainly as a result of the lower carbon intensity of electricity and an increase in natural gas in the fuel mix.

Commercial and Public Services

- The commercial and public services sector experienced the highest growth in final energy consumption in 2003. Growth in 2003 was 8.3%.
- Growth in services was dominated by a 17% increase in electricity consumption and a 4% increase in natural gas consumption. Oil consumption in services fell by 2% in 2003.
- Unit energy consumption per employee in the services sector increased by 4.6% in 2003. This was made up of a 0.2% decline in the fuel consumption per employee but a 13% increase in the electricity consumption per employee.

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1 Introduction

Energy in Ireland 1990 - 2003 continues SEI's annual review of energy trends, issues and indicators prepared by SEI's Energy Policy Statistical Support Unit, based in Cork. This Unit was established to deliver on the remit of Sustainable Energy Ireland in respect of the development, collation, analysis, publication and maintenance of national energy statistics, indicators and trends.

The report examines energy trends in Ireland since 1990, with particular emphasis on 2003, discusses the underlying causes and relates the trends to Government and EU targets in order to inform the development of the policies and measures employed to meet the targets. The year 1990 is significant as a baseline, not least because, under the Kyoto Protocol and associated EU targets, Ireland's obligations to contain emissions of greenhouse gases, of which the bulk is CO_2 derived from energy utilization, are referenced against relevant emissions for that year.

This report is based on data compiled by SEI's Energy Policy Statistical Support Unit that is used to generate the annual energy balance and to fulfil Ireland's legal obligations in completing questionnaires issued by EUROSTAT and the International Energy Agency. The authors are grateful to the Government Departments and Agencies, energy suppliers and distributors for the provision of this data and acknowledge in particular those listed at the end of this report, who provided additional data for this report.

Energy balance data presented in this report is the most up-to-date at the time of writing. Balance data is updated whenever more accurate information is known. To obtain the most up-to-date balance figures visit the statistics section of the Info Centre on Sustainable Energy Irelands website
(http://www.sei.ie/content/content.asp?section_id=864).

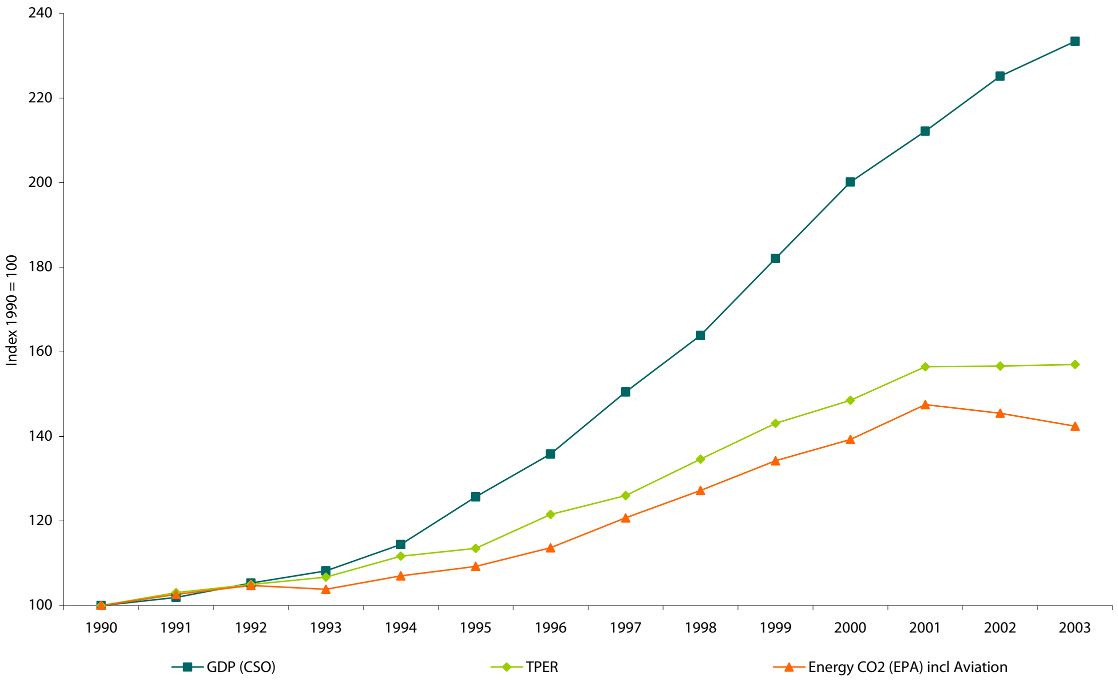
Feedback and comment on the report are welcome and should be addressed by post to the address on the rear cover or by email to EPSSU@SEI.ie.

2 Energy Trends

This section provides an overview of energy trends in Ireland, covering the period 1990 – 2003, and with a particular focus on 2003. Ireland's total energy supply (gross energy demand or consumption) is examined first, both in terms of the mix of fuels used and consumption by sector. Energy demand, the amount of energy used by final consumers, is then explored. The link between energy consumption, economic activity and the impacts of structural and efficiency changes are also discussed and finally electricity production is examined in its own right.

Energy supply depends on i) the demand for energy and ii) how that demand is delivered. Energy demand in turn is driven primarily by economic activity. Throughout the 1990's economic growth has been particularly strong, especially from 1993 onwards. This resulted in GDP (a measure of economic growth) in 2000 being almost double that of 1990.

Figure 1: Index of Gross Domestic Product, TPER and Energy-Related CO_2



Source: Based on SEI, CSO and EPA data.

Figure 1 shows the relative decoupling of total primary energy requirement (TPER, also known as gross inland consumption) from economic growth since 1992. This is a result of changes in the structure of the economy and improvements in energy efficiency. To a lesser extent, the decoupling of CO_2 emissions[1] from energy consumption is also evident, particularly since 1993.

The most dramatic change in the period occurred in 2002. While there was a 6.9% increase in GDP on the previous year, primary energy increased only very slightly (0.1%). In addition, energy-related CO_2 emissions fell by 1.4%[2] showing the most notable decoupling in both energy and CO_2 emissions from economic growth. This trend continued in 2003 with 3.7% increase in GDP, energy consumption remaining essentially constant (0.2% increase) and energy related CO_2 emissions decreasing again by 2.1%[3].

[1] Energy-related CO_2 emissions shown here are sourced from the Environmental Protection Agency (EPA) and cover all energy related CO_2 emissions associated with TPER, including emissions associated with international air transport. These are usually excluded from the national GHG emissions inventory in accordance with the reporting procedures of the UN Framework Convention on Climate Change (UNFCCC) guidelines.

[2] The reduction in energy related CO_2 was 2% in 2002 if international air transport emissions were excluded.

[3] The reduction in energy related CO_2 was 1.3% in 2003 if international air transport emissions were excluded.

The factors contributing to this change are discussed in more detail later in the report but could be summarised as follows:

- the commissioning of additional high efficiency electricity power plant in 2002 with 2003 being the first full year of operation;
- changes in the fuel mix for electricity generation as a result of the commissioning of the new plant and an increase in imports of electricity;
- lower consumption of energy in industry in general and gas being the only fuel used in industry that experienced growth;
- a slow down in the rate of growth of energy consumption in transport.

It is not anticipated that the downward trend in CO_2 emissions will continue in the long term. Depending on future energy demand growth levels, there may however, be further reductions brought about by the combined effects of the projected increase in wind generation and the planned large scale CHP plant at Aughinish.

A number of distinct growth rate patterns are evident in figure 1. GDP growth averaged 2.7%/annum between 1990 and 1993, rising to 8.6%/annum from 1993 to 1997 and to 10.0%/annum between 1997 and 2000. Over the decade as a whole, GDP growth was 7.2%/annum on average, representing a doubling in 2000. Growth slowed to 6.2% in 2001 and increased to 6.9% in 2002 before slowing back to 3.7% in 2003 (€97,756 million at constant 1995 prices in 2003).

Table 1 tabulates the economic, energy and CO_2 growth rates for the period 1990 – 2003 using five yearly intervals. It emphasizes a number of the key features already mentioned, including the high GDP growth rates compared with those for energy and CO_2, the notable increases in all three in the latter part of the nineties and the significant decoupling that started in 2002 and continued in 2003.

Table 1: GDP, TPER and CO_2 Growth Rates

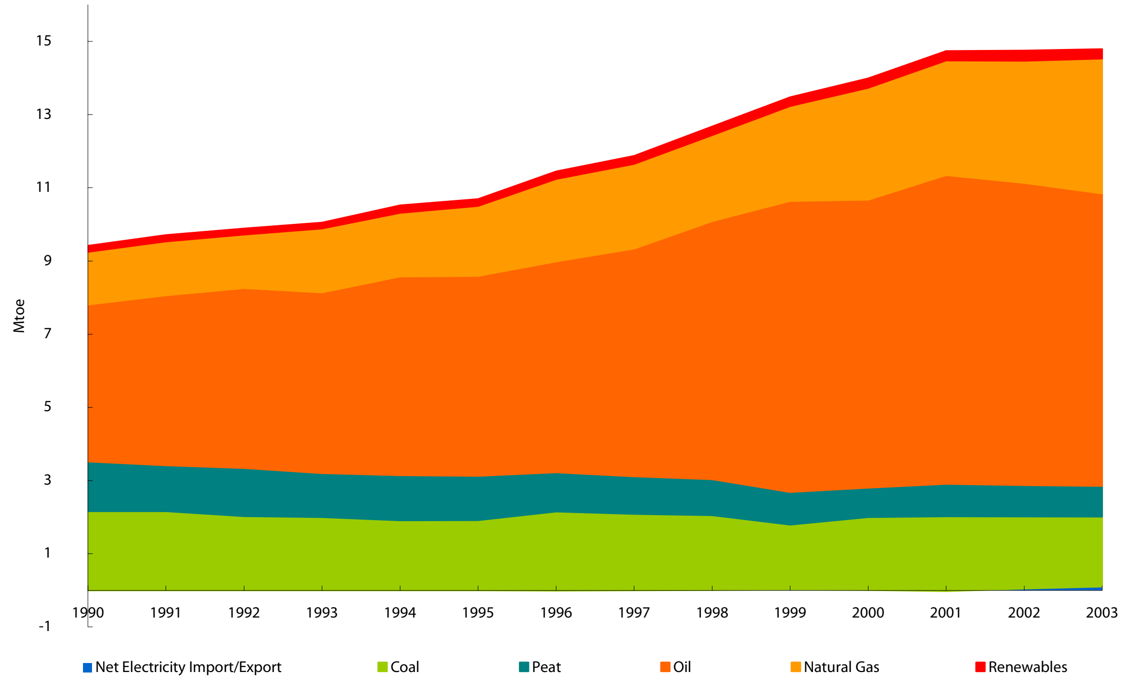
	Growth %	**Average annual growth rates %**				
	1990 – '03	**1990 – '03**	**1990 – '95**	**1995 – '00**	**2000 – '03**	**2003**
GDP	133.4	6.7	4.7	9.8	5.3	3.7
TPER	57.0	3.5	2.6	5.5	1.9	0.2
Energy CO_2	42.4	2.8	1.8	5.0	0.7	-2.1

2.1 Energy Supply

Ireland's energy supply is discussed in terms of changes to the total primary energy requirement (TPER), defined as the total amount of energy consumed within Ireland in any given year. This represents the consumption of energy in all the activities of Irish life and also includes the energy requirements for the conversion of primary sources of energy into forms that are useful for the final consumer, for example electricity generation and oil refining. These conversion activities are not wholly directly related to the level of economic activity that drives energy use but are dependent to a large extent, as in the case of electricity, on the efficiency of the transformation process and the technologies involved.

Figure 2 illustrates the trend in energy supply over the period 1990 – 2003, emphasizing changes in the fuel mix.

Figure 2: Total Primary Energy Requirement (Mtoe)



Over the period 1990 – 2003 Ireland's total annual energy requirement grew in absolute terms by 57% (average annual growth rate of 3.5%) but only increased very slightly in 2003 (0.2%). The individual fuel growth rates and shares are shown in table 2.

Table 2: Growth Rates and Shares of TPER Fuels

	Growth %	**Average annual growth rates%**					**Shares %**	
	1990 – '03	**1990 – '03**	**1990 – '95**	**1995 – '00**	**2000 – '03**	**2003**	**1990**	**2003**
Coal	-11.6	-0.9	-2.4	0.7	-1.3	-3.2	23.0	12.9
Peat	-38.3	-3.6	-2.2	-7.9	1.4	-1.9	14.4	5.7
Oil	86.6	4.9	4.9	7.6	0.5	-3.2	45.5	54.1
Natural Gas	154.8	7.5	5.8	9.8	6.4	10.5	15.4	24.9
Renewables	54.2	3.4	2.6	6.2	0.0	-8.9	1.8	1.8
Total	57.0	3.5	2.6	5.5	1.9	0.2		

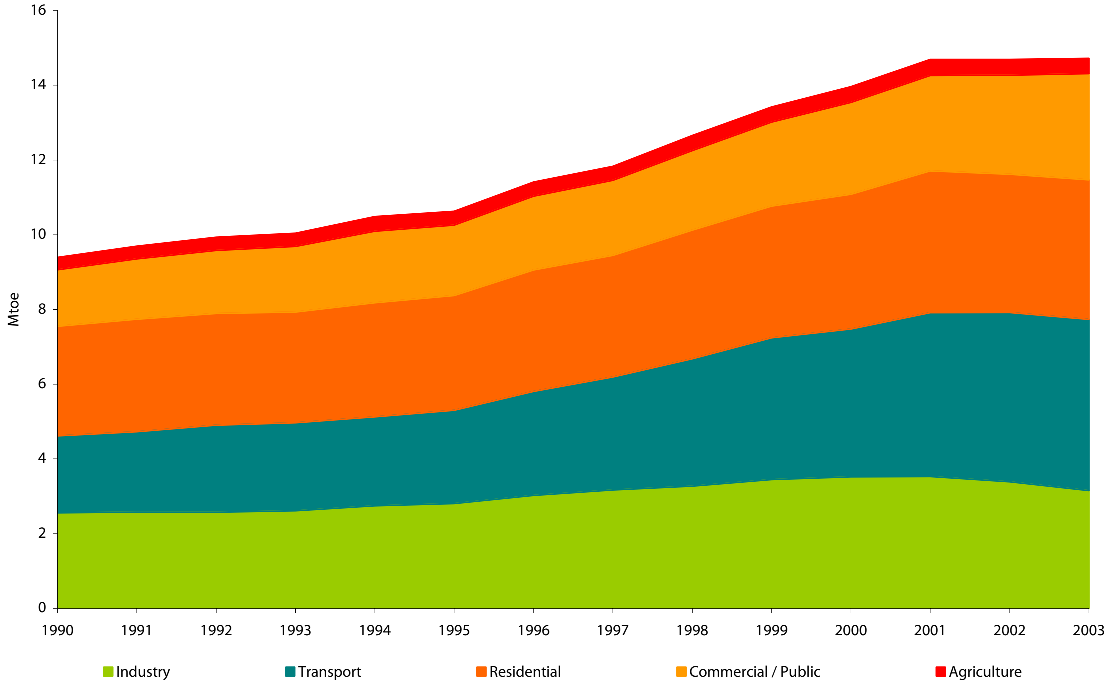
The following are the main trends in national fuel share over the period:

- Oil continues to remain the dominant energy source and with that dominance increasing from a share of 46% in 1990 to a peak of 59% in 1999. Its share reduced back to 54% by 2003. Oil consumption decreased by 3.2% in 2003, the most significant reduction in the period.
- The relative share of coal in energy supply declined from 23% to 13%. In absolute terms over the period coal declined by 11.6%. In 2003 the use of coal decreased by 3.2% over the previous year.
- Peat experienced a decline in absolute terms over the period of 38% with its share of national energy supply also falling from 14% to 5.7%. In 2003, peat consumption decreased by 1.9% compared with 2002, primarily in electricity generation.
- Natural gas use increased by 155% (7.5%/annum) over the period, its share of energy supply increasing from 15% to 25%. Growth of natural gas consumption in 2003 was 10.5%, making it the only fossil fuel that experienced growth for the second year running. This growth was primarily in electricity generation (13.9% increase) but the residential sector also saw an increase in gas consumption (13.3%).

- Renewable energy grew by 54% (3.4% per annum) over the period from a very small base. This growth is keeping pace with TPER growth, which has resulted in renewables maintaining its share at around 1.8%. The 9% decrease in renewable energy in 2003 was as a result of the 35% reduction in hydro production in 2003 compared to 2002.

Figure 3 allocates Ireland's energy supply to each sector of the economy, according to their energy demand. Where fuels are used directly by a particular sector this is a straightforward allocation. Regarding electricity, the primary energy associated with each sector's electricity demand is calculated. The energy used directly is then added to the primary energy associated with electricity demand to yield the total energy supply for each sector.

Figure 3: Total Primary Energy Requirement by Sector[4]



This gives a more complete measure (than the amount of final energy, accounted for in the gas, oil, electricity and coal bills) of the impact that each of the sectors has on energy consumption and subsequent CO_2 emissions. Figure 3 illustrates the sectoral share of TPER in 1990 and 2003.

It is notable that only the transport and the commercial and public services (or "tertiary") sectors have increased their share with transport being the dominant sector at 31% in 2003.

Table 3 tabulates the growth rates of the different sectors in terms of TPER and also provides the shares for 1990 and 2003.

[4] International air transport kerosene is included in the transport sector in these graphs. Later graphs showing CO_2 emissions by sector omits air international transport energy emissions following UN Intergovernmental Panel on Climate Change (IPCC) guidelines.
The effects of cross border trade and smuggling of diesel and petrol are not included in this analysis. The Society of the Irish Motor Industry (SIMI) and ESB International (ESBI) estimate this results in exports of around 10% of transport energy consumption.

Table 3: Growth Rates and Shares of TPER by Sector

	Growth %	Average annual growth rates%					Shares %	
	1990 – '03	**1990 – '03**	**1990 – '95**	**1995 – '00**	**2000 – '03**	**2003**	**1990**	**2003**
Industry	23.1	1.6	1.9	4.6	-3.7	-7.1	27.2	21.4
Transport	122.8	6.4	3.9	9.7	5.0	1.3	21.9	31.2
Residential	27.1	1.9	0.9	3.2	1.2	0.9	31.3	25.4
Commercial / Public	88.1	5.0	4.4	5.5	5.0	7.2	16.1	19.3
Agriculture	23.7	1.6	2.8	2.5	-1.6	-2.7	3.5	2.8

In absolute terms sectoral primary energy consumption grew as follows;

- Industry energy consumption grew by 23% over the period 1990 – 2003 (1.6%/annum). In 2002 energy consumption declined by 4%, due to a significant reduction in oil consumption and improved efficiency in electricity generation. Energy consumption was reduced by a further 7.1% in 2003, the first full year with no fertilizer production and of the operation of the two new CCGT power plants.

- Transport energy consumption grew by 123% (6.4%/annum). Growth in 2003 was 1.3%, down from 10.5% in 2001, 3.5% in 2002 and below the average annual growth rates of the early 1990's. There was a 0.6% reduction in petrol consumption in 2003 and a 0.3% increase in kerosene, suggesting the low growth was due to reduced private car transport and a slow down in air travel growth (or increased refuelling outside of Ireland).

- Residential primary energy consumption grew by 27% (1.9%/annum) over the period. Consumption in 2003 was 0.9% higher than in 2002, due a 3.4% increase in final energy consumption in the residential sector being offset somewhat by the higher efficiency of electricity generation.

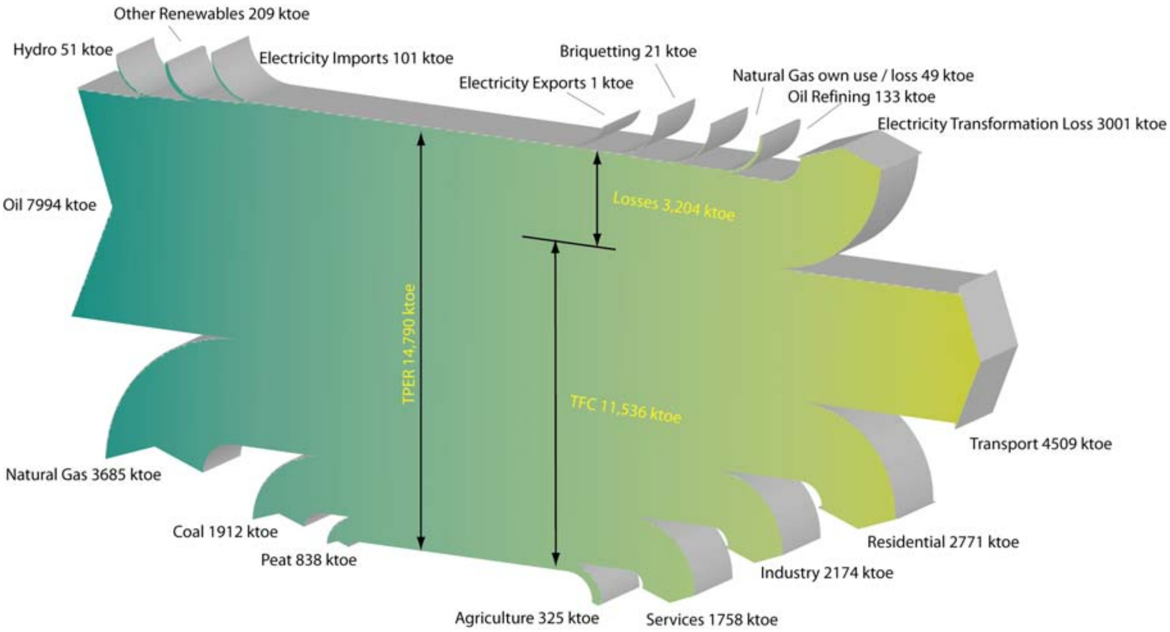
- Commercial and public services (also known as tertiary) consumption of primary energy grew by 88% (5%/annum). Growth in 2003 was 7.2%, due largely to a 17% increase in gas demand, making it the fastest growing sector in 2003 and the sector that experienced the second highest growth after transport over the period as a whole.

- Agriculture energy consumption grew by 24% (1.6%/annum). There was a 2.7% reduction in 2002.

2.2 Energy Balance for 2003

Figure 4 shows the energy balance for Ireland in 2003 as a flow diagram. This illustrates clearly the significance of each of the fuel inputs as well as showing how much energy is lost and where final energy is used.

Figure 4: Energy Flow in Ireland 2003[5]



Note: Some statistical differences exit between inputs and outputs

The dominance of oil as a fuel and the small contribution of renewables (hydro and other renewables) are clearly shown in this graphical representation. Although there was a 3.2% reduction in oil consumption, the share of oil accounted for by transport increased to 56% (2% points up on 2002), which is the largest of the end use sectors.

Also notable is the large amount of energy (3,001 ktoe or 20% of TPER) lost in the transformation of primary energy to electricity. It should be noted that this, however, represents 2 percentage points improvement on 2002 when 22% of TPER went to transformation losses.

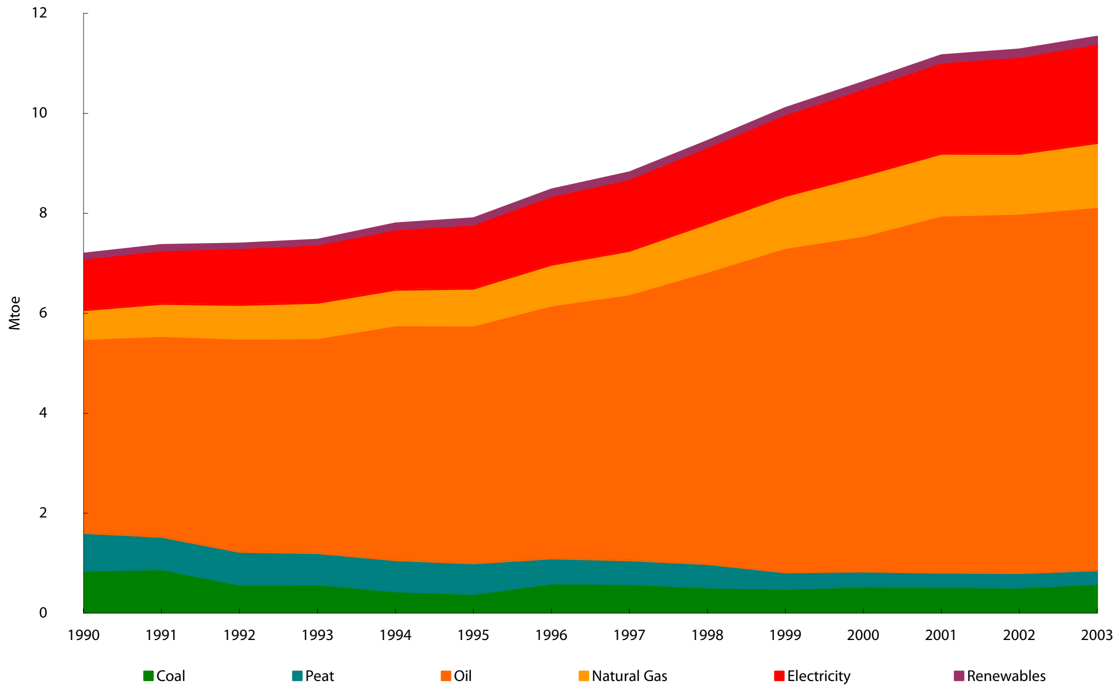
2.3 Energy Demand

Final energy demand is a measure of the energy that is delivered to energy end users in the economy to undertake activities as diverse as manufacturing, movement of people and goods, essential services and other day-to-day energy requirements of living. This is also known as *Total Final Consumption (TFC)* and is essentially total primary energy consumption less the quantities of energy required to transform primary sources such as crude oil into forms suitable for end use consumers such as refined oils, electricity, patent fuels etc. (Transformation, processing or other losses entailed in delivery to final consumers are known as "energy overhead".)

Figure 5 shows the shift in the pattern of final energy demand by fuel over the period 1990 – 2003.

[5] All energy inputs shown here represent the sum of indigenous production plus, where applicable, net imports i.e. imports minus exports.

Figure 5: Total Final Consumption by Fuel



Ireland's TFC in 2003 was 11.5 Mtoe, an increase of just 2.3% on 2002 and 60% above 1990 levels (representing an average growth rate of 3.7% per annum). This increase in final consumption was achieved with just a 0.2% increase in primary energy consumption, again pointing largely to the impact of increased efficiency of electricity generation during the year.

There have been a number of changes in the growth rates and respective shares of individual fuels in final consumption over the period, as shown in table 4.

Table 4: Growth Rates and Shares of TFC Fuels

	Growth %	**Average annual growth rates%**					**Shares %**	
	1990 – '03	**1990 – '03**	**1990 – '95**	**1995 – '00**	**2000 – '03**	**2003**	**1990**	**2003**
Coal	-30.9	-2.8	-14.8	6.8	3.5	15.2	11.8	5.1
Peat	-64.2	-7.6	-4.1	-13.2	-3.6	-7.6	10.5	2.4
Oil	87.5	5.0	4.2	7.1	2.7	1.1	53.8	63.0
Natural Gas	122.2	6.3	5.1	10.3	2.1	6.8	8.0	11.1
Electricity	92.0	5.1	4.5	6.3	4.4	2.1	14.3	17.2
Renewables	39.2	2.6	3.6	1.5	2.7	-2.9	1.5	1.3
Total	60.3	3.7	1.9	6.1	2.8	2.3		

The most significant changes can be summarised as follows:

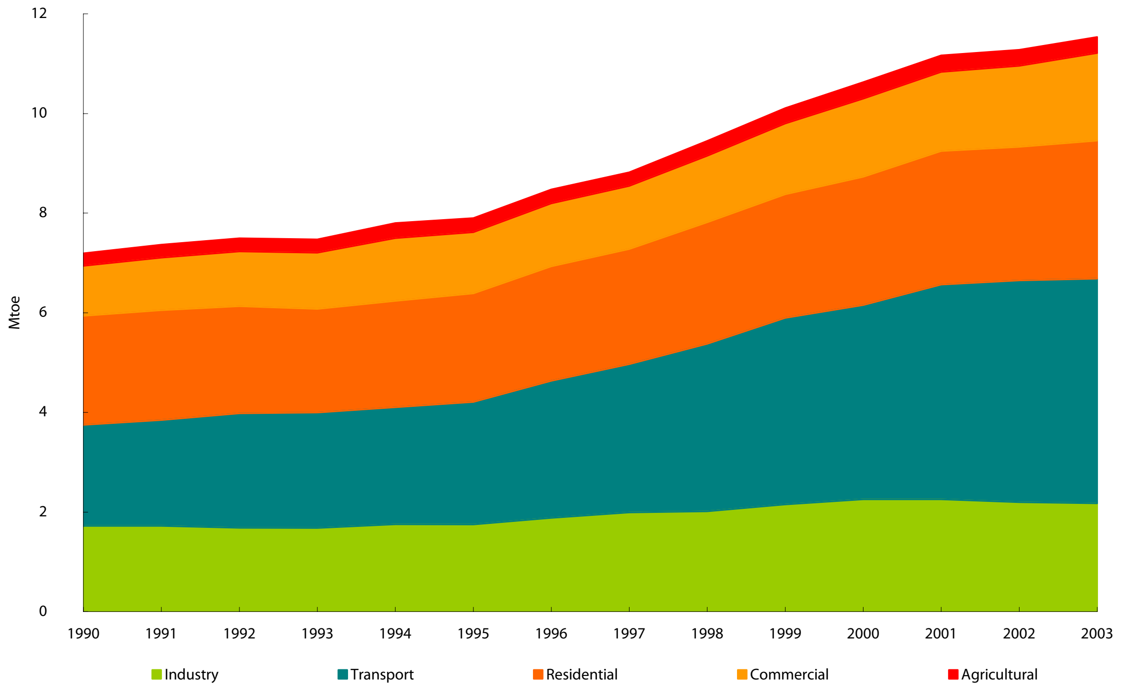
- Final consumption of coal experienced the highest growth in 2003 with consumption increasing by 77 ktoe to 585 ktoe. Most of this 15% increase occurred in industry.
- Natural gas has shown the highest growth rate over the 1990 – 2003 period increasing by 122% and averaging 6.3% per annum. The share of natural gas in final consumption increased from 8% to 11%. Final consumption of natural gas increased by 6.8% in 2003 to 1.3 Mtoe, with the largest increase occurring in the residential sector.
- The share of electricity in final consumption rose from 14% to 17% during the 1990 – 2003 period. The consumption of electricity by end users was 92% higher at the end of the period (indicating a 5.1% average

annual growth). Electricity consumption grew by 2.1% in 2003, considerably less than the 6.5% growth in 2002, due to the 10% reduction in demand in industry.

- Over the 1990 – 2003 period, oil consumption grew by 87.5% (5%/annum) and its share of TFC increased from 54% to 63%. Consumption of oil by final consumers grew by just 1.1% in 2003. This rate of growth was slightly higher than in 2002 (0.6%), due to increased growth in the residential sector.
- Peat consumption dropped by 64% between 1990 and 2003. In 2003 final consumption of peat (including briquettes) fell by 7.6%.

Figure 6 also shows the trend in TFC over the period, here allocated to each of the sectors of the economy.

Figure 6: Total Final Energy Consumption by Sector



Over the period the relative weighting of the sectors has changed. Transport has continued to increase its dominance as the largest energy consuming sector (on a final energy basis) while the share of industry and residential have decreased.

Table 5: Growth Rates and Shares of TFC by Sector

	Growth %	Average annual growth rates %					Shares %	
	1990 – '03	1990 – '03	1990 – '95	1995 – '00	2000 – '03	2003	1990	2003
Industry	26.3	1.8	0.3	5.2	-1.2	-1.0	23.9	18.8
Transport	122.6	6.3	4.0	9.7	4.9	1.2	28.2	39.1
Residential	26.5	1.8	-0.1	3.4	2.5	3.4	30.4	24.0
Commercial / Public	74.8	4.4	4.1	5.0	3.9	8.3	14.0	15.2
Agriculture	29.0	2.0	2.7	3.0	-0.9	-1.2	3.5	2.8

The changes in growth rates are tabulated in table 5 and summarised as follows.

- Transport final energy consumption increased by 123% over the period 1990 – 2003, reaching a consumption figure of 4.5 Mtoe in 2003. This represents an average annual growth rate of 6.3% and transport's share of TFC increased from 28% to 39%. Growth in 2003 was 1.2%, down from 3.3% in 2002 and somewhat lower than the 11% recorded for 2001 and even lower than the average annual growth rate for the early 1990's of 4%. This points to a possible reduction in private car transport and a slowdown in growth of air travel (or an increase in refuelling outside of Ireland).

- Final energy consumption in the residential sector during 2003 was 2.8 Mtoe, a 3.4% growth on 2002, in spite of a TPER growth of only 1%. Over the 1990 – 2003 period residential energy consumption grew by 26.5% in real terms or a 1.8% average annual growth rate. Its share of TFC decreased from 30% in 1990 to 24% in 2003.
- Industry's final consumption fell by 1% to 2.2 Mtoe in 2003. Over the 1990 – 2003 period industry experienced an average growth rate of 1.8% per annum (or 26% in absolute terms) and its share of TFC dropped from 24% to 19%.
- The commercial and public services sector is the only other sector along with transport to increase its share in final consumption over the period. This increased from 14% in 1990 to 15.2% in 2003. In absolute terms, final energy consumption grew by 75% to 1.8 Mtoe (4.4% per annum) over the period. This makes it the second fastest growth sector behind transport in terms of energy use albeit from a lower base. Growth in 2003 was 8.3% making it the fastest growing sector in this year, due mostly to a 17% increase in electricity consumption.
- The agricultural sector's relative share fell from 3.5% in 1990 to 2.8% in 2003 although final energy consumption grew by 29% to 0.3 Mtoe (2% per annum). In absolute terms, agriculture also experienced a decline of 1.2% in energy consumption in 2003.

2.4 Energy Intensities

Energy intensity is defined as the amount of energy required to produce some functional output. In the case of the economy the measure of output is generally taken to be gross domestic product (GDP)[6]. GDP measured in constant prices is used to remove the influence of inflation. The inverse of energy intensity represents the energy productivity of the economy.

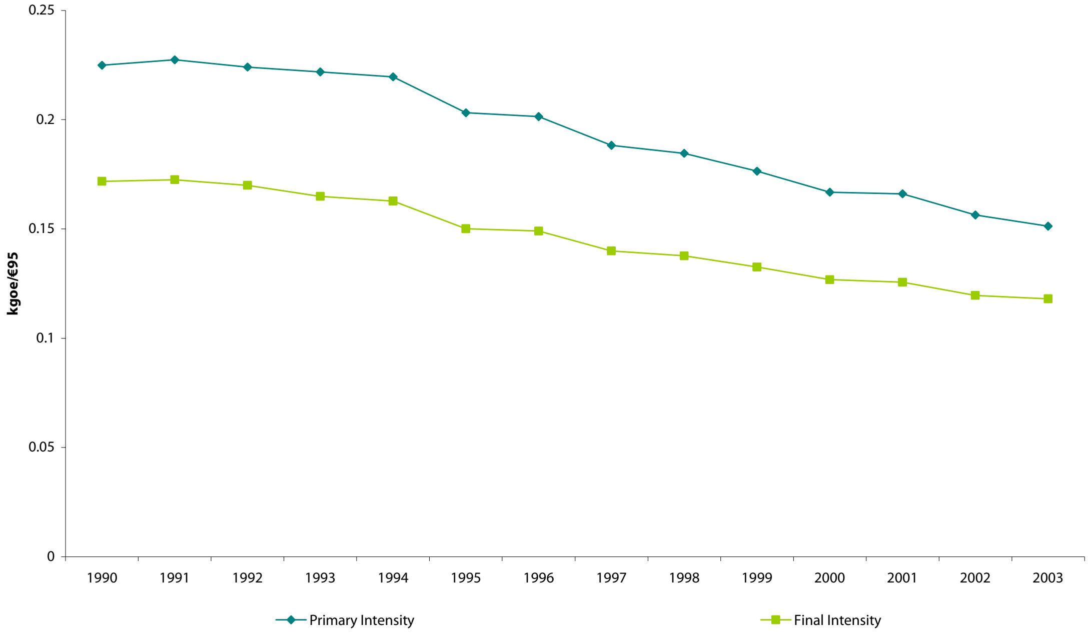
Figure 7 shows that the intensity of both primary and final energy requirements has been falling since 1990. The primary energy intensity of the economy fell by 33% between 1990 and 2003 (3% per annum). In 1990 it required 0.22 kilograms of oil equivalent (kgoe) to produce one euro of GDP (in constant 1995 values) whereas in 2003 only 0.15 kgoe was required. This would suggest that the economy is continuing to become more energy efficient.

Figure 7 shows the trend in both primary (TPER/GDP) and final (TFC/GDP) energy intensities (at constant 1995 prices). The difference between these two trends reflects the amount of energy required in the transformation from primary energy to final energy – primarily used for electricity generation. Throughout the 1990's there has been a slight convergence of these trends, particularly since 1994, mostly reflecting the increasing efficiency of the electricity generation sector. The recent improvements in the transformation sector is illustrated particularly in 2002 and 2003 when primary intensity fell at a faster rate than final intensity. The rates of decrease for primary intensity were 4.8% and 5.8% for 2002 and 2003 respectively whereas for final intensity the respective figures were 1.3% and 3.3%.

Newer transformation plant coming on stream, such as combined cycle gas turbine generators (CCGT), tends to be of higher efficiency and has contributed to increasing the aggregate efficiency of the transformation process. In August 2002, the 392 MW Dublin Bay Power CCGT plant was commissioned, thus improving 2002 generating efficiency. Huntstown's 343 MW CCGT plant also contributed late in 2002 and these development had full effect in 2003 with both plants operational for the full year. Finally, increasing contributions from CHP and renewable sources also bring the trends closer together.

[6] It can be argued that in Ireland's case, gross national product (GNP) should be used to address the impacts due to the practice of transfer pricing by some multinationals. The counter argument is that energy is used to produce the GDP and by using GNP some of the activity would be omitted. The practice internationally is to use GDP, so for comparison purposes it is sensible to follow this convention.

Figure 7:   Primary and Final Energy Intensity



There are many factors that contribute to how the trend in energy intensity evolves. These factors may be technological efficiency, choice of fuel mix, economies of scale and not least the structure of the economy. Economic structure in Ireland's case has changed considerably over the past twenty years. The structure of today's GDP has shifted in the direction of the high value added sectors such as pharmaceuticals electronics and services. Relative to traditional "heavier" industries, such as car manufacturing and steel production these more recently added sectors are not highly energy intensive.

Energy intensity will continue to show a decreasing trend if, as expected, the structure of the economy continues to move away from low value-added high energy consuming sectors to one that is dominated by high-value added low energy consuming sectors. This results in a more productive economy from an energy perspective but does not necessarily mean that the actual processes used are more energy efficient. There may therefore still be room for improvement.

Other factors apart from the new electricity generation stations that contributed to reductions in intensity included structural changes in industry such as the cessation of steel production in 2001 and fertiliser production late in 2002.

2.5 Electricity Generation

Figure 8 shows graphically the flow of energy in electricity generation. The relative size of the useful final electricity consumption to the energy lost in transformation and transmission is striking. These losses represent 60% of the energy inputs, but they are 3% points down on 2002. The small contribution from renewables, (hydro, wind and landfill gas) is also notable as is the dominance of gas in the generation fuel mix.

Figure 8: Flow of Energy in Electricity Generation 2003

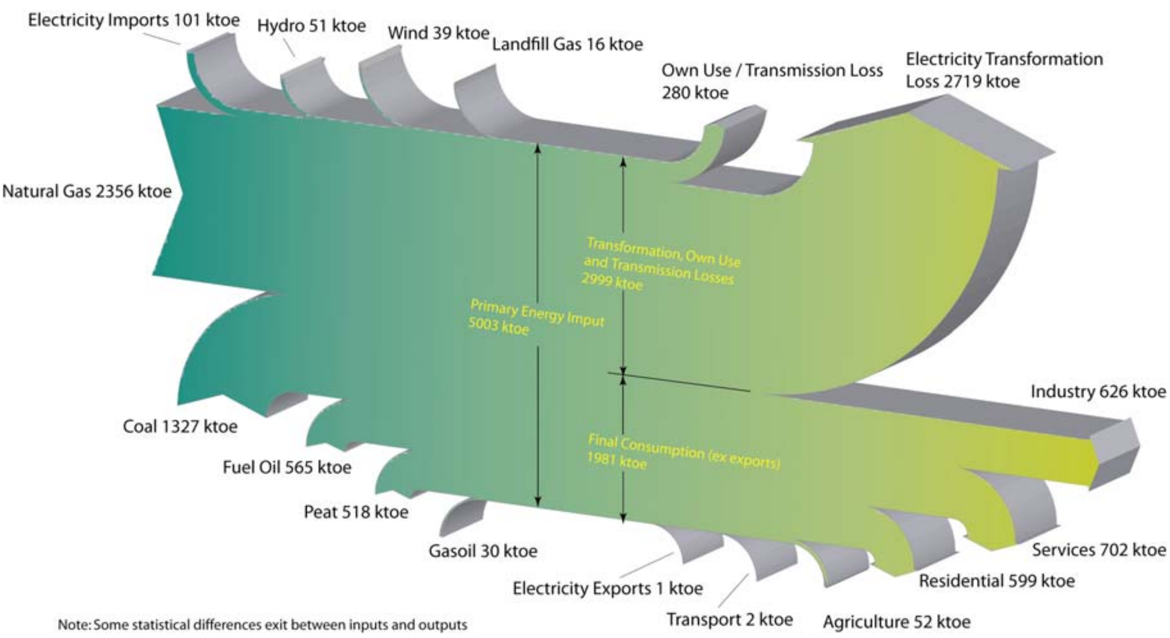
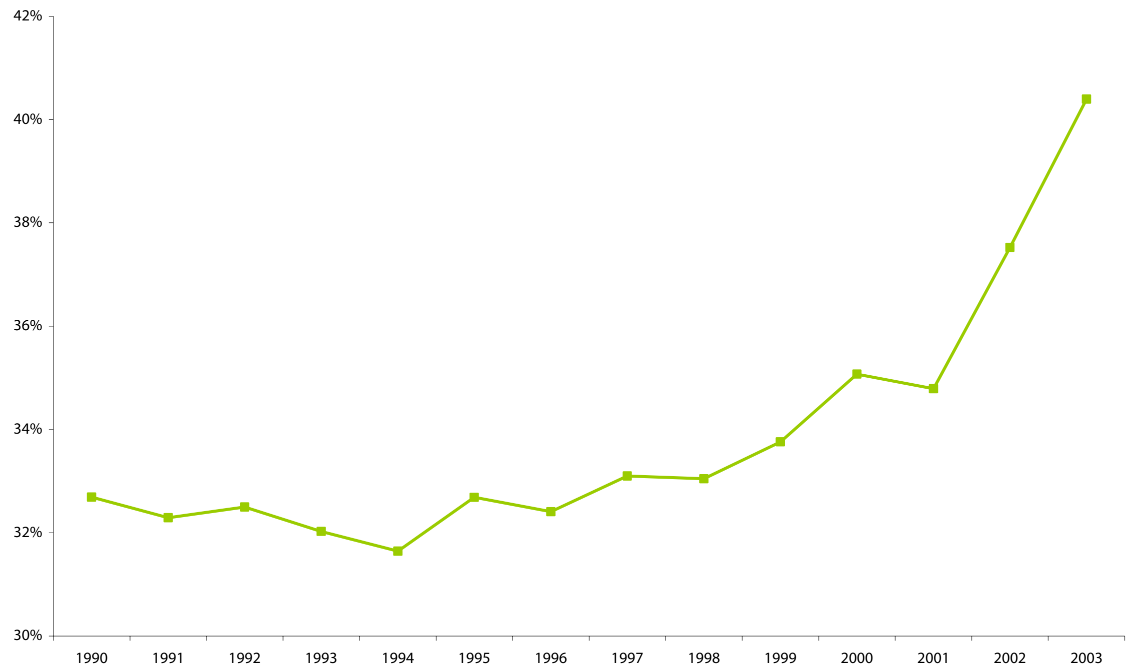


Figure 9: Efficiency of Electricity Supply

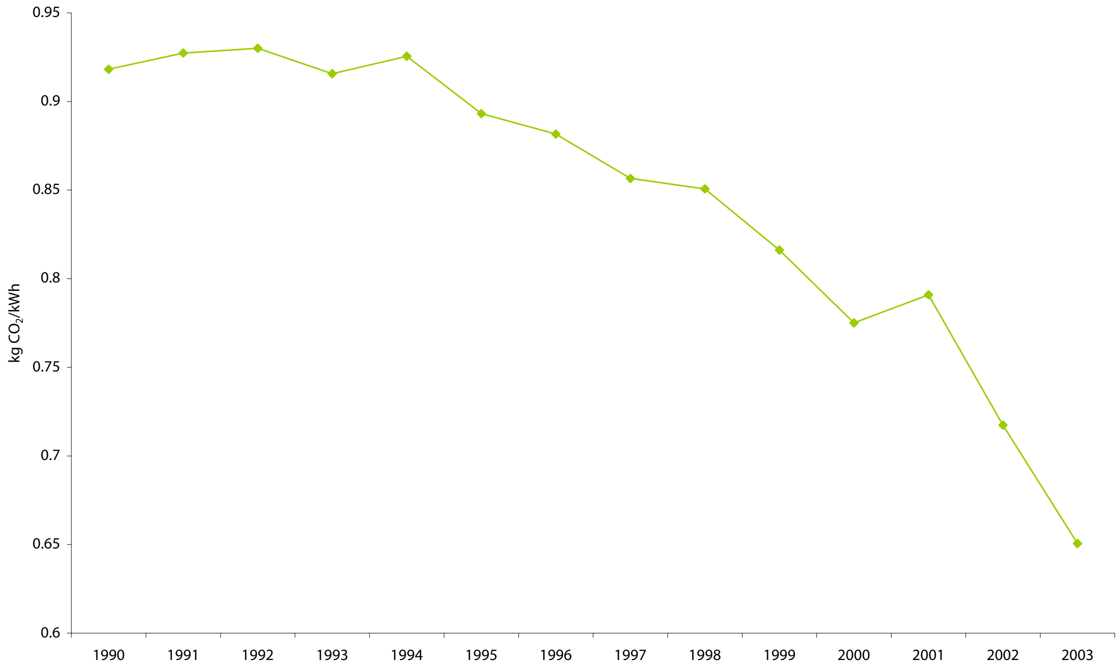


The efficiency of electricity supply shown in figure 9 is defined as final consumption of electricity divided by the fuel inputs required to generate this electricity and expressed as a percentage. This takes account of inputs from renewable sources, the generation plants 'own use' of electricity and transmission and distribution losses.

From the mid 1990's onwards the influence of the use of higher efficiency natural gas plants and the increase in production from renewable sources is evident. The sharp rise in 2002 (from 35% to 37%) is accounted for principally by the coming on stream of new CCGT plant (392 MW in August and 343 MW in November) and the increase in imports of electricity relative to 2001. The trend has continued in 2003 with the efficiency of electricity supply increasing to 40.4% resulting from a full year with the two new CCGT plants in operation in addition to increased imports of electricity.

These shifts in generating technology and indeed fuel mix have also resulted in changes in the CO_2 emissions per kWh of electricity supplied, as illustrated in figure 10.

Figure 10: CO_2 Emissions per kWh of Electricity Supplied



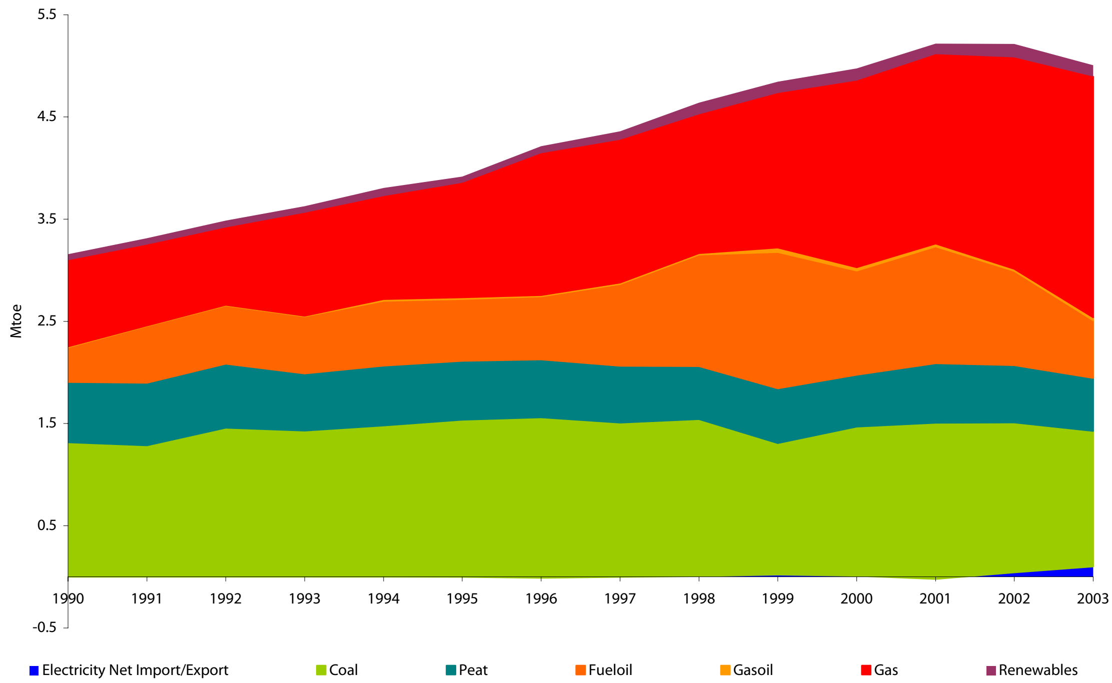
Since 1990 the share of high carbon content fuels such as coal have been reducing with a corresponding rise in the low carbon fuel natural gas, relatively low fuel oil and zero carbon renewables. This resulted in the carbon intensity of electricity dropping from 925 g CO_2/kWh in 1990 to 721 g CO_2/kWh in 2002. This represents a reduction of 9.3% in 2002 alone and 22% over the period 1990 – 2002 (2.1% reduction per annum). This trend continued in 2003 with the carbon intensity of electricity falling by a further 9.3% and reaching 651 g CO_2/kWh.

Reasons for the increase (relative to 2001) in generating efficiency and decrease in carbon intensity of electricity in 2003 are:

- The addition of 2 large CCGT plants in August 2002 (392 MW) and November 2002 (343 MW)
- Increase in the gas share of the fuel mix for electricity generation from 35% in 2001 to 47% in 2003.
- A decrease in the share of fuel oil generation from 22% in 2001 to 11% in 2003.
- A decrease in the share of coal generation from 29% in 2001 to 26.5% in 2003.
- A decrease in the share of peat generation from 11.1% in 2001 to 10.4% in 2003.
- The contribution of renewables and combined heat and power (CHP) in electricity generation.
- An increase in electricity imports to 100 ktoe in 2003.

The trends in the mix of primary fuels employed for electricity generation are shown in figures 11. The decrease in primary energy required for electricity generation in 2002, the first decrease since 1990, continued in 2003 with a further 4% reduction. The shift from oil to gas is also very evident from the graph.

Figure 11: Primary Fuel Mix for Electricity Generation



The primary fuel requirement for electricity generation has grown by 59% from 3.2 Mtoe in 1990 to 5 Mtoe in 2003 (3.6% per annum). In 2003 the requirement reduced by 4%. As a share of total primary energy requirement it has grown slightly from 34% in 1990 to 35% in 2002 falling back to just under 34% in 2003. This compares with the growth in electricity consumption as a share of total final consumption rising from 14% to 17% in the same period.

Table 6 presents the growth rates and shares of the primary fuel mix for electricity generation over the period 1990 – 2003.

Table 6: Growth Rates and Shares of Electricity Fuel Mix

	Growth %	**Average annual growth rates %**					**Shares %**	
	1990 – '03	**1990 – '03**	**1990 – '95**	**1995 – '00**	**2000 – '03**	**2003**	**1990**	**2003**
Coal	0.9	0.1	3.2	-1.0	-3.2	-9.6	41.7	26.5
Peat	-12.5	-1.0	-0.6	-2.5	0.8	-7.4	18.8	10.4
Fuel oil	66.1	4.0	12.2	11.0	-17.9	-38.9	10.8	11.3
Gasoil	324.1	11.8	18.0	14.8	-2.5	47.6	0.2	0.6
Gas	179.5	8.2	5.9	10.3	8.8	13.9	26.7	47.1
Renewables	85.2	4.9	0.8	14.0	-2.6	-15.7	1.9	2.2
Total	58.6	3.6	4.4	4.9	0.2	-4.0		

The main trends over the period are:

- The share of coal used in electricity generation has reduced from 42% in 1990 to 27% in 2003. In absolute terms the consumption of coal has risen by 0.9% over the period (0.1% per annum) to a figure of 1.3 Mtoe. There was a reduction in coal use in 2003 of 9.6%.
- Natural gas use for the generation of electricity has grown by 180% (8.2% per annum) since 1990 to a figure of 2.4 Mtoe in 2003, making it the most significant fuel in electricity generation. Its share has gone from 27% to 47% over the period. In 2003 alone the use of gas grew by 14%.
- Fuel oil had a share in electricity generation of 11% in 1990; this had risen to 18% in 2002 but has fallen back to 11% in 2003. In absolute terms, fuel oil use has grown by 66% since 1990 (4% per annum) to a figure of 0.6 Mtoe in 2003. The use of fuel oil in electricity generation declined significantly by 19% in 2002 compared to 2001, and further fell in 2003 by 39%.

- The use of peat has fallen by 12.5% since 1990 (an average reduction of 1% per annum) to a figure of 0.5 Mtoe in 2003 and its share has gone from 19% to 10% over the period. In 2003 the use of peat to generate electricity decreased by 7% below 2002 quantities.
- Renewable generation as a share of primary energy for electricity generation increased from 1.9% to 2.5% between 1990 and 2002 but fell back to 2.2% in 2003 due mainly to reduced hydro output. The increased share in the fuel mix since 19990 came from wind farms and landfill gas projects commissioned during the late 1990's.

The primary energy attributed to hydro and wind is equal to the amount of electrical energy generated, rather than the primary energy avoided through the displacement of fossil fuel based generation[7]. It is therefore more common to see the share of hydro and wind reported as a percentage of electricity generated. The share of electricity generated by renewables has increased from 4.8% in 1990 to 5.4% in 2002 but has fallen slightly to 4.4% in 2003.

Figure 12 shows the final electricity consumption in each of the main sectors. A striking feature is the nearly threefold difference between fuel input (see figure 11) and delivered electricity output in 1990 (figure 12). This difference is because electricity in Ireland is predominately generated from fossil fuels and the actual energy requirement has always been somewhat higher than final electricity consumption. This ratio of primary to final energy in electricity consumption reduced to 2.7 in 2002 and to 2.5 in 2003. Also striking is the continued growth in delivered electricity output in 2002 and 2003 despite a reduction in fuel input in those years, associated with the new power plants.

Figure 12: Final Consumption of Electricity by Sector

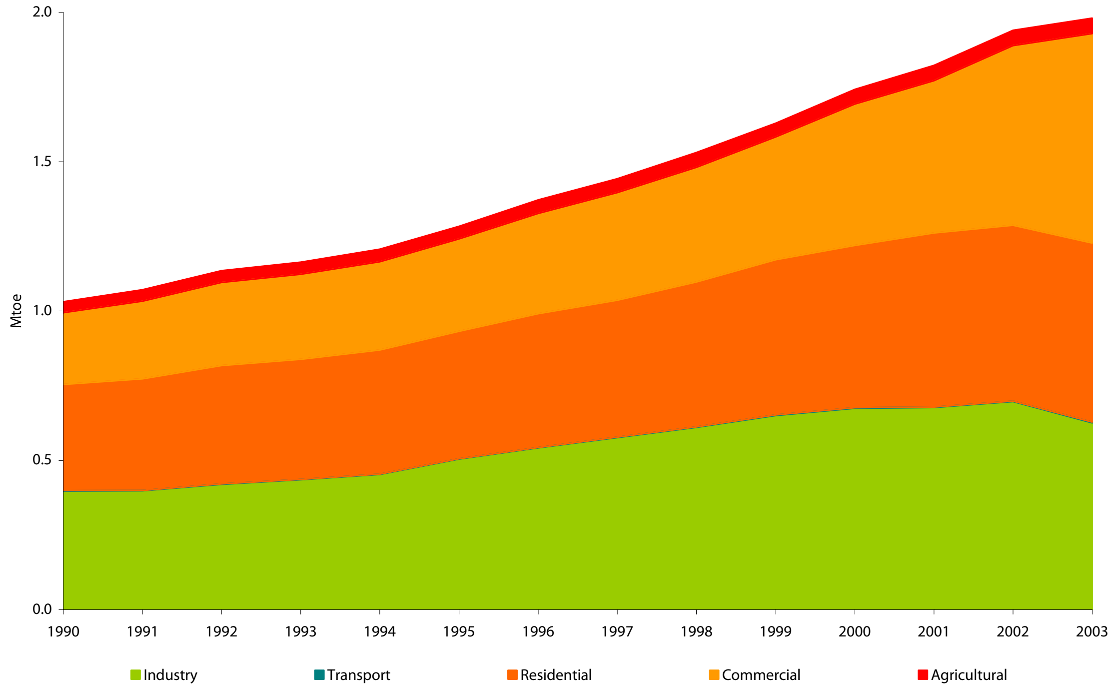


Table 7 tabulates changes in individual sector's electricity demand and the impact on their shares of final consumption of electricity. The most striking feature is the 192% growth in electricity consumption by the commercial and public services sector over the period. The annual growth in 2003 was 17%, significantly higher than the annual average growth rate of 8.6%. Also striking was the low growth rates in electricity consumption by the other sectors in 2003. Electricity consumption in industry fell in 2003 for the first time in the period (by 10%) and residential sector growth was less than half the annual rate in the late 1990's. This together with the 17% growth in the services sector means that in 2003 the services sector is the largest electricity consuming sector.

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[7] An alternative approach based on *primary energy equivalent* is provided in a separate report SEI (2004) *Renewable Energy in Ireland – Trends and Issues 1990 – 2002* available from http://www.sei.ie/documents/upload/publications/Renewable_Energy_in_Ireland_1990_-_2002.pdf.

Table 7: Growth Rates and Shares of Electricity Final Consumption

	Growth %	Average annual growth rates %					Shares %	
	1990 – '03	**1990 – '03**	**1990 – '95**	**1995 – '00**	**2000 – '03**	**2003**	**1990**	**2003**
Industry	57.6	3.6	4.9	6.0	-2.4	-10.2	38.5	31.6
Transport	32.9	2.2	0.6	5.3	0.0	0.0	0.1	0.1
Residential	68.5	4.1	3.7	5.0	3.3	1.8	34.5	30.3
Commercial / Public	192.0	8.6	5.2	8.9	14.1	16.6	23.3	35.4
Agriculture	41.9	2.7	3.2	2.7	2.0	0.8	3.6	2.6
Total	92.0	5.1	4.5	6.3	4.4	2.1		

3 Key Policy Issues

The energy trends discussed in section 2 may be analysed to assess performance with regard to Government policies and targets, in particular those detailed in the *Green Paper on Sustainable Energy (1999),* the *National Climate Change Strategy (2000), EU Directive 2001/77/EC* on electricity from renewable sources and *EU Directive 2004/8/EC* on cogeneration. This section discusses a number of key energy policy issues, grouped under the three pillars of sustainable energy development, namely:

- environmental responsibility;
- security of supply;
- cost competitiveness.

3.1 Environmental Responsibility

The key policy areas, which are discussed under this pillar, are:

1. limiting energy-related greenhouse gas and transboundary gas emissions ;
2. accelerating the penetration of renewable energy;
3. increasing the deployment of CHP .

3.1.1 Greenhouse Gas Emissions

On May 31, 2002 Ireland, along with the other EU Member States, ratified the Kyoto Protocol, an international legally binding agreement to reduce GHG (greenhouse gas) emissions. With the recent ratification by Russia in November 2004, the Protocol enters into force as a legally binding document on February 16th 2005. Under the Protocol, the EU has committed to reduce its annual GHG emissions to 8% below 1990 levels by the period 2008 – 2012.

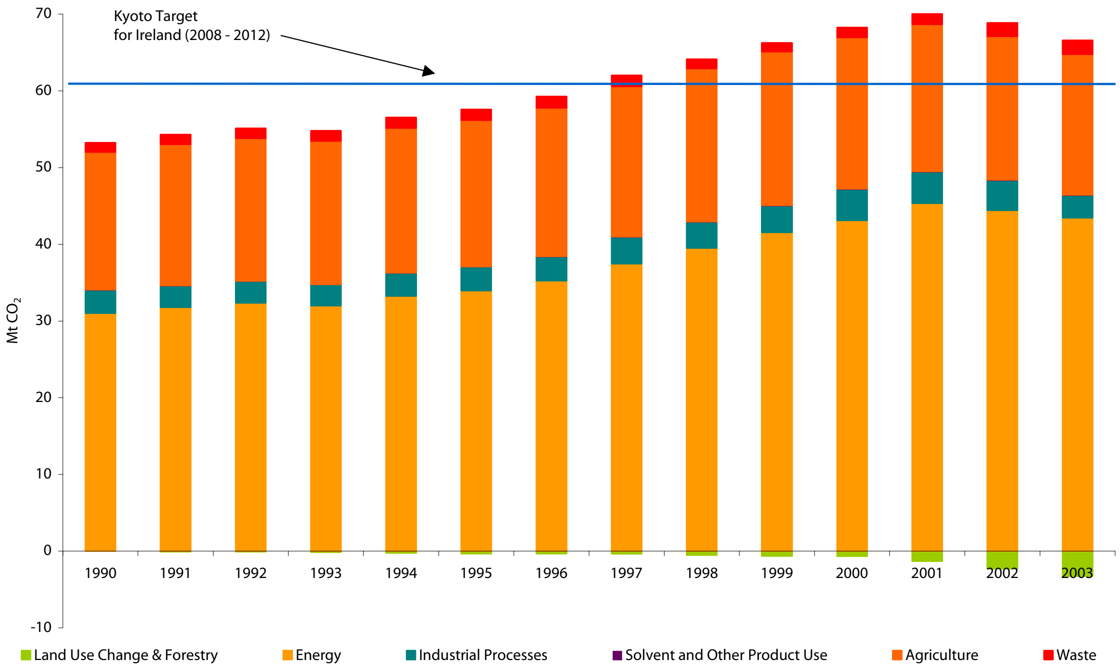
Decision 2002/358/EC apportioned this 8% reduction among the Member States and requires Ireland to limit the growth in annual emissions to 13% above 1990 levels by the same period. Projections in the National Climate Change Strategy indicate that emissions levels may rise to 74 Mt CO_2 equivalent by 2010 (37% above 1990 levels and 13.1 Mt CO_2 equivalent above the Kyoto target) if the country continues on a "business as usual" path. This Strategy has set a target of reducing greenhouse gas emissions by 15.4 Mt CO_2 equivalent relative to a projected "business as usual" rate of emissions CO_2 equivalent emissions by 2010.

More recent projections[8] used to determine the share of emissions allocated to emissions trading, indicate a gap of 9.2 Mt CO_2 equivalent on average over the compliance period (2008 – 2012) between "base case scenario" and Ireland's Kyoto target. This scenario is based on updated economic growth and activity projections, together with measures that have been introduced since the NCCS was published.

Figure 13 shows the trend in annual GHG emissions for the period 1990 – 2003. The emissions are grouped according to the individual source. These are land use change and forestry, energy, industrial processes (including cement production), solvent and other product use, agriculture and waste. Increases in forestry cause a reduction in emissions and hence appear as a negative in the graph.

[8] ICF Consulting and Byrne Ó Cléirigh (2004) *Determining the share of national greenhouse gas emissions for emissions trading in Ireland.*

Figure 13: Greenhouse Gas Emissions by Source

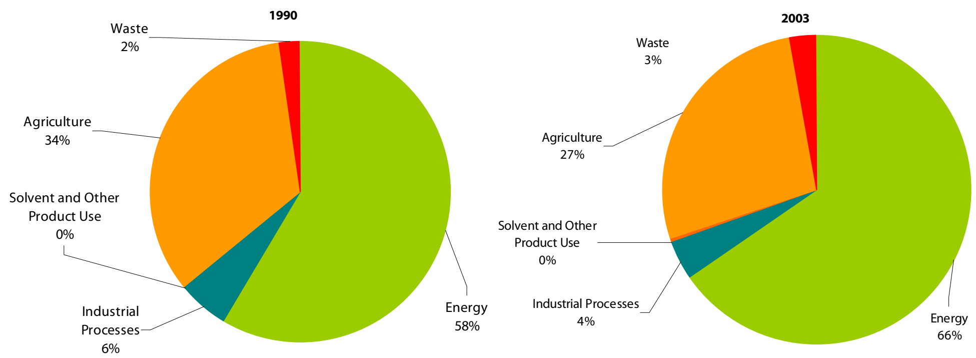


It is clear from figure 13 that Ireland's Kyoto target for the period 2008 – 2012 was breached in 1997. By 2001, annual GHG emissions[9] peaked at 31% above 1990 levels. It is also evident from figure 13 that the most significant area of growth is in energy-related emissions, in particular since 1995.

In 2002 there was a reversal in the upward trend for the first time with GHG emissions dropping slightly to 29% above 1990 levels. This downward trend continued in 2003, the first full year of operation for the two new CCGT power plants and the first full year without fertiliser production, reaching 25% above 1990 levels. It is anticipated that this downward trend will continue for another year or two before starting to rise again.

Figure 14 shows the GHG emissions by source for 1990 and 2003, illustrating the increased role of energy as an emissions source.

Figure 14: Greenhouse Gas Emissions by Source



53.2 Mt CO_2 **66.6 Mt CO_2**

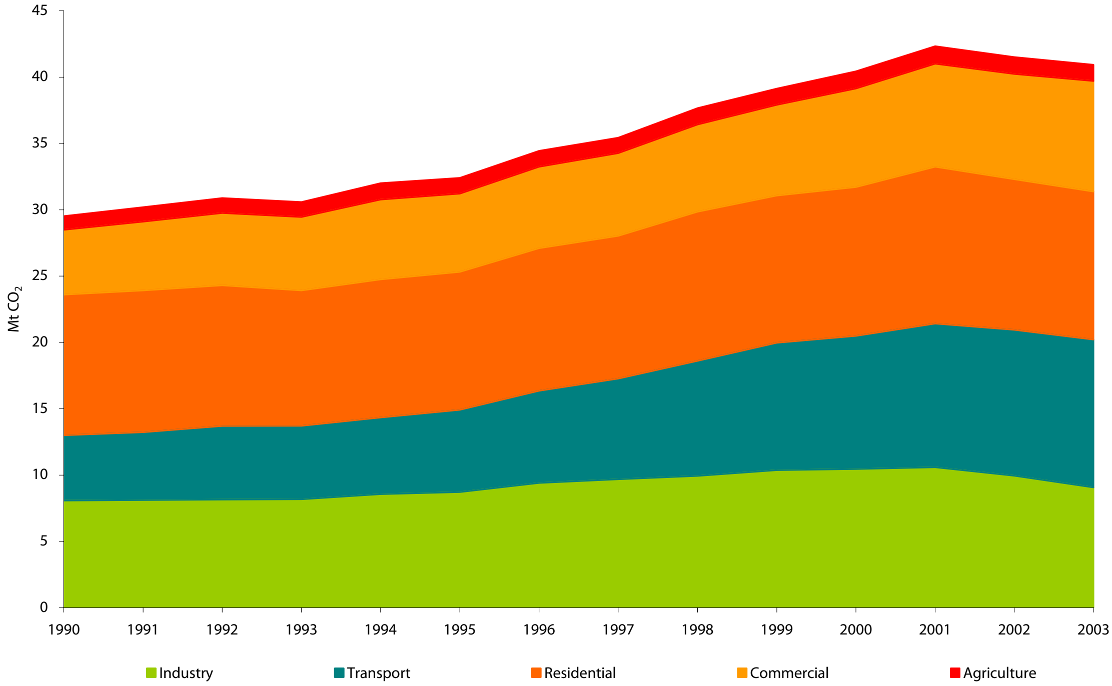
The share of GHG emissions arising from energy-related activities was 66% in 2003 compared with 58% in 1990. The share from agriculture dropped from 34% to 26% in the same period. It is interesting to note that for the EU as a

[9] Based on data for 2001 from EPA

whole, energy production and use represented 80% of GHG emissions in 1990[10]. The significant role of agriculture in the Irish economy underlies Ireland's variance from the EU average.

To examine more closely where the growth has been occurring, figure 15 shows the sectoral breakdown of energy-related CO_2 emissions [which represent 96% of energy-related GHG emissions, 4% accounted for by energy-related nitrous oxide (N_2O) and methane (CH_4)]. Energy-related CO_2 emissions in 2003 were 39% higher than 1990 levels after reaching a peak in 2001 of 46% above 1990. Notable from the graph is the 2% reduction in energy-related emissions in 2002 and a further 1.3% reduction in 2003.

Figure 15: Energy-Related CO_2 Emissions by Sector[11]



These growth rates are also presented in tabular form in table 8.

Table 8: Growth Rates and Shares of Primary Energy-Related CO_2 by Sector

	Growth %	**Average annual growth rates %**					**Shares %**	
	1990 – '03	**1990 – '03**	**1990 – '95**	**1995 – '00**	**2000 – '03**	**2003**	**1990**	**2003**
Industry	12.3	0.9	1.6	3.7	-4.7	-8.8	26.3	20.1
Transport	126.6	6.5	4.7	10.1	3.6	1.5	16.0	24.7
Residential	5.1	0.4	-0.4	1.6	-0.3	-1.9	34.6	24.7
Commercial / Public	71.1	4.2	3.9	4.7	4.0	5.1	15.9	18.5
Agriculture	17.0	1.2	2.7	1.7	-1.9	-2.9	3.4	2.7
Total	38.7	2.5	1.9	4.5	0.4	-1.3		

The most significant area of growth was in the transport sector, where CO_2 emissions in 2003 were 127% higher than those in 1990 (6.5% average annual growth rate). Growth in 2003 was only 1.5%, slightly down on 2002 (1.6%) and down considerably compared to the 8% growth witnessed in 2001. Energy use in transport accounted for 25% of energy-related CO_2 emissions in 2003 and for the first time now equals the share accounted for by the residential sector.

[10] Commission of the European Communities (1998) *COM(98)353 Climate Change – Towards an EU Post-Kyoto Strategy.*

[11] International air transport emissions are excluded from the national GHG emissions inventory in accordance with the reporting procedures of the UN Framework Convention on Climate Change (UNFCCC) guidelines and are also excluded here.

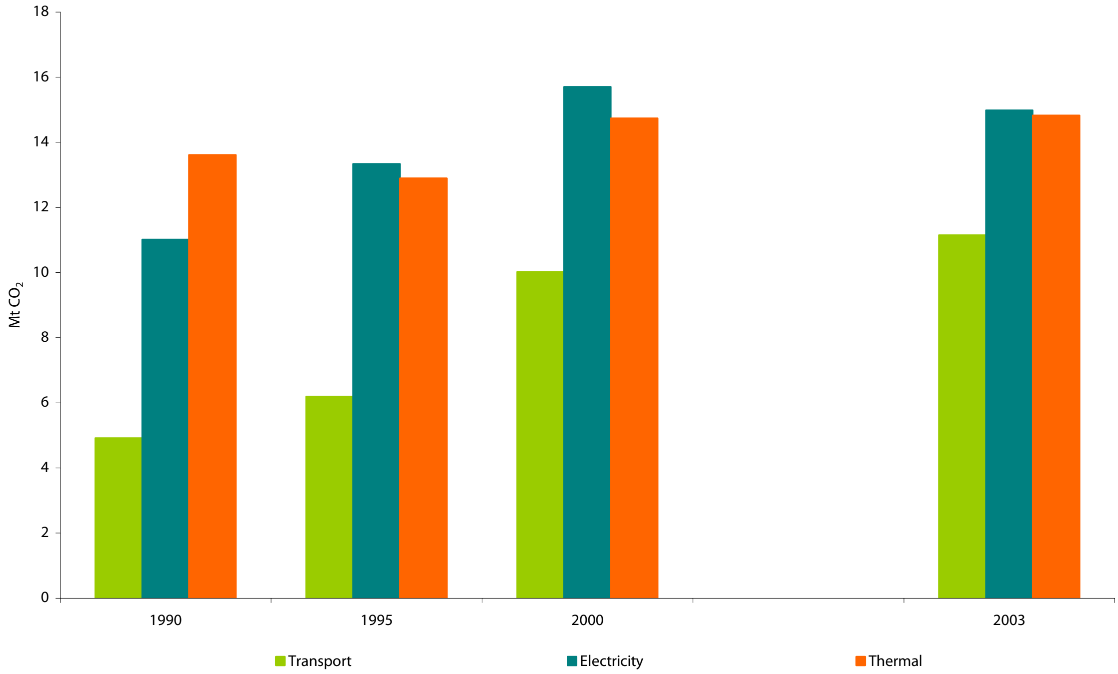
The commercial and public services sector experienced the highest growth in 2003 at 5.1% with transport being the only other sector experiencing growth in energy related emissions. Services emissions grew by 71% over the 1990 – 2003 period and as a result saw its share of energy-related emissions increase from 16% to 18.5%.

Industry displayed the highest reduction in energy-related emissions in 2003 of almost 9% and its share fell to 20% of emissions, due to the combination of lower energy consumption and increased electricity generating efficiency. Annual growth averaged over the period 1990 – 2003 period was 0.9%.

CO_2 emissions arising from energy use in the residential sector exhibited a low annual growth rate of 0.4% from 1990 to 2003, representing a total growth of 5% over the period. The sector showed a large reduction in emissions in 2002 of 4%, due in part to 2002 being a relatively warm year (resulting in an 8.4% reduction in the number of heating degree days) compared to 2001. It experienced a further fall in energy-related emissions of almost 2% in 2003 and now shares the top position in emissions with transport.

Figure 16 illustrates the variations in emissions by mode of energy. Here the emissions are allocated according to whether the energy used is for mobility (transport), in the form of electricity (power) or as thermal energy (for heating). The graph presents the emissions for five yearly intervals between 1990 and 2000 and for 2003.

Figure 16: Energy-Related CO_2 Emissions by Mode of Energy Application



The growth in emissions related to mobility (127% over the period) is again striking. Also clearly evident is the increase in emissions from electricity, which became the dominant mode in terms of emissions from 1995 onwards, although dropping back somewhat since 2001. CO_2 emissions from electricity generation in 2003 were 36% above 1990 levels.

In 2003, energy-related emissions from electricity fell by 7% despite the 2.1% growth in final consumption of electricity. This was mainly due in part to fuel switching and improved efficiency of electricity generation. Emissions from transport and thermal sources increased by 1.5% and 3.4% respectively in 2003.

3.1.2 Transboundary Gas Emissions

Air quality is a term used to describe issues relating to acid rain, smog and other environmental impacts (including acidification and eutrophication) largely associated with emissions of sulphur dioxide (SO_2) and nitrogen oxides[12] (or

[12] Collective term for nitric oxide (NO) and nitrogen dioxide (NO_2)

NO_x). The concerns relate back to the 1960s when scientists demonstrated the interrelationship between sulphur emissions in continental Europe and the acidification of Scandinavian lakes. Following the Stockholm conference in 1992, several studies confirmed the hypothesis that air pollutants could travel several thousands of kilometres before deposition and damage occurred. This also implied that cooperation at the international level was necessary to solve problems such as acidification.

A ministerial level meeting was held in Geneva in 1979, which was organised by the UN Economic Commission for Europe (ECE). The meeting resulted in the signature of the Convention on Long-range Transboundary Air Pollution by 34 Governments and the European Community (EC).

The Convention entered into force in 1983 and was the first international legally binding instrument to deal with problems of air pollution on a broad regional basis. In addition to laying down the general principles of international cooperation for air pollution abatement, the Convention set up an institutional framework that brings together research and policy. By June 2004, 49 Parties had ratified the Convention.

The Convention has been extended since 1983 by 8 Protocols[13], each dealing with different emissions. The key ones relating to energy being the

- *1985 Helsinki Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent,*
- *1988 Sofia Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes,*
- *1994 Oslo Protocol on Further Reduction of Sulphur Emissions,*
- *1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone.*

In June 1999 the European Commission presented a proposal for a directive setting national emission ceilings (NECs) for four air pollutants that cause acidification and the formation of ground-level ozone: sulphur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs), and ammonia (NH_3). After two years of negotiation, Directive 2001/81/EC, the 'National Emissions Ceiling Directive' was adopted by the Council of Ministers and the European Parliament in July 2001.

The aim of the directive is to gradually improve, through a stepwise reduction of the four pollutants, the protection both of human health and the environment throughout the EU. By means of EU strategies to combat acidification and ground-level ozone, the directive establishes interim environmental quality targets that are to be attained by 2010. Table 9 compares 2002 values (from EPA) for SO_2 and NO_x together with the emissions limits for the year 2010, which emphasizes the challenge ahead.

Table 9: SO_2 and NO_x Emissions and NEC Directive Ceilings for 2010

	1990 (kt)	2002 (kt)	2010 Ceiling (kt)	% reduction on 2002 to meet 2010 Ceiling
NO_X	115	121	65	46 %
SO_2	178	96	42	56 %

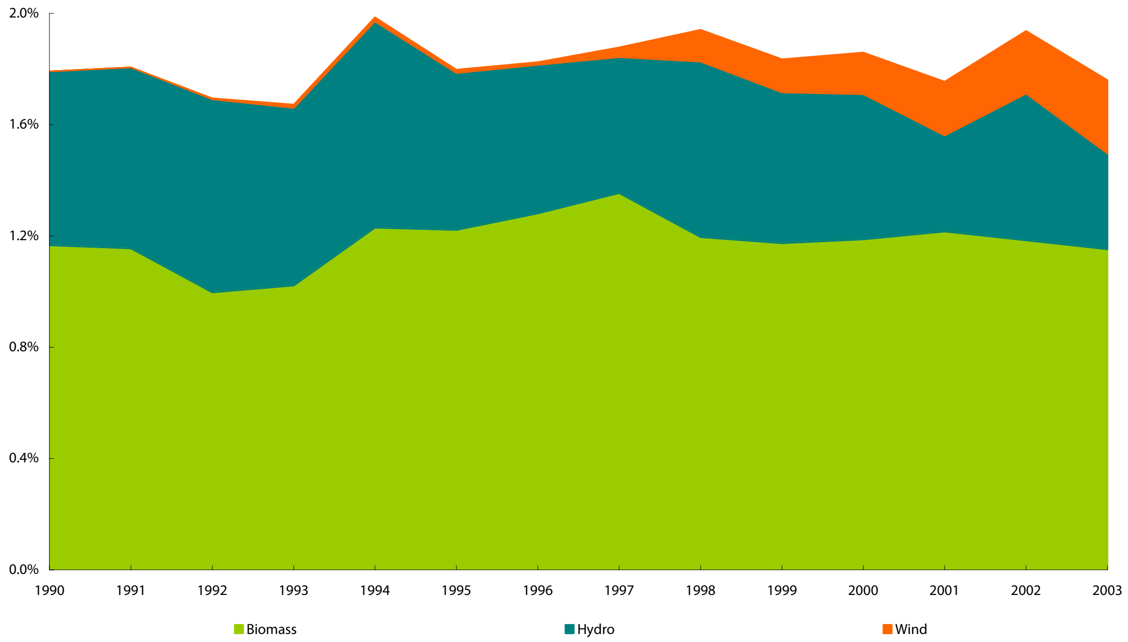
3.1.3 Renewable Energy

As shown in figure 17, renewable energy has been contributing nearly 2% of Ireland's primary energy supply since 1990. Most of this has been delivered by traditional biomass, waste wood used by the timber processing industry for drying and wood burnt by the residential sector for home heating. The second most significant contribution has been from the large-scale hydro power plants, whose output has varied from year to year depending on rainfall patterns. The growing contribution from wind energy is also evident in figure 17, in particular since 1998. In 2003, biomass contributed 1.2%, hydro power 0.34% and wind energy 0.26% of Ireland's energy requirements. A more

[13] UNECE (Various Years) *Protocols*

detailed discussion of renewable energy in Ireland can be found in SEI's recent publication *Renewable Energy in Ireland*[14].

Figure 17: Renewable Energy Contribution to TPER



With reference to figure 17, the variations in contribution can mostly be explained by the growth in biomass and the variations in hydro production. Also notable is the small but growing levels of wind energy, particularly since 1995 when the wind farms under the Alternative Energy Requirement (AER) programme were erected.

In order to stimulate an increase in renewable energy development within the EU, the European Commission published a White Paper on Renewable Energy in 1997[15], which was endorsed by the European Council and European Parliament in 1998. In this document a target was set for the EU as a whole to double the contribution from renewable energy to primary energy supply by 2010 from 6% to 12%. The strategy also detailed the expected contribution from each renewable energy resource and its allocation as electricity, heat production, or as energy use in transport.

Regarding renewable energy use in transport, the EU Biofuels Directive[16] stipulates that Member States "s*hould ensure a minimum proportion of biofuels and other renewable fuels is placed on their markets, and, to that effect, shall set national indicative targets."* The Directive establishes a reference value of 2% for 2005 and 5.75% for 2010. In order to assist the Government in the formulation of goals and strategies as required by this Directive, Sustainable Energy Ireland commissioned a study[17] on the impacts of the establishment of an Irish biofuel industry and to identify the most strategic routes towards the implementation of the Directive.

The target and strategy in the area of electricity generation was further detailed in 2001, with the publication of the EU Renewable Energy Directive[18] (2001/77/EC). In this Directive indicative targets for each Member State are

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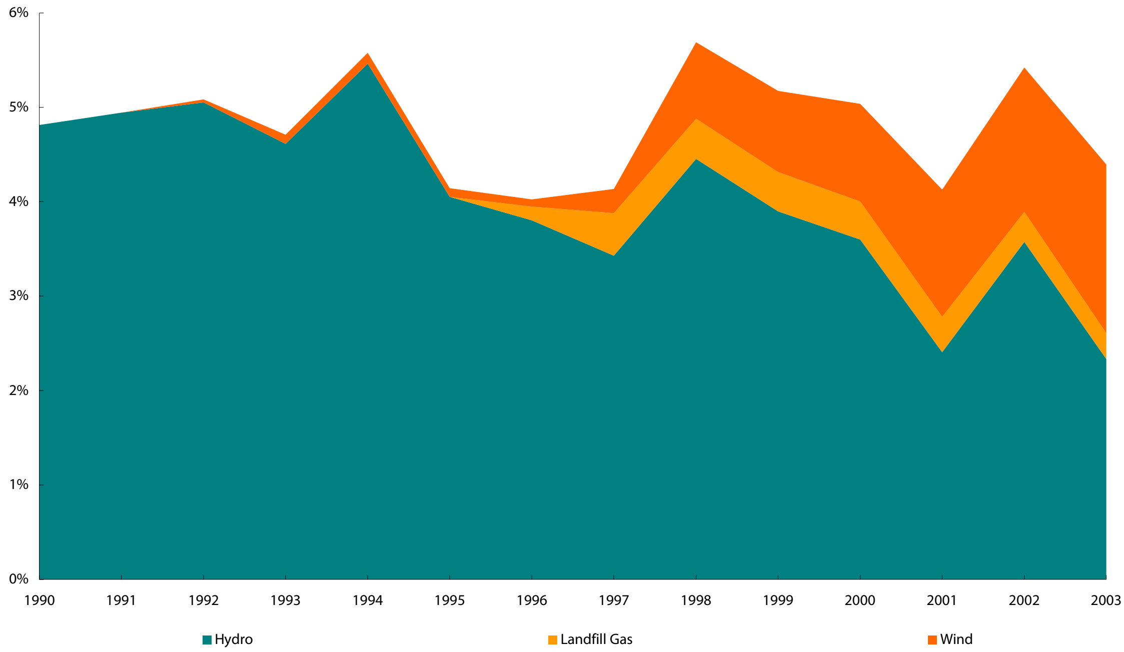
[14] SEI (2004) *Renewable Energy in Ireland – Trends and Issues 1990 – 2002*
http://www.sei.ie/uploads/documents/upload/publications/Renewable_Energy_in_Ireland_1990_-_2002.pdf
[15] Commission of the European Communities (1997) *COM(97)599 Energy for the Future: Renewable Sources of Energy. White Paper for a Community Strategy and Action Plan.*
[16] European Union (2003) *Directive 2003/30/EC of the European Parliament and of the Council on the Promotion of the Use of Biofuels or Other Renewable Fuels for Transport*
[17] Sustainable Energy Ireland (2004) *Liquid Biofuels Strategy Study for Ireland*. Available from
http://www.sei.ie/uploads/documents/upload/publications/Liquid_biofuel_Full.pdf.
[18] European Union (2001) *Directive 2001/77/EC of the European Parliament and of the Council on the Promotion of Electricity from Renewable Energy Sources in the Internal Electricity Market.*

provided for the contribution of renewable generated electricity to gross electricity consumption by 2010. These targets are consistent with indicative target contribution of 22.1% to electricity consumption for the EU as a whole, which in turn is consistent with the target contribution of 12% to overall primary energy consumption.

The indicative target for Ireland is a 13.2% share of gross electricity consumption by 2010. The contribution of renewable energy to gross electricity consumption from 1990 – 2003 is shown in figure 18. The share achieved in 2003 was 4.4%, a drop of one percentage point on 2002, due to lower rainfall levels affecting hydro production.

Figure 18: Renewable Energy Contribution to Gross Electricity Consumption



A key focus of national policy in the area of renewable energy has been in the area of electricity production from wind energy, due to the size of the wind energy resource in Ireland and the cost competitiveness of the technology. While the contribution from hydro has declined, figure 18 shows how electricity production from wind energy and landfill gas has increased. Wind energy in 2003 accounted for 1.7% of gross electricity consumption, the output of 31 wind farms with a combined installed generating capacity of 189 MW. The contribution from wind energy is set to grow further due to a significant increase in deployment.

3.1.4 Combined heat and power

Combined Heat and Power (CHP) is the simultaneous generation of usable heat and electricity in a single process. The EU has formally promoted CHP since 1977[19], when a Council recommendation set as an objective the elimination of non-technical obstacles to the development of CHP. The Commission's strategy document on CHP[20] has as its aim the doubling of 1994 CHP penetration by 2010 (from 9% of electricity generated to 18%). In 2000 the proportion of total electrical output in the EU that was generated from CHP was 10%. In 2003 2.4% of Ireland's electricity was generated from CHP (see figure 20).

The EU CHP Directive[21], approved in February 2004, seeks to create a favourable environment for CHP installations. The Directive requires all Member States to analyse national potentials for CHP identifying the potential for heating and cooling demands. It further requires a separate analysis of barriers that may prevent the realisation of the national potential for CHP. In addition, Member States must ensure that support for CHP is based on useful heat demand.

[19] Council recommendation (1977) on the creation in the Member States of advisory bodies or committees to promote combined heat and power production and the exploitation of residual heat.
[20] Commission of the European Communities (1997) A community strategy to promote combined heat and power and to dismantle barriers to its development.
[21] European Union (2004) *Directive 2004/8/EC of the European Parliament and of the Council on the Promotion of Cogeneration Based on Useful Heat Demand in the Internal Energy Market and Amending Directive 92/42/EEC.*

The Directive makes provides for the evaluation of support schemes until a harmonised community framework is put into place and states that the Commission will monitor the situation in Member Sates and report on experiences across the EU.

In Ireland, the NCCS specifically advocates the use of CHP, targeting a saving of 0.25 Mt CO_2 per year by 2010 from CHP. A report by SEI[22] has estimated this to mean that an additional 250 MWe of CHP plant will need to be installed by the end of this decade if the Government target is to be achieved.

The Department of Communications, Marine and Natural Resources (DCMNR) established a CHP Strategy Group in March 2004 to analyse and make recommendations on possible options for future national CHP policy, based on staged and achievable targets. The CHP Strategy Group will produce a Strategy Report for publication early in 2005.

Figure 19 illustrates the contribution from CHP to Ireland's energy requirements in the period 1994 – 2003[23]. Thermal and electrical outputs increased by 27% and 145 % respectively over the period. Recent increases in gas prices have led to reduced output as indicated by the drop in 2003.

Figure 19: CHP Fuel Input and Thermal/Electricity Output 1994 – 2003

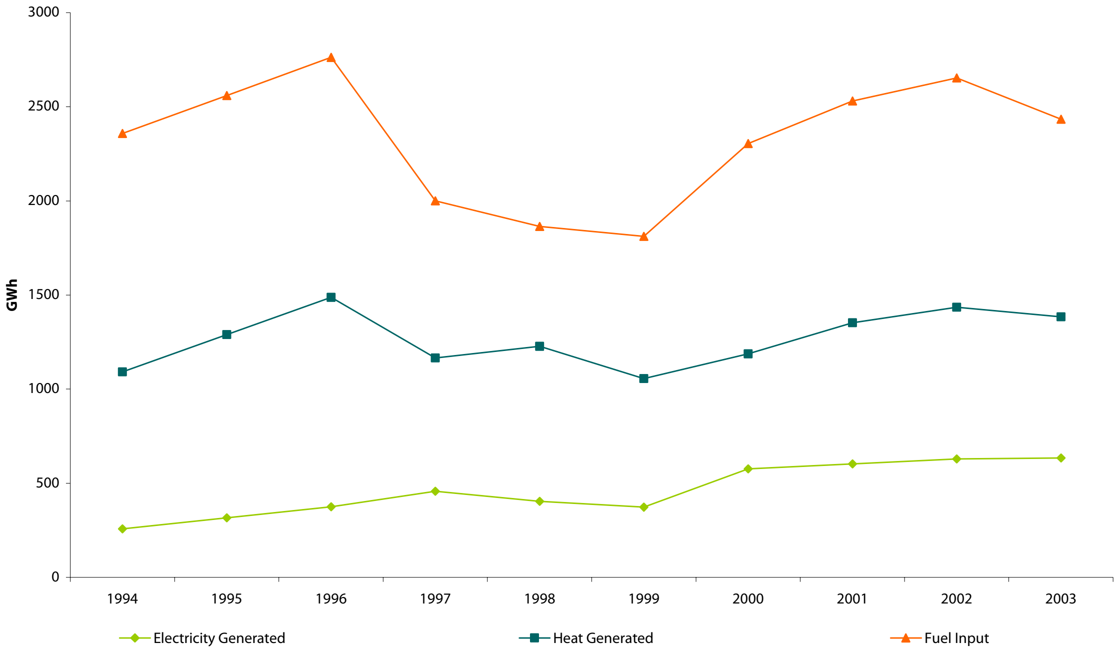


Figure 20 focuses on CHP generated electricity in Ireland as a proportion of total electricity generation in the period 1994 – 2003. After growth in the mid 1990's and then again in 2000, the share of total generation from CHP has reduced slightly each year. The reduction in share in 2003 was 2.4%.

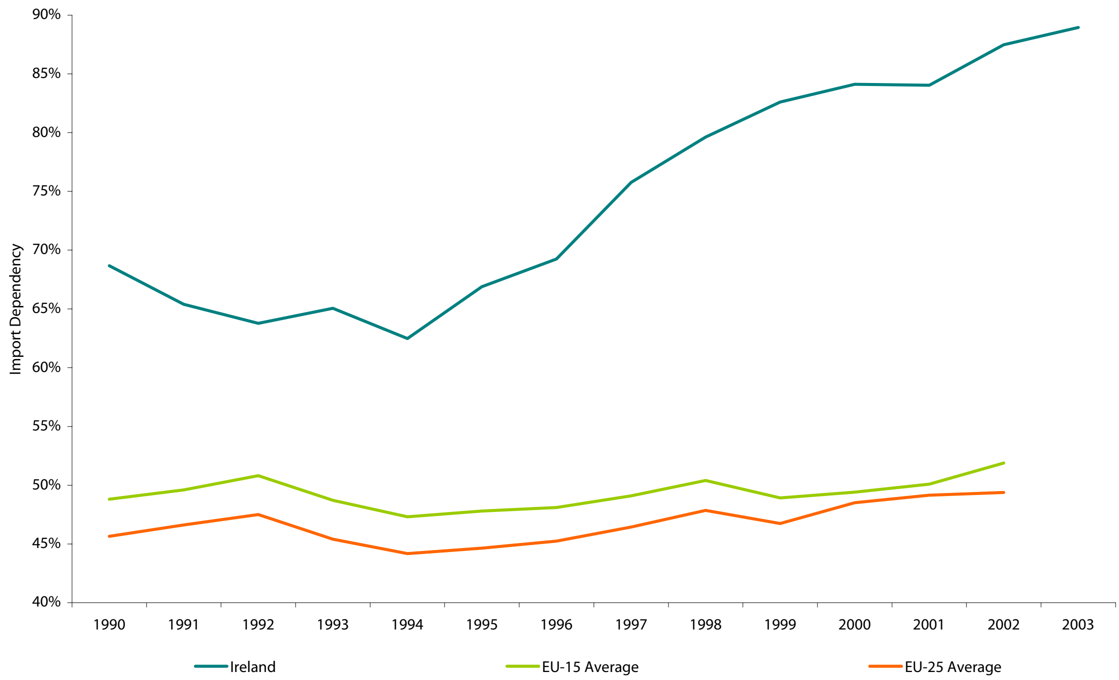
[22] Irish Energy Centre (2001) *An Examination of the Future Potential of CHP in Ireland- A Report for Public Consultation.*
[23] Sustainable Energy Ireland (2004) *Combined heat and power in Ireland- Trends and issues 1991 – 2002,* http://www.sei.ie/uploads/documents/upload/publications/Final_CHP_in_Ireland.pdf.

Figure 20: CHP Electricity as % of Electricity Generation 1994 – 2003

3.2 Security of Supply

Security of energy supply relates to import dependency, fuel diversity and the capacity and integrity of the supply and distribution infrastructure. Ireland's security of supply is closely linked to EU security of supply, but import dependency is examined here for Ireland in its own right. Figure 21 illustrates the trend since 1990, comparing it with the EU as a whole (distinguishing between EU-15 and the enlarged EU-25).

Figure 21: Import Dependency of Ireland and EU-15

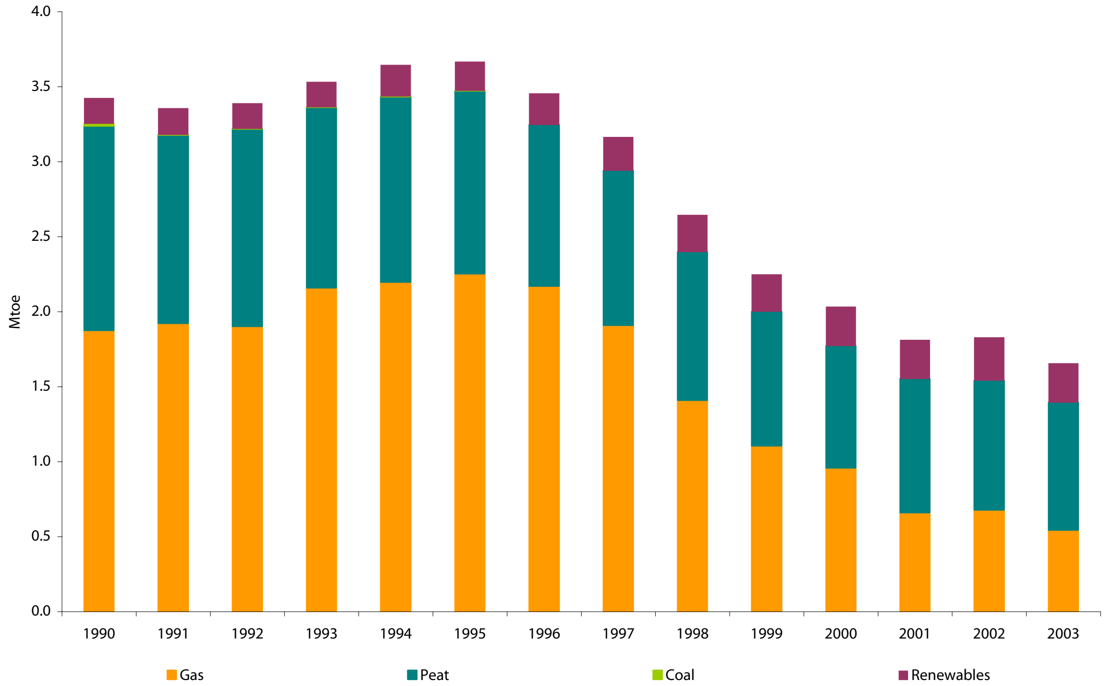


Source: SEI and Eurostat

Domestic production accounted for 35% of Ireland's energy requirements in 1990. However, since the mid-1990's import dependency has grown significantly, due to the increase in energy consumption together with the decline in indigenous natural gas production at Kinsale since 1995 and decreasing peat production. Imported oil and gas accounted for 76% of TPER in 2003, compared with 45% in 1990. In 2003, Ireland's import dependency reached 89%, increasing from 65% in 1990. As figure 21 illustrates, this trend contrasts with that for the EU, where import dependency has remained at about 50%.

This trend reflects the fact that Ireland is not endowed with significant indigenous fossil fuel resources and has to date not harnessed significant quantities of renewable resources. Figure 22 shows the indigenous energy fuel mix for Ireland over the period. The reduction in indigenous supply of natural gas is clearly evident from the graph and the switch away from peat. Consumption of indigenous gas decreased by 71% over the period and peat by 38%. Indigenous production peaked in 1995 and there has been a 55% reduction since then.

Figure 22: Indigenous Energy by Fuel

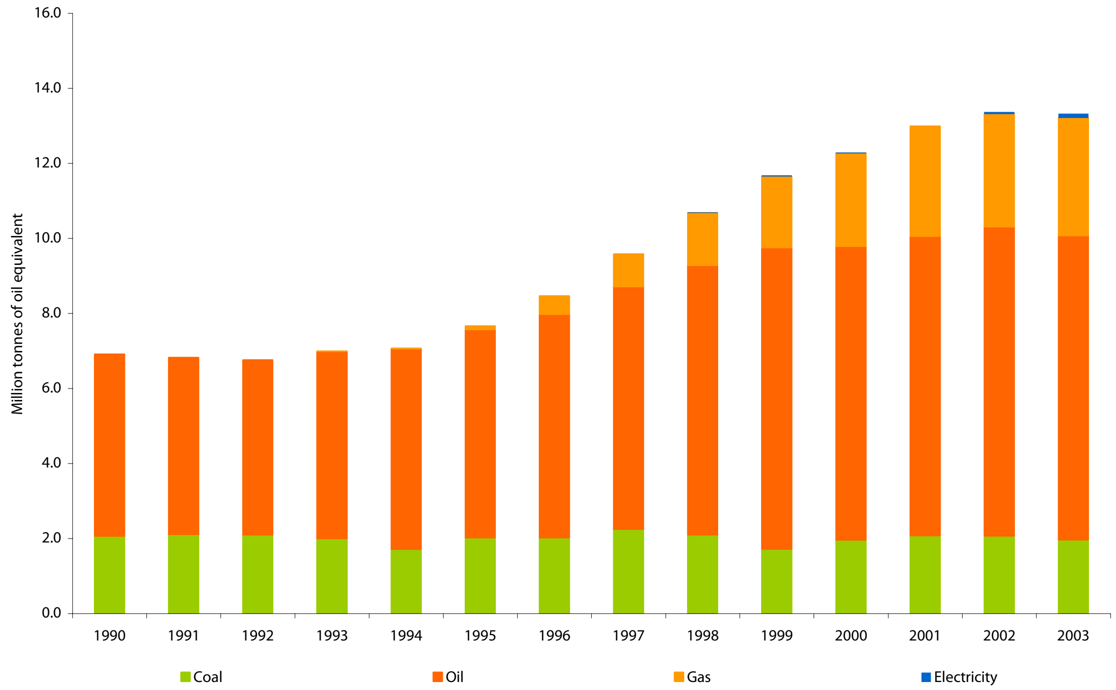


The share of native gas within the indigenous fuels contribution was 33% in 2003, compared with 54% in 1990. Peat increased its share from 40% in 1990 to 51% in 2003 mainly as a result of a greater decline in the availability of indigenous gas, however in absolute terms its consumption reduced by 38%. Renewable energy increased its share from 5% to 16% and in absolute terms by 54%.

Some proposed developments are likely to impact on this trend including the plans to extract and utilise gas at the Corrib Gas Field and the targets for increasing the deployment of renewable energy to be achieved by 2010.

Figure 23 shows the trend for net fuel imports (imports minus exports) over the period 1990 – 2003. The growing dependence on oil due largely to increase in energy consumption in transport is the most striking feature. There was a 167% increase in net imports of oil over the period. The decline of indigenous natural gas reserves at Kinsale is also evidenced by the growth in imported natural gas in the latter part of the decade. Coal imports have remained stable over the period reflecting the base load operation of Moneypoint electricity generating plant. In 2003, oil, gas and coal accounted for 61%, 24% and 15% of net imports respectively.

Figure 23: Imported Energy by Fuel



3.3 Cost Competitiveness

Energy is an important component in economic activity and therefore the price paid for this energy is a determining factor in the competitiveness of the economy. The EU has introduced competition into the electricity and gas markets through the liberalisation process in order to reduce energy costs to final consumers.

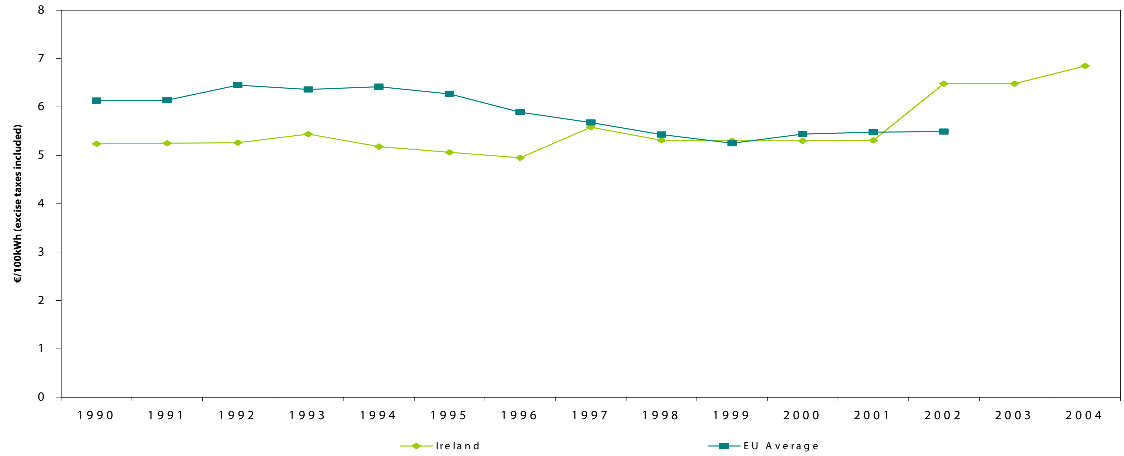
This section presents comparisons of the cost of energy in various forms with the EU average. The source of the data presented here is from Eurostat[24] and where possible the latest data available is shown. Prices shown are in current money; therefore where prices are similar to 1990 there has been a decrease in costs in real terms.

Comparisons of energy prices across countries poses difficulties because of differing tariff structures and typical consumption patterns and volumes. Eurostat data compares prices for given consumption volumes and load patterns. The choice of price data shown here tries to reflect typical consumption patterns here in Ireland compared to identical patterns in the other EU countries. However, the choice is also constrained by data availability, as data for all the differing categories is not available for Ireland. Eurostat has not published updated aggregated average EU data for most of the indicators chosen since 2002. The latest data for most of the EU countries is given however, to show Ireland's ranking against the others.

[24] The fuel prices including comparisons with other EU countries can be found at http://europa.eu.int/comm/energy_transport/etif/ENERGY

3.3.1 Energy Prices in Industry

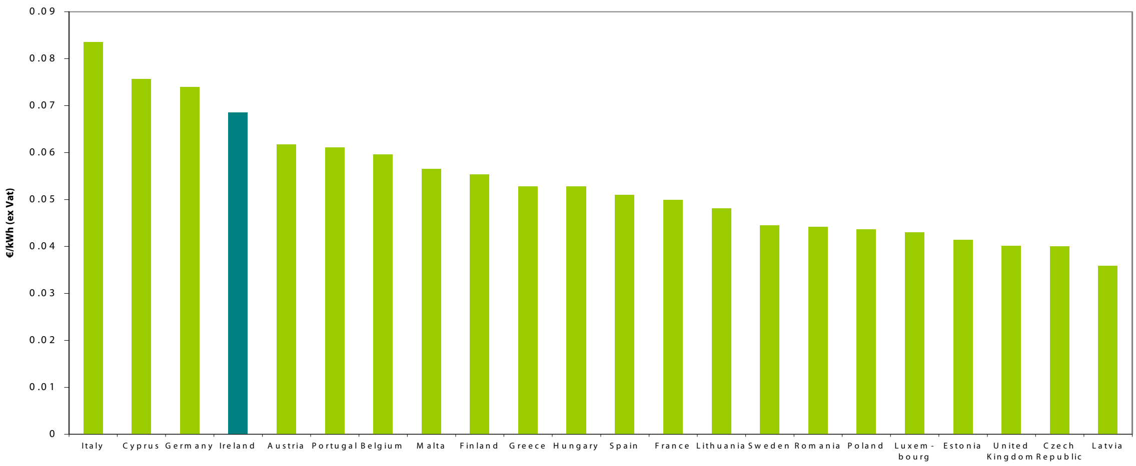
Figure 24: Electricity Prices to Industry



Source: Eurostat.

Electricity prices to Irish industry have risen by 29% between 2000 and 2004[25]. In January 2004 Ireland ranked 4th most expensive for this category of consumption and was 27% above the average based on the data shown in figure 25.

Figure 25: Electricity Prices to Industry in Europe (January 2004)



Source: Eurostat.

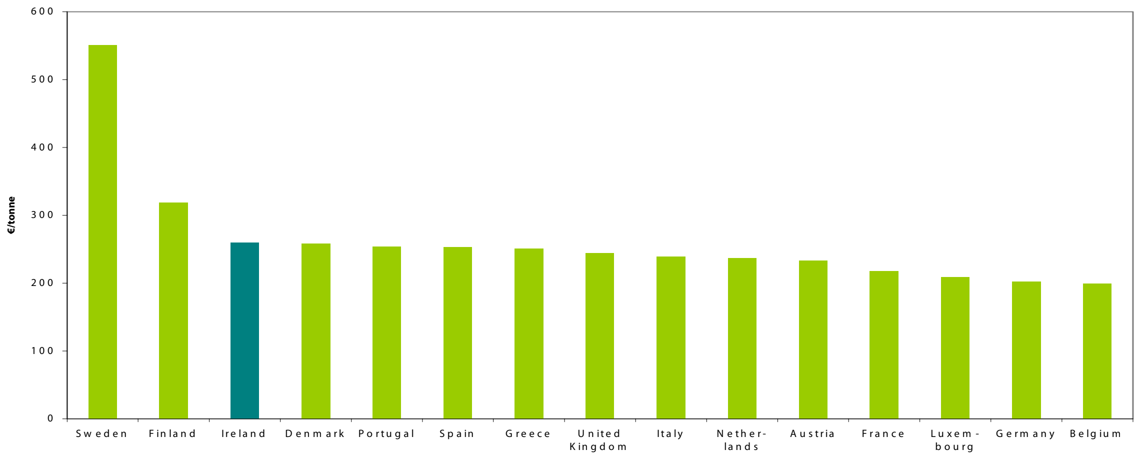
[25] Eurostat consumption category 4162350 Industry - Ig (Annual consumption: 24 000 MWh; maximum demand: 4 000 kW; annual load: 6 000 hours) (for Luxembourg: 50% power reduction during hours of heavy loading)

Figure 26: Fuel Oil Prices to Industry[26]

Source: Eurostat.

Irish industrial fuel oil prices have followed a similar trend to that of the EU average with an average price difference of 3.9% in Ireland's favour between 1990 and 1999. The significant increase (82%) in average EU fuel oil prices between 1999 and 2003 is striking in figure 26. Data beyond 1999 is not available from Eurostat.

Figure 27: Fuel Oil Prices to Industry in Europe (January 2003)

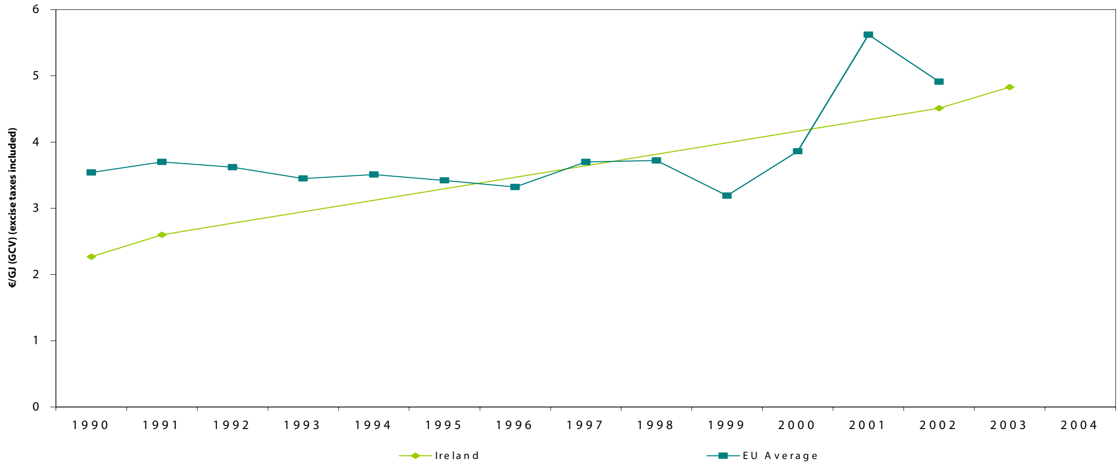


Source: Eurostat.

As the volume of deliveries to any one enterprise is significantly less than the category published by Eurostat and as no price was published for Ireland the price shown for Ireland in figure 27 is an estimate provided by an oil industry source. At approximately €260 per tonne it is just under 8% above the EU average although the EU average price is for larger sales volumes.

[26] Eurostat consumption category 4132600 Industry (monthly deliveries of less than 2 000 tons or annual deliveries of less than 24 000 tons).

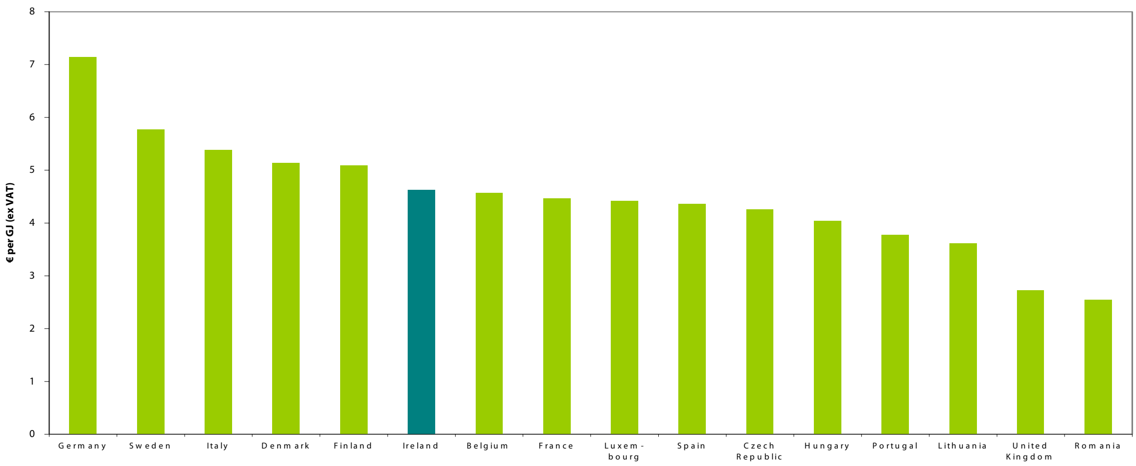
Figure 28: Natural Gas Prices to Industry[27]



Source: Eurostat.

Natural gas prices for Ireland are only available for 1990, 1991 and 2002 onwards, as shown in figure 28. The EU average is also shown for the whole period. Gas prices in Ireland were 8% lower than the EU average in 2002, compared with a 36% gap in 1990. The manner in which gas prices follow oil prices is also evident from comparing figure 26 with figure 28. The EU average gas price to industrial consumers was 76% higher in 2001 than in 1999, before dropping 14% in 2002.

Figure 29: Natural Gas Prices to Industry in Europe (July 2003)



Source: Eurostat.

Price data for the second half of 2003 shows Ireland in the middle range for gas prices to industry being just 3% above the average based on the data shown in figure 29.

In order to develop greater insights into the impact of energy price changes on industry, SEI carried out an analysis of energy consumption and costs[28] using CSO data for the year 1998 and an updated analysis[29] with recently available data from 2001. The main purpose of this work was to assess the sensitivity of the manufacturing industries to energy price changes in the context of Government plans to implement the EU Emissions Trading Directive[30] and other policy or market effects on energy price.

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[27] Eurostat consumption category 4142300 Industry - I4-2 (Annual consumption: 418 600 GJ; load factor: 330 days and 4142350 Industry - I5 (Annual consumption: 4 186 000 GJ; load factor: 330 days

[28] Sustainable Energy Ireland (2003) *Profiling energy consumption and CO_2 emissions in industry*

[29] Sustainable Energy Ireland (2004) *Profiling energy consumption and CO_2 emissions in industry 2004*

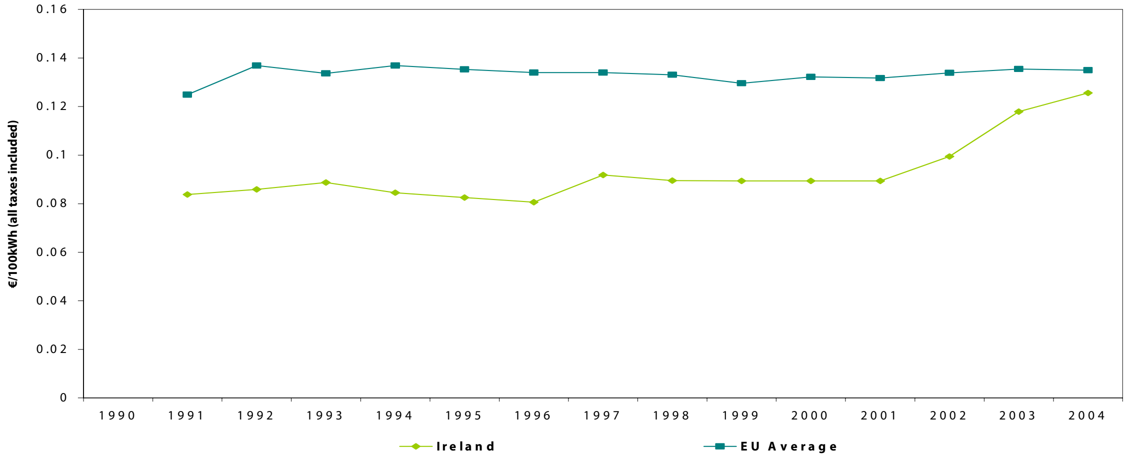
[30] European Union (2003) *Directive 2003/87/EC of the European Parliament and of the Council establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC.*

The key findings of the profile were as follows:

- Over the period 1998 – 2001 there was a 26% increase (in current prices) in industrial energy expenditure, reaching €723 million in 2001. Expenditure on heat was €317 million accounting for 44%, and electricity expenditure totalled €406 million accounting for 56%. There was a 12% increase in energy demand in industry over this period reaching 2.3 Mtoe in 2001;
- 96% of industrial output (Gross Value Added) in 2001 (€34.3 billion) was produced by enterprises where the energy bill represented 4% or less of total costs. These enterprises (4387 or 92% of all industrial enterprises) account for 96% of industrial employment and also for 61% of industrial energy-related emissions;
- About 211 enterprises (4% of all industrial enterprises) have energy costs in excess of 5% of their direct costs and this group is responsible for 34% of energy-related emissions;
- 10 enterprises have an energy bill accounting for more than 20% of their direct costs. These account for 15% of industrial expenditure on energy and 18% of energy-related CO_2 emissions. They contribute 0.5% of industrial gross value added and 0.5% of industrial employment;
- 97% of industrial gross value added was generated by enterprises from which fuel costs represented no more than 2% of direct costs. A total of 14 enterprises have a fuel to direct costs ratio of more than 10%. These accounted for 34% of fuel-related emissions.

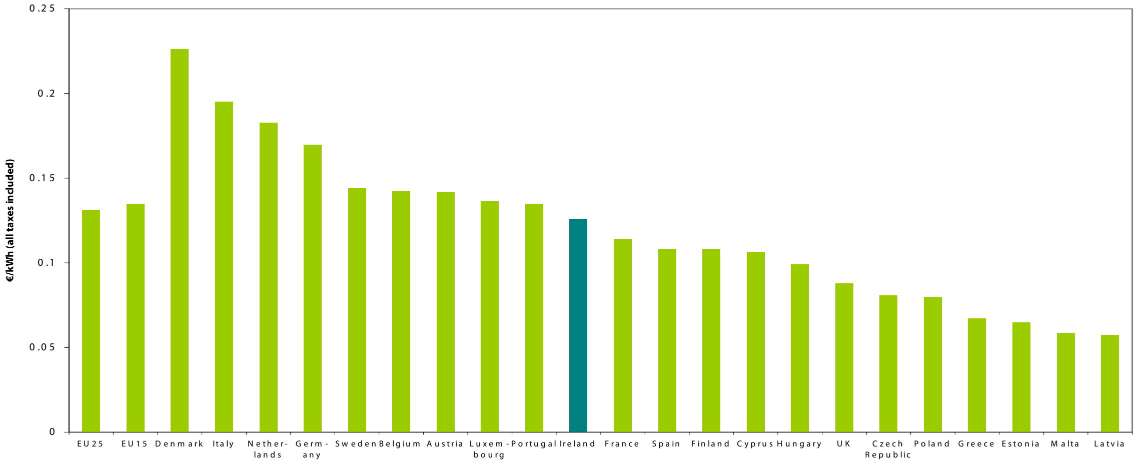
3.3.2 Household Energy Prices

Figure 30: Household Electricity Prices[31]



Source: Eurostat.

Figure 31: Household Electricity Prices in Europe (January 2004)



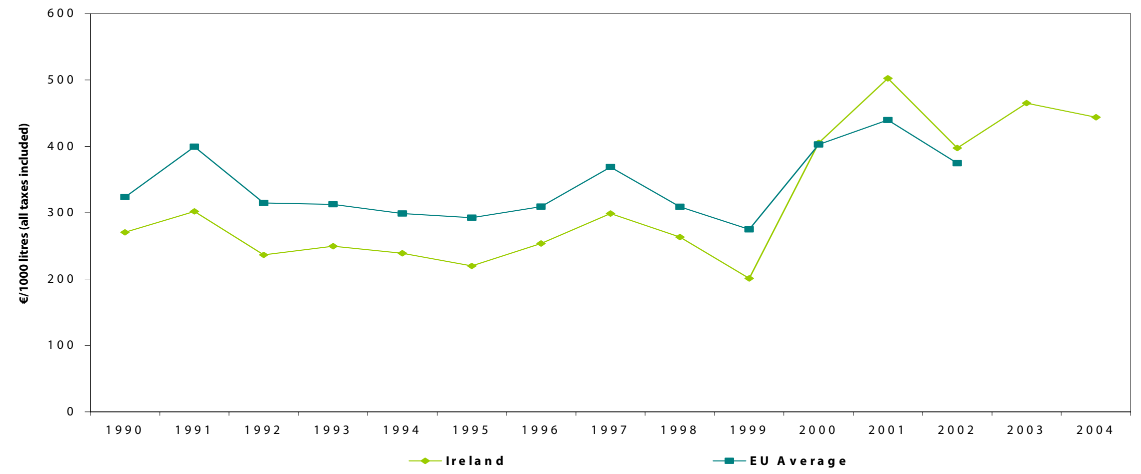
Source: Eurostat.

As figure 30 shows, household electricity prices in Ireland are generally lower than the EU average with an average price difference of 30.1% over the period in Ireland's favour. The differential decreased to 25% in 2002 due to a 9% price increase in Ireland compared with 2% increase in the EU average.

In 2004, household electricity prices in Ireland were 7% below the EU average prices based on the data in figure 31.

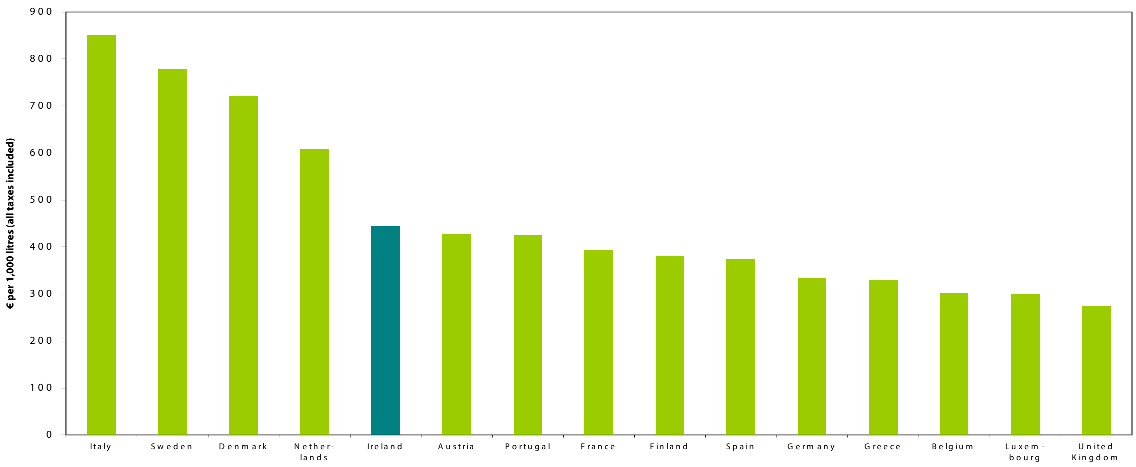
[31] Eurostat consumption category 4161150 Households - Dc (Annual consumption: 3 500 kWh of which night 1 300)

Figure 32: Household Heating Oil Prices



Source: Eurostat.

Figure 33: Household Heating Oil Prices in Europe (January 2004)

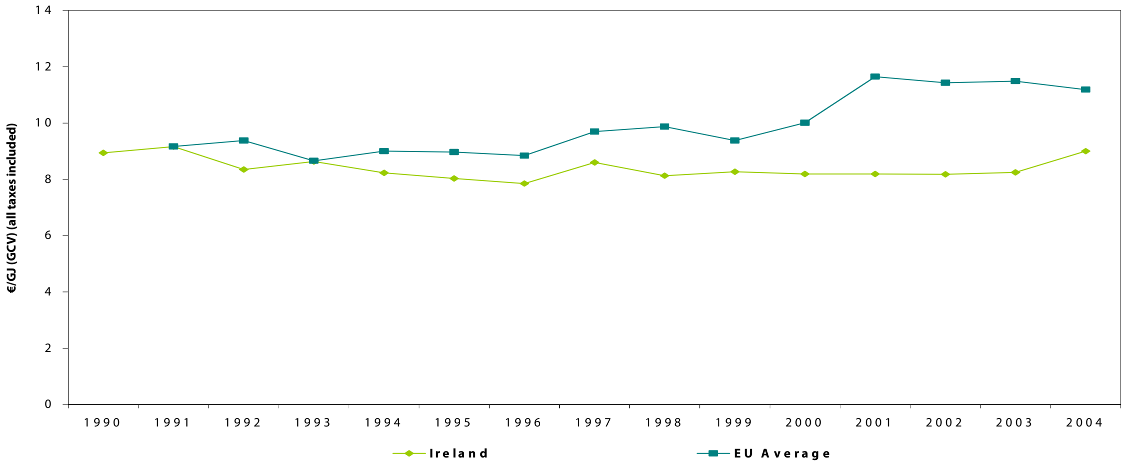


Source: Eurostat.

Household heating oil prices in Ireland were lower than the EU average until 2000, as shown in figure 32. Oil prices in Ireland rose sharply in 2000, by 102% compared with 1999 and since then Ireland's prices have been higher than the EU average. In 2002, Ireland's prices dropped by 21% compared with 2001.

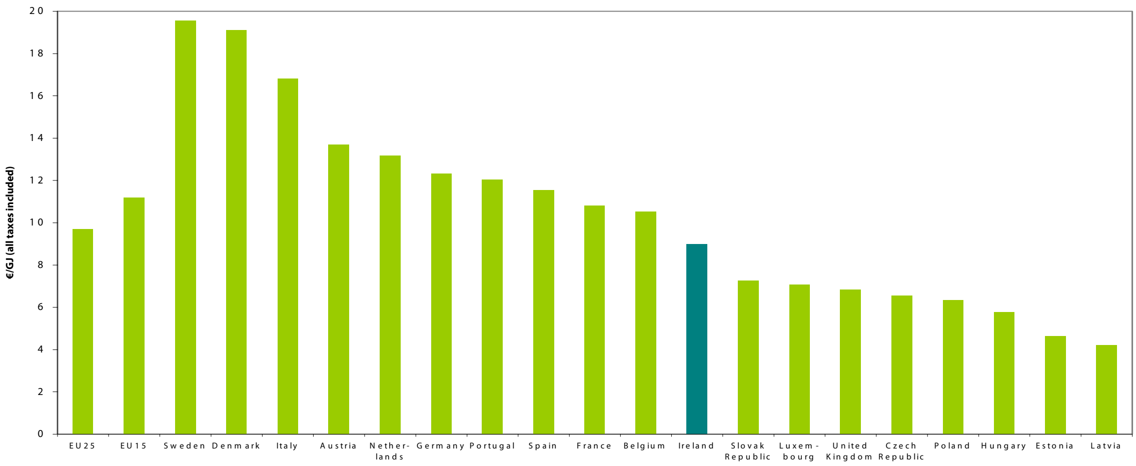
In 2004 the price of heating oil in Ireland was 4% less than the average based on the data in figure 33.

Figure 34: Household Natural Gas Prices



Source: Eurostat.

Figure 35: Household Natural Gas Prices in Europe (January 2004)



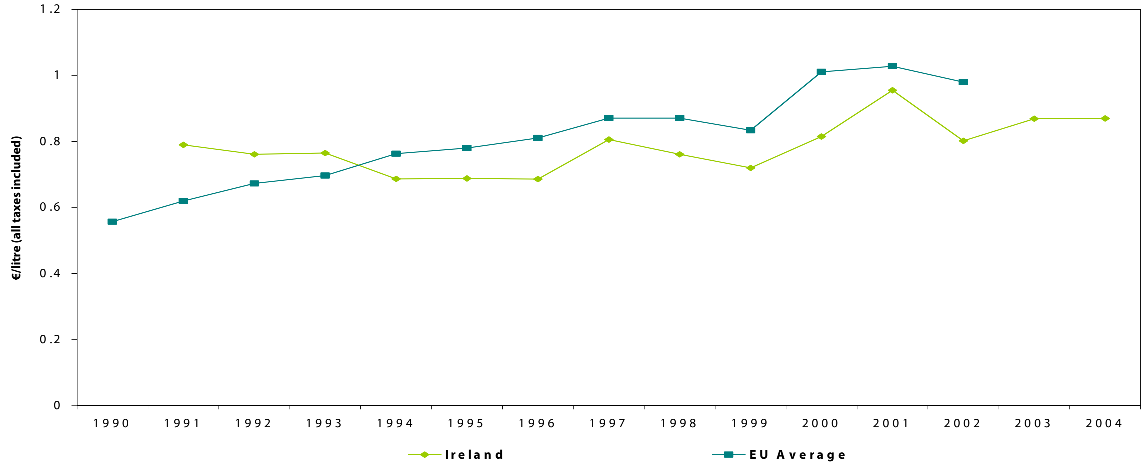
Source: Eurostat.

Natural gas prices to Irish households have been on average 16% lower than the EU average since 1992[32]. The price differential peaked in 2001 at almost 30% lower than the EU average. In 2004 natural gas prices to Irish households were 13% lower than the average based on the data shown in figure 35.

[32] Energy in Ireland 1990 – 2002 presented gas prices based on Eurostat's D1 category (8.37GJ/annum). The D3 (87.3GJ/annum) category is more appropriate for households using gas for space heating purposes.

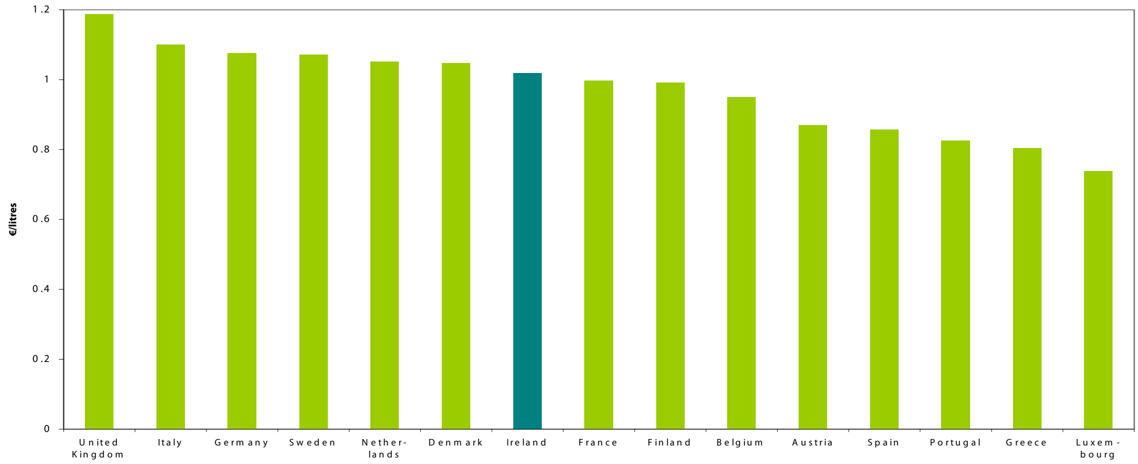
3.3.3 Transport Energy Prices

Figure 36: Retail Unleaded Petrol Prices (95 RON)



Source: Eurostat.

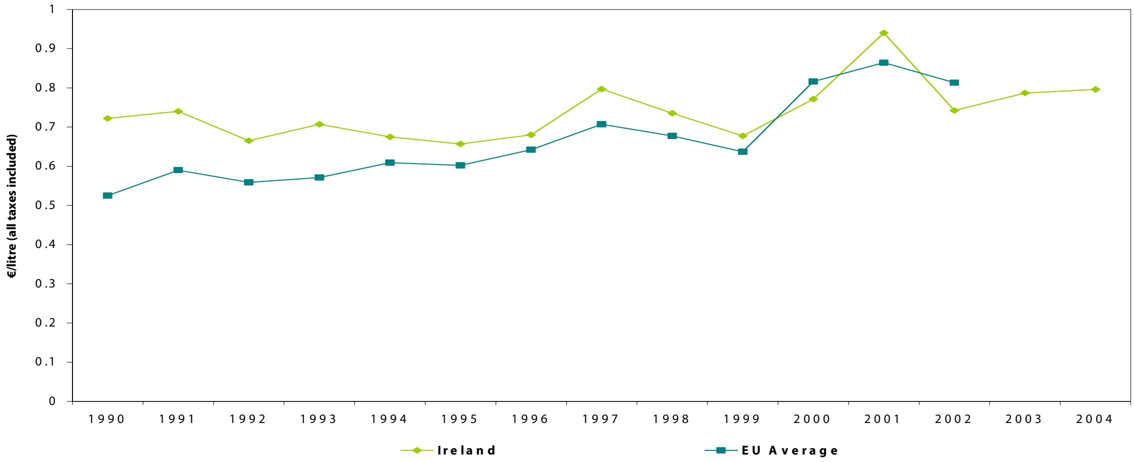
Figure 37: Retail Unleaded Petrol Prices (95 RON) in Europe (January 2004)



Source: Eurostat.

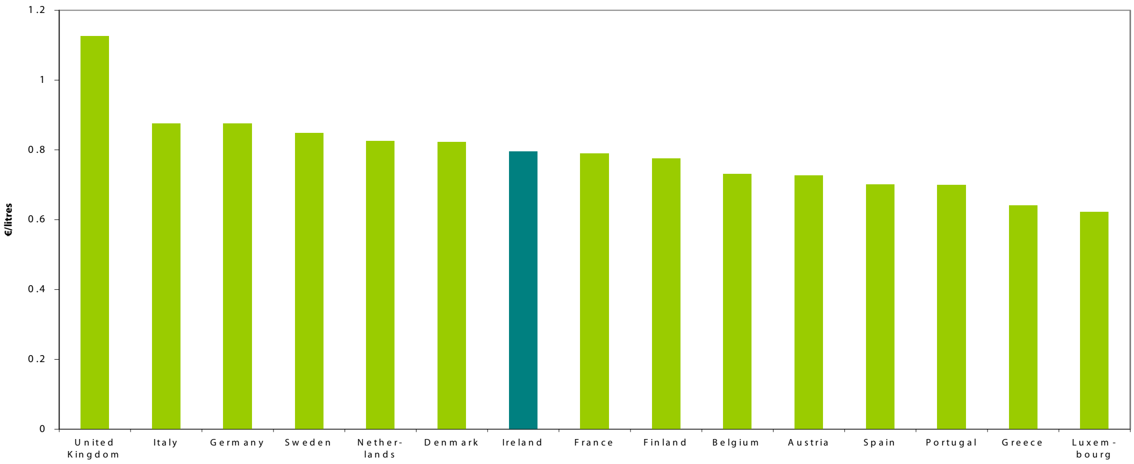
Unleaded petrol prices in Ireland have been lower than the EU average since 1994. A sharp increase of 33% occurred between 1999 and 2001 before a 16% drop in 2002. The drop in average EU prices in 2002 was only 5% by comparison. In 2004, the price of petrol in Ireland was 10.6% lower than the average based on the data shown in figure 37.

Figure 38: Retail Road Diesel Prices



Source: Eurostat.

Figure 39: Retail Road Diesel Prices in Europe (January 2004)



Source: Eurostat.

Automotive diesel prices in Ireland were higher than the EU average with the exception of 2000 and 2002, as shown in figure 38. As in the case of petrol prices, Ireland's price increase between 1999 and 2001 was significant (39%), followed in 2002 by a steep decrease of 21%. In 2004, the price of auto diesel was just 0.7% above the average based on the data shown in figure 39.

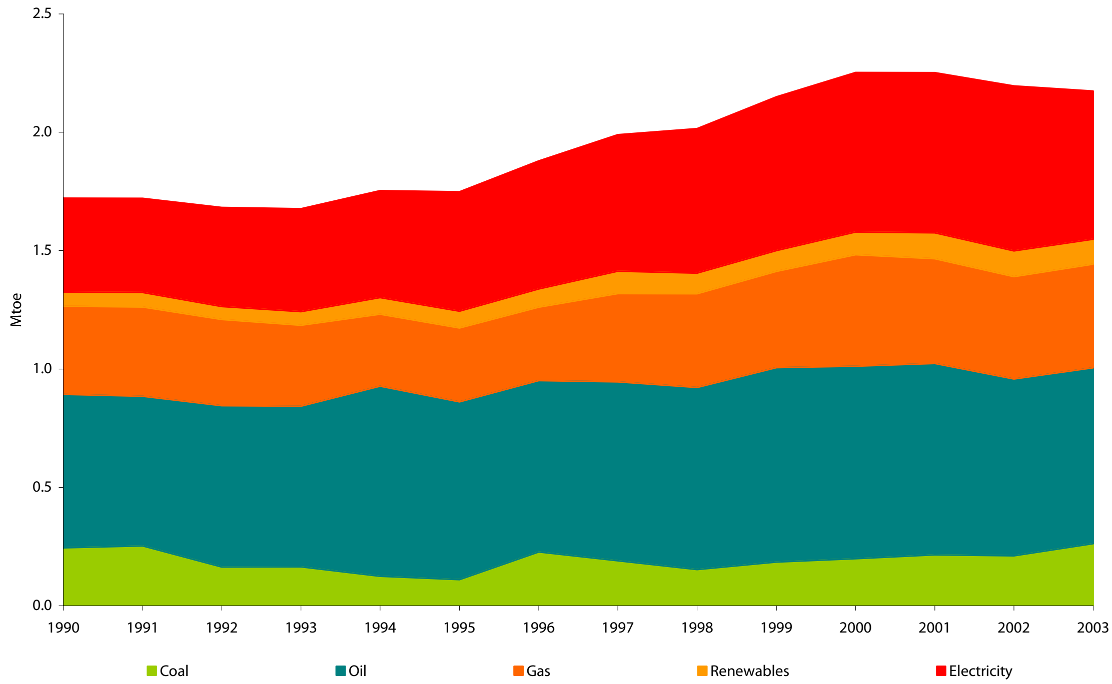
4 Sectoral Indicators

It is important to explore the changes in energy trends that are taking place at a sectoral level, in order to deepen our understanding of energy patterns generally and to assist in assessing the likely impacts of policies and measures to achieve a particular target.

4.1 Industry

Final energy use in industry has grown by 26% (1.8% per annum) to 2.2 Mtoe over the period 1990 – 2003. Within that period only electricity and renewables have increased their share. The share of electricity has risen from 23% to 29% (down from 32% in 2002), and renewables from 3.5% to 5%. The increase in renewables is mainly due to the use of biomass in the wood processing industry and the use of tallow in the rendering industry.

Figure 40: Industry Final Energy Use by Fuel



Electricity is the second most dominant energy form in industry at 29% behind oil at 34%. Growth averaged 3.6% over the period 1990 – 2003 but in 2003 consumption of electricity in industry decreased by 10%. This reduction is due in part to closures such as Irish Fertilizer Industries.

Overall final energy growth in industry fell by 1% in 2003 relative to the previous year, with oil and gas falling by 0.5% and 1.2% respectively. The 24% increase in coal consumption in industry in notable in this context.

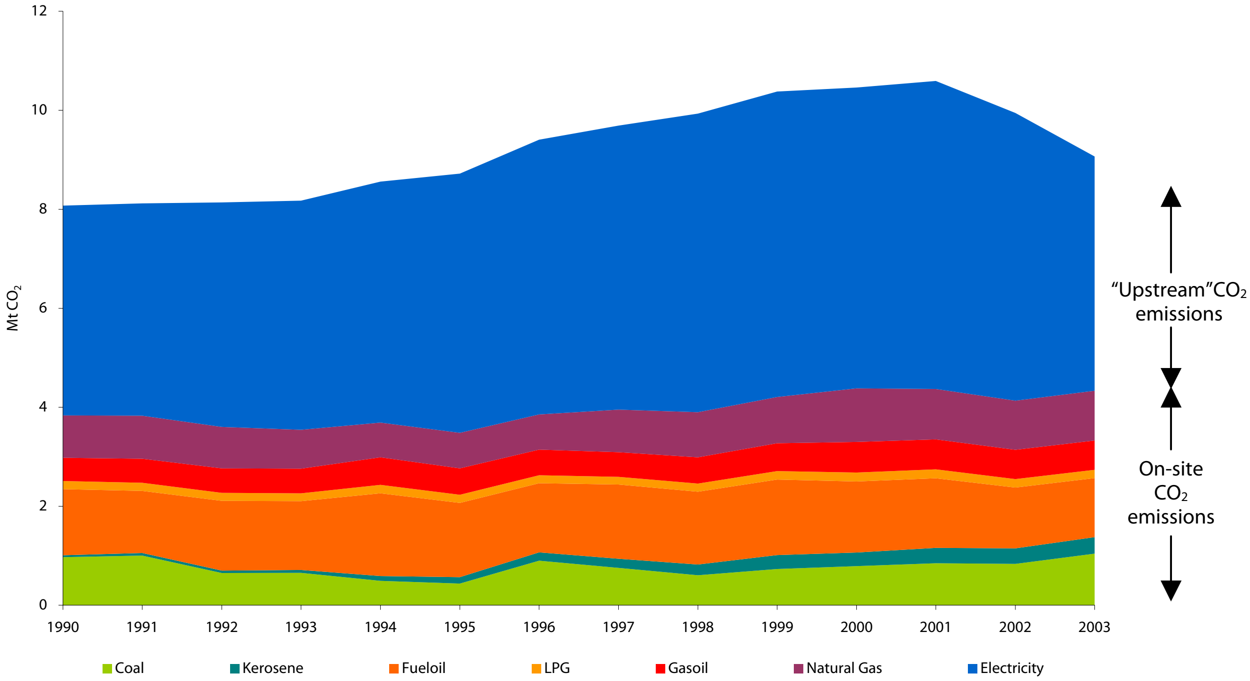
Table 10: Growth Rates and Shares of Final Consumption in Industry

	Growth %	**Average annual growth rates %**					**Shares %**	
	1990 – '03	**1990 – '03**	**1990 – '95**	**1995 – '00**	**2000 – '03**	**2003**	**1990**	**2003**
Coal	7.1	0.5	-14.8	12.6	9.7	24.4	14.2	12.1
Oil	14.7	1.1	3.0	1.6	-3.0	-0.5	37.6	34.2
Gas	17.6	1.3	-3.4	8.5	-2.4	1.2	21.6	20.1
Renewables	76.5	4.5	3.5	6.2	3.3	-3.0	3.5	4.9
Electricity	57.6	3.6	4.9	6.0	-2.4	-10.2	23.1	28.8
Total	26.3	1.8	0.3	5.2	-1.2	-1.0		

In order to determine industry's energy-related CO_2 emissions it is necessary to view electricity on a primary energy basis, i.e. the fuels required to generate the electricity consumed by industry. In 2003 electricity represented 50% of energy used in industry, when calculated on a primary energy basis, compared to 29% on a final energy basis.

Figure 41 shows the primary energy-related CO_2 emissions of industry, distinguishing between the *on-site CO_2* emissions associated with direct fuel use and the *upstream emissions* associated with electricity consumption.

Figure 41: Industry Energy-Related CO_2 Emissions by Fuel



As detailed in table 11, industrial energy-related CO_2 emissions grew 31% between 1990 and 2001 followed by a 6.1% reduction in 2002 and an 8.8% reduction in 2003. Electricity consumption was responsible for 59% of industry's energy related emissions in 2002. This share dropped to 52% in 2003. However, it was still responsible for more CO_2 emissions in industry than all the other fuels used by industry combined.

Table 11 tabulates the growth rates and relative shares of energy related CO_2 emissions in industry.

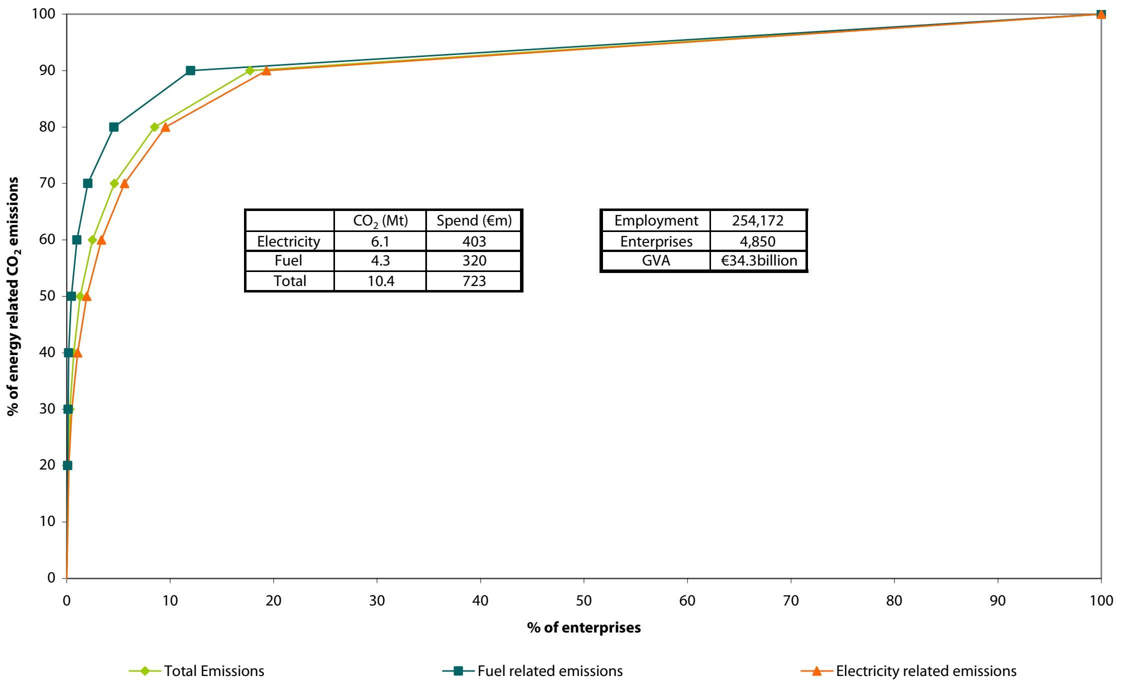
Table 11: Growth Rates and Shares of Energy-related CO_2 Emissions in Industry

	Growth %	**Average annual growth rates %**					**Shares %**	
	1990 – '03	**1990 – '03**	**1990 – '95**	**1995 – '00**	**2000 – '03**	**2003**	**1990**	**2003**
Coal	7.1	0.5	-14.8	12.6	9.7	24.4	12.0	11.5
Kerosene	757.1	18.0	27.6	15.9	6.6	7.1	0.5	3.7
Fuel Oil	-10.6	-0.9	2.3	-0.9	-5.9	-2.9	16.6	13.2
LPG	1.6	0.1	0.0	1.9	-2.5	-1.7	2.0	1.9
Gas Oil	26.8	1.8	2.7	3.0	-1.6	0.0	5.8	6.5
Gas	17.6	1.3	-3.4	8.5	-2.4	1.2	10.6	11.1
Total Combustible Fuels	13.0	0.9	-1.9	4.7	-0.4	4.8	47.5	47.8
Electricity	11.7	0.9	4.3	3.0	-8.0	-18.6	52.5	52.2
Overall Total	12.3	0.9	1.6	3.7	-4.7	-8.8		

4.1.1 Profile of CO_2 Emissions in Industry and Industrial Emissions Trading Sites

Energy consumption in Irish industry is concentrated in a relatively small number of large enterprises. This was demonstrated in an SEI report on energy and CO_2 emissions in industry[33], in which a *Pareto* analysis was carried out on energy consumption in industry based on anonymised data from the CSO's Census of Industrial Production.

Figure 42: Profile of energy-related CO_2 emissions in industry in 2001 (Pareto analysis)



Source: Based on CSO data.

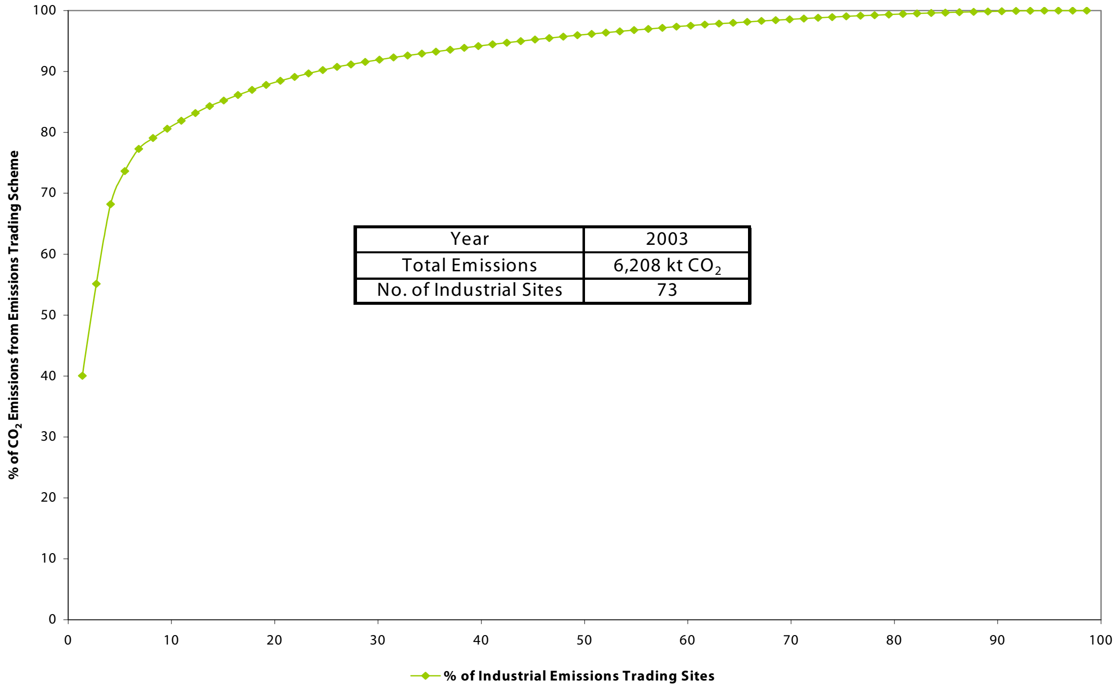
Figure 42 profiles energy consumption in industry for 2001 across 4,850 enterprises. It demonstrates the concentration of energy consumption amongst a relatively small number of enterprises. For example, 12% of enterprises account for 90% of fuel-related CO_2 emissions. It is clear from figure 42 that the concentration of thermal energy consumption was greater than electricity consumption, reflected in the increased steepness of the thermal energy curve.

Figure 43 focuses on the 73[34] industrial sites that have a greenhouse gas emission permit and are involved in emissions trading. The data in this case includes CO_2 emissions from direct on site energy consumption and process related CO_2 emissions. As indicated in the graph, the emissions from these industrial sites totalled 6.2 Mt CO_2 in 2003. Figure 43 illustrates the concentration of emissions amongst a small number of emissions trading sites, with 25% of sites accounting for 90% of emissions.

[33] Sustainable Energy Ireland, (2004), *Profiling Energy Consumption and CO_2 Emissions in Industry 2004 Update – Sensitivity to Energy Price Changes*.

[34] The other sites involved in emissions trading are the large scale fossil fuel based electricity power plants and a number of sites associated with the public services sector (namely hospitals and universities)

Figure 43: Profile of industry CO_2 emission in 2003- National Allocation Plan (Pareto analysis)

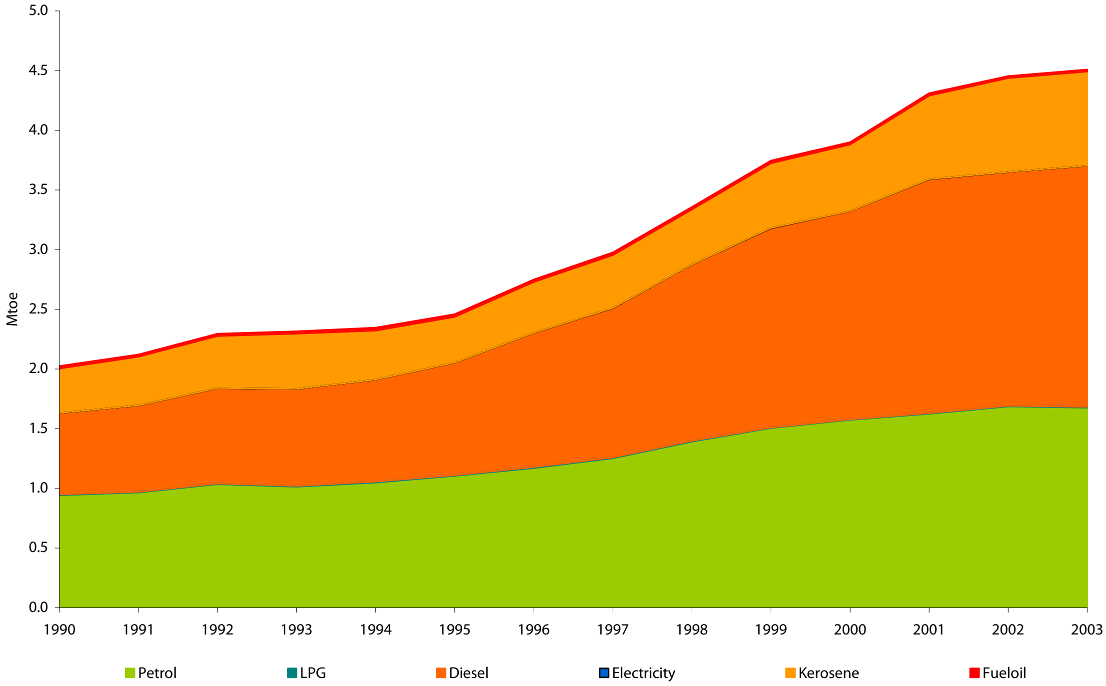


Source: Based on EPA data.

4.2 Transport

Transport energy consumption increased by 1.2% to 4.5 Mtoe in 2003. This growth is somewhat reduced from 3.3% in 2002 and an average annual rate of 6.9% between 2000 and 2002.

Figure 44: Transport Final Energy Use by Fuel[35]



The growth rates for the different transport fuels over the period are shown in table 12. It can be seen that in 2003 petrol actually declined by 0.6% whereas diesel consumption grew by 3.2%. This indicates a possible reduction in private car transport and an increase in freight transport. This is a reversal of the situation in 2002 where there was no growth in diesel and petrol grew by 3.8%. The share of diesel in transport energy has risen from 34% to 45% over the period 1990 – 2003, up one percentage point on last year. This reflects the increasing transport requirements of goods over the period and a shift to greater use of diesel in private transport.

Table 12: Growth Rates and Shares of Final Consumption in Transport

	Growth %	**Average annual growth rates %**					**Shares %**	
	1990 – '03	**1990 – '03**	**1990 – '95**	**1995 – '00**	**2000 – '03**	**2003**	**1990**	**2003**
Total Oil Products	122.7	6.4	4.0	9.7	4.9	1.2	99.9	99.96
Petrol	77.8	4.5	3.2	7.4	2.1	-0.6	46.6	37.2
Diesel	197.2	8.7	6.7	13.2	5.0	3.2	33.6	44.8
Kerosene	110.4	5.9	0.5	7.6	12.4	0.3	18.5	17.4
LPG	-30.8	-2.8	0.0	-15.6	17.3	-1.7	0.3	0.1
Fuel Oil	-10.6	-0.9	2.8	-1.8	-5.2	2.8	1.0	0.4
Electricity	32.9	2.2	0.6	5.3	0.0	0.0	0.1	0.04
Total	122.6	6.3	4.0	9.7	4.9	1.2		

Petrol consumption in transport stood at 1.7 Mtoe in 2003. The share of petrol in total transport energy fell to 37% in 2003.

[35] The effect of cross border trade (fuel tourism) or smuggling is not taken in to account in the figures presented here. The Society for the Irish Motor Industry (SIMI) estimate that this is in the region of 10% of final consumption of energy in transport.

The growth rates and shares of the energy-related CO_2 emissions from the different transport fuels are tabulated in table 13.

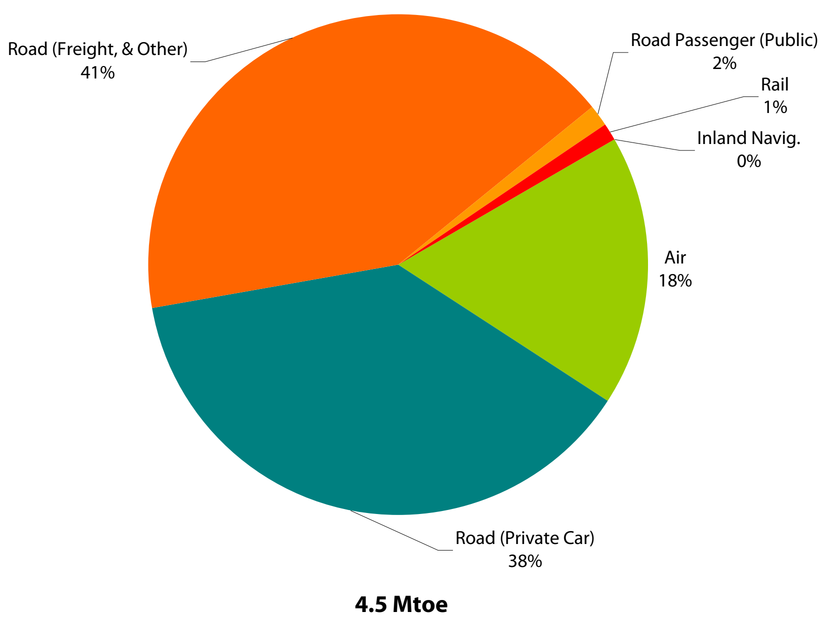
Table 13: Growth Rates and Shares of Energy-Related CO_2 Emissions in Transport

	Growth %	Average annual growth rates %					Shares %	
	1990 – '03	1990 – '03	1990 – '95	1995 – '00	2000 – '03	2003	1990	2003
Total Oil Products	127.1	6.5	4.7	10.1	3.6	1.5	99.7	99.9
Petrol	77.8	4.5	3.2	7.4	2.1	-0.6	55.6	43.6
Diesel	197.2	8.7	6.7	13.2	5.0	3.2	42.4	55.6
Kerosene	110.4	5.9	0.5	7.6	12.4	0.3	22.7	21.1
LPG	-30.8	-2.8	0.0	-15.6	17.3	-1.7	0.4	0.1
Fuel Oil	-10.6	-0.9	2.8	-1.8	-5.2	2.8	1.3	0.5
Electricity	-5.8	-0.5	0.0	2.3	-5.7	-9.3	0.3	0.1
Total	126.6	6.5	4.7	10.1	3.6	1.5		

4.2.1 Transport Energy Demand by Mode

Fuel consumption in transport is closely aligned to the mode of transport used: kerosene almost all used for air transport; fuel oil for shipping and electricity only consumed by the Dublin Area Rapid Transport (DART) system (and LUAS from 2004). Liquefied petroleum gas (LPG) is almost exclusively used for road transport, as is petrol. The bulk of petrol consumption for road transport can be assumed to be for private car use although there is a significant number of petrol driven taxis in operation. Diesel consumption is used for navigation, rail and road purposes but the bulk (92% in 2003) is used for road transport. This diesel consumption is used for freight transportation, public transport in buses and taxis, private car transport and other applications such as agricultural, construction and other machines. The contribution from each mode of transport to energy demand in 2003 is shown in figure 45.

Figure 45: Transport Energy Demand by Mode (2003)



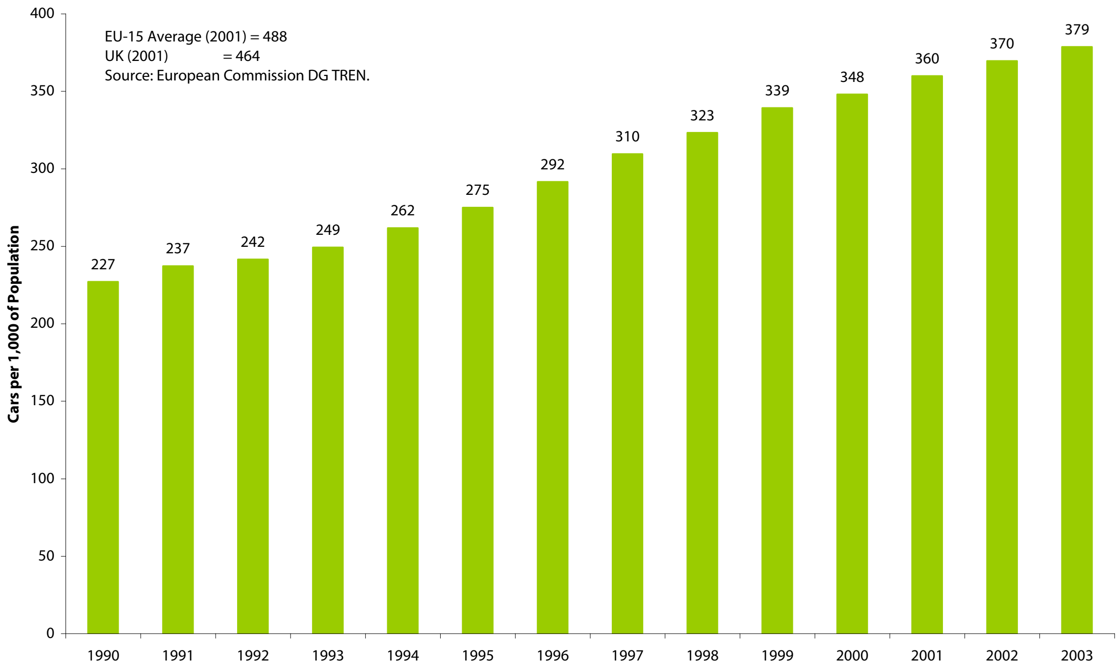
Source SEI

As illustrated in figure 45, energy consumption in transport was 4.5 Mtoe in the year 2003. Road transport accounted for 81% of this. It is difficult to accurately separate private from total road transport because data relating to petrol and diesel consumption is not classified by mode. However, it is estimated that private cars account for just less than 48% of road transport energy (1.7 Mtoe approx.) or approximately 38% of all transport energy[36]. Private cars thus account for approximately 15% of Ireland's final energy consumption or 12% of primary energy consumption. Figure 45 also illustrates the relative weighting of private car transport compared to road passenger services (bus) and rail travel.

4.2.2 Private Car Transport

The number of vehicles on Irish roads rose to just over 1.9 million[37] in 2003 an increase of 87,383 on 2002 or 4.7%. Of this there were 1.5 million private cars or 77.8% of the total. Private car ownership increased by 4.1% in 2003 and resulted in an increase in car density as shown in figure 46 to 379 cars per 1000, compared to an EU-15 average of 488 and a UK average of 464 (both in 2001).

Figure 46: Private Cars per 1000 of Population



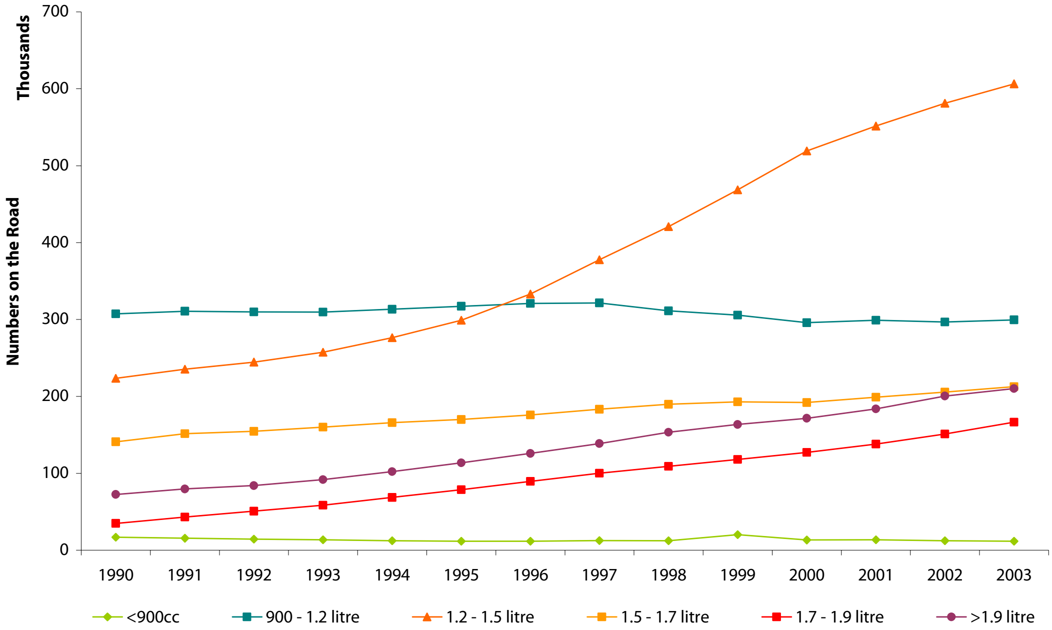
Source: Based on Vehicle Registration Unit and CSO data.

Figure 47 shows how purchasing patterns with respect to engine size have changed over time. The less than 900cc and 900cc – 1.2 litre are showing steady or declining numbers whereas the fastest growing range is the 1.2 – 1.5 litre range. The 1.7 – 1.9 litre and greater than 1.9 litre range are also growing strongly illustrating the trend to purchasing larger vehicles. The greater than 1.9 litre range is in fourth place as the most popular sized car only just behind the 1.5 – 1.7 litre range. If the rate of growth shown in figure 46 continues in 2004 then the larger sized cars will have the third largest share of the private car stock.

[36] This is estimated based on assumptions of 90% of petrol and 10% of diesel (from road transport) being consumed by private cars. Diesel private cars represent approx. 35% of all diesel vehicles but consume considerably less than large trucks and other heavy vehicles so 10% of diesel consumption, while an estimate, is a reasonable assumption.

[37] Source: Vehicle Registration Unit (Department of the Environment, Heritage & Local Government), (2004) *Irish Bulletin of Vehicle and Driver Statistics 2003*

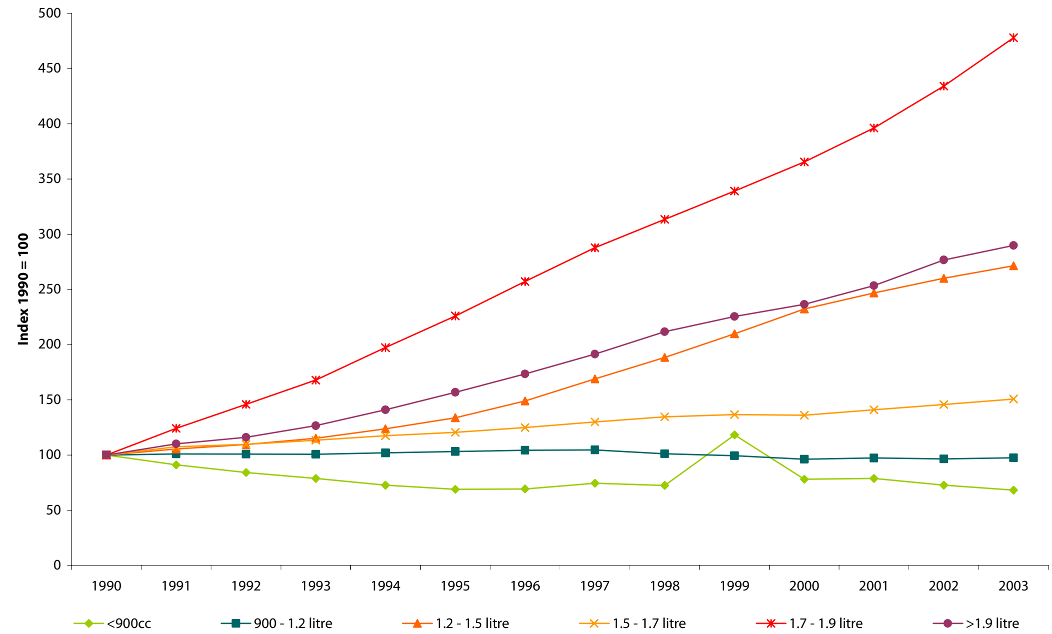
Figure 47: Changes in Car Engine Size



Source: Based on Vehicle Registration Unit data.

Figure 48 illustrates how the consumer's preference of engine size has changed over time expressed as an index. This gives a clearer indication of the rate of increase of the differing size classes. Cars with engines less than 900 cc and 1 – 1.2 litre are showing steady or declining numbers whereas the other classes are showing an increase with the fastest growing range being the 1.7 – 1.9 litre category. This clearly shows a changing preference towards larger cars. The number of cars in the 1.7 – 1.9 litre range grew by 478% since 1990 and those in the greater than 1.9 litre range grew by 290%.

Figure 48: Change in Car Engine Size



Source: Based on Vehicle Registration Unit data.

4.3 Residential

Residential final energy consumption grew by 27% (1.8% per annum) over the period 1990 – 2003 to a figure of 2.8 Mtoe. During this time the number of households in the State increased by 30% from approx. 1.01 million to 1.29 million in 2002[38]. Residential energy consumption increased by 3.4% during 2003 following a decrease of 0.1% in 2002. When corrections for climate effects[39] are taken into account the increase in 2003 was 2.5% (see table 14).

Figure 49: Residential Final Energy Use by Fuel

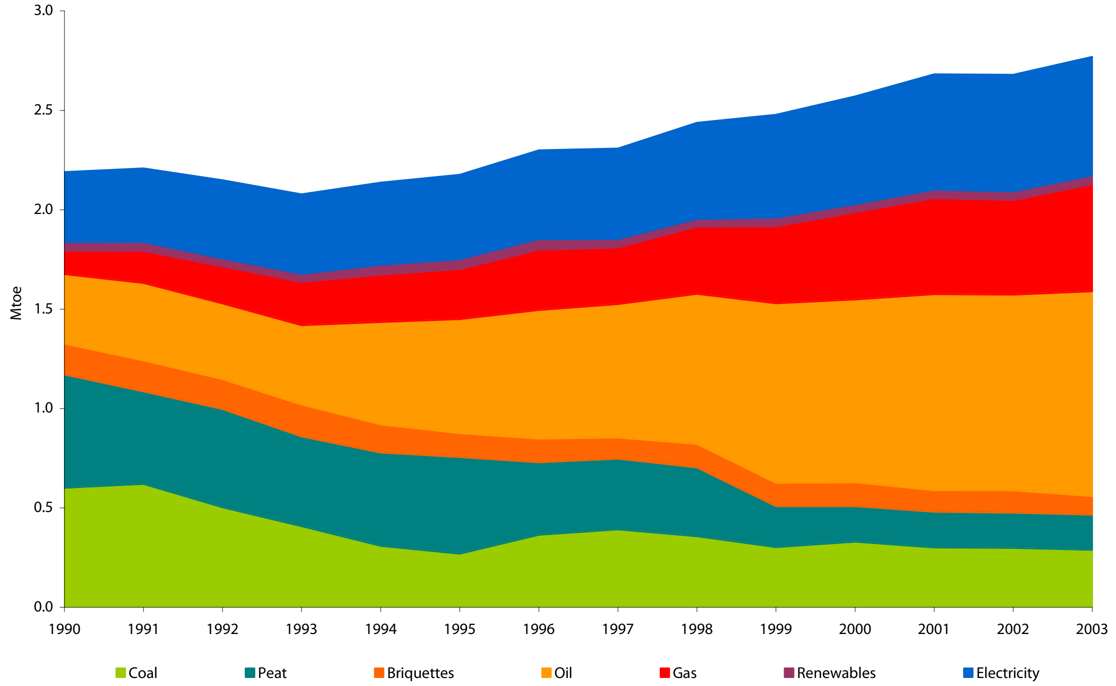


Figure 49 shows significant changes in the mix of fuels that have been consumed in the residential sector over the period. This can largely be explained by the move away from the use of open fires and solid fuel fired back-boiler heating systems that were popular in the seventies and eighties. New houses built in the 1990's predominantly had oil- or gas-fired central heating or perhaps even electric storage heating and there has been a trend to convert existing back-boiler systems to either oil or gas. Increased comfort levels associated with central heating would tend to increase heating demand, for a given standard of insulation. Change to the relatively higher efficiency of the oil and gas heating technologies (or indeed the more efficient types of solid fuel heating technologies) would have had the opposite effect and helped to slow the growth of energy in the sector.

The increase in electricity usage in households can be explained by an increase in the use of appliances, such as washing machines, driers, dishwashers, microwave ovens, computers, televisions etc. in the home.

As can be seen from figure 49, oil has become the dominant fuel in the residential sector more than doubling its share from 16% in 1990 to almost 37% in 2003. Electricity is the second most dominant fuel in the sector at 22%. Natural gas usage more than tripled its share over the period to become the third fuel of choice. In 2003 gas consumption grew by 13.3% and oil grew by 4.5% after a slight reduction in 2002. Electricity was the only other energy source to increase in consumption in residential with a 1.8% growth.

The growth rates and shares are tabulated in table 14.

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[38] Central Statistics Office (2003). *Census 2002 – Volume 3 Household composition and family units..*

[39] Annual variations in climate affect the space heating requirements of occupied buildings. Climate correction involves adjusting the energy used for space heating by benchmarking the climate in a particular year with that of a long-term average measured in terms of number of degree days.

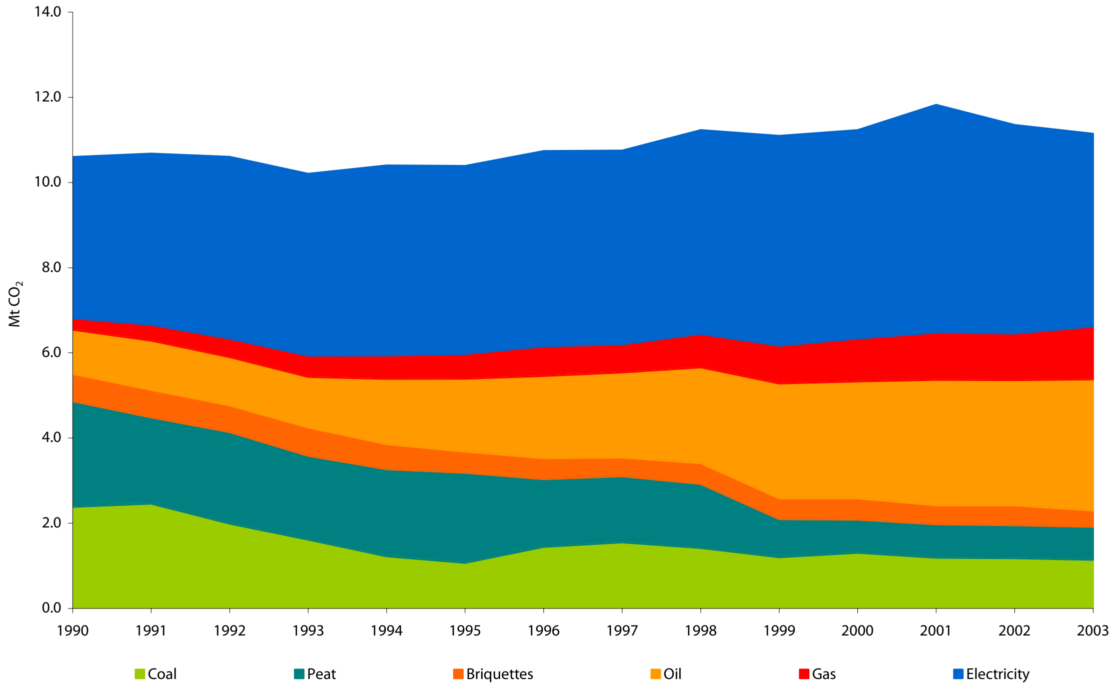
Table 14: Growth Rates and Shares of Final Consumption in Residential Sector

	Growth %	Average annual growth rates %					Shares %	
	1990 – '03	1990 – '03	1990 – '95	1995 – '00	2000 – '03	2003	1990	2003
Coal	-52.1	-5.5	-14.9	4.1	-4.3	-3.0	27.4	10.4
Peat	-69.0	-8.6	-3.1	-18.1	-0.4	-0.5	26.0	6.4
Briquettes	-39.7	-3.8	-5.0	0.0	-8.0	-16.9	7.1	3.4
Oil	195.3	8.7	10.5	9.9	3.9	4.6	15.9	37.2
Gas	359.6	12.4	16.5	11.8	7.1	13.3	5.4	19.5
Renewables	2.2	0.2	3.3	-4.4	2.8	0.9	1.9	1.6
Electricity	68.5	4.1	3.7	5.0	3.3	1.8	16.2	21.6
Total	26.5	1.8	-0.1	3.4	2.5	3.4		
Total Climate Corrected	25.4	1.8	-0.6	3.0	3.7	2.5		

The salient trends in energy use in the residential sector over the period 1990 – 2003 are as follows:

- Coal usage dropped by 52% between 1990 and 2003 to 0.29 Mtoe. The share of coal fell from 27% to 10%.
- Sod peat usage dropped by 69% (8.6% per annum on average) to 0.17 Mtoe and its share fell from 26% to 6.4% over the period.
- Peat briquette usage reduced by 40% to 0.09 Mtoe and its share fell from 7.1% to 3.4%. Briquettes saw a large reduction of 17% in 2003.
- Oil usage increased considerably by 195% to just over 1 Mtoe and its share in the residential sector grew from 16% to 37%.
- Natural gas usage increased even more significantly by 360% (or 12% per annum) to 0.54 Mtoe and its share rose from 5.4% to 19.5%, 1.5% points up on 2002. Growth of natural gas consumption in residential sector in 2003 was 13%.
- Renewables (mainly wood) usage increased slightly by 1.2% to 0.04 Mtoe but its share dropped from 1.9% to 1.6%.
- Electricity usage increased by 68% to 0.6 Mtoe and its share increased from 16% to 21.6%. The share of electricity decreased slightly (0.3% points) during 2003.

Figure 50: Residential Energy-related CO_2 by Fuel



4.3.1 Energy Intensity of Residential Sector

The energy intensity of the residential sector is typically defined in terms of the unit consumption of energy or the energy consumed per dwelling. Figure 51 shows the trend in unit consumption per dwelling, which decreased by 2.5% during the period 1990 – 2003.

While the overall unit energy consumption has decreased, figure 51 also shows an increasing trend in electricity consumption per households. This has increased by 30% since 1990. The increasing penetration of household appliances such as washing machines, dishwashers, driers etc and, of late, products such as computers and multiple televisions can account this for this increase.

Figure 51 also shows the overall unit energy consumption in households corrected for climate variations. Looking at this and in conjunction with table 16, it can be seen that the reduction in unit consumption over the period at 3.4% is greater than the uncorrected consumption (2.7%). However, it can also be seen that most of the improvement in unit consumption occurred during the early 1990's. The reduction in the early 1990's can be explained by changes in fuel mix and improvement in efficiency in the move away from open fires and back boilers to gas and oil heating together with improvements in insulation.

Figure 51: Unit Consumption of Energy per Dwelling (permanently occupied)

Source: Based on SEI, CSO and Met Éireann data

One reason for the counter trend in the late 1990's could be explained by the trend towards larger houses as shown in figure 52. Larger houses have higher space-heat requirements and they also have proportionally greater surface area and therefore higher heat losses. Table 16 shows that the rate of growth in the floor area of new houses and flats was much higher in the second half of the 1990's than in the first half. This strong trend continued in 2003.

Table 15: Growth Rates Residential Floor Areas per new Dwelling[40]

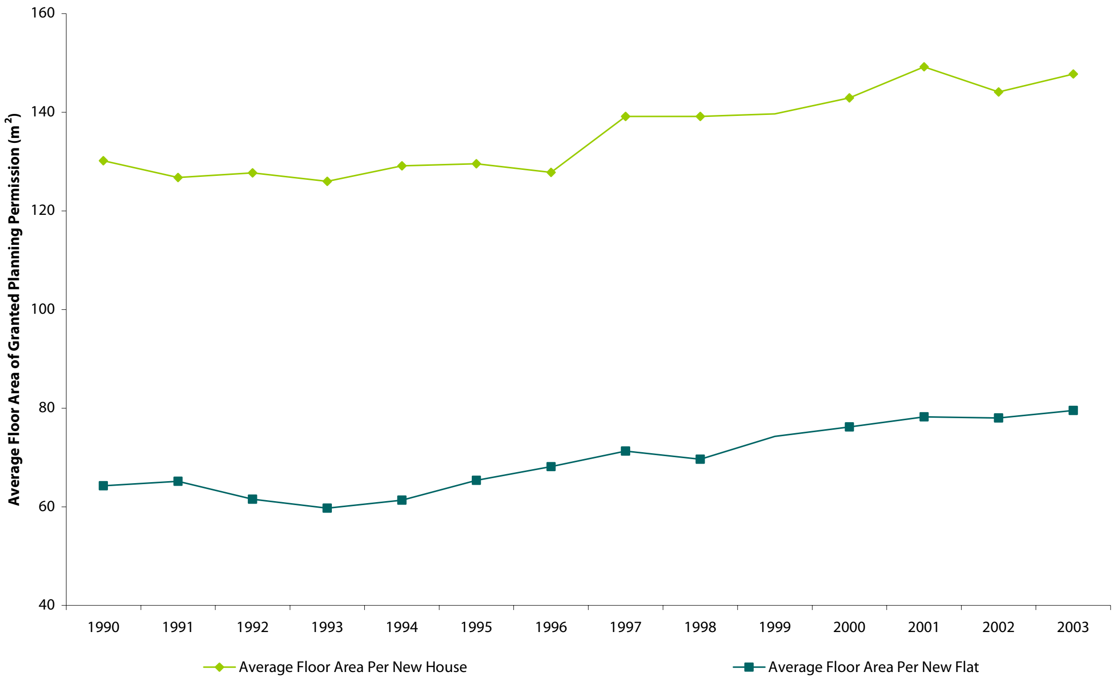
	Growth %	Average annual growth rates %				
	1990 – '03	**1990 – '03**	**1990 – '95**	**1995 – '00**	**2000 – '03**	**2003**
New Houses	13.5	1.0	-0.1	2.0	1.1	2.5
New Flats	23.8	1.7	0.3	3.1	1.4	2.0

[40] Note that the figures used in table 12 and figure 53, are for the average floor area of new houses that were granted planning permission. It is not known if all those granted permission were actually built but the figures provide a very good proxy for the trend in new house size.

Floor areas of new houses grew by 13.5% between 1990 and 2003. They declined slightly in the early 1990's and grew at a rate of 2% per annum in the latter half of the decade. 2002 saw a decline in the average floor area compared to 2001 but this rebounded again in 2003 rising by 2.5%.

Floor areas of new flats showed a stronger growth of 24% over the period. The ratio of new houses to new flats granted planning in 1990 was approximately 9 to 1 whereas in 2002 it was 3 to 1 and reducing to less than 2 to 1 in 2003, indicating an increasing impact on residential energy consumption. The 2002 Census[41] notes that in 1991, 6.5% of the housing stock consisted of apartments or flats whereas in 2002 the proportion was 8.6%.

Figure 52: Floor Areas of New Houses and New Flats



Source: CSO

Table 16: Growth Rates of Residential Unit Energy Consumption and Unit CO_2 Emissions

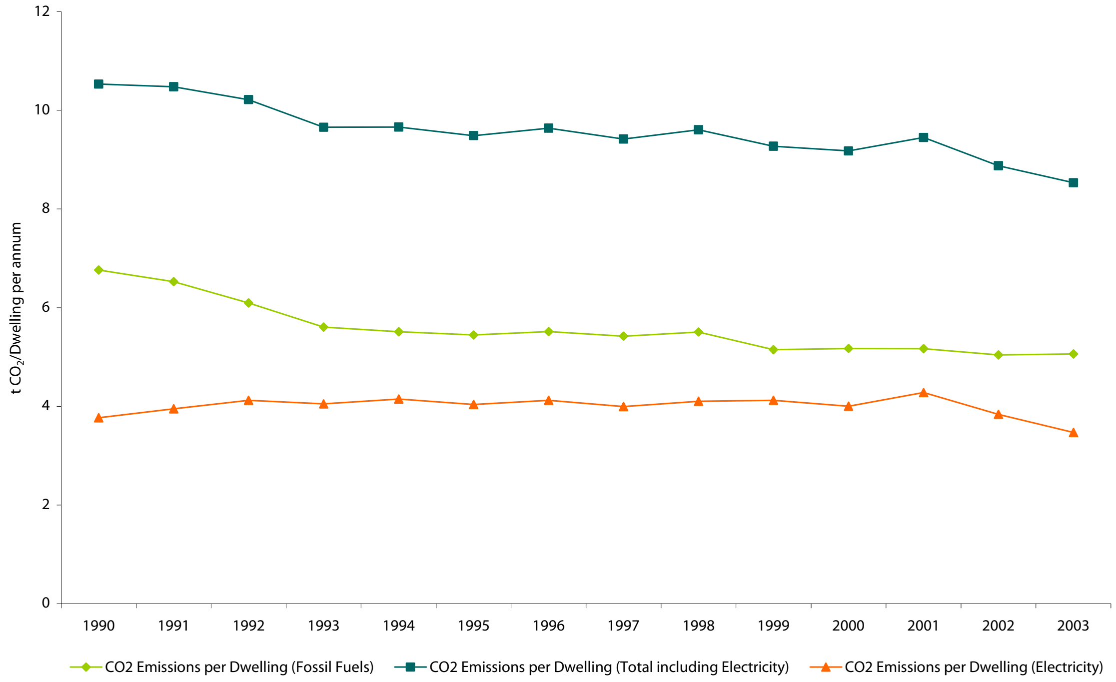
	Growth %	Average annual growth rates %				
Unit Energy Consumption	**1990 – '03**	**1990 – '03**	**1990 – '95**	**1995 – '00**	**2000 – '03**	**2003**
Total Energy	-2.5	-0.2	-1.8	1.1	0.3	1.2
Total Energy Climate Corrected	-3.4	-0.3	-2.3	0.7	1.4	0.3
Fossil Fuel Energy	-8.8	-0.7	-2.6	0.7	0.1	1.7
Electrical Energy	29.9	2.0	2.0	2.7	1.1	-0.3
Unit Energy-Related CO_2 Emissions						
Total Energy CO_2	-19.0	-1.6	-2.1	-0.7	-2.4	-3.9
Fossil Fuel CO_2	-25.1	-2.2	-4.2	-1.0	-0.7	0.4
Electricity CO_2	-8.0	-0.6	1.4	-0.2	-4.7	-9.6

Unit emissions of energy-related CO_2 per dwelling decreased by 19% over the period, a considerably faster rate of reduction than for energy consumption. Consumers switching away from coal and peat to lower CO_2 emitting fuels such as gas and oil account for the different trends in unit CO_2 emissions and energy consumption. This relates to the changes in table 14 in the relative shares of coal and peat with respect to gas and oil.

[41] CSO, (2004), *2002 Census of Population – Volume 13 – Housing*.

Upstream emissions associated with the use of electricity per dwelling fell by 8% over the period but this is mainly due to the reduced carbon intensity of electricity generation from 2001 onwards brought about by new generating plant and a shift in fuel mix to lower carbon fuels. This trend is apparent in fact since 1995, as shown in table 16. The annual growth rates in unit consumption of electricity were 2.7% and 1.1% for the periods 1995 – 2000 and 2000 – 2003 respectively. The associated annual change in energy related emissions per household decreased by 0.2% per annum in the period 1995 – 2000 and by 4.7% in the period 2000 – 2003. These trends are also apparent by comparing figure 53, showing energy related CO_2 emissions per dwelling with figure 51 (energy consumption per dwelling).

Figure 53: Unit Energy-Related CO_2 Emissions per Dwelling



4.4 Commercial and Public Services / Tertiary

Final energy consumption in the commercial and public services (or tertiary) sector grew by 75% (4.4% per annum) over the period 1990 – 2003 to a figure of 1.8 Mtoe. During this period the value added generated by the sector grew by 95% (5.3% per annum) while the numbers employed grew by 85%.

Figure 54: Commercial and Public Services / Tertiary Final Energy Use by Fuel

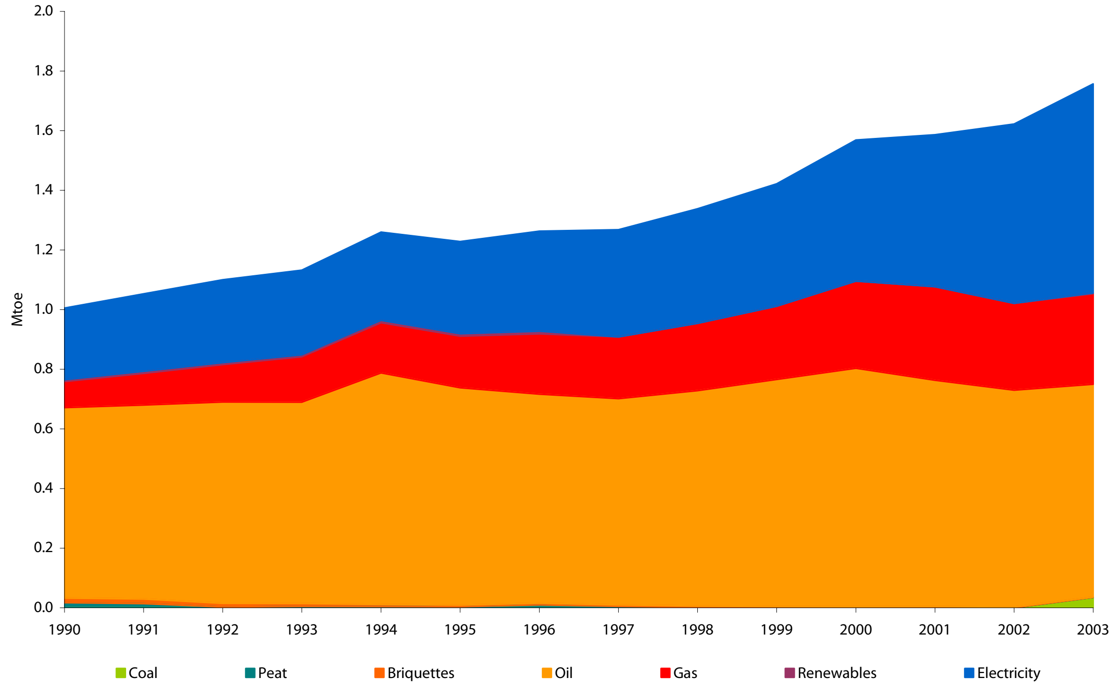


Figure 54 shows the changes in the fuel mix in the tertiary/services sector over the period. One interesting feature is the small range of fuels utilised in this sector – essentially oil, gas and electricity. Oil and gas are used predominately for space-heating purposes but also for water heating, cooking and, in some subsectors, laundry. Oil consumption increased by 12% over the period and gas consumption increased by 250% although this was from a low base.

Electricity consumption in services increased by 192% between 1990 and 2003 making it the second most significant energy consumption in this sector after oil. Its share of final consumption in services increased from 24% to 40%. This growth is fuelled by the changing structure of this sector and the general increase in the use of information and communication technology (ICT) and air conditioning.

Growth rates and shares are tabulated in table 17.

Table 17: Growth Rates and Shares of Final Consumption in the Commercial and Public Services Sector

	Growth %	**Average annual growth rates %**					**Shares %**	
	1990 – '03	**1990 – '03**	**1990 – '95**	**1995 – '00**	**2000 – '03**	**2003**	**1990**	**2003**
Oil	11.7	0.9	2.6	1.9	-3.7	-1.8	63.5	40.6
Gas	250.4	10.1	14.9	11.0	1.2	4.3	8.6	17.3
Electricity	192.0	8.6	5.2	8.9	14.1	16.6	23.9	39.9
Total	74.8	4.4	4.1	5.0	3.9	8.3		

The key trends are as follows:

- Final energy consumption grew by 75% over the period 1990 – 2003 (4.4% per annum). Growth in 2003 was 8.3%.
- Oil, gas and electricity make up the bulk of energy consumed in the tertiary sector. The small contributions from coal and peat in the early 1990's is now negligible.
- Oil usage grew by 12% (0.9% per annum) over the period 1990 – 2003 to 714 ktoe and its share of services final energy consumption fell from 64% to 41%. In 2003 oil consumption fell by 1.8%.
- Natural gas consumption grew by 250% (10.1% per annum) over the period to 303 ktoe. Its share has grown from 8.6% in 1990 to 17% in 2003. In 2003 gas consumption grew by 8.6%.
- Electricity consumption in tertiary grew by 192% (8.6% per annum) over the period 1990 – 2003. Its share has grown from 24% in 1990 to 40% in 2003. The growth of electricity in 2003 was 16.6%, down slightly on the highest growth rate of 18% in 2002.

Figure 55 shows the primary energy-related CO_2 emissions of the services sector distinguishing between the *on-site* CO_2 emissions associated with direct fuel use and the *upstream* emissions associated with electricity consumption. Emissions from non-electrical energy increased by 32% over the period whereas the emissions associated with electricity consumption increased by 107%. In 2003 the non-electricity emissions increased by 4% and the electricity associated emissions in services rose by 6%. This would have been higher (there was an 16.6% growth in electricity consumption) but for the improvements in the CO_2 intensity of electricity supply.

In the services sector, the share of emissions associated with electricity consumption in 2003 was approximate two thirds (63%) compared to the combustion of oil and gas. In 1990 the proportions was closer to half and half (53% electricity and 47% fuels).

Figure 55: Commercial and Public Services Sector CO_2 Emissions by Fuel

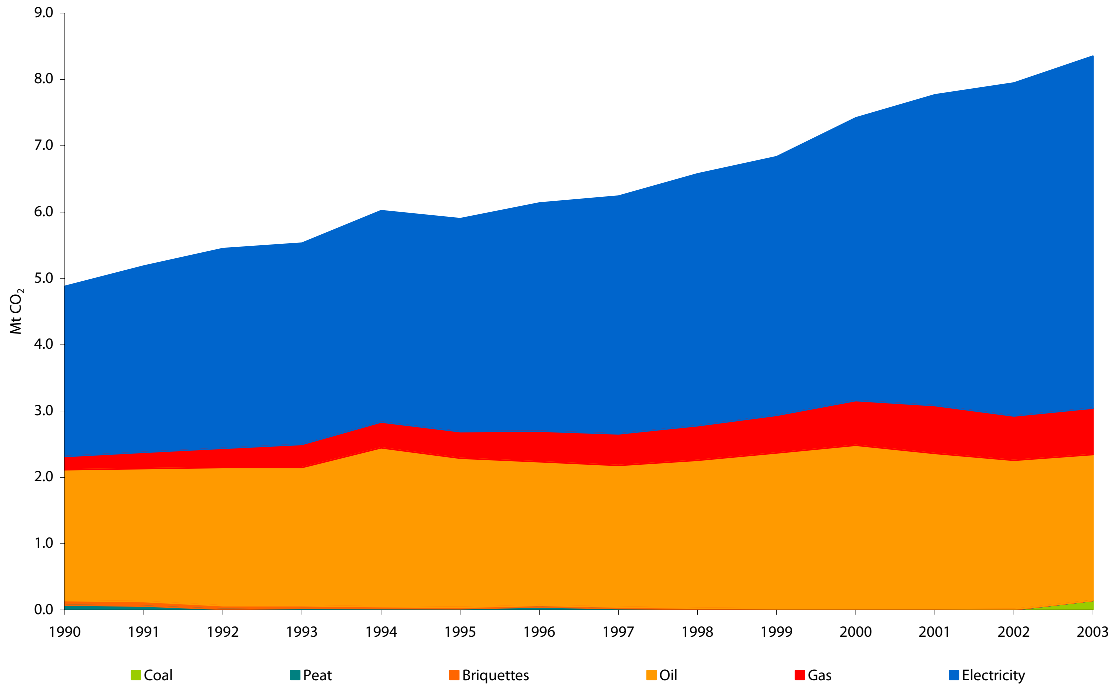


Table 18: Growth Rates and Shares CO_2 Emissions in Commercial/Public Services

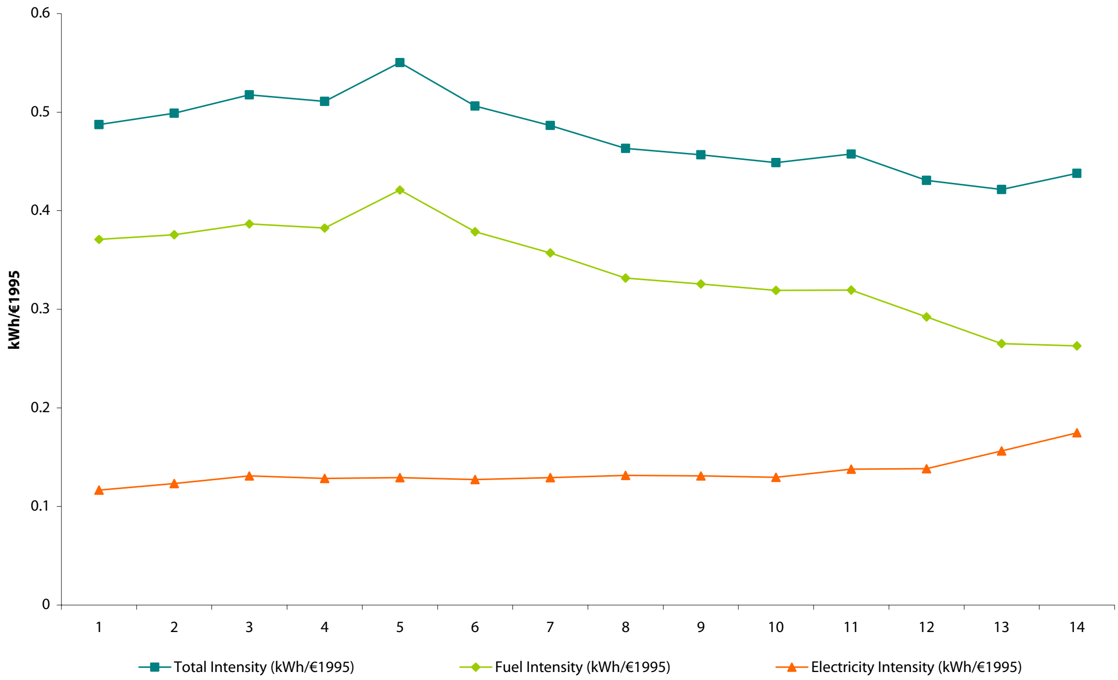
	Growth %	Average annual growth rates %					Shares %	
	1990 – '03	1990 – '03	1990 – '95	1995 – '00	2000 – '03	2003	1990	2003
Combustible Fuels	31.5	2.1	3.1	3.3	-1.2	4.0	47.4	36.4
Electricity	106.9	5.8	4.6	5.8	7.6	5.8	52.6	63.6
Total	71.1	4.2	3.9	4.7	4.0	5.1		

4.4.1 Energy Intensity of the Services Sector

The energy intensity of the services sector is generally measured with respect to the value added generated by services activities. As shown in figure 56, this intensity is much flatter than that of industry although it is showing a declining trend since 1994. The energy intensity of the services sector was 14% lower in 2002 than it was in 1990, principally because of the rapid growth in the value added in the sector. The downward trend was reversed in 2003 however, with intensity rising by 3.9% on 2002.

As can be seen in figure 56 the fuel intensity of services continued to fall in 2003 (-0.9%) but the electricity intensity increased by 11.9% thereby contributing exclusively to the reversal in the overall intensity trend in services.

Figure 56: Energy Intensity of Commercial and Public Services Sector



Two other measures of intensity in this sector are energy consumption per unit of floor area and per employee. The consumption of oil and gas is mainly for heating purposes and is related to the floor area heated and not directly related to the number of people occupying a building at a given time. It is not currently possible to calculate the intensity per unit of floor area due to an absence of data on floor area in the services sector.

Unit consumption of electricity per employee is used as an indicator of energy use in the services sector because in the main, electricity is affected by the number of people that require light and the number using IT equipment. With reference to figure 57 it can be seen unit consumption of electricity was rising steadily since 1990. By 2002 it was 40% higher than in 1990 and in 2003 this increased to 57.6% following a growth of 12.6%. This can be linked to the increasing use of office equipment, computers, printers, photocopiers etc during this time.

By contrast, the fuel consumption per employee has declined by 26% since 1994 (-2.2% per annum).

Figure 57: Unit Consumption of Electricity per Employee in the Service Sector

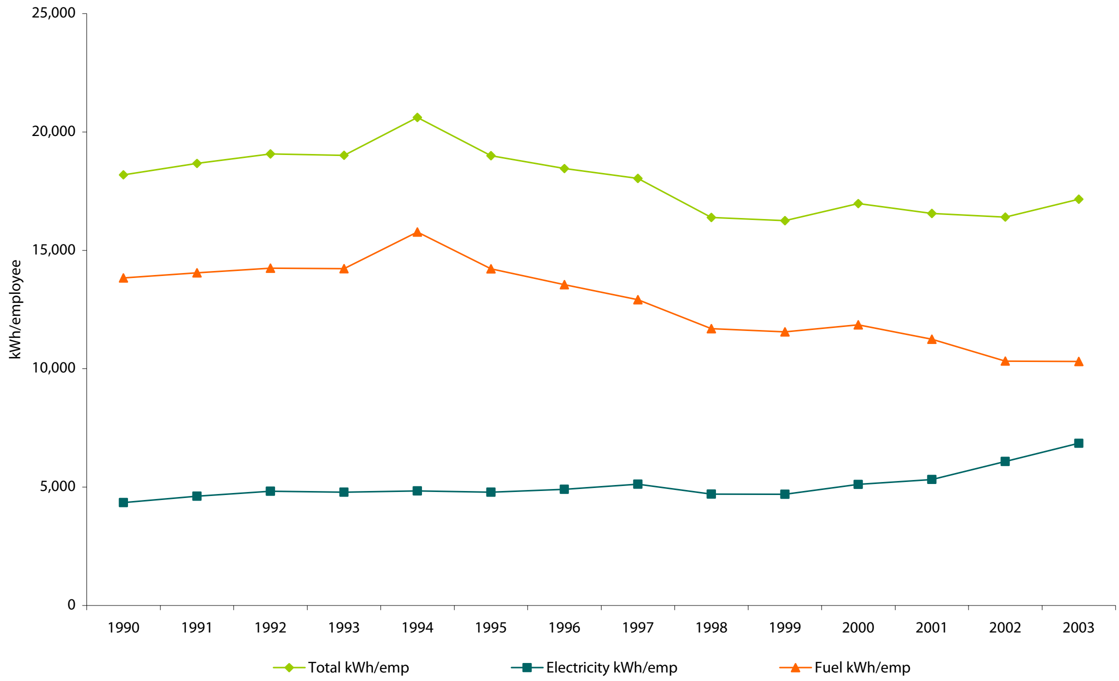


Table 19: Growth Rates and Shares Unit Consumption per Employee in Commercial/Public Services

	Growth %	Average annual growth rates %				
	1990 – '03	**1990 – '03**	**1990 – '95**	**1995 – '00**	**2000 – '03**	**2003**
Total kWh/employee	-5.7	-0.4	0.9	-2.2	0.4	4.6
Fuel kWh/employee	-25.5	-2.2	0.5	-3.6	-4.6	-0.2
Electricity kWh/employee	57.6	3.6	1.9	1.4	10.2	12.6

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 almost 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*.

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.

Heating Degree Days: "Degree Days" is the measure or index used to take account of the severity of the weather when looking at energy consumption in terms of heating (or cooling) "load" on a building. A "Degree Day" is an expression of how cold (or warm) it is outside, relative to a day on which little or no heating (or cooling) would be required. It is thus a measure of cumulative temperature deficit (or surplus) of the outdoor temperature relative to a neutral target temperature (base temperature) at which no heating or cooling would be required.

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 (eg 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.

Energy Conversion Factors

To :	**toe**	**MWh**	**GJ**
From :	*Multiply by*		
toe	1	11.63	41.868
MWh	0.086	1	3.6
GJ	0.02388	0.2778	1

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.

Decimal Prefixes

deca (da)	10^{1}	deci (d)	10^{-1}
hecto (h)	10^{2}	centi (c)	10^{-2}
kilo (k)	10^{3}	milli (m)	10^{-3}
mega (M)	10^{6}	micro (μ)	10^{-6}
giga (G)	10^{9}	nano (n)	10^{-9}
tera (T)	10^{12}	pico (p)	10^{-12}
peta (P)	10^{15}	femto (f)	10^{-15}
exa (E)	10^{18}	atto (a)	10^{-18}

Calorific Values

Fuel	Net Calorific Value toe/t	Net Calorific Value MJ/t
Crude Oil	1.0226	42,814
Gasoline (petrol)	1.0650	44,589
Kerosene	1.0556	44,196
Jet Kerosene	1.0533	44,100
Gasoil / Diesel	1.0344	43,308
Residual Fuel Oil (heavy oil)	0.9849	41,236
Milled Peat	0.1860	7,787
Sod Peat	0.3130	13,105
Peat Briquettes	0.4430	18,548
Coal	0.6650	27,842
Liquefied Petroleum Gas (LPG)	1.1263	47,156
Petroleum Coke	0.8329	34,870
	Conversion Factor	**Conversion Factor**
Electricity	86 toe/GWh	3.6 MJ/GWh

Emission Factors[42]

	$t\ CO_2/TJ$ (NCV)	$g\ CO_2/kWh$ (NCV)
Liquid Fuels		
Motor Spirit (Gasoline)	69.30	249.5
Jet Kerosene	71.32	256.8
Other Kerosene	71.39	257.0
Gas/Diesel Oil	73.30	263.9
Residual Oil	76.01	273.6
LPG	63.69	229.3
Naphta	73.33	264.0
Petroleum Coke	100.80	362.9
Solid Fuels and Derivatives		
Coal	94.60	340. 6
Milled Peat	115	414.0
Sod Peat	104	374.4
Peat Briquettes	98.86	355.9
Gas		
Natural Gas	54.94	197. 8
Electricity (2003)	180.8	651

[42] Note: Following a harmonisation project carried out by SEI on behalf of Eurostat some of the figures in this table have changed slightly from the last edition of Energy in Ireland.

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