Environmental Accounts for Ireland

1995-2002

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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 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 fifth set of environmental satellite accounts for Ireland. They set out a longitudinal series of air emissions in respect of the years 1995-2002 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

August 2004

Chapter 1 Introduction

These satellite accounts give a sectoral breakdown 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)[1], 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.

[1] "Emissions to Air 1990-1998," McGettigan and Duffy (2000) or "Air Quality Monitoring, Annual Report 2001," McGovern and McGettigan (2002) and Annual National Inventory reports to the UNFCC

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_2
Nitrous Oxide - N_2O ⟹ Global warming potential
Methane - CH_4

Sulphur Dioxide - SO_2
Oxides of Nitrogen - NO_x ⟹ Acid rain precursors
Ammonia - NH_3

Chapter 2 Environmental Themes

Global warming potential

Carbon dioxide (CO_2) emissions are the result of burning fossil fuels such as coal, turf and petroleum. Carbon dioxide is also sequestered by vegetation growth, the most important being by trees. **Nitrous oxide** (N_2O) 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_4) emissions. There are other greenhouse gases (VOC and CO) that are not considered in this exercise.

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_2 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_2 equivalents per tonne of gas emitted)
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	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_2). **Oxides of nitrogen** (NO_x) arise when fossil fuels are burnt under certain conditions. **Ammonia** (NH_3) emissions arise primarily from animal manure and nitrogen based fertilisers. Acid rain precursor emissions are expressed in sulphur dioxide (SO_2) equivalents using the following conversion factors:

Emitted gas	**Acid rain precursors (SO_2 equivalents per tonne of gas emitted)**
Sulphur Dioxide (SO_2)	1.0000
Oxides of Nitrogen (NO_x)	0.6957
Ammonia (NH_3)	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[2]. 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.

[2] Emissions factors are reproduced in an appendix.

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.

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 1995-2001.

Chapter 4 Results Air Emissions Accounts 1995-2002

The rapid growth in the Irish economy during the past 7 years implies an increase in the consumption of raw materials and energy inputs, which have knock-on effects on the environment. The increase in economic activity is evidenced, for example, 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 energy consumption and raw materials inputs. The ensuing increases in emissions of greenhouse gases and acid rain precursors put further pressure on the environment.

Aspects of Economic Activity 1995-2002

	Units	1995	2002	% change
Gross domestic product (GDP) at 1995 prices	€ Million	52,641	94,310	+79%
Gross domestic fixed capital formation at 1995 prices	€ Million	9,149	18,587	+103%
Numbers at work	'000	1,282	1,750	+36%
Total Primary Energy Requirement	TOE '000	10,983	14,754	+34%
Greenhouse Gas emissions	ktonne CO_2 equiv	57,349	67,366	+17%
Acid Rain precursors	ktonne SO_2 equiv	472	407	-14%
Household and commercial waste	ktonne	1,385	2,399	+73%

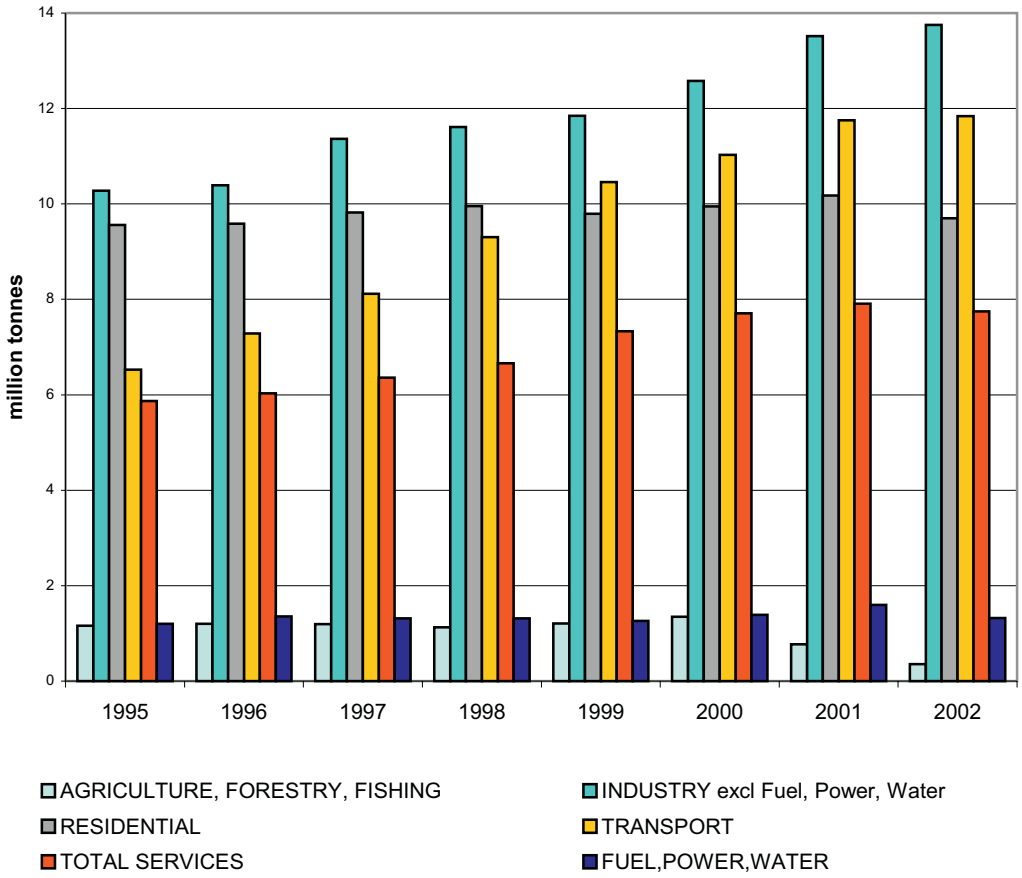
Trends in emissions of carbon dioxide, which are lower than trends in energy consumption, can be explained by changes in the mix of energy sources such as for example, a switch from hard coal to natural gas in electricity generation in particular.

Greenhouse Gases

CO_2 emissions

Emissions estimates for carbon dioxide (CO_2) are presented in Table 1. In the period 1995 to 2002 aggregate national emissions increased by 29% from approximately 34.7 to 44.8 million tonnes. In the industrial and services sectors there were similar percentage increases in CO_2, while emissions from the residential sector increased by 2% over the period. The most marked increase in CO_2 emissions occurred in transport (which includes both the Transport Sector and transport activities carried out in all other sectors), where emissions increased by 81% between 1995 and 2002, with transport comprising both private and business transport. Emissions trends are presented graphically in Figure 1.

Figure 1: Carbon Dioxide Emissions



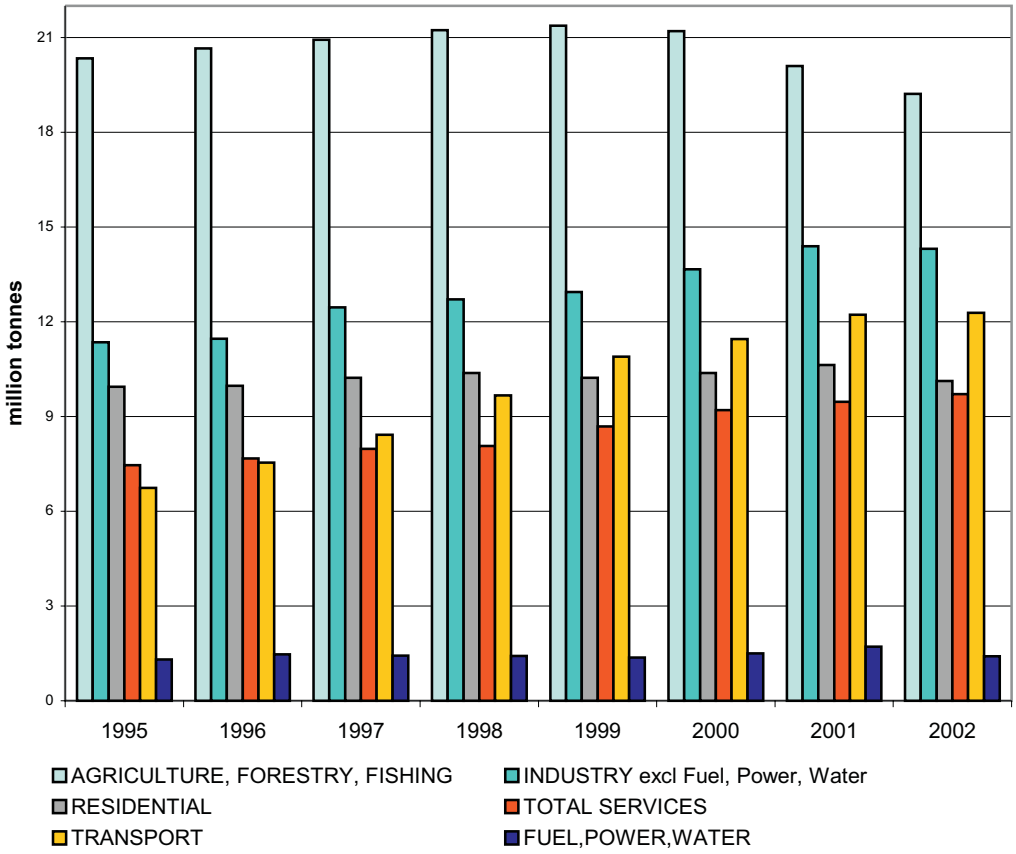
N_2O and CH_4 emissions

Emissions of nitrous oxide (N_2O) and methane (CH_4) are presented in Tables 2 and 3. Although the aggregate magnitude of emissions of these gases are significantly lower than those for CO_2 emissions, N_2O and CH_4 are relatively more potent in terms of global warming potential. Aggregate N_2O emissions decreased by 3% over the eight-year period due primarily to the drop and subsequent closure of production in a specific plant in the Chemical sector. However this masks the relatively large growth in emissions from the transport sector where N_2O emissions increased by 117% between 1995 and 2002. Although three-way catalytic converters are now prevalent in vehicles these devises do not curb N_2O emissions. Ruminant animals are the primary source of CH_4 emissions with gas distribution losses the other significant source.

Total Greenhouse Gases

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_2 emissions, the high level of emissions of N_2O and CH_4 (when expressed as CO_2 equivalents) from farming contributes to agriculture, forestry and fishing being the sector with the highest level of greenhouse gas emissions. For the period 1995-2000 greenhouse gas emissions in this sector were roughly stationary at an average of 21 million tonnes/annum but there was a 10% reduction in net emissions between 2000 and 2002 due primarily to a decrease in livestock numbers. All other sectors in the economy recorded increases in greenhouse gas emissions. Transport in particular changed from having the fifth highest level of emissions in 1996 to the third highest in 1999, a position it continued to hold in 2002 while the industrial sectors' emissions increased by an average of 4% per annum.

Figure 2: Greenhouse Gas (CO_2, N_2O, CH_4) 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 29% above the 1990 baseline level in 2002. Clearly, as identified in the National Climate Change Strategy (October 2000), significant remedial measures are required to meet our commitment under the Kyoto protocol.

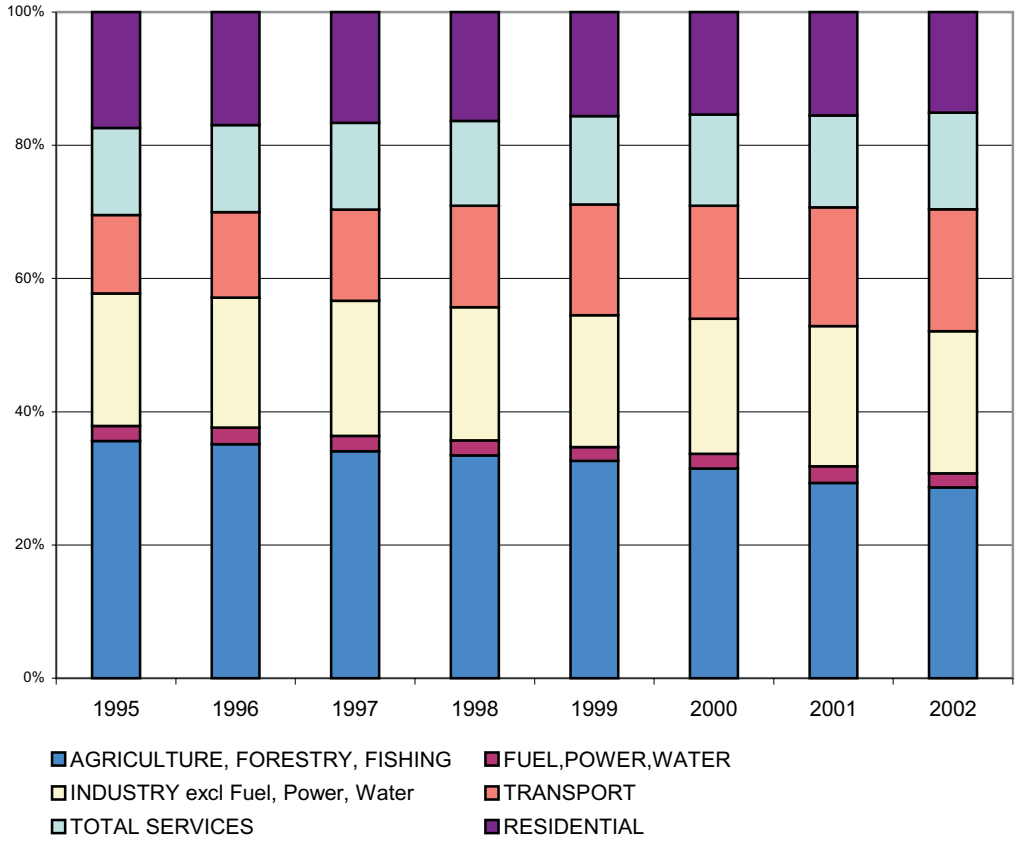
Greenhouse gas emissions as a percentage of 1990 Kyoto protocol baseline*

1995	1996	1997	1998	1999	2000	2001	2002
108%	111%	116%	120%	124%	128%	131%	129%

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

While aggregate emissions have been increasing between 1995 and 2002, the relative sectoral shares of greenhouse gas emissions have also changed, as shown in Figure 3. The share of emissions emanating from the residential and agricultural sectors have declined whereas share of emissions from the transport and industry sectors increased.

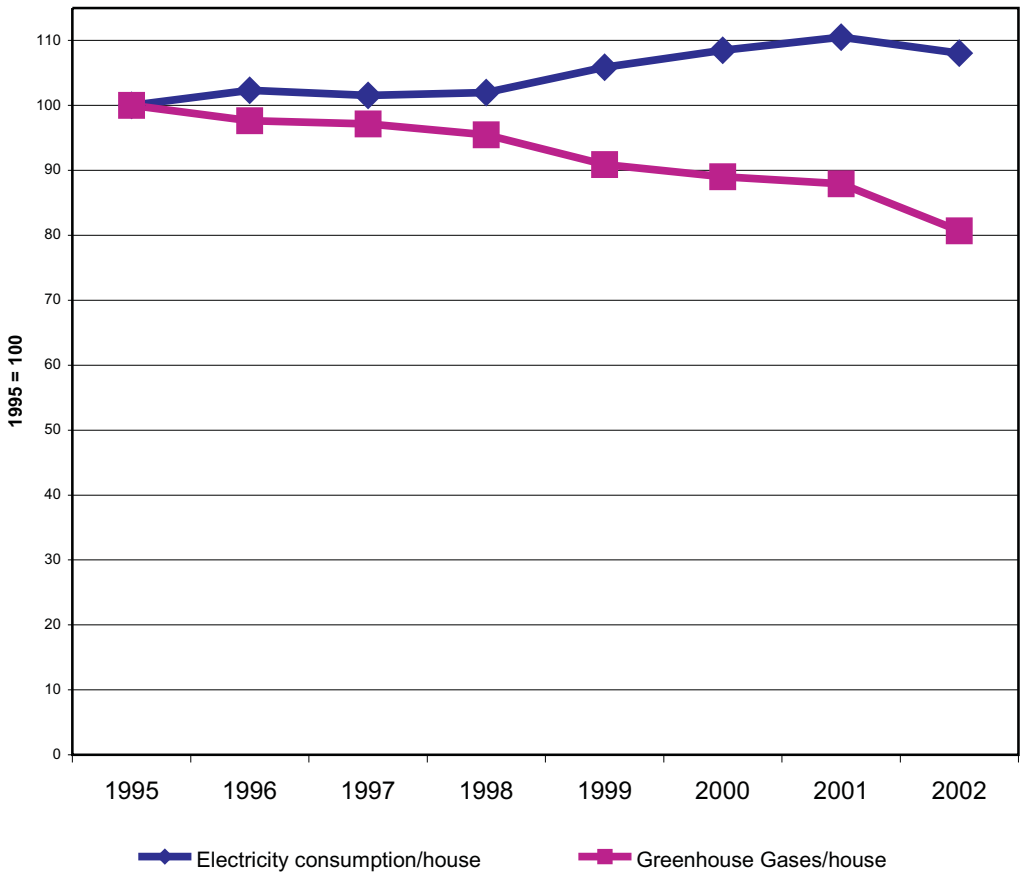
Figure 3: Sector Shares - Greenhouse Gas (CO_2, N_2O, CH_4) Emissions



Residential Sector

Residential greenhouse gas emissions were stationary at approximately 10 million tonnes per annum between 1995 and 2002. Over the same period the housing stock increased by approximately 26% 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 8% between 1995 and 2002. The increase in per household electricity demand in parallel to a decline in per household emissions is explained by the fact that electricity generation has become cleaner in recent years in terms of intensity of greenhouse gas emissions. Secondly, emissions from solid fuels used directly by the residential sector have also declined, leading to a decline in emissions per household. These two components are the primary factors explaining the 19% decline in residential greenhouse gas emissions per household between 1995 and 2002 as shown in Figure 4.

Figure 4: Residential Sector Electricity Demand and Emissions

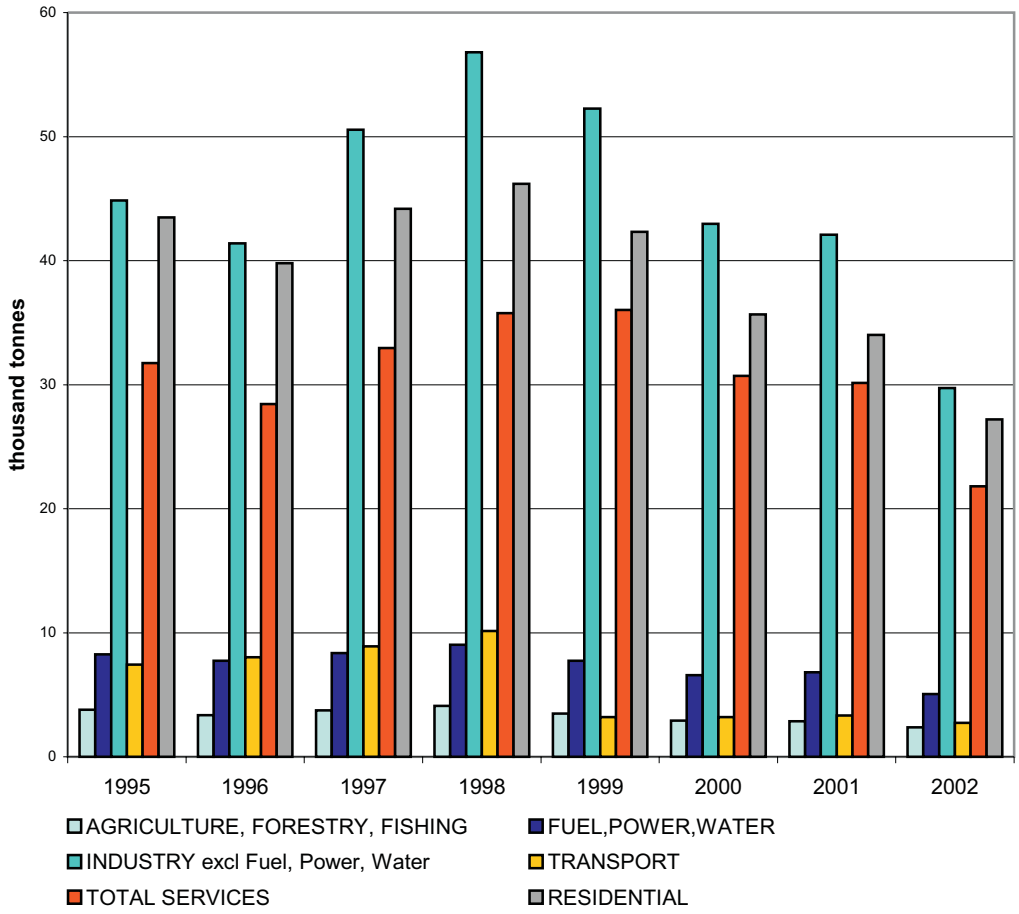


Acid rain precursors

SO_2 emissions

Sulphur dioxide (SO_2) emissions are presented in Table 5, which shows that emissions declined by 40% between 1995 and 2002. 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. Figure 5 shows that the industrial, residential and services sectors now emit over 82% of all SO_2 emissions.

Figure 5: Sulphur Dioxide Emissions



NO_x and NH_3 emissions

Tables 6 and 7 contain emissions estimates for oxides of nitrogen (NO_x) and ammonia (NH_3). The growth of NO_x emissions between 1995 and 2002 was 3% overall for the period but the residential (-14%) sector shows a significant downward movement over the period due primarily to less intensive emissions in electricity generation. Ammonia (NH_3) emissions which predominantly derive from agricultural sources were 6% higher in 1999 compared to 1995 levels and was followed by a 7% reduction in emissions in 2002 due to the significant drop in both cattle and sheep numbers in this period.

Total Acid Rain Precursors

Estimates of emissions of acid rain precursors, which are expressed in SO_2 equivalents, are presented in Table 8 (and Figure 6). Emissions totalled 407 thousand tonnes in 2002, a decline of 14% since 1995. The agricultural sector predominates, accounting for 57% of total emissions. 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_2, NO_x, NH_3) Emissions

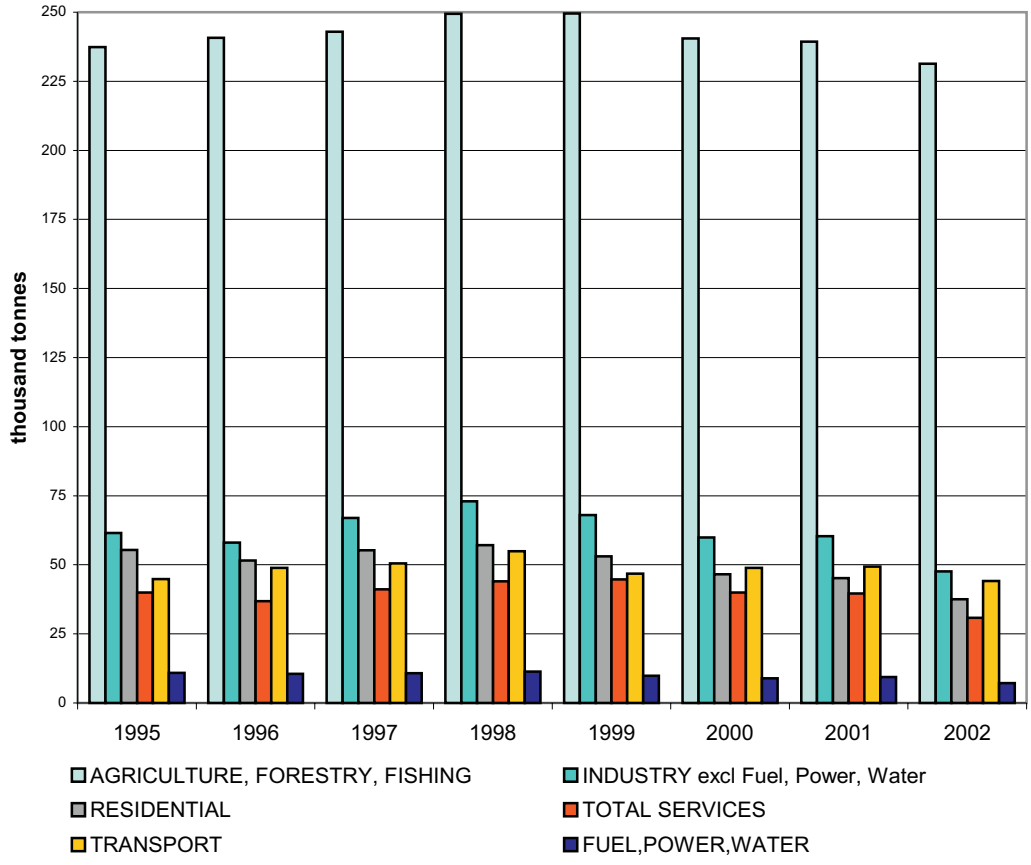
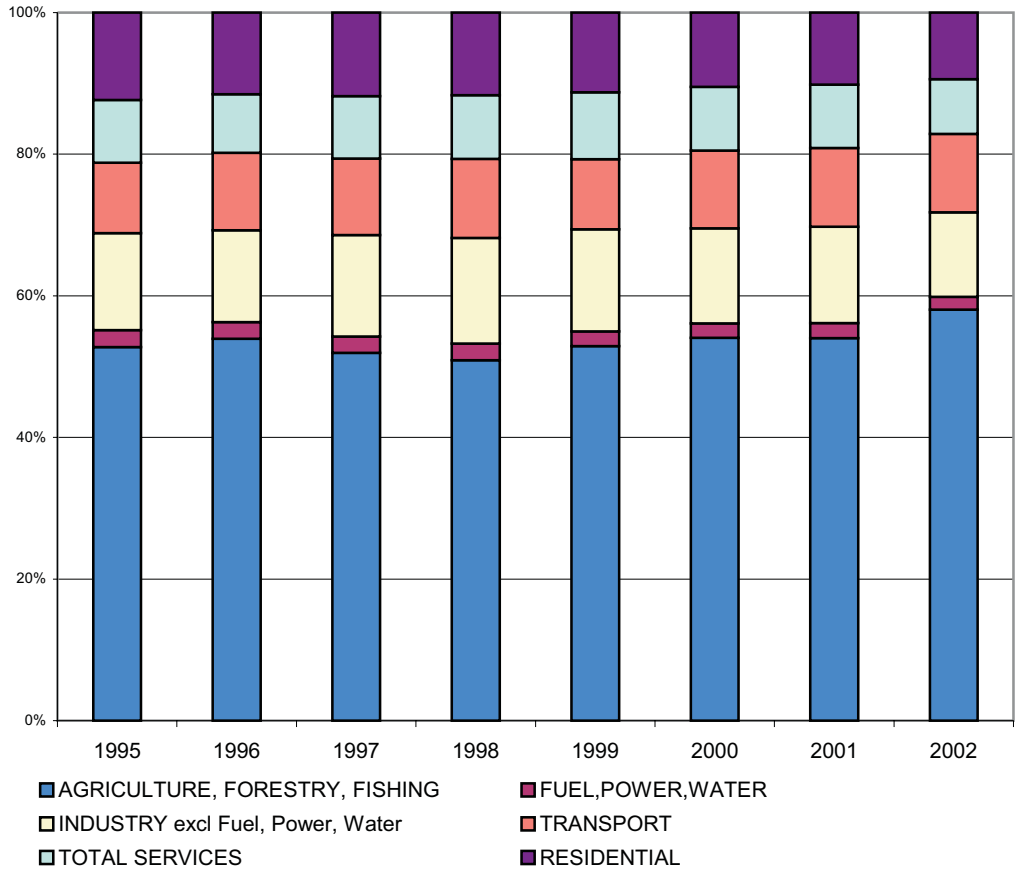


Figure 7: Sector Shares - Acid Rain Precursor (SO_2, NO_x, NH_3) Emissions



Ireland's targets under the Gothenburg Protocol

Ireland is committed to reducing the three acid rain precursor emissions and volatile organic compounds (VOCs) under the 1999 Gothenburg Protocol. The EU has put in place a Directive setting National Emissions Ceilings (NECs), which in Ireland's case are the same as the Gothenburg Protocol targets. Significant further reductions in Ireland's emissions are required if these targets are to be met.

Pollutant	Year 2002 Emissions (kt)	Ceiling by 2010 (kt)	Reduction required to meet 2010 target (kt)	Percentage reduction required
Sulphur Dioxide (SO_2)	96	42	54	56%
Nitrogen Oxides (NO_x)	125	65	70	48%
Volatile Organic Compounds (VOC_s)	81	55	32	32%
Ammonia (NH_3)	119	116	3	3%

Source: Department of the Environment and Local Government

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Tables

The data provided in this report incorporates revisions to the estimates previously published in respect of the years 1995-2001

Table 1: Carbon Dioxide (CO_2) Emissions **Thousand tonnes**

	NACE REV 1	1995	1996	1997	1998	1999	2000	2001	2002
Emissions by Agriculture, Forestry, Fishing		1,592.1	1,621.1	1,693.4	1,702.4	1,706.4	1,754.2	1,780.7	1,672.2
Sequestration by forestry		-428.7	-420.2	-497.9	-573.6	-500.5	-407.3	-1,007.0	-1,319.6
AGRICULTURE, FORESTRY, FISHING	1,2,5	1,163.4	1,201.0	1,195.4	1,128.8	1,205.9	1,346.9	773.7	352.6
FUEL,POWER,WATER	40-41	1,202.2	1,354.1	1,316.1	1,317.7	1,263.8	1,391.9	1,596.8	1,322.0
Coal, peat, petroleum, metal ores, quarrying	10-14	670.6	756.7	773.4	824.9	860.0	884.4	991.3	996.6
Food, beverage, tobacco	15-16	2,230.2	2,268.7	2,381.3	2,431.1	2,461.3	2,631.5	2,783.7	2,827.9
Textiles Clothing Leather & Footwear	17-19	313.0	327.0	381.0	383.0	392.0	391.4	445.3	383.5
Wood & wood products	20	196.5	216.3	215.8	202.5	210.0	206.7	218.2	184.2
Pulp, paper & print production	21-22	157.7	158.9	141.4	139.5	144.6	140.3	149.4	135.6
Chemical production	24	2,229.4	2,137.3	2,394.4	2,401.3	2,325.5	2,315.1	2,359.1	2,133.1
Rubber & plastic production	25	189.1	186.1	258.3	267.0	274.1	260.2	204.5	235.0
Non-metallic mineral production	26	2,067.5	2,119.9	2,299.4	2,281.8	2,358.7	3,001.3	3,563.0	3,889.2
Metal prod. excl. machinery & transport equip.	27-28	756.0	780.4	861.0	917.4	903.0	881.7	788.3	696.0
Agriculture & industrial machinery	29	687.0	683.7	700.0	724.6	749.6	753.2	795.7	779.2
Office and data process machines	30	142.6	79.2	106.8	118.6	129.4	127.1	191.3	223.8
Electrical goods	31-33	306.2	366.5	517.7	522.3	545.8	521.0	592.3	677.6
Transport equipment	34-35	74.1	65.5	71.7	73.8	75.2	71.6	71.6	65.3
Other manufacturing	36-37,23	224.3	210.3	223.1	280.1	375.2	347.8	314.8	468.7
Construction	45	33.4	36.6	41.5	43.8	45.1	44.8	47.4	59.2
INDUSTRY excl. Fuel, Power, Water		10,277.5	10,392.9	11,366.8	11,611.9	11,849.4	12,578.0	13,516.0	13,754.9
TRANSPORT*		6,529.9	7,283.7	8,119.8	9,304.6	10,458.3	11,029.7	11,750.6	11,840.6
SERVICES excl Transport		5,872.4	6,029.7	6,360.5	6,663.7	7,335.4	7,710.9	7,911.1	7,749.2
RESIDENTIAL		9,560.2	9,588.4	9,820.6	9,956.7	9,792.1	9,945.8	10,175.0	9,702.0
Sub-TOTAL		34,605.6	35,849.7	38,179.2	39,983.4	41,904.9	44,003.1	45,723.2	44,721.2
Not attributed to any sector		98.3	100.2	102.8	105.3	106.8	109.2	108.6	109.2
TOTAL		34,703.9	35,949.9	38,281.9	40,088.7	42,011.7	44,112.3	45,831.8	44,830.4

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

Table 2: Nitrous Oxide (N_2O) Emissions **Thousand tonnes**

	NACE REV 1	1995	1996	1997	1998	1999	2000	2001	2002
AGRICULTURE, FORESTRY, FISHING	1,2,5	26.4	26.9	27.1	27.5	27.7	27.4	26.7	25.8
FUEL,POWER,WATER	40-41	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Coal, peat, petroleum, metal ores, quarrying	10-14	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Food, beverage, tobacco	15-16	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
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	2.7	2.0	1.0
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	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Metal prod. excl. machinery & transport equip.	27-28	0.1	0.1	0.1	0.1	0.1	0.1	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	0.0	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		3.2	3.3	3.3	3.4	3.4	3.3	2.7	1.6
TRANSPORT*		0.6	0.7	0.8	1.0	1.3	1.2	1.3	1.3
SERVICES excl Transport		0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.8
RESIDENTIAL		1.0	1.0	1.1	1.2	1.2	1.2	1.3	1.2
Sub-TOTAL		32.1	32.8	33.2	34.0	34.5	34.2	33.0	30.9
Not attributed to any sector		0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5
TOTAL		32.4	33.1	33.6	34.4	34.9	34.7	33.6	31.4

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

Table 3: Methane (CH_4) Emissions **Thousand tonnes**

	NACE REV 1	1995	1996	1997	1998	1999	2000	2001	2002
AGRICULTURE, FORESTRY, FISHING	1,2,5	523.1	528.8	539.7	551.6	551.8	540.3	525.8	517.0
FUEL,POWER,WATER	40-41	2.9	3.1	3.0	2.5	2.5	2.5	2.5	2.1
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	0.8	0.7	0.7	0.6	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	0.1	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	1.6	1.3	1.3	1.1	0.9	0.8	0.8	0.5
Rubber & plastic production	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-
Non-metallic mineral production	26	0.5	0.5	0.5	0.5	0.4	0.5	1.0	1.0
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	0.1	0.2	0.1	0.1	0.2
Construction	45	-	-	-	-	-	-	-	-
INDUSTRY excl. Fuel, Power, Water		3.3	2.9	2.8	2.4	2.2	2.1	2.6	2.3
TRANSPORT*		1.9	2.0	2.1	2.3	2.4	2.6	2.6	2.5
SERVICES excl Transport		65.4	68.0	66.0	55.6	52.0	58.5	61.1	81.1
RESIDENTIAL		3.1	3.3	3.3	3.2	2.7	2.7	2.6	2.5
Sub-TOTAL		599.8	608.0	616.9	617.6	613.6	608.8	597.2	607.3
Not attributed to any sector		-	-	-	-	-	-	1.0	2.0
TOTAL		599.8	608.0	616.9	617.6	613.6	608.8	598.2	609.3

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

Table 4: Greenhouse Gas Emissions (CO_2, N_2O, CH_4) **Thousand tonnes CO_2 equivalents**

	NACE REV 1	1995	1996	1997	1998	1999	2000	2001	2002
AGRICULTURE, FORESTRY, FISHING	1,2,5	20,340.9	20,655.4	20,924.3	21,229.3	21,369.2	21,201.4	20,097.0	19,208.4
FUEL,POWER,WATER	40-41	1,308.8	1,469.7	1,427.2	1,420.8	1,364.9	1,495.4	1,708.5	1,412.8
Coal, peat, petroleum, metal ores, quarrying	10-14	687.0	775.7	791.7	844.1	879.9	904.9	1,014.4	1,018.2
Food, beverage, tobacco	15-16	2,292.7	2,330.0	2,444.7	2,496.9	2,527.4	2,695.8	2,851.1	2,889.1
Textiles Clothing Leather & Footwear	17-19	322.3	337.1	393.1	396.0	405.1	404.2	459.4	395.3
Wood & wood products	20	202.7	223.4	223.1	209.9	217.5	213.9	225.9	190.2
Pulp, paper & print production	21-22	162.8	164.1	146.1	144.4	149.6	145.1	154.5	139.9
Chemical production	24	3,101.9	3,003.0	3,263.2	3,268.3	3,188.1	3,171.2	2,990.6	2,464.4
Rubber & plastic production	25	195.3	192.1	267.0	276.4	283.6	269.0	211.8	243.0
Non-metallic mineral production	26	2,093.2	2,146.8	2,326.9	2,309.6	2,385.6	3,029.7	3,602.3	3,925.6
Metal prod. excl. machinery & transport equip.	27-28	777.0	801.1	880.0	937.9	923.7	901.5	804.0	705.1
Agriculture & industrial machinery	29	712.0	708.2	725.3	751.8	777.3	780.0	824.5	806.4
Office and data process machines	30	147.7	81.5	110.2	122.3	133.2	130.6	197.5	230.7
Electrical goods	31-33	315.6	378.5	535.1	541.2	565.0	538.8	612.4	699.7
Transport equipment	34-35	76.3	67.7	74.0	76.2	77.7	73.9	74.1	67.4
Other manufacturing	36-37,23	230.4	215.7	229.2	287.3	383.5	355.0	321.5	476.8
Construction	45	34.6	38.0	43.1	45.5	46.8	46.4	49.1	61.4
INDUSTRY excl. Fuel, Power, Water		11,351.4	11,462.8	12,452.6	12,707.7	12,944.0	13,660.3	14,393.1	14,313.1
TRANSPORT*		6,741.3	7,540.2	8,423.6	9,670.8	10,896.0	11,456.0	12,216.7	12,286.4
SERVICES excl Transport		7,458.7	7,671.9	7,971.6	8,070.2	8,684.7	9,203.8	9,468.6	9,711.7
RESIDENTIAL		9,938.5	9,973.1	10,227.0	10,381.8	10,223.0	10,376.4	10,625.9	10,127.7
Sub-TOTAL		57,139.6	58,773.2	61,426.3	63,480.6	65,481.7	67,393.2	68,509.9	67,060.1
Not attributed to any sector		209.6	209.6	232.5	229.7	243.0	263.8	285.2	305.6
TOTAL		57,349.2	58,982.8	61,658.8	63,710.3	65,724.7	67,657.0	68,795.1	67,365.7

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

Table 5: Sulphur Dioxide (SO_2) Emissions **Thousand tonnes**

	NACE REV 1	1995	1996	1997	1998	1999	2000	2001	2002
AGRICULTURE, FORESTRY, FISHING	1,2,5	3.8	3.3	3.8	4.1	3.5	2.9	2.9	2.4
FUEL,POWER,WATER	40-41	8.3	7.7	8.3	9.0	7.7	6.6	6.8	5.1
Coal, peat, petroleum, metal ores, quarrying	10-14	3.0	3.4	3.7	4.3	4.2	3.4	2.4	2.1
Food, beverage, tobacco	15-16	11.6	10.9	12.9	14.5	13.4	10.9	11.0	7.4
Textiles Clothing Leather & Footwear	17-19	2.0	1.8	2.2	2.4	2.2	1.7	1.9	1.3
Wood & wood products	20	1.1	1.1	1.3	1.4	1.3	1.0	1.1	0.7
Pulp, paper & print production	21-22	1.0	0.9	0.9	1.0	0.9	0.7	0.7	0.5
Chemical production	24	6.1	5.2	6.1	6.8	6.4	5.0	4.9	3.8
Rubber & plastic production	25	1.3	1.1	1.7	1.9	1.8	1.3	0.9	0.9
Non-metallic mineral production	26	3.6	3.5	4.0	4.5	4.0	3.4	4.2	2.3
Metal prod. excl. machinery & transport equip.	27-28	5.9	5.8	7.8	9.0	7.9	7.7	7.6	3.7
Agriculture & industrial machinery	29	4.5	3.7	4.3	4.8	4.5	3.5	3.4	2.9
Office and data process machines	30	1.0	0.4	0.6	0.7	0.6	0.5	0.7	0.7
Electrical goods	31-33	2.2	2.3	3.4	3.7	3.4	2.6	2.5	2.4
Transport equipment	34-35	0.5	0.4	0.5	0.6	0.5	0.4	0.3	0.2
Other manufacturing	36-37,23	0.7	0.6	0.9	1.0	0.9	0.7	0.6	0.6
Construction	45	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2
INDUSTRY excl. Fuel, Power, Water		44.9	41.4	50.6	56.8	52.3	43.0	42.1	29.7
TRANSPORT*		7.4	8.0	8.9	10.1	3.2	3.2	3.3	2.7
SERVICES excl Transport		31.7	28.4	33.0	35.8	36.0	30.7	30.2	21.8
RESIDENTIAL		43.5	39.8	44.2	46.2	42.3	35.7	34.0	27.2
Sub-TOTAL		139.6	128.8	148.7	162.1	145.0	122.1	119.3	88.9
Not attributed to any sector		21.6	18.6	17.4	14.0	12.3	9.4	6.8	7.3
TOTAL		161.2	147.4	166.1	176.1	157.4	131.5	126.1	96.2

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

Table 6: Oxides of Nitrogen (NO_x) Emissions **Thousand tonnes**

	NACE REV 1	1995	1996	1997	1998	1999	2000	2001	2002
AGRICULTURE, FORESTRY, FISHING	1,2,5	13.1	12.9	12.1	13.0	13.9	15.0	13.6	13.1
FUEL,POWER,WATER	40-41	3.7	4.0	3.5	3.4	3.0	3.4	3.7	3.0
Coal, peat, petroleum, metal ores, quarrying	10-14	1.6	1.8	1.7	1.7	1.8	2.1	2.3	2.2
Food, beverage, tobacco	15-16	6.4	6.3	6.1	6.1	5.9	6.4	6.5	6.4
Textiles Clothing Leather & Footwear	17-19	1.0	1.0	1.1	1.0	1.0	1.0	1.2	1.0
Wood & wood products	20	0.7	0.7	0.6	0.5	0.5	0.5	0.5	0.4
Pulp, paper & print production	21-22	0.5	0.5	0.4	0.3	0.3	0.3	0.3	0.3
Chemical production	24	3.7	3.5	3.3	3.2	3.1	3.3	3.1	2.9
Rubber & plastic production	25	0.6	0.5	0.7	0.7	0.6	0.6	0.5	0.5
Non-metallic mineral production	26	3.2	3.3	3.2	3.1	2.8	3.3	5.2	5.1
Metal prod. excl. machinery & transport equip.	27-28	2.1	2.2	2.2	2.3	2.1	2.2	1.9	1.7
Agriculture & industrial machinery	29	2.1	2.1	1.9	1.9	1.8	1.9	1.9	1.8
Office and data process machines	30	0.4	0.2	0.3	0.3	0.3	0.3	0.5	0.5
Electrical goods	31-33	0.9	1.1	1.4	1.3	1.3	1.3	1.4	1.6
Transport equipment	34-35	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Other manufacturing	36-37,23	0.5	0.5	0.5	0.6	0.7	0.7	0.6	0.9
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	23.9	23.6	23.3	22.7	24.3	26.2	25.7
TRANSPORT*		52.5	57.1	57.6	61.5	58.9	60.9	60.9	53.7
SERVICES excl Transport		11.8	12.0	11.8	11.9	12.5	13.3	13.5	13.0
RESIDENTIAL		17.2	16.8	15.9	15.6	15.4	15.8	16.0	14.8
Sub-TOTAL		122.2	126.8	124.5	128.6	126.3	132.7	134.0	123.3
Not attributed to any sector		-	-	-	-	-	-	1.0	2.0
TOTAL		122.2	126.8	124.5	128.6	126.3	132.7	135.0	125.3

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

Table 7: Ammonia (NH_3) Emissions **Thousand tonnes**

	NACE REV 1	1995	1996	1997	1998	1999	2000	2001	2002
AGRICULTURE, FORESTRY, FISHING	1,2,5	119.2	121.4	122.6	125.5	125.6	120.7	120.6	116.8
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*		0.4	0.6	0.8	1.0	1.4	1.8	1.9	2.2
SERVICES excl Transport		-	-	-	-	-	-	-	-
RESIDENTIAL		-	-	-	-	-	-	-	-
Sub-TOTAL		119.7	121.9	123.4	126.6	127.0	122.4	122.6	119.0
Not attributed to any sector		-	-	-	-	-	-	-	-
TOTAL		119.7	121.9	123.4	126.6	127.0	122.4	122.6	119.0

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

Table 8: Acid Rain Precursor Emissions (SO_2, NO_x, NH_3) **Thousand tonnes SO_2 equivalents**

	NACE REV 1	1995	1996	1997	1998	1999	2000	2001	2002
AGRICULTURE, FORESTRY, FISHING	1,2,5	237.3	240.8	243.0	249.4	249.6	240.5	239.4	231.4
FUEL,POWER,WATER	40-41	10.8	10.5	10.8	11.4	9.8	9.0	9.4	7.2
Coal, peat, petroleum, metal ores, quarrying	10-14	4.1	4.6	4.8	5.5	5.4	4.9	4.0	3.7
Food, beverage, tobacco	15-16	16.1	15.3	17.2	18.7	17.5	15.3	15.4	11.9
Textiles Clothing Leather & Footwear	17-19	2.7	2.5	3.0	3.1	2.9	2.5	2.7	1.9
Wood & wood products	20	1.5	1.6	1.7	1.8	1.7	1.4	1.4	1.0
Pulp, paper & print production	21-22	1.4	1.2	1.1	1.2	1.1	0.9	0.9	0.7
Chemical production	24	8.7	7.6	8.5	9.0	8.6	7.3	7.0	5.8
Rubber & plastic production	25	1.7	1.5	2.2	2.4	2.2	1.8	1.2	1.2
Non-metallic mineral production	26	5.8	5.8	6.2	6.6	6.0	5.8	7.8	5.8
Metal prod. excl. machinery & transport equip.	27-28	7.4	7.3	9.3	10.6	9.4	9.2	8.9	4.9
Agriculture & industrial machinery	29	6.0	5.2	5.6	6.1	5.7	4.8	4.7	4.1
Office and data process machines	30	1.3	0.6	0.8	0.9	0.8	0.7	1.0	1.1
Electrical goods	31-33	2.9	3.0	4.4	4.6	4.3	3.5	3.4	3.5
Transport equipment	34-35	0.7	0.5	0.6	0.7	0.6	0.5	0.4	0.3
Other manufacturing	36-37,23	1.1	0.9	1.2	1.4	1.4	1.2	1.0	1.2
Construction	45	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.3
INDUSTRY excl. Fuel, Power, Water		61.5	58.0	67.0	73.0	68.1	59.9	60.3	47.6
TRANSPORT*		44.8	48.8	50.5	54.9	46.8	48.9	49.4	44.2
SERVICES excl Transport		39.9	36.8	41.2	44.0	44.7	40.0	39.6	30.8
RESIDENTIAL		55.4	51.5	55.2	57.1	53.0	46.6	45.2	37.5
Sub-TOTAL		449.9	446.5	467.6	489.8	472.0	444.8	443.2	398.6
Not attributed to any sector		21.6	18.6	17.4	14.0	12.3	9.4	7.5	8.7
TOTAL		471.5	465.1	485.0	503.8	484.3	454.3	450.7	407.3

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

Appendix

A1: Air Emission Conversion Factors

	TOE per tonne	TOE per 1000 litres	Tonnes CO_2/TJ	Tonnes SO_2/TJ	Tonnes NO_X/TJ	Tonnes CH_4/TJ
	1 TOE (Tonne of Oil Equivalent) = 41.868 x 10^{-3} TJ and TJ (Tera Joule) = 10^{12} Joules					
Briquettes	0.443		98.860	0.280	0.100	0.050
Milled Peat	0.186		111.580	0.270	0.160	0.050
Sod Peat	0.313		104.000	0.300	0.100	0.050
Coal	0.665		94.600	0.325*	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.

Emitted Gas	**Global warming potential over 100 years (CO_2 equivalents per tonne of gas emitted)**
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310
	Acid rain precursors (SO_2 equivalents per tonne of gas emitted)
Sulphur dioxide (SO_2)	1
Oxides of Nitrogen (NO_x)	0.6957
Ammonia (NH_3)	1.8824