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Environmental Accounts for Ireland

1994-2000

Compiled by Dr John A Curtis and John Eakins of the
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Contents

Tables

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 show how economic developments by industry impact on the environment and on the economy as a whole in a more objective, and systematic way. The idea is to list in quantifiable terms the amount of potential pollutants produced by industry and households, which can be compared to employment and 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 third set of environmental satellite accounts for Ireland. They set out a longitudinal series of air emissions in respect of the years 1994-2000 and have been compiled by the Economic and Social Research Institute (ESRI). The research was carried out by John Curtis and John Eakins and was funded by Eurostat (the Statistical Office of the European Communities).

The CSO welcomes the results of the study and publishes them 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 by the ESRI: Environmental Protection Agency, Department of Communications, Marine and Natural Resources, Sustainable Energy Ireland (formerly the Irish Energy Centre), Electricity Supply Board and Bord Gáis.

Central Statistics Office

February 2003

Chapter 1 Introduction

These satellite accounts quantify the source of greenhouse gas and acid rain precursor emissions, two phenomena that can impinge on our future well-being. However, it is important to bear in mind that the figures in these accounts represent estimates of emissions and are not pollution levels. 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 now or in the future occurring.

Under the Kyoto protocol to the United Nations Framework Convention on Climate Change, which is framed in terms of emissions to air of the gases that are known as greenhouse gases, Ireland is committed to limit the increase in emissions of six greenhouse gases to 13% above 1990 levels between the years 2008 to 2012.

While this agreement focuses on national emissions levels, plans to reduce emissions require a breakdown of emissions by sector. Sectors in which emissions are growing can be identified and industrial development plans co-ordinated with the need to satisfy our obligations under such agreements. Independent of our international commitments it is in our interest to protect our environment and the information on air emissions provide a basis from which to plan accordingly.

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 attribute air emissions to economic 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 thus subject to a margin of error, which in some cases is potentially large.

[1] 'Emissions to Air 1990-1998', McGettigan and Duffy (2000) or 'Air Quality Monitoring, Annual Report 2000', McGovern and McGettigan (2001).

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

Global warming potential	Carbon Dioxide - CO_2 Nitrous Oxide - N_2O Methane - CH_4
Acid rain precursors	Sulphur Dioxide - SO_2 Oxides of Nitrogen - NO_x 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, for instance 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 International 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 publishes under the CORINAIR programme of the EU environment directorate. The present 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 (formerly the Irish Energy Centre). 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.

Figures for the services sectors, both market and non-market, are derived from the Department of Communications, Marine and Natural Resources' 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.

[2] Emissions 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 therefore subject to error and are best interpreted as indicative in nature. However, this cautionary remark aside, it is hoped that they give further insights into the interaction the different economic sectors have with the environment and, in particular, air.

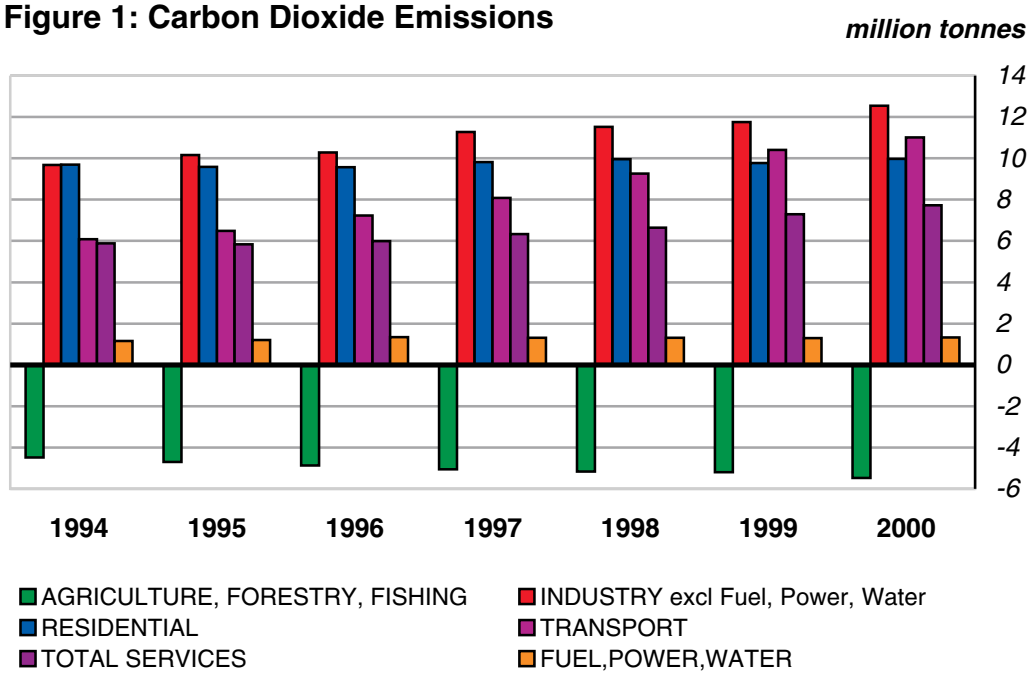
Chapter 4 Air Emissions Accounts 1994-2000

Greenhouse Gases

CO_2 emissions

Emissions estimates for carbon dioxide (CO_2) are presented in Table 1. In the period 1994 to 2000 aggregate national emissions increased by 33% from approximately 28.1 to 37.2 million tonnes. In the industrial and services sectors there were similar percentage increases in CO_2, while emissions from the residential sector remained stagnant over the period. The most marked increase in CO_2 emissions occurred in the transport sector where emissions increased by 81% between 1994 and 2000, with transport comprising both private and business transport. Carbon sequestration in trees overshadows emissions from the combined agricultural, forestry and fishing sector. In 2000 carbon sequestration, measured in CO_2, was approximately 7.2 million tonnes compared to emissions of approximately 1.8 million tonnes. Emissions trends are presented graphically in Figure 1.

Figure 1: Carbon Dioxide Emissions



N_2O and CH_4 emissions

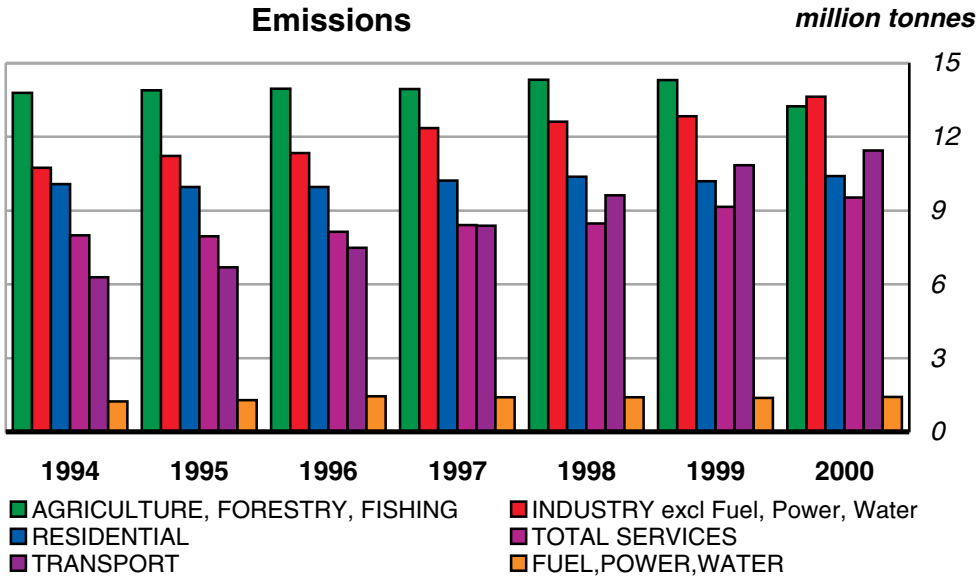
Emissions of nitrous oxide (N_2O) and methane (CH_4) are presented in Tables 2 and 3. Although the aggregate magnitude of emissions of these gases are significantly lower than those for CO_2 emissions, N_2O and CH_4 are relatively more potent in terms of global warming potential. Aggregate N_2O emissions increased by just 5% over the seven-year period but this masks somewhat the relatively large growth in emissions from the transport, services and residential sectors. N_2O emissions from transport increased by 124% between 1994 and 2000. Although three-way catalytic converters are now prevalent in vehicles these devices do not curb N_2O emissions. Ruminant animals are the primary source of CH_4 emissions with gas distribution losses the other significant source.

Greenhouse Gases

Figure 2 and Table 4 combine the three greenhouse gases into a single emissions estimate in terms of carbon dioxide equivalents[3]. Although the forestry acts as a large sink for CO_2 emissions, the high level of emissions of N_2O and CH_4 from agriculture, forestry and fishing contributes to it being the sector with the highest level of greenhouse gas emissions. For the period 1994-1999 greenhouse gas emissions in the agricultural sector (incl. forestry and fishing) were roughly stationary at an average of 14 million tonnes/annum but there was a 7% reduction in net emissions in 2000. All other sectors in the economy recorded increases in greenhouse gas emissions. The transport sector changed from being the sector with the fifth highest level of emissions in 1997 to the third highest in 1999, a position it continued to hold in 2000 and the industrial sector's emissions increased by an average of 4.5% per annum.

[3] 1 tonne of CH_4 is equivalent to 21 tonnes of CO_2 and 1 tonne of N_20 is equivalent to 310 tonnes of CO_2 in terms of global warming potential.

Figure 2: Greenhouse Gas (CO_2, N_2O, CH_4) Emissions



Ireland is committed under the Kyoto protocol to the United Nations Framework Convention on Climate Change 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 24% above the 1990 baseline level in 2000. Significant remedial measures are required if we are to meet our commitment under the Kyoto protocol to the UNFCC. This fact has been identified in the National Climate Change Strategy.

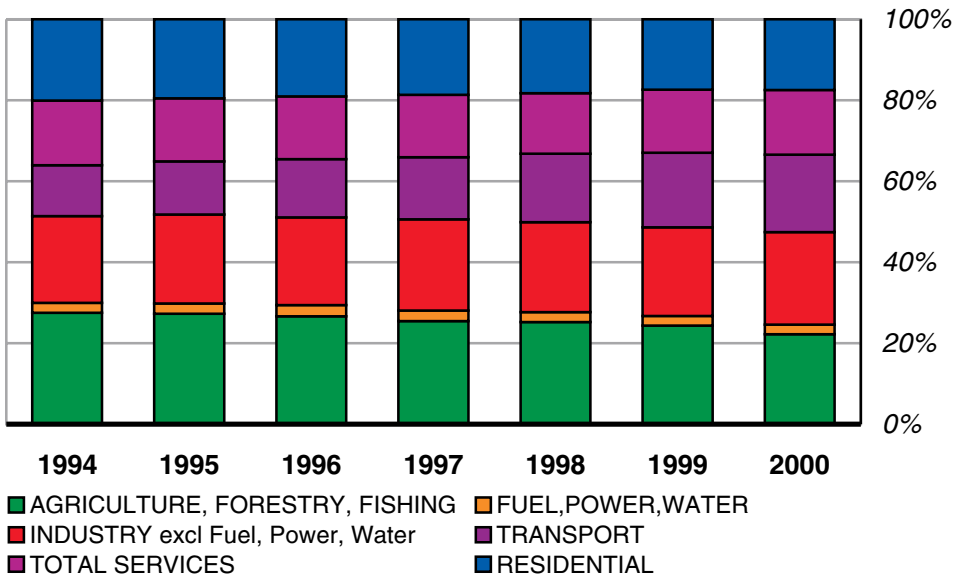
Greenhouse gas emissions as a percentage of 1990 Kyoto protocol baseline*

1994	1995	1996	1997	1998	1999	2000
105%	107%	110%	115%	117%	122%	124%

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

While aggregate emissions have been increasing between 1994 and 2000, 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.

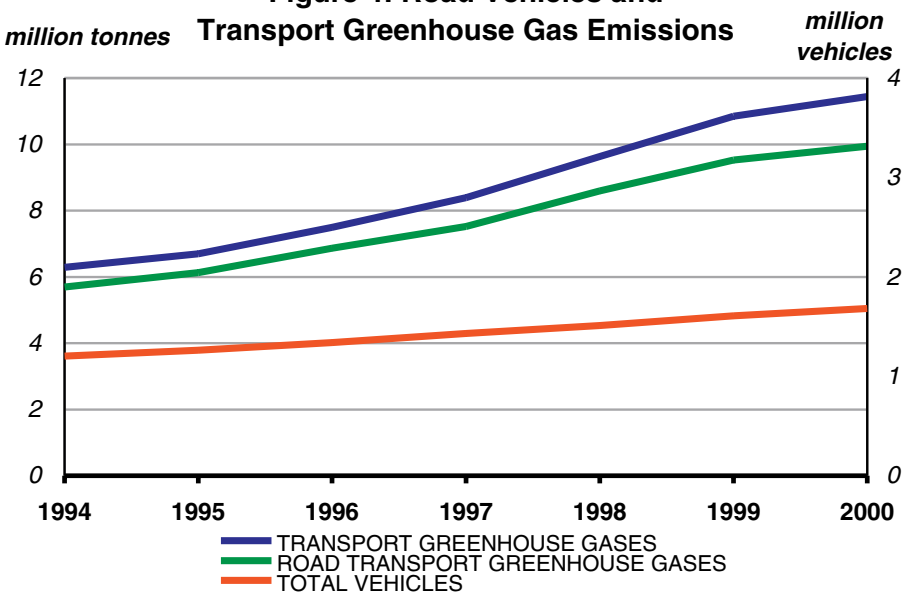
Figure 3: Sector Shares - Greenhouse Gas (CO_2, N_2O, CH_4) Emissions



Note on the Transport Sector

Between 1994 and 2000, greenhouse gas emissions from the transport sector (which includes road, rail and water transport), increased by 82% from 6.3 to 11.4 million tonnes while the road transport element within this increased from 5.7 to 9.9 million tonnes (+75%), as shown in Figure 4. During the same period vehicle numbers increased by only 40% from 1.2 to 1.7 million[4] implying that greenhouse gas emissions per vehicle increased from 4.7 to 5.9 tonnes/vehicle.

Figure 4: Road Vehicles and Transport Greenhouse Gas Emissions



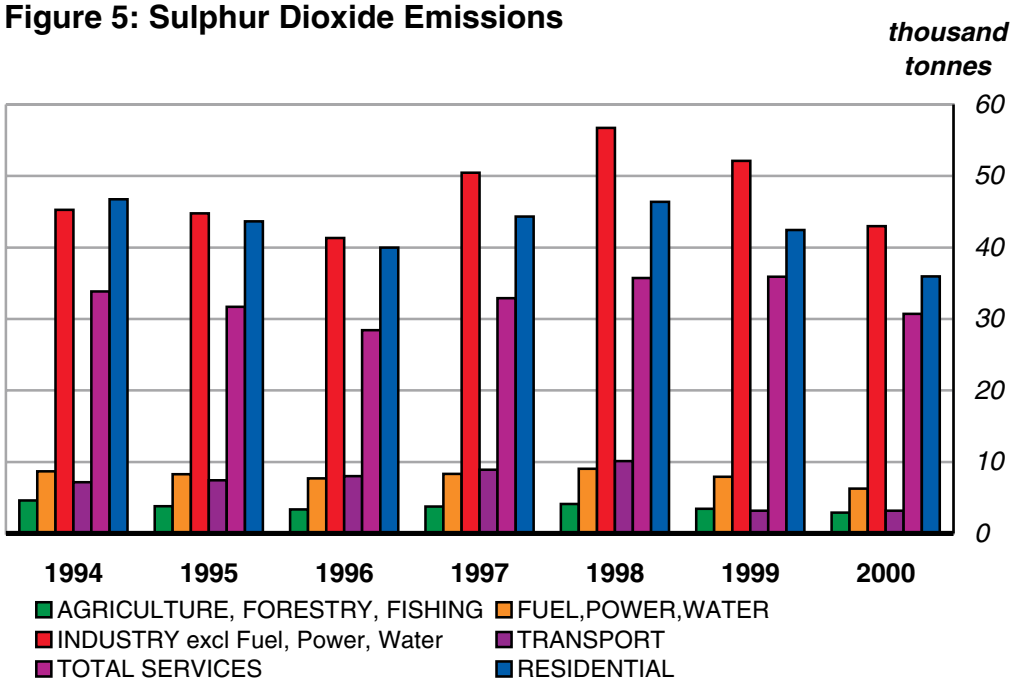
[4] Department of Environment and Local Government, *Bulletin of Vehicle and Driver Statistics.*

Acid rain precursors

SO_2 emissions

Sulphur dioxide (SO_2) emissions are presented in Table 5, which shows that emissions declined by 25% between 1994 and 2000. 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. Figure 5 shows that the industrial, residential and services sectors are the most intensive emitters of SO_2 and the three sectors combined now emit over 80% 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 1994 and 2000 was relatively low at just 8% for the period with only the transport (+25%) and residential (-16%) sectors showing any significant movement over the period. Ammonia (NH_3) emissions predominantly derive from agricultural sources and were 6% higher in 1999 compared to 1994 levels, which was followed by a 4% reduction in emissions in 2000 due to the significant drop in both cattle and sheep numbers.

Acid Rain Precursors

Estimates of emissions of acid rain precursors, which are expressed in SO_2 equivalents, are presented in Figure 6 and Table 8[5]. Emissions totalled 449 thousand tonnes in 2000, a decline of 6% since 1994. The agricultural sector predominates, accounting for roughly half of total emissions. In the rest of the economy, (of which the industrial sector is largest and accounted for less than 15% share of total SO_2 emissions), there have been only relatively small fluctuations in the magnitude of emissions, as illustrated in Figure 7.

Figure 6: Acid Rain Precursor (SO_2, NO_x, NH_3) Emissions

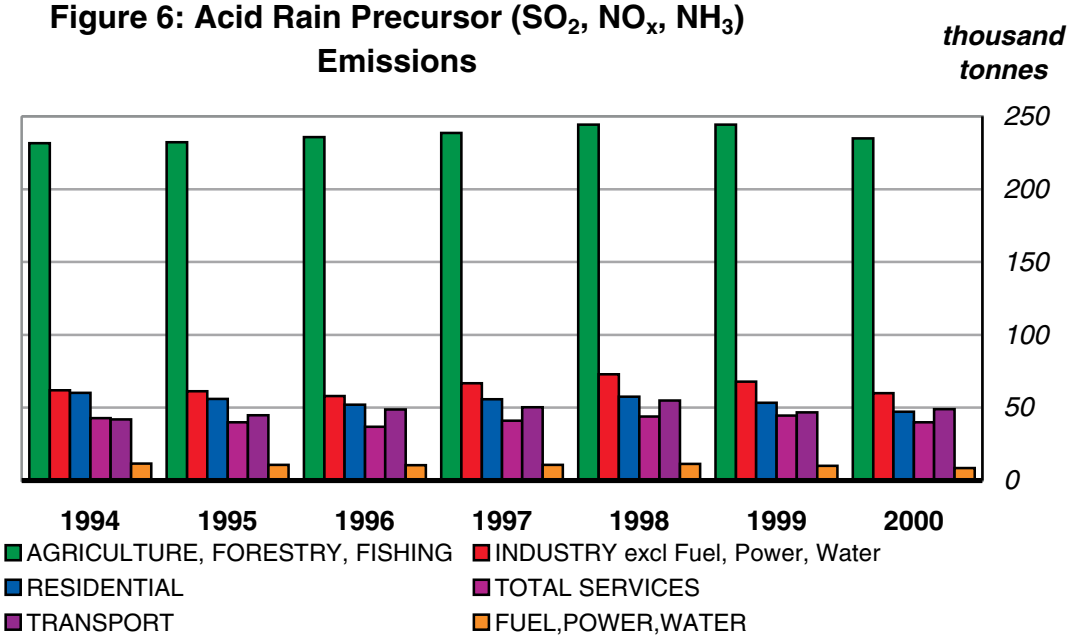
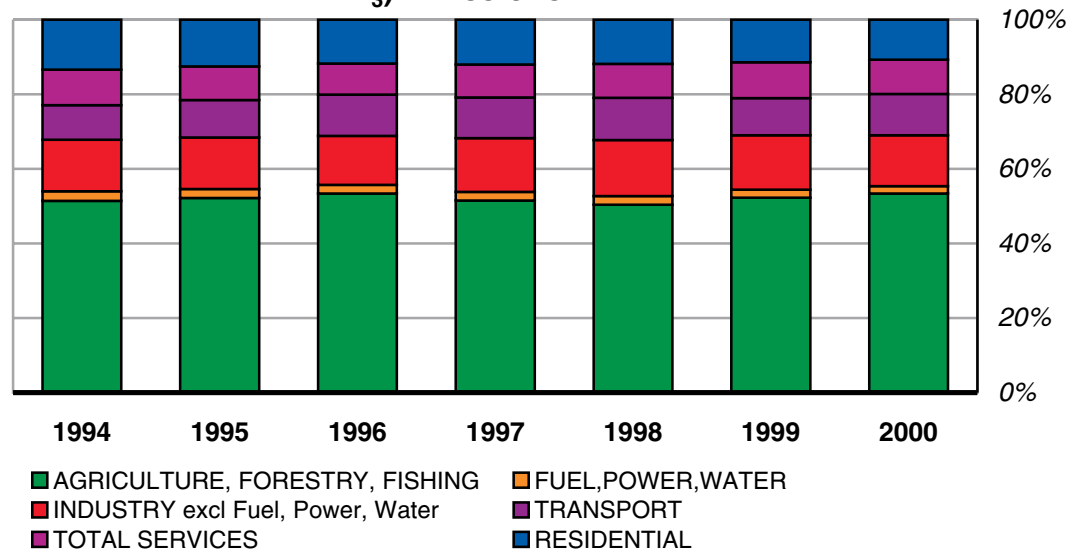


Figure 7: Sector Shares - Acid Rain Precursor (SO_2, NO_x, NH_3) Emissions

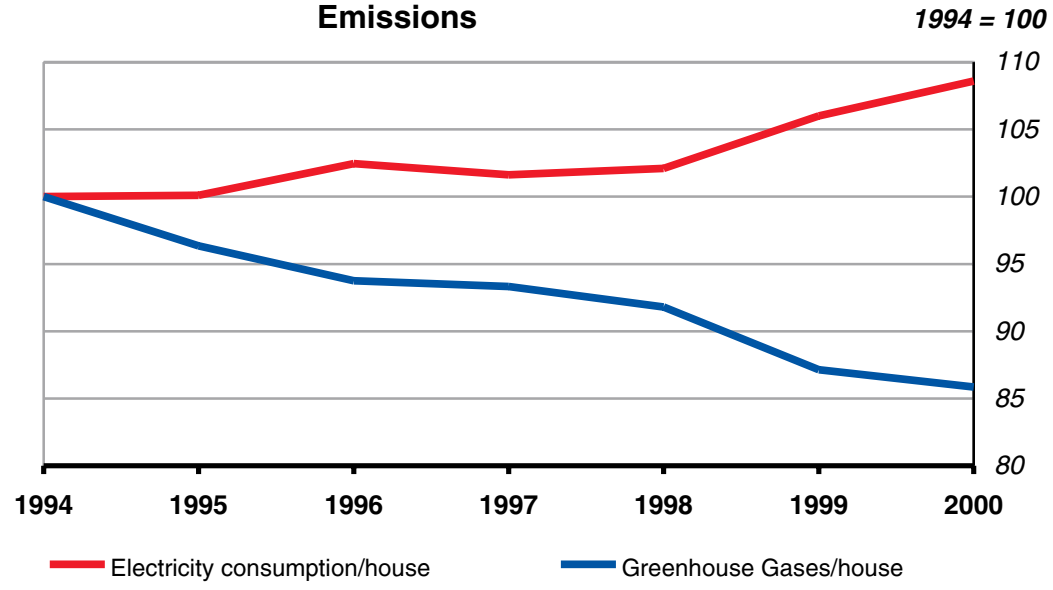


5 1 tonne of NO_x is equivalent to 0.6957 of tonnes SO_2 and 1 tonne NH_3 is equivalent to 1.8824 tonnes of SO_2 in terms of acid rain precursors.

Note on the Residential Sector

Residential greenhouse gas emissions were stationary at approximately 10 million tonnes per annum between 1994 and 2000. Over the same period the housing stock increased by approximately 20% suggesting that emissions per household declined. However, this hides the fact that households actually increased their demand for energy. Figure 8 shows that residential electricity demand per household increased by over 8% between 1994 and 2000. 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 14% decline in residential greenhouse gas emissions per household between 1994 and 2000 as shown in Figure 8.

Figure 8: Residential Sector Electricity Demand and Emissions



Conclusion

Some of the more significant emissions trends in the main sectors of the economy have been highlighted above but the emissions tables themselves provide more detail on the sectors, in particular on individual sectors within manufacturing industry. In analysing the accounts it should be noted that the accounts are estimates and subject to error. However, the data presented should provide a reasonable indication of emissions trends and the relative performance of various sectors. Specific estimates of emissions within sectors should be treated as indicative rather than definite and caution exercised in the interpretation of the accounts.

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Tables

Table 1: CO_2 Emissions - thousand tonnes

	NACE Rev 1	1994	1995	1996	1997	1998	1999	2000
Emissions by Agriculture, Forestry, Fishing		1,622.6	1,625.0	1,663.6	1,639.9	1,706.3	1,680.0	1,756.6
Sequestration by forestry		-6,097.8	-6,329.6	-6,535.3	-6,694.8	-6,871.9	-6,871.9	-7,229.7
AGRICULTURE, FORESTRY, FISHING	1,2,5	-4,475.2	-4,704.6	-4,871.7	-5,054.9	-5,165.6	-5,191.9	-5,473.1
FUEL,POWER,WATER	40-41	1,150.0	1,199.4	1,340.2	1,312.8	1,312.5	1,289.7	1,323.2
Coal, peat, petroleum,metal ores, quarrying	10-14	497.5	666.0	751.9	770.1	821.1	855.4	885.5
Food, beverages, tobacco	15-16	2,040.4	2,200.1	2,241.3	2,359.2	2,410.0	2,436.8	2,603.3
Textiles Clothing Leather & Footwear	17-19	291.0	308.5	322.5	376.6	378.7	386.9	386.5
Wood & wood products	20	154.7	192.5	213.1	213.8	201.6	208.7	206.6
Pulp, paper & print production	21-22	144.6	156.0	157.5	140.6	138.9	143.7	140.7
Chemical production	24	2,345.9	2,208.7	2,119.8	2,382.0	2,390.4	2,313.2	2,321.9
Rubber & plastic production	25	181.4	187.5	184.7	257.1	265.8	272.3	267.9
Non-metallic mineral production	26	1,946.0	2,034.5	2,087.1	2,270.5	2,252.5	2,330.2	2,974.7
Metal prod. excl. machinery & transport equip.	27-28	751.6	750.4	775.3	857.2	913.2	897.7	879.6
Agriculture & industrial machinery	29	596.9	680.3	677.8	695.6	720.0	743.5	746.9
Office and data process machines	30	135.5	141.5	78.7	106.3	118.0	128.6	130.1
Electrical goods	31-33	270.9	303.8	364.1	515.3	519.9	542.3	536.6
Transport equipment	34-35	61.6	73.5	65.1	71.4	73.4	74.7	72.5
Other manufacturing	36-37,23	241.4	222.7	209.0	222.1	278.8	373.2	351.5
Construction	45	24.8	33.1	36.4	41.4	43.6	44.8	44.9
INDUSTRY excl Fuel, Power, Water		9,684.3	10,159.0	10,284.3	11,279.1	11,525.9	11,752.0	12,549.4
TRANSPORT*		6,082.4	6,485.9	7,236.4	8,085.8	9,262.3	10,410.4	11,015.5
SERVICES excl Transport		5,875.9	5,834.2	5,995.7	6,336.5	6,635.4	7,295.4	7,720.8
RESIDENTIAL		9,697.9	9,583.2	9,575.0	9,814.4	9,957.0	9,767.3	9,974.4
Sub-TOTAL		28,015.4	28,557.2	29,559.9	31,773.7	33,527.6	35,322.9	37,110.2
Not attributed to any sector		71.2	71.2	71.2	71.2	71.2	71.2	109.2
TOTAL		28,086.6	28,628.4	29,631.1	31,844.9	33,598.8	35,394.1	37,219.4

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

Table 2: N_2O Emissions - thousand tonnes

	NACE Rev 1	1994	1995	1996	1997	1998	1999	2000
AGRICULTURE, FORESTRY, FISHING	1,2,5	24.0	24.7	24.7	24.3	25.5	25.5	24.2
FUEL,POWER,WATER	40-41	0.1	0.1	0.2	0.2	0.2	0.2	0.2
Coal, peat, petroleum,metal ores, quarrying	10-14	0.0	0.0	0.1	0.1	0.1	0.1	0.1
Food, beverages, tobacco	15-16	0.1	0.1	0.1	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
Wood & wood products	20	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
Chemical production	24	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Rubber & plastic production	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-metallic mineral production	26	0.0	0.0	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	0.1
Agriculture & industrial machinery	29	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
Electrical goods	31-33	0.0	0.0	0.0	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
Other manufacturing	36-37,23	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
INDUSTRY excl Fuel, Power, Water		3.2	3.2	3.3	3.3	3.4	3.4	3.4
TRANSPORT*		0.5	0.6	0.7	0.8	1.0	1.3	1.2
SERVICES excl Transport		0.7	0.7	0.7	0.7	0.8	0.8	0.9
RESIDENTIAL		1.0	1.0	1.0	1.1	1.2	1.2	1.2
Sub-TOTAL		29.6	30.3	30.5	30.5	31.9	32.3	31.0
Not attributed to any sector		0.4	0.4	0.4	0.4	0.4	0.4	0.5
TOTAL		30.0	30.7	30.9	30.9	32.3	32.8	31.5

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

Table 3: CH_4 Emissions - thousand tonnes

	NACE Rev 1	1994	1995	1996	1997	1998	1999	2000
AGRICULTURE, FORESTRY, FISHING	1,2,5	515.3	521.6	532.1	545.1	552.0	551.9	533.7
FUEL,POWER,WATER	40-41	2.2	2.3	2.4	2.3	1.9	2.2	2.1
Coal, peat, petroleum,metal ores, quarrying	10-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Food, beverages, tobacco	15-16	0.7	0.7	0.6	0.6	0.5	0.5	0.5
Textiles Clothing Leather & Footwear	17-19	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Wood & wood products	20	0.0	0.1	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
Chemical production	24	1.5	1.2	1.0	1.1	0.9	0.8	0.7
Rubber & plastic production	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-metallic mineral production	26	0.4	0.5	0.5	0.5	0.4	0.4	0.5
Metal prod. excl. machinery & transport equip.	27-28	0.1	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
Office and data process machines	30	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
Transport equipment	34-35	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	0.1	0.1	0.1
Construction	45	-	-	-	-	-	-	-
INDUSTRY excl Fuel, Power, Water		2.9	2.8	2.5	2.4	2.1	2.0	2.0
TRANSPORT*		1.9	1.9	2.0	2.1	2.3	2.4	2.6
SERVICES excl Transport		90.3	91.1	91.9	87.9	76.2	76.3	73.7
RESIDENTIAL		3.2	3.0	3.1	3.1	3.0	2.6	2.6
Sub-TOTAL		615.7	622.7	634.1	643.0	637.5	637.3	616.8
Not attributed to any sector		-	-	-	-	-	-	-
TOTAL		615.7	622.7	634.1	643.0	637.5	637.3	616.8

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

Table 4: Green House Gas Emissions (CO_2, N_2O, CH_4) - thousand tonnes CO_2 equivalents

	NACE Rev 1	1994	1995	1996	1997	1998	1999	2000
AGRICULTURE, FORESTRY, FISHING	1,2,5	13,785.2	13,896.1	13,955.4	13,939.6	14,318.7	14,305.7	13,243.1
FUEL,POWER,WATER	40-41	1,241.4	1,292.8	1,441.4	1,410.9	1,403.9	1,384.0	1,416.8
Coal, peat, petroleum,metal ores, quarrying	10-14	509.0	682.2	770.8	788.3	840.2	875.2	906.0
Food, beverages, tobacco	15-16	2,099.6	2,260.4	2,300.8	2,420.9	2,474.1	2,501.9	2,666.5
Textiles Clothing Leather & Footwear	17-19	300.3	317.7	332.6	388.7	391.6	400.0	399.3
Wood & wood products	20	160.1	198.7	220.2	221.0	209.0	216.1	213.9
Pulp, paper & print production	21-22	149.5	161.0	162.7	145.2	143.8	148.7	145.5
Chemical production	24	3,216.1	3,073.7	2,979.0	3,244.0	3,250.7	3,172.3	3,177.7
Rubber & plastic production	25	187.8	193.7	190.7	265.8	275.1	281.8	277.1
Non-metallic mineral production	26	1,969.4	2,059.7	2,113.7	2,297.6	2,280.0	2,356.9	3,003.0
Metal prod. excl. machinery & transport equip.	27-28	773.4	771.2	795.9	876.0	933.5	918.3	899.4
Agriculture & industrial machinery	29	619.7	705.2	702.3	720.8	747.2	771.1	773.7
Office and data process machines	30	140.4	146.6	81.0	109.8	121.7	132.4	133.7
Electrical goods	31-33	280.4	313.2	376.1	532.7	538.7	561.4	555.0
Transport equipment	34-35	63.8	75.7	67.2	73.6	75.8	77.2	74.9
Other manufacturing	36-37,23	247.8	228.2	213.9	227.9	285.5	381.0	358.6
Construction	45	25.8	34.4	37.8	42.9	45.3	46.5	46.6
INDUSTRY excl Fuel, Power, Water		10,743.1	11,221.7	11,344.7	12,355.2	12,612.3	12,840.8	13,630.8
TRANSPORT*		6,287.7	6,697.1	7,492.7	8,389.1	9,627.9	10,847.8	11,442.5
SERVICES excl Transport		7,991.6	7,960.2	8,140.1	8,407.1	8,474.4	9,154.5	9,533.6
RESIDENTIAL		10,078.0	9,958.0	9,956.3	10,217.6	10,378.5	10,195.5	10,404.6
Sub-TOTAL		50,127.1	51,025.9	52,330.6	54,719.6	56,815.7	58,728.3	59,671.4
Not attributed to any sector		189.6	182.5	180.7	200.9	195.6	207.4	263.8
TOTAL		50,316.7	51,208.4	52,511.3	54,920.5	57,011.3	58,935.7	59,935.2

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

Table 5: SO_2 Emissions - thousand tonnes

	NACE Rev 1	1994	1995	1996	1997	1998	1999	2000
AGRICULTURE, FORESTRY, FISHING	1,2,5	4.6	3.8	3.3	3.7	4.1	3.5	2.9
FUEL,POWER,WATER	40-41	8.7	8.3	7.7	8.4	9.0	7.9	6.3
Coal, peat, petroleum,metal ores, quarrying	10-14	2.4	3.0	3.4	3.7	4.3	4.1	3.4
Food, beverages, tobacco	15-16	11.8	11.6	10.9	12.9	14.5	13.4	10.8
Textiles Clothing Leather & Footwear	17-19	2.0	2.0	1.8	2.2	2.4	2.2	1.7
Wood & wood products	20	1.0	1.1	1.1	1.3	1.4	1.3	1.0
Pulp, paper & print production	21-22	1.0	1.0	0.9	0.9	1.0	0.9	0.7
Chemical production	24	6.8	6.1	5.2	6.1	6.8	6.4	5.1
Rubber & plastic production	25	1.4	1.3	1.1	1.7	1.9	1.8	1.4
Non-metallic mineral production	26	3.7	3.6	3.5	4.0	4.5	4.0	3.4
Metal prod. excl. machinery & transport equip.	27-28	6.3	5.9	5.8	7.8	9.0	7.8	7.7
Agriculture & industrial machinery	29	4.3	4.5	3.7	4.3	4.8	4.4	3.4
Office and data process machines	30	1.0	1.0	0.4	0.6	0.7	0.6	0.5
Electrical goods	31-33	2.1	2.2	2.3	3.4	3.6	3.4	2.7
Transport equipment	34-35	0.5	0.5	0.4	0.5	0.6	0.5	0.4
Other manufacturing	36-37,23	0.8	0.7	0.6	0.9	1.0	0.9	0.7
Construction	45	0.2	0.2	0.2	0.3	0.3	0.3	0.2
INDUSTRY excl Fuel, Power, Water		45.3	44.8	41.3	50.5	56.7	52.1	43.0
TRANSPORT*		7.2	7.4	8.0	8.9	10.1	3.2	3.2
SERVICES excl Transport		33.9	31.7	28.4	32.9	35.7	35.9	30.7
RESIDENTIAL		46.7	43.6	40.0	44.3	46.4	42.4	35.9
Sub-TOTAL		146.4	139.6	128.8	148.7	162.1	145.0	122.1
Not attributed to any sector		28.7	21.6	18.6	17.4	14.0	12.3	9.4
TOTAL		175.1	161.2	147.4	166.1	176.1	157.4	131.5

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

Table 6: NO_x Emissions - thousand tonnes

	NACE Rev 1	1994	1995	1996	1997	1998	1999	2000
AGRICULTURE, FORESTRY, FISHING	1,2,5	6.2	5.8	5.8	5.7	5.7	6.3	6.8
FUEL,POWER,WATER	40-41	4.1	3.7	4.0	3.5	3.4	3.1	3.2
Coal, peat, petroleum,metal ores, quarrying	10-14	1.2	1.6	1.8	1.7	1.7	1.8	2.1
Food, beverages, tobacco	15-16	6.3	6.4	6.3	6.1	6.1	5.9	6.3
Textiles Clothing Leather & Footwear	17-19	1.0	1.0	1.0	1.1	1.0	1.0	1.0
Wood & wood products	20	0.6	0.7	0.7	0.6	0.5	0.5	0.5
Pulp, paper & print production	21-22	0.5	0.5	0.5	0.4	0.3	0.3	0.3
Chemical production	24	4.1	3.7	3.4	3.3	3.2	3.1	3.3
Rubber & plastic production	25	0.6	0.6	0.5	0.7	0.7	0.6	0.7
Non-metallic mineral production	26	2.9	3.1	3.3	3.2	3.1	2.8	3.3
Metal prod. excl. machinery & transport equip.	27-28	2.4	2.1	2.2	2.2	2.3	2.1	2.2
Agriculture & industrial machinery	29	2.1	2.1	2.1	1.9	1.9	1.8	1.9
Office and data process machines	30	0.5	0.4	0.2	0.3	0.3	0.3	0.3
Electrical goods	31-33	0.9	0.9	1.1	1.4	1.3	1.3	1.3
Transport equipment	34-35	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Other manufacturing	36-37,23	0.6	0.5	0.5	0.5	0.6	0.7	0.7
Construction	45	0.1	0.1	0.1	0.1	0.1	0.1	0.1
INDUSTRY excl Fuel, Power, Water		24.0	23.9	23.8	23.6	23.3	22.7	24.3
TRANSPORT*		48.7	52.5	57.0	57.5	61.4	58.9	60.9
SERVICES excl Transport		12.9	11.8	12.1	11.8	11.9	12.5	13.4
RESIDENTIAL		19.4	17.7	17.3	16.3	16.1	15.9	16.4
Sub-TOTAL		115.4	115.3	120.0	118.4	121.8	119.2	125.1
Not attributed to any sector		-	-	-	-	-	-	-
TOTAL		115.4	115.3	120.0	118.4	121.8	119.2	125.1

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

Table 7: NH_3 Emissions - thousand tonnes

	NACE Rev 1	1994	1995	1996	1997	1998	1999	2000
AGRICULTURE, FORESTRY, FISHING	1,2,5	118.2	119.2	121.4	122.6	125.5	125.6	120.7
FUEL,POWER,WATER	40-41	-	-	-	-	-	-	-
Coal, peat, petroleum,metal ores, quarrying	10-14	-	-	-	-	-	-	0.0
Food, beverages, 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
TRANSPORT*		0.4	0.4	0.6	0.8	1.0	1.4	1.8
SERVICES excl Transport		-	-	-	-	-	-	-
RESIDENTIAL		-	-	-	-	-	-	-
Sub-TOTAL		118.7	119.7	121.9	123.4	126.6	127.0	122.4
Not attributed to any sector		-	-	-	-	-	-	-
TOTAL		118.7	119.7	121.9	123.4	126.6	127.0	122.4

* Includes both the Transport Sector and 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	1994	1995	1996	1997	1998	1999	2000
AGRICULTURE, FORESTRY, FISHING	1,2,5	231.5	232.3	235.8	238.5	244.3	244.3	234.8
FUEL,POWER,WATER	40-41	11.6	10.9	10.5	10.8	11.4	10.1	8.5
Coal, peat, petroleum,metal ores, quarrying	10-14	3.2	4.1	4.6	4.8	5.5	5.4	4.9
Food, beverages, tobacco	15-16	16.2	16.0	15.3	17.1	18.7	17.5	15.2
Textiles Clothing Leather & Footwear	17-19	2.7	2.6	2.5	3.0	3.1	2.9	2.4
Wood & wood products	20	1.4	1.5	1.6	1.7	1.8	1.7	1.4
Pulp, paper & print production	21-22	1.4	1.4	1.2	1.1	1.2	1.1	0.9
Chemical production	24	9.7	8.7	7.6	8.4	9.0	8.6	7.4
Rubber & plastic production	25	1.8	1.7	1.5	2.2	2.4	2.2	1.8
Non-metallic mineral production	26	5.7	5.8	5.8	6.2	6.6	6.0	5.7
Metal prod. excl. machinery & transport equip.	27-28	8.0	7.4	7.3	9.3	10.6	9.3	9.2
Agriculture & industrial machinery	29	5.8	6.0	5.2	5.6	6.1	5.7	4.7
Office and data process machines	30	1.3	1.3	0.6	0.8	0.9	0.8	0.7
Electrical goods	31-33	2.7	2.9	3.0	4.4	4.6	4.3	3.6
Transport equipment	34-35	0.6	0.7	0.5	0.6	0.7	0.6	0.5
Other manufacturing	36-37,23	1.2	1.0	0.9	1.2	1.4	1.4	1.2
Construction	45	0.2	0.3	0.3	0.3	0.4	0.3	0.3
INDUSTRY excl Fuel, Power, Water		62.0	61.4	57.9	66.9	72.9	67.9	59.9
TRANSPORT*		41.9	44.7	48.8	50.4	54.8	46.8	48.9
SERVICES excl Transport		42.8	39.9	36.8	41.1	44.0	44.6	40.1
RESIDENTIAL		60.2	55.9	52.0	55.7	57.6	53.5	47.3
Sub-TOTAL		450.0	445.1	441.8	463.4	485.0	467.0	439.6
Not attributed to any sector		28.7	21.6	18.6	17.4	14.0	12.3	9.4
TOTAL		478.7	466.7	460.4	480.8	499.0	479.4	449.0

* Includes both the Transport Sector and 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		108.350	0.330	0.200	0.050
Milled Peat	0.186		108.350	0.330	0.200	0.050
Sod Peat	0.313		108.350	0.300	0.100	0.050
Coal	0.665		90.139	0.575	0.050	0.100
Gas/Diesel Oil	1.034	0.869	73.247	0.090	0.100	
Kerosene	1.056	0.845	71.342	0.045	0.100	0.005
Residual Fuel Oil	0.985		75.959	1.260	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, Department of Communications, Marine and Natural Resources

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