



**Central Statistics Office**  
An Phríomh-Oifig Staidrimh

# Environmental Accounts for Ireland 1996-2003

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## **Foreword**

### **Background**

The national accounts provide a comprehensive framework within which economic data can be presented in a coherent, consistent manner. They present in a condensed manner, using internationally agreed standards, information about the working of the economy.

The Irish national accounts are basically compiled in accordance with "The European System of Accounts 1995" (ESA 95) which is used in all member states of the European Community.

However, such accounts can be incomplete depending on the analytical focus. In particular, the effects or the potential effects of pollution are not considered. Hence satellite accounts are generated to organise information to supplement the general-purpose orientation of the national accounts.

### **Environmental Satellite Accounts**

The aim of the present accounts is to outline the potential impact on the environment of economic and social activity. The idea is to list in quantifiable terms the amount of potential air pollutants produced by industry and households, which may in turn be compared to the employment and the value of output produced by these sectors. Due to the difficulties in dealing with aspects of environmental accounts in monetary terms, physical data is used instead which can be linked to the main accounts to describe the effects of pollution.

This publication represents the sixth set of environmental satellite accounts for Ireland. They set out a longitudinal series of air emissions in respect of the years 1996-2003 and have been compiled by the Economic and Social Research Institute (ESRI) and the Central Statistics Office (CSO). The work for years prior to 2001 was funded by Eurostat (the Statistical Office of the European Communities).

The CSO publishes the results as a potentially useful adjunct to the National Income & Expenditure (NIE) annual report.

The contributions from and assistance of the following bodies to the background material in this report is gratefully acknowledged: Environmental Protection Agency, Department of Communications, Marine & Natural Resources, Sustainable Energy Ireland, Electricity Supply Board and Bord Gáis.

Central Statistics Office

July 2005

## Chapter 1 Introduction

These satellite accounts give a breakdown by economic sector of greenhouse gas emissions and acid rain precursor emissions, two phenomena that can impinge on our future well-being. The allocations are based on the sector of the energy end-user as distinct from the sector of energy generation/production. The figures in these accounts do not measure pollution levels but rather are estimates of emissions into the environment. Emissions are the flow into the environment whereas the level of pollution depends on the state of the receiving medium and its capacity to absorb and assimilate emissions without damage occurring now or in the future.

Under the Kyoto protocol to the United Nations Framework Convention on Climate Change, EU Member States agreed to reduce greenhouse gas emissions in the EU as a whole to 8 per cent below 1990 levels in the period 2008-2012. Ireland's burden-sharing contribution is a target of 13 per cent increase above 1990 levels.

Ireland is also committed to reducing the emissions of four acid rain precursor air pollutants by 2010 under the 1999 Gothenburg Protocol. These pollutants contribute to regional acidification, eutrophication and local air pollution. The EU has put in place a Directive setting National Emissions Ceilings (NECs) for each Member State.

While official estimates of Irish air emissions are compiled and published by the Environmental Protection Agency (EPA)<sup>1</sup>, the aim of this publication is to further attribute air emissions to economic sub-sectors rather than the physical processes that generate the emissions. When analysing these air emissions accounts it should be borne in mind that the figures are estimates and recalculations are periodically done as improved data and models become available.

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<sup>1</sup> <http://www.coe.epa.ie/CRF2005/nirdownloads.html>  
<http://www.epa.ie/OurEnvironment/ClimateChange/GreenhouseGasEmissions>

The six gases examined in these environmental accounts are classified into two separate themes based on their potential effects on the environment:

Carbon Dioxide - CO<sub>2</sub>

Nitrous Oxide - N<sub>2</sub>O      ⇒⇒      Global warming potential

Methane - CH<sub>4</sub>

Sulphur Dioxide - SO<sub>2</sub>

Oxides of Nitrogen - NO<sub>x</sub>      ⇒⇒      Acid rain precursors

Ammonia - NH<sub>3</sub>

## Chapter 2 Environmental Themes

### *Global warming potential*

**Carbon dioxide** (CO<sub>2</sub>) emissions are the result of burning fossil fuels such as coal, turf and petroleum. Carbon dioxide is also sequestered (absorbed) by vegetation growth, the most important in this context being by trees. **Nitrous oxide** (N<sub>2</sub>O) emissions arise from a few industrial processes and from nitrogen fertilisers. The digestive systems of ruminant animals and waste treatment systems lead to **methane** (CH<sub>4</sub>) emissions. There are other greenhouse gases (HFC, PFC and SF<sub>6</sub>) which are not considered in this exercise - the emissions from these gases is estimated to be approximately 1 per cent of the total greenhouse gas emissions for Ireland.

The relative contribution of each gas to the greenhouse effect can be expressed in terms of global warming potential. This is measured in tonnes of CO<sub>2</sub> equivalents. The global warming potential of each gas takes account of the fact that different gases remain in the atmosphere for differing lengths of time. The relevant conversions are as follows:

Emitted gas	Global warming potential over 100 years (CO <sub>2</sub> equivalents per tonne of gas emitted)
Carbon dioxide (CO <sub>2</sub> )	1
Methane (CH <sub>4</sub> )	21
Nitrous oxide (N <sub>2</sub> O)	310

It should be noted that these measures of global warming potential are those given by the Inter Governmental Panel on Climate Change (1995) and are used by the EPA but may be subject to revision.

**Acid rain precursors**

Acid rain occurs when acidic gases and particles are transported in the air before falling as wet or dry deposition. High concentrations can be harmful to health, to water and soil quality, to buildings, and can reduce plant growth and damage forests. Emissions *per se* are not necessarily harmful but they have acidification potential and are therefore aggregated into an acid rain precursor theme.

Burning of coal with high sulphur content is a significant source of **sulphur dioxide** (SO<sub>2</sub>). **Oxides of nitrogen** (NO<sub>x</sub>) arise when fossil fuels are burnt under certain conditions. **Ammonia** (NH<sub>3</sub>) emissions arise primarily from animal manure and nitrogen based fertilisers. There are other acid rain precursors (VOC and CO) that are not considered in this exercise. Acid rain precursor emissions are expressed in sulphur dioxide (SO<sub>2</sub>) equivalents using the following conversion factors:

Emitted gas	Acid rain precursors (SO <sub>2</sub> equivalents per tonne of gas emitted)
Sulphur Dioxide (SO <sub>2</sub> )	1.0000
Oxides of Nitrogen (NO <sub>x</sub> )	0.6957
Ammonia (NH <sub>3</sub> )	1.8824



## Chapter 3 Sources of Data

Estimates of air emissions in both the Global Warming Potential and Acid Rain Precursors themes derive from the same data sources. Both involve emissions to air and are primarily due to the combustion of fossil fuels. The EPA compiles the official air emissions estimates, which it submits annually to the United Nations Framework Convention on Climate Change (UNFCCC) and the European Environment Agency (EEA). These satellite accounts use and complement EPA's work by estimating emissions by sector within the economy. Both the EPA's estimates and the data sources mentioned below were used to attribute emissions to the relevant economic sectors. Much of the sectoral data available is company accounts data and the work undertaken in compiling these accounts involved inferring from this economic data the extent of emissions to air attributable to each economic sector (e.g. from fuel expenditure data).

Estimates of emissions to air by industry are primarily derived from the data collected in the CSO's annual *Census of Industrial Production (CIP)*. Periodically, the CIP collects detailed information on the breakdown of fuel expenditure and these detailed analyses were used also to infer expenditure by fuel type in the intervening years. Quantities of fuels consumed were estimated by dividing fuel expenditure by average fuel prices using fuel price time series maintained by Sustainable Energy Ireland. Standard conversion factors were then used to convert the fuel quantities consumed into estimates of air emissions<sup>2</sup>. The methodology employed, where fuel consumption is inferred from fuel expenditure, is the best available in the absence of sectoral data on quantities of fuel consumption.

Figures for the services sectors, both market and non-market, are derived from the Sustainable Energy Ireland's Energy Balance Sheets. These balance sheets disaggregate consumption by fuel type into five major sectors: Industry, Transport, Agriculture, Commercial and Public services, and the Residential sector. The balance sheets were also used to estimate sectoral air emissions for the agricultural and residential sectors.

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<sup>2</sup> Emission factors are reproduced in an appendix.

Electricity-related emissions were attributed to the individual economic sectors in proportion to their final demand for electricity. Emissions associated with natural gas consumption were similarly attributed to individual economic sectors in proportion to their consumption except where natural gas is used as a production feedstock, in which case the associated emissions are estimated separately.

The estimates presented here are best interpreted as indicative in nature but it is hoped that they give further insights into the interaction which the different economic sectors have with the environment and, in particular, air.

*The data provided in this report incorporates revisions to the estimates previously published in respect of the years 1996-2002.*

## Chapter 4 Results Air Emissions Accounts 1996-2003

The large growth in the Irish economy during the past 7 years has required an equally large increase in the consumption of raw materials and energy inputs, with consequential knock-on effects on the environment. The increase in economic activity is evidenced in the increase in the size of the labour force and in the level of fixed capital formation over the period. The increase in the use of natural resources can be gauged by the expansion in the area of land used for construction and the increase in both energy consumption and raw materials inputs. The ensuing increases in emissions of greenhouse gases put further pressure on the environment.

### Aspects of Economic Activity 1996-2003

	Units	1996	2003	% change
Gross domestic product (GDP) at 1995 prices	€ Million	56,623	97,756	+73%
Gross domestic fixed capital formation at 1995 prices	€ Million	10,454	19,215	+84%
Numbers at work	'000	1,328	1,793	+35%
Total Primary Energy Requirement	TOE '000	11,707	14,790	+26%
Greenhouse Gas emissions	ktonne CO <sub>2</sub> equiv	59,107	65,999	+12%
Acid Rain precursors	ktonne SO <sub>2</sub> equiv	465	378	-19%
Household and commercial waste	ktonne	1,541*	2,559	+66%

\* Estimate

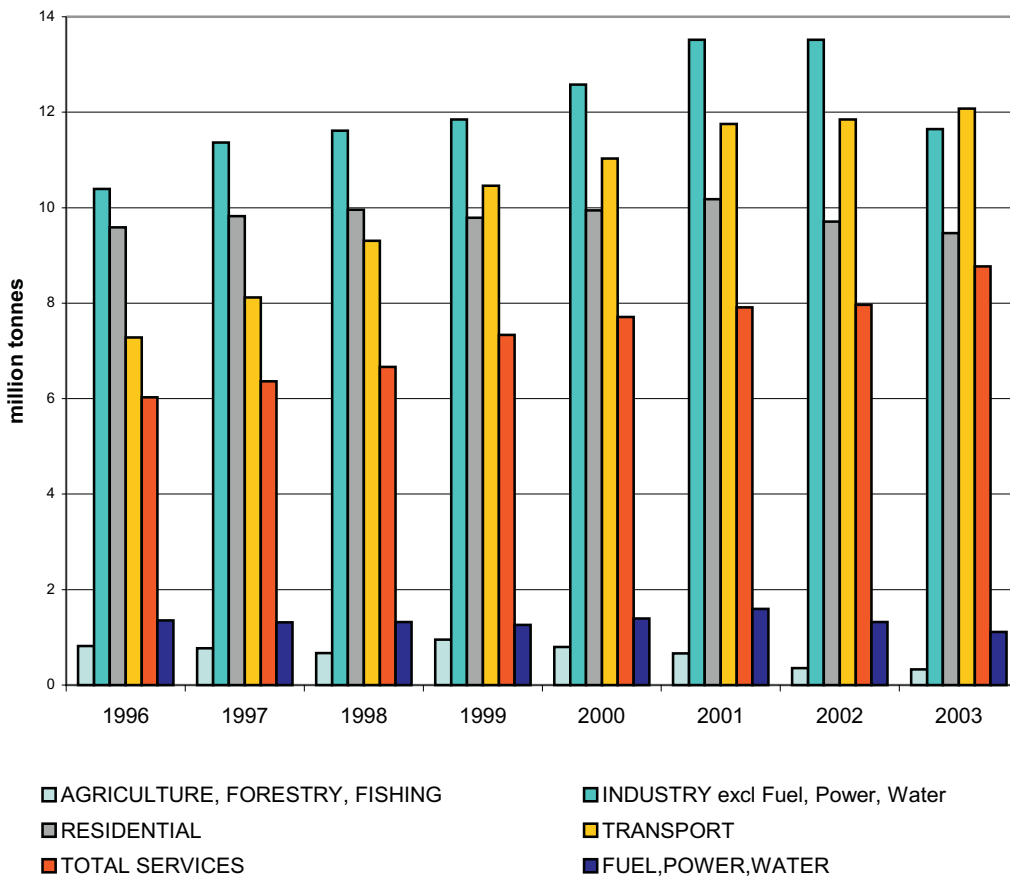
Trends in emissions of carbon dioxide, which are lower than trends in energy consumption, can be explained by changes in the mix of energy sources such as increasing usage of natural gas in electricity generation and increasing imports of electricity.

## Greenhouse Gases

### CO<sub>2</sub> emissions

Emissions estimates for carbon dioxide (CO<sub>2</sub>) are presented in Table 1. In the period 1996 to 2003 aggregate national emissions increased by 22% from approximately 35.6 to 43.5 million tonnes. In the industrial sector there was a 12% increase, a 45% increase in the services sector while emissions from the residential sector decreased by 1%. The most marked increase in CO<sub>2</sub> emissions occurred in transport<sup>3</sup> where emissions increased by 66% between 1996 and 2003. Emissions trends are presented graphically in Figure 1.

Figure 1: Carbon Dioxide Emissions Trends



<sup>3</sup> Included here are both the Transport Sector and transport activities carried out in all other sectors (both private and business).

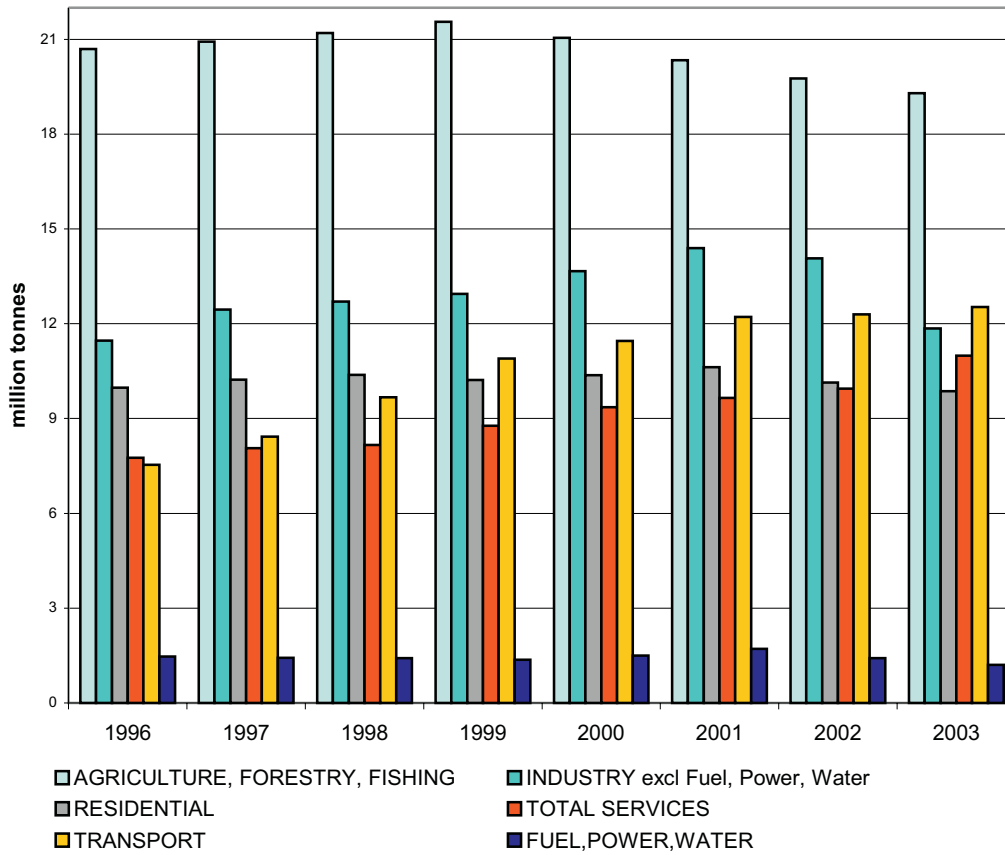
*N<sub>2</sub>O and CH<sub>4</sub> emissions*

Emissions of nitrous oxide (N<sub>2</sub>O) and methane (CH<sub>4</sub>) are presented in Tables 2 and 3 respectively. Although the aggregate magnitude of emissions of these gases are significantly lower than those for CO<sub>2</sub> emissions, N<sub>2</sub>O and CH<sub>4</sub> are relatively more potent in terms of global warming potential. Aggregate N<sub>2</sub>O emissions decreased by 9% over the seven-year period due primarily to the drop in production and subsequent closure of a specific plant in the Chemical sector. However the relatively large growth in emissions from the transport sector is notable where N<sub>2</sub>O emissions increased by 86% between 1996 and 2003. Ruminant animals are the primary source of CH<sub>4</sub> emissions while gas distribution losses is another significant source.

*Greenhouse Gases combined*

Table 4 (and Figure 2) shows the three greenhouse gases as a single emissions estimate in terms of carbon dioxide equivalents. Although the forestry acts as a large sink for CO<sub>2</sub> emissions, the high level of emissions of N<sub>2</sub>O and CH<sub>4</sub> (when expressed as CO<sub>2</sub> equivalents) from farming contributes to agriculture, forestry and fishing being the sector with the highest level of greenhouse gas emissions. For the period 1996-2000 greenhouse gas emissions in this sector were roughly stationary at an average of 21 million tonnes/annum but there was a 8% reduction in net emissions between 2000 and 2003 due primarily to a decrease in livestock numbers. All other sectors in the economy recorded increases in greenhouse gas emissions in the period, except residential which showed a 1% decrease. Transport in particular changed from having the fifth highest level of emissions in 1996 to the second highest in 2003 while the industrial sector's emissions increased by 3% over the period.

**Figure 2: Greenhouse Gas (CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub>) Emissions**



Under the Kyoto protocol of the United Nations Framework Convention on Climate Change, Ireland is committed to limit its increase in emissions of six greenhouse gases to 13% above 1990 levels between the years 2008 to 2012. Based on the EPA's official estimates, national greenhouse gas emissions exceeded the Kyoto target in 1997 and were 25% above the 1990 baseline level in 2003. Clearly, as identified in the National Climate Change Strategy (October 2000), significant remedial measures are required to meet our commitment under the Kyoto protocol.

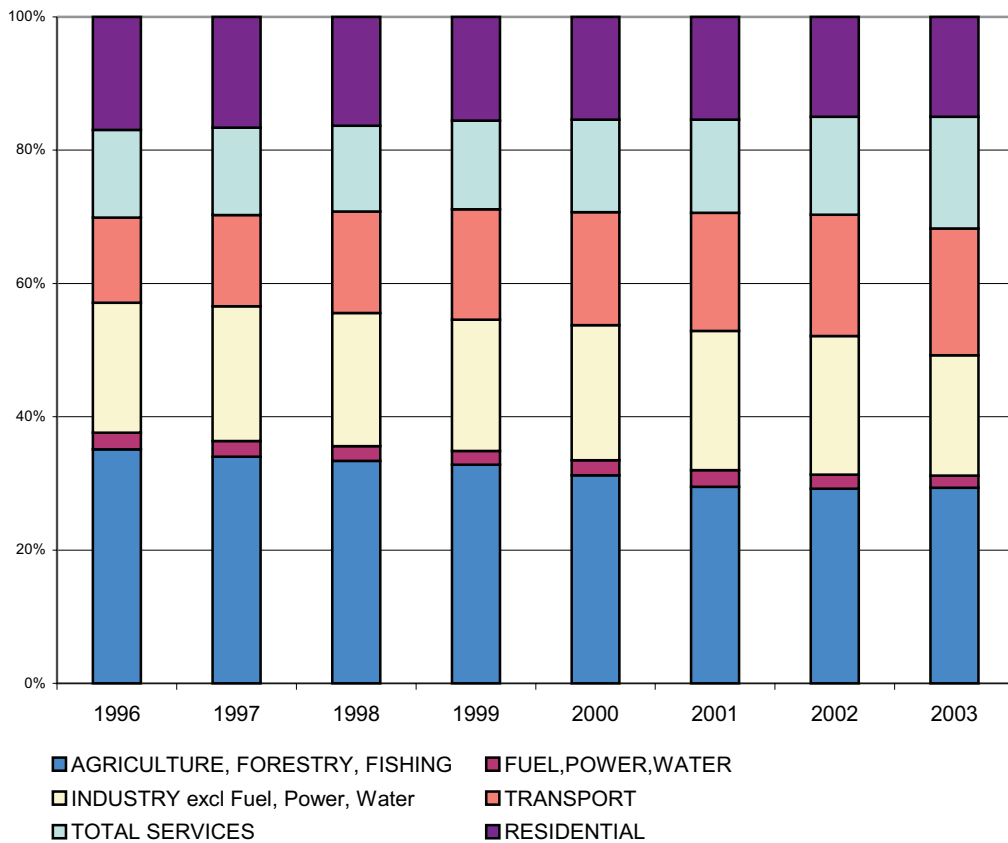
**Greenhouse gas emissions as a percentage of 1990 Kyoto protocol baseline\***

1996	1997	1998	1999	2000	2001	2002	2003
111%	116%	120%	124%	128%	131%	129%	125%

\* Calculations based on official aggregate emissions estimates compiled by the EPA and Kyoto definitions.

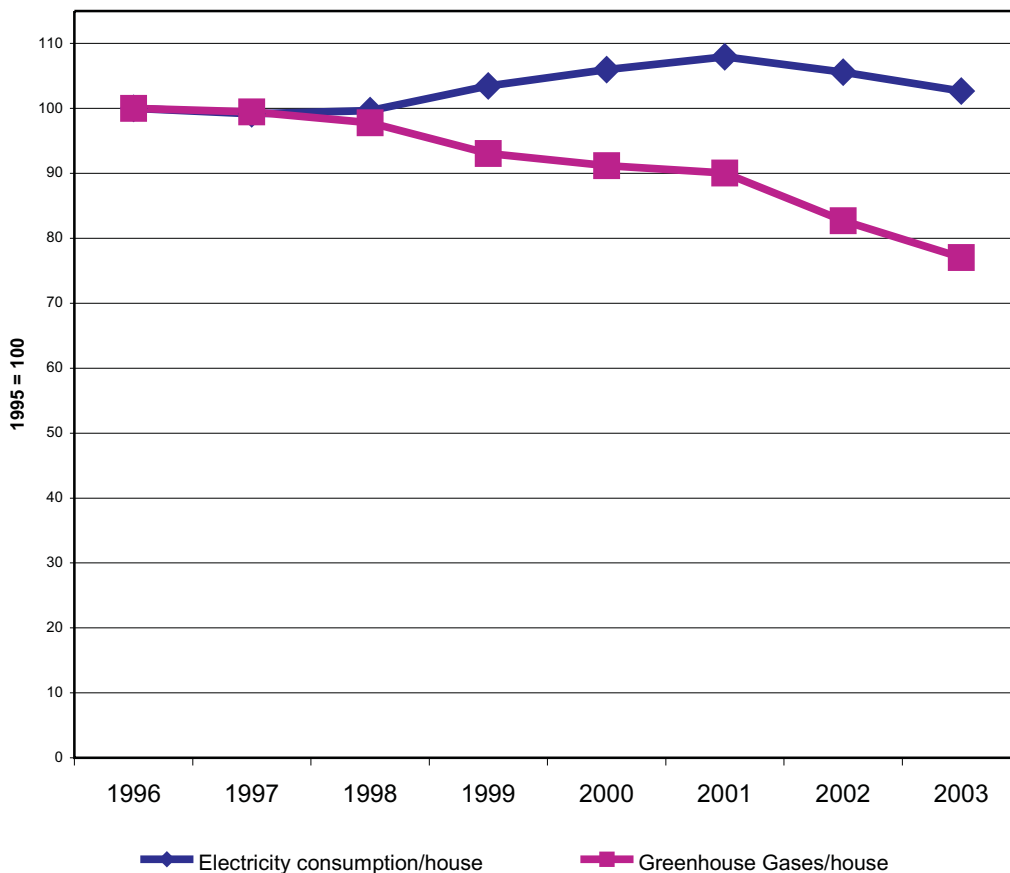
While aggregate emissions have been increasing between 1996 and 2003, the relative sectoral shares of greenhouse gas emissions have also changed, as shown in Figure 3. The share of emissions emanating from the industrial, residential and agricultural sectors have declined whereas share of emissions from the transport and services sectors increased.

**Figure 3: Sector Shares - Greenhouse Gas (CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub>) Emissions**



Residential greenhouse gas emissions were stationary at approximately 10 million tonnes per annum between 1996 and 2003. Over the same period the housing stock increased by approximately 28% suggesting that emissions per household declined. However, this hides the fact that households actually increased their demand for energy. Figure 4 shows that residential electricity demand per household increased by over 3% between 1996 and 2003 (source Energy Balances) while the greenhouse gas emissions per household declined by 23% in the same period. This increase in per household electricity demand in tandem with a decline in per household emissions is influenced by factors such as electricity generation becoming cleaner in recent years in terms of intensity of greenhouse gas emissions, less solid fuels used directly by the residential sector and changing patterns of occupancy.

**Figure 4: Residential Sector Electricity Demand and Emissions**



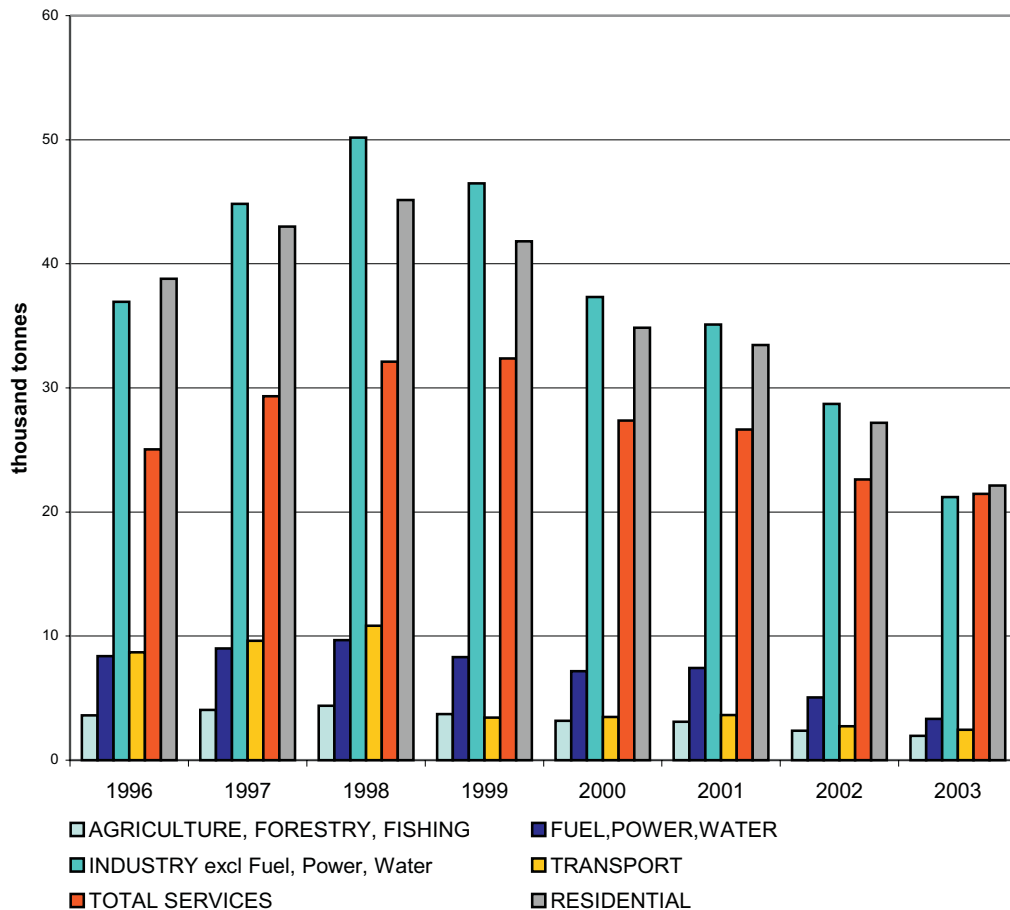


## Acid rain precursors

### *SO<sub>2</sub> emissions*

Sulphur dioxide (SO<sub>2</sub>) emissions are presented in Table 5, which shows that emissions declined by 48% between 1996 and 2003. The decline occurred in all sectors of the economy, which is due in part to a decline in the volume of sulphur emissions from electricity generation and the introduction in 1999 of low sulphur transport fuel. The industrial, residential and services sectors now emit over 85% of all SO<sub>2</sub> emissions in contrast to 68% in 1996.

**Figure 5: Sulphur Dioxide Emissions**



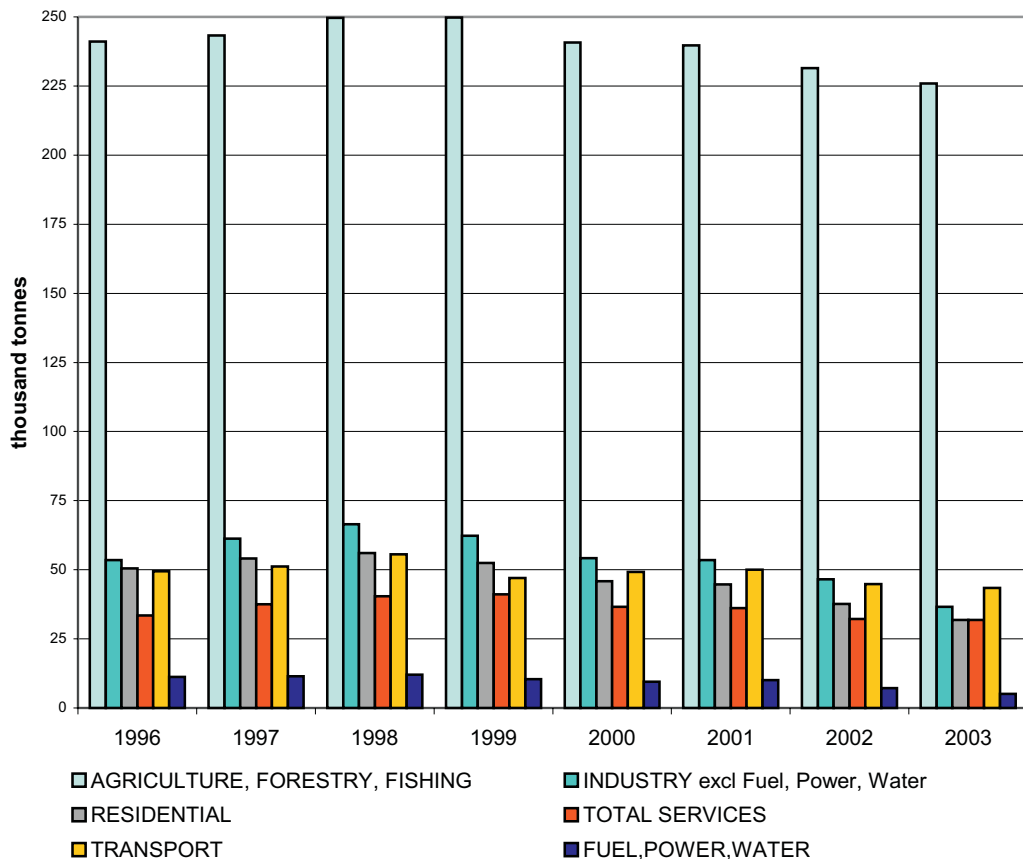
*NO<sub>x</sub> and NH<sub>3</sub> emissions*

Tables 6 and 7 give emissions estimates for oxides of nitrogen (NO<sub>x</sub>) and ammonia (NH<sub>3</sub>). The decline in NO<sub>x</sub> emissions between 1996 and 2003 was 6% overall while the residential sector showed a significant downward movement (-17%) over the period due primarily to less intensive emissions in electricity generation. Ammonia (NH<sub>3</sub>) emissions which predominantly derive from agricultural sources were 3% higher in 1999 compared to 1996 levels but subsequently declined by 9% in the period to 2003 reflecting the significant drop in both cattle and sheep numbers.

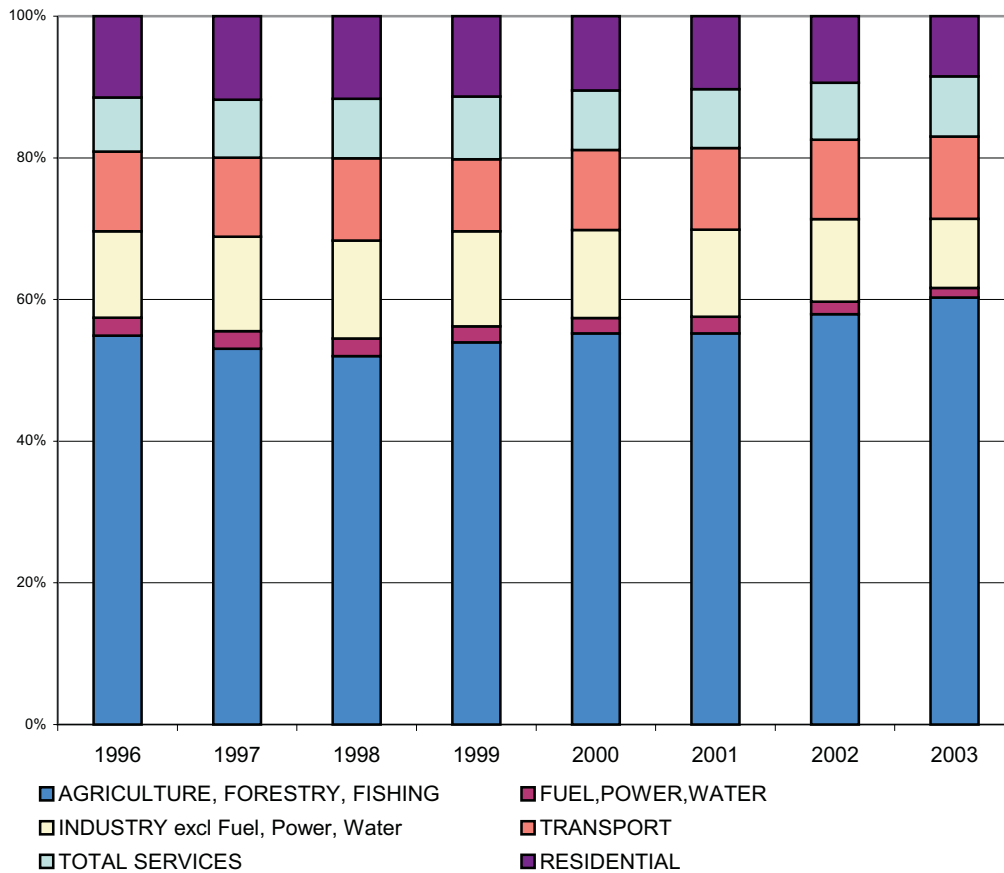
*Acid Rain Precursors combined*

Estimates of emissions of total acid rain precursors, expressed in SO<sub>2</sub> equivalents, are presented in Table 8 (and Figure 6). The emissions declined by 19% over the period reaching 378 thousand tonnes in 2003. The agricultural sector which accounts for 60% of total emissions at present, fell by 6% in the period. Elsewhere in the economy there have been only relatively small fluctuations in the magnitude of emissions up to 2001, as illustrated in Figure 7.

**Figure 6: Acid Rain Precursor (SO<sub>2</sub>, NO<sub>x</sub>, NH<sub>3</sub>) Emissions**



**Figure 7: Sector Shares - Acid Rain Precursor (SO<sub>2</sub>, NO<sub>x</sub>, NH<sub>3</sub>) Emissions**



### ***Ireland's targets under the Gothenburg Protocol***

Under the Gothenburg Protocol (UNECE 1999) Ireland is committed to reducing the three acid rain precursor emissions and volatile organic compounds (VOCs). The subsequent National Emissions Ceilings Directive (EU 2001) set national emissions ceilings for EU member states which in Ireland's case are the same as the Gothenburg Protocol targets as outlined below. With the exception of ammonia, significant further reductions in Ireland's emissions are required if these targets are to be met.

**National Emissions Ceilings for Ireland**

Pollutant	Year 2003 Emissions (kt)	Ceiling by 2010 (kt)	Reduction required to meet 2010 target (kt)	Percentage reduction required
Sulphur Dioxide (SO <sub>2</sub> )	76	42	34	45%
Nitrogen Oxides (NO <sub>x</sub> )	120	65	55	46%
Ammonia (NH <sub>3</sub> )	116	116	0	0%
Volatile Organic Compounds (VOC)	78	55	23	29%

Source: Department of the Environment and Local Government & EPA

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## **Tables**

**Because of the uncertainties regarding the sectoral allocations of electricity and gas in recent years, the year on year changes must be interpreted as indicative rather than absolute. This report incorporates revisions to the estimates previously published in respect of the years 1996-2002**

Table 1: Carbon Dioxide (CO<sub>2</sub>) Emissions

Thousand tonnes

	NACE REV 1	1996	1997	1998	1999	2000	2001	2002	2003
Emissions by Agriculture, Forestry, Fishing		1,621.1	1,693.4	1,702.4	1,706.4	1,754.2	1,780.7	1,673.6	1,655.3
Sequestration by forestry		-802.3	-919.5	-1,033.5	-754.7	-954.7	-1,117.5	-1,316.0	-1,329.9
AGRICULTURE, FORESTRY, FISHING	1,2,5	818.8	773.8	668.9	951.7	799.5	663.2	357.6	325.3
FUEL,POWER,WATER	40-41	1,354.1	1,316.1	1,317.7	1,263.8	1,391.9	1,596.8	1,323.2	1,115.3
Coal, peat, petroleum, metal ores, quarrying	10-14	756.7	773.4	824.9	860.0	884.4	991.3	997.7	968.0
Food, beverage, tobacco	15-16	2,268.7	2,381.3	2,431.1	2,461.3	2,631.4	2,783.7	2,957.8	2,423.5
Textiles Clothing Leather & Footwear	17-19	327.0	381.0	383.0	392.0	391.4	445.3	386.5	315.7
Wood & wood products	20	216.3	215.8	202.5	210.0	206.7	218.2	184.3	152.4
Pulp, paper & print production	21-22	158.9	141.4	139.5	144.6	140.3	149.4	133.1	109.0
Chemical production	24	2,137.4	2,394.4	2,401.3	2,325.5	2,315.1	2,359.1	2,131.5	1,043.7
Rubber & plastic production	25	186.1	258.3	267.0	274.1	260.2	204.5	195.0	192.9
Non-metallic mineral production	26	2,119.9	2,299.4	2,281.8	2,358.7	3,002.0	3,563.0	3,892.8	3,915.7
Metal prod. excl. machinery & transport equip.	27-28	780.4	861.0	917.4	903.0	881.7	787.8	664.9	668.3
Agriculture & industrial machinery	29	683.6	700.0	724.6	749.6	753.2	795.8	779.8	638.2
Office and data process machines	30	79.2	106.8	118.6	129.4	127.1	191.3	183.4	179.7
Electrical goods	31-33	366.5	517.7	522.3	545.8	521.0	592.3	563.6	572.3
Transport equipment	34-35	65.5	71.7	73.8	75.2	71.6	71.6	65.4	53.0
Other manufacturing	36-37,23	210.3	223.1	280.1	375.2	347.8	314.9	319.9	366.9
Construction	45	36.6	41.5	43.8	45.1	44.8	47.4	59.3	47.3
INDUSTRY excl. Fuel, Power, Water		10,393.0	11,366.8	11,611.9	11,849.4	12,578.6	13,515.7	13,515.1	11,646.7
TRANSPORT*		7,283.7	8,119.8	9,304.6	10,458.3	11,029.5	11,750.7	11,850.9	12,073.4
SERVICES excl Transport		6,029.7	6,360.5	6,663.7	7,335.4	7,710.7	7,911.2	7,967.6	8,767.7
RESIDENTIAL		9,588.3	9,820.6	9,956.7	9,792.1	9,945.6	10,175.1	9,710.4	9,467.6
Sub-TOTAL		35,467.6	37,757.5	39,523.5	41,650.7	43,455.7	45,612.7	44,724.8	43,396.0
Not attributed to any sector		100.2	102.8	105.3	106.8	109.2	108.6	109.2	110.8
TOTAL		35,567.7	37,860.3	39,628.8	41,757.5	43,564.9	45,721.3	44,834.0	43,506.8

\* Includes both the Transport sector and road transport activities carried out in all other sectors.

**Table 2: Nitrous Oxide (N<sub>2</sub>O) Emissions**
**Thousand tonnes**

	NACE REV 1	1996	1997	1998	1999	2000	2001	2002	2003
AGRICULTURE, FORESTRY, FISHING	1,2,5	28.6	28.7	29.2	29.4	29.2	28.4	27.5	26.9
FUEL,POWER,WATER	40-41	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Coal, peat, petroleum, metal ores, quarrying	10-14	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Food, beverage, tobacco	15-16	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Textiles Clothing Leather & Footwear	17-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wood & wood products	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pulp, paper & print production	21-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chemical production	24	2.7	2.7	2.7	2.7	2.7	2.0	1.0	0.1
Rubber & plastic production	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-metallic mineral production	26	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Metal prod. excl. machinery & transport equip.	27-28	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
Agriculture & industrial machinery	29	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Office and data process machines	30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electrical goods	31-33	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Transport equipment	34-35	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other manufacturing	36-37,23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INDUSTRY excl. Fuel, Power, Water		3.3	3.3	3.4	3.4	3.3	2.7	1.6	0.5
TRANSPORT*		0.7	0.8	1.0	1.3	1.2	1.3	1.3	1.3
SERVICES excl Transport		0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9
RESIDENTIAL		1.0	1.1	1.2	1.2	1.2	1.3	1.2	1.1
Sub-TOTAL		34.4	34.9	35.6	36.2	36.0	34.7	32.6	30.9
Not attributed to any sector		0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5
<b>TOTAL</b>		<b>34.7</b>	<b>35.3</b>	<b>36.1</b>	<b>36.7</b>	<b>36.5</b>	<b>35.2</b>	<b>33.1</b>	<b>31.4</b>

\* Includes both the Transport sector and road transport activities carried out in all other sectors.

Table 3: Methane (CH<sub>4</sub>) Emissions

		Thousand tonnes							
	NACE REV 1	1996	1997	1998	1999	2000	2001	2002	2003
AGRICULTURE, FORESTRY, FISHING	1,2,5	524.6	535.5	547.0	547.6	533.2	518.1	518.7	506.0
FUEL,POWER,WATER	40-41	3.1	2.9	2.5	2.5	2.5	2.4	2.1	2.4
Coal, peat, petroleum, metal ores, quarrying	10-14	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
Food, beverage, tobacco	15-16	0.7	0.7	0.6	0.5	0.5	0.5	0.5	0.5
Textiles Clothing Leather & Footwear	17-19	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Wood & wood products	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pulp, paper & print production	21-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chemical production	24	1.3	1.3	1.1	0.9	0.8	0.8	0.5	0.1
Rubber & plastic production	25	0.0	0.0	0.0	0.0	0.0	0.0	-	-
Non-metallic mineral production	26	0.5	0.5	0.5	0.4	0.5	1.0	1.0	0.9
Metal prod. excl. machinery & transport equip.	27-28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture & industrial machinery	29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Office and data process machines	30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electrical goods	31-33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transport equipment	34-35	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other manufacturing	36-37,23	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1
Construction	45	-	-	-	-	-	-	-	-
INDUSTRY excl. Fuel, Power, Water		2.9	2.8	2.4	2.2	2.1	2.6	2.3	1.8
TRANSPORT*		2.0	2.1	2.2	2.3	2.6	2.5	2.5	2.3
SERVICES excl Transport		72.2	70.3	60.3	56.2	65.7	69.9	81.3	92.3
RESIDENTIAL		3.3	3.3	3.1	2.7	2.7	2.6	2.5	2.4
Sub-TOTAL		608.0	616.9	617.6	613.6	608.8	598.2	609.3	607.3
Not attributed to any sector		-	-	-	-	-	-	-	-
TOTAL		608.0	616.9	617.6	613.6	608.8	598.2	609.3	607.3

\* Includes both the Transport sector and road transport activities carried out in all other sectors.



**Table 4: Greenhouse Gas Emissions (CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub>)**

 Thousand tonnes CO<sub>2</sub> equivalents

	NACE REV 1	1996	1997	1998	1999	2000	2001	2002	2003
AGRICULTURE, FORESTRY, FISHING	1,2,5	20,688.4	20,930.2	21,197.6	21,558.3	21,052.2	20,340.8	19,760.2	19,296.4
FUEL,POWER,WATER	40-41	1,469.2	1,426.7	1,420.3	1,364.4	1,494.7	1,707.8	1,414.0	1,202.7
Coal, peat, petroleum, metal ores, quarrying	10-14	775.7	791.7	844.1	879.9	904.9	1,014.4	1,019.3	987.1
Food, beverage, tobacco	15-16	2,329.9	2,444.6	2,496.8	2,527.3	2,695.6	2,851.0	3,019.3	2,471.5
Textiles Clothing Leather & Footwear	17-19	337.1	393.1	396.0	405.1	404.1	459.4	398.3	324.8
Wood & wood products	20	223.4	223.0	209.9	217.5	213.9	225.9	190.4	157.0
Pulp, paper & print production	21-22	164.1	146.1	144.4	149.6	145.1	154.5	137.4	112.2
Chemical production	24	3,002.4	3,262.6	3,267.6	3,187.6	3,171.0	2,991.8	2,462.7	1,067.9
Rubber & plastic production	25	192.1	267.0	276.4	283.6	269.0	211.8	201.5	198.9
Non-metallic mineral production	26	2,146.8	2,326.9	2,309.5	2,385.6	3,030.3	3,602.0	3,929.3	3,947.2
Metal prod. excl. machinery & transport equip.	27-28	801.1	880.0	937.8	923.7	901.5	803.5	674.0	675.0
Agriculture & industrial machinery	29	708.2	725.3	751.8	777.3	780.0	824.5	807.0	658.8
Office and data process machines	30	81.5	110.2	122.3	133.2	130.6	197.5	189.0	184.9
Electrical goods	31-33	378.5	535.1	541.2	565.0	538.8	612.4	581.7	589.1
Transport equipment	34-35	67.7	74.0	76.2	77.7	73.9	74.1	67.5	54.6
Other manufacturing	36-37,23	215.7	229.2	287.2	383.5	355.0	321.5	325.8	372.9
Construction	45	38.0	43.1	45.5	46.8	46.4	49.1	61.4	48.9
INDUSTRY excl. Fuel, Power, Water		11,461.9	12,451.8	12,706.7	12,943.2	13,660.3	14,393.4	14,064.8	11,850.7
TRANSPORT*		7,539.8	8,423.1	9,670.2	10,895.4	11,455.1	12,216.0	12,296.7	12,529.7
SERVICES excl Transport		7,760.4	8,061.6	8,168.9	8,773.7	9,354.7	9,653.8	9,943.4	10,992.2
RESIDENTIAL		9,972.4	10,226.3	10,381.0	10,222.4	10,375.5	10,625.1	10,136.2	9,865.9
Sub-TOTAL		58,892.0	61,519.8	63,544.7	65,757.4	67,392.6	68,936.9	67,615.3	65,737.6
Not attributed to any sector		214.9	236.1	235.5	246.3	263.8	264.2	263.6	261.5
<b>TOTAL</b>		<b>59,106.9</b>	<b>61,755.8</b>	<b>63,780.3</b>	<b>66,003.7</b>	<b>67,656.4</b>	<b>69,201.1</b>	<b>67,878.9</b>	<b>65,999.0</b>

\* Includes both the Transport sector and road transport activities carried out in all other sectors.

Table 5: Sulphur Dioxide (SO<sub>2</sub>) Emissions

Thousand tonnes

	NACE REV 1	1996	1997	1998	1999	2000	2001	2002	2003
AGRICULTURE, FORESTRY, FISHING	1,2,5	3.6	4.1	4.4	3.7	3.2	3.1	2.4	2.0
FUEL,POWER,WATER	40-41	8.4	9.0	9.7	8.3	7.2	7.4	5.1	3.3
Coal, peat, petroleum, metal ores, quarrying	10-14	3.1	3.3	3.8	3.7	3.0	2.2	2.1	1.5
Food, beverage, tobacco	15-16	9.2	10.9	12.2	11.3	9.1	8.9	7.4	5.2
Textiles Clothing Leather & Footwear	17-19	1.6	2.1	2.3	2.2	1.7	1.7	1.3	0.8
Wood & wood products	20	1.1	1.3	1.5	1.4	1.1	1.0	0.7	0.5
Pulp, paper & print production	21-22	0.9	0.9	1.0	0.9	0.7	0.7	0.5	0.3
Chemical production	24	4.7	5.6	6.3	5.9	4.6	4.4	3.7	2.5
Rubber & plastic production	25	1.1	1.7	1.9	1.7	1.3	0.9	0.7	0.6
Non-metallic mineral production	26	3.0	3.4	3.8	3.5	2.8	2.9	2.3	1.6
Metal prod. excl. machinery & transport equip.	27-28	4.5	5.3	6.0	5.4	4.9	4.3	3.5	3.6
Agriculture & industrial machinery	29	4.0	4.6	5.1	4.7	3.7	3.6	2.9	1.8
Office and data process machines	30	0.4	0.7	0.7	0.7	0.5	0.8	0.6	0.5
Electrical goods	31-33	2.2	3.4	3.7	3.5	2.6	2.6	2.0	1.6
Transport equipment	34-35	0.4	0.5	0.5	0.5	0.4	0.3	0.2	0.2
Other manufacturing	36-37,23	0.6	0.9	1.0	0.9	0.7	0.6	0.5	0.4
Construction	45	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.1
INDUSTRY excl. Fuel, Power, Water		36.9	44.8	50.2	46.5	37.3	35.1	28.7	21.2
TRANSPORT*		8.7	9.6	10.8	3.4	3.5	3.6	2.7	2.4
SERVICES excl Transport		25.0	29.3	32.1	32.4	27.4	26.6	22.6	21.5
RESIDENTIAL		38.8	43.0	45.1	41.8	34.8	33.4	27.2	22.1
Sub-TOTAL		121.5	139.8	152.4	136.1	113.4	109.4	88.7	72.5
Not attributed to any sector		25.9	26.3	23.7	21.2	18.1	16.7	7.5	3.8
TOTAL		147.4	166.1	176.1	157.4	131.5	126.1	96.2	76.4

\* Includes both the Transport sector and road transport activities carried out in all other sectors.

**Table 6: Oxides of Nitrogen (NO<sub>x</sub>) Emissions**
**Thousand tonnes**

	NACE REV 1	1996	1997	1998	1999	2000	2001	2002	2003
AGRICULTURE, FORESTRY, FISHING	1,2,5	12.9	12.1	13.0	13.9	15.0	13.7	13.3	13.4
FUEL,POWER,WATER	40-41	4.0	3.5	3.4	3.0	3.4	3.8	3.1	2.5
Coal, peat, petroleum, metal ores, quarrying	10-14	1.8	1.7	1.7	1.8	2.1	2.3	2.3	1.9
Food, beverage, tobacco	15-16	6.3	6.1	6.1	5.9	6.4	6.5	6.8	5.6
Textiles Clothing Leather & Footwear	17-19	1.0	1.1	1.0	1.0	1.0	1.2	1.0	0.8
Wood & wood products	20	0.7	0.6	0.5	0.5	0.5	0.5	0.4	0.3
Pulp, paper & print production	21-22	0.5	0.4	0.3	0.3	0.3	0.3	0.3	0.2
Chemical production	24	3.5	3.3	3.2	3.1	3.3	3.1	3.0	2.2
Rubber & plastic production	25	0.5	0.7	0.7	0.6	0.6	0.5	0.4	0.4
Non-metallic mineral production	26	3.3	3.2	3.1	2.8	3.3	5.3	5.2	4.8
Metal prod. excl. machinery & transport equip.	27-28	2.2	2.2	2.3	2.1	2.2	1.9	1.6	1.7
Agriculture & industrial machinery	29	2.1	1.9	1.9	1.8	1.9	1.9	1.9	1.5
Office and data process machines	30	0.2	0.3	0.3	0.3	0.3	0.5	0.4	0.4
Electrical goods	31-33	1.1	1.4	1.3	1.3	1.3	1.4	1.3	1.3
Transport equipment	34-35	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1
Other manufacturing	36-37,23	0.5	0.5	0.6	0.7	0.7	0.6	0.6	0.7
Construction	45	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
INDUSTRY excl. Fuel, Power, Water		23.9	23.6	23.3	22.7	24.3	26.4	25.6	22.1
TRANSPORT*		57.1	57.6	61.5	58.9	60.9	61.4	54.6	52.9
SERVICES excl Transport		12.0	11.8	11.9	12.5	13.3	13.6	13.7	14.9
RESIDENTIAL		16.8	15.9	15.6	15.4	15.8	16.1	15.0	13.9
Sub-TOTAL		126.8	124.5	128.6	126.3	132.7	135.0	125.3	119.8
Not attributed to any sector		-	-	-	-	-	-	-	-
<b>TOTAL</b>		<b>126.8</b>	<b>124.5</b>	<b>128.6</b>	<b>126.3</b>	<b>132.7</b>	<b>135.0</b>	<b>125.3</b>	<b>119.8</b>

\* Includes both the Transport sector and road transport activities carried out in all other sectors.

Table 7: Ammonia (NH<sub>3</sub>) Emissions

Thousand tonnes

	NACE REV 1	1996	1997	1998	1999	2000	2001	2002	2003
AGRICULTURE, FORESTRY, FISHING	1,2,5	121.4	122.6	125.5	125.6	120.7	120.6	116.8	114.0
FUEL,POWER,WATER	40-41	-	-	-	-	-	-	-	-
Coal, peat, petroleum, metal ores, quarrying	10-14	-	-	-	-	0.0	0.0	-	-
Food, beverage, tobacco	15-16	-	-	-	-	-	-	-	-
Textiles Clothing Leather & Footwear	17-19	-	-	-	-	-	-	-	-
Wood & wood products	20	-	-	-	-	-	-	-	-
Pulp, paper & print production	21-22	-	-	-	-	-	-	-	-
Chemical production	24	-	-	-	-	-	-	-	-
Rubber & plastic production	25	-	-	-	-	-	-	-	-
Non-metallic mineral production	26	-	-	-	-	-	-	-	-
Metal prod. excl. machinery & transport equip.	27-28	-	-	-	-	-	-	-	-
Agriculture & industrial machinery	29	-	-	-	-	-	-	-	-
Office and data process machines	30	-	-	-	-	-	-	-	-
Electrical goods	31-33	-	-	-	-	-	-	-	-
Transport equipment	34-35	-	-	-	-	-	-	-	-
Other manufacturing	36-37,23	-	-	-	-	-	-	-	-
Construction	45	-	-	-	-	-	-	-	-
INDUSTRY excl. Fuel, Power, Water		-	-	-	-	0.0	0.0	-	-
TRANSPORT*		0.6	0.8	1.0	1.4	1.8	1.9	2.2	2.2
SERVICES excl Transport		-	-	-	-	-	-	-	-
RESIDENTIAL		-	-	-	-	-	-	-	-
Sub-TOTAL		121.9	123.4	126.6	127.0	122.4	122.6	119.0	116.3
Not attributed to any sector		-	-	-	-	-	-	-	-
<b>TOTAL</b>		<b>121.9</b>	<b>123.4</b>	<b>126.6</b>	<b>127.0</b>	<b>122.4</b>	<b>122.6</b>	<b>119.0</b>	<b>116.3</b>

\* Includes both the Transport sector and road transport activities carried out in all other sectors.

**Table 8: Acid Rain Precursor Emissions (SO<sub>2</sub>, NO<sub>x</sub>, NH<sub>3</sub>)**
**Thousand tonnes SO<sub>2</sub> equivalents**

	NACE REV 1	1996	1997	1998	1999	2000	2001	2002	2003
AGRICULTURE, FORESTRY, FISHING	1,2,5	241.1	243.3	249.7	249.8	240.8	239.7	231.5	225.9
FUEL,POWER,WATER	40-41	11.2	11.5	12.0	10.4	9.5	10.1	7.2	5.1
Coal, peat, petroleum, metal ores, quarrying	10-14	4.4	4.5	5.0	4.9	4.4	3.9	3.7	2.8
Food, beverage, tobacco	15-16	13.6	15.2	16.4	15.4	13.5	13.4	12.1	9.1
Textiles Clothing Leather & Footwear	17-19	2.3	2.9	3.1	2.9	2.4	2.5	2.0	1.4
Wood & wood products	20	1.6	1.7	1.8	1.7	1.4	1.4	1.0	0.7
Pulp, paper & print production	21-22	1.2	1.1	1.2	1.1	0.9	0.9	0.7	0.5
Chemical production	24	7.1	7.9	8.5	8.1	6.9	6.6	5.8	4.1
Rubber & plastic production	25	1.5	2.2	2.4	2.2	1.8	1.3	1.0	0.9
Non-metallic mineral production	26	5.3	5.6	6.0	5.5	5.2	6.6	5.9	4.9
Metal prod. excl. machinery & transport equip.	27-28	6.0	6.8	7.6	6.9	6.4	5.7	4.7	4.8
Agriculture & industrial machinery	29	5.4	5.9	6.4	6.0	5.0	4.9	4.2	2.9
Office and data process machines	30	0.6	0.8	0.9	0.9	0.7	1.1	0.9	0.7
Electrical goods	31-33	2.9	4.3	4.6	4.4	3.5	3.5	2.9	2.5
Transport equipment	34-35	0.5	0.6	0.6	0.6	0.5	0.4	0.3	0.2
Other manufacturing	36-37,23	0.9	1.2	1.4	1.4	1.2	1.0	0.9	0.9
Construction	45	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.2
INDUSTRY excl. Fuel, Power, Water		53.5	61.2	66.4	62.3	54.2	53.5	46.5	36.6
TRANSPORT*		49.5	51.2	55.6	47.0	49.2	50.0	44.8	43.5
SERVICES excl Transport		33.4	37.5	40.4	41.1	36.6	36.1	32.2	31.8
RESIDENTIAL		50.5	54.1	56.0	52.5	45.8	44.7	37.6	31.8
Sub-TOTAL		439.2	458.7	480.1	463.1	436.2	434.0	399.8	374.7
Not attributed to any sector		25.9	26.3	23.7	21.2	18.1	16.7	7.5	3.8
<b>TOTAL</b>		<b>465.1</b>	<b>485.0</b>	<b>503.8</b>	<b>484.3</b>	<b>454.3</b>	<b>450.7</b>	<b>407.3</b>	<b>378.5</b>

\* Includes both the Transport sector and road transport activities carried out in all other sectors.

## Appendix

## Air Emission Conversion Factors

	TOE per tonne	TOE per 1000 litres	Tonnes CO <sub>2</sub> /TJ	Tonnes SO <sub>2</sub> /TJ	Tonnes NO <sub>x</sub> /TJ	Tonnes CH <sub>4</sub> /TJ
1 TOE (Tonne of Oil Equivalent) = 41.868 x 10 <sup>-3</sup> TJ and TJ (Tera Joule) = 10 <sup>12</sup> Joules						
Briquettes	0.443		98.860	0.280	0.100	0.050
Milled Peat	0.186		113.262*	0.270	0.160	0.050
Sod Peat	0.313		104.000	0.300	0.100	0.050
Coal	0.665		94.600	0.323*	0.050	0.100
Gas/Diesel Oil	1.034	0.869	73.247	0.074	0.100	
Kerosene	1.056	0.845	71.342	0.034	0.100	0.005
Residual Fuel Oil	0.985		75.959	0.485	0.200	
LPG	1.126	0.579	63.647	0.000	0.100	
Natural Gas			54.890	0.000	0.100	0.005

Sources: Environmental Protection Agency, Sustainable Energy Ireland

\* Factors revised.

## Global Warming Potential

Emitted Gas	Global warming potential over 100 years (CO <sub>2</sub> equivalents per tonne of gas emitted)		
	Carbon dioxide (CO <sub>2</sub> )	1	
Methane (CH <sub>4</sub> )	21		
Nitrous Oxide (N <sub>2</sub> O)	310		
Emitted Gas	Acid rain precursors (SO <sub>2</sub> equivalents per tonne of gas emitted)		
	Sulphur dioxide (SO <sub>2</sub> )	1	
	Oxides of Nitrogen (NO <sub>x</sub> )	0.6957	
	Ammonia (NH <sub>3</sub> )	1.8824	