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COMPILATION OF SATELLITE ENVIRONMENT ACCOUNTS

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Introduction

This working paper describes in more detail the work involved in constructing the *Pilot Environmental Accounts,* published by the CSO (1999). That publication was the result of a project commissioned by the CSO (1997) to compile a set of so-called satellite environmental accounts for the Irish economy.

The first three sections of this paper cover in turn emissions to air, discharges to water and solid waste disposal to land. Section 4 deals with depletion of resources. Section 5 combines some of the foregoing data into what are called environmental themes. The compilation of themes is tentative at this stage. The four most promising themes given the availability of data are Global Warming Potential, Acid Rain Precursors, Eutrophication Potential and Solid Waste Arising. The theme Eutrophication Potential is derived differently in the published report. The best method for calculating such a theme is uncertain and a different derivation is shown here, as a record of another approach.

The aim of the Satellite Environmental Accounts is to complement publications of the CSO that give the contribution of various economic sectors to national product. The term *satellite* is used to indicate that these accounts accompany and relate to the national accounts. In particular these satellite accounts show the link between sectors and their effects on the environment. The sectors used in this report were selected by CSO and are based on the NACE70 (and NACE/CLIO) classification system used in the Input-Output Tables for 1990 and those for 1993 (CSO, 1996 and 1999). It was decided that the study should refer to the year 1994, which is a year of good coverage by economic data, it being the year of a recent Census of Industrial Production, Household Budget Inquiry, Road Freight Transport Survey and also of comprehensive data on emissions to air.

The correct attribution of emissions to various sectors is frequently uncertain. This is not merely an issue of imprecise data, but also a fundamental question of distinguishing cause and effect. One could debate as to who or what sector causes emissions to occur - for example is it the purchaser who requires the supplier to transport goods long distances, or the supplier who adds heavy packaging? Except in two cases in this report, the approach has been to consider the final emitter to the environment to be the source of the emissions. So, in the cases of fuel use, of discharges to water, or of solid waste disposal, emissions are attributed respectively to the sector with the combustion machinery, the sector emitting directly to waters or the final sector producing waste for disposal. Exceptions to this system of allocation occur in the versions (versions b) in which electricity emissions are attributed to the sectors which use electricity - these being the sectors that turn on the electric switches and that can be considered as the "cause" - and in the versions in which transport fuels are attributed to users of transport or transport services (versions c).

While the information given here refers to emissions, it is important to stress at the outset the distinction between emissions and pollution. They are not synonymous. Pollution, by which is meant harmful concentrations and damage, may or may not result from emissions. It depends on the state of the receiving medium, which may or may not be able to absorb emissions without damage occurring. However information on emissions *per se* is useful, as it provides at least one side of the picture. It is also

particularly necessary to have such information available at a time of strong economic growth, and to make explicit the link to economic activities.

1. Emissions to air

a. Broken down by sector

A major source of emissions to air is fuel use. According to data supplied by McGettigan (1996) to the UNECE, combustion of fuels accounts for virtually all the CO_2, NOx and SO_2 emissions, for example. Therefore to derive sectoral emissions it has been necessary to break down fuel use by sector, as shown in Table 1.a.1. The procedure for breaking down fuel use in this manner is described in Appendix A1.a. The table shows total primary energy use in 1994 to have been just under 10.5 million tonnes of oil equivalent (TOE).

In this version use of electricity does not appear in the table, only the use of fuels by generation. With electricity it is at the stage of generation that emissions occur though, as described in the introduction, electricity use is given in later versions. In the case of transport fuels, fuels used are all attributed to the Transport sector, which includes all use of transport, be it private, business or by means of transport services, such as taxis or hauliers.

Emissions of CO_2 from these uses of fuels are calculated by means of the emission factors supplied by McGettigan (1997), given in Appendix A2. To these emissions must be added those arising from activities other than energy combustion. Examples of such sources would include the manufacture of fertiliser and cement and lime and the absorption of CO_2 by trees. The last is an example of a negative source or "sequestration". On this point it should be borne in mind that there is some uncertainty, particularly as to the levels of net sequestration by forests on peaty soils. In future a new convention will be used, that only the changes in afforestation since 1990 will be considered, measured in terms of the change in stock of wood. The reason for this is that a constant stock of wood does not sequester in the long run, because when the trees decay they emit the CO_2 back into the atmosphere. In the meantime, in keeping with McGettigan (1996), the old convention which counts all sequestration is used in this paper.

Table 1.a.2 gives CO_2 arising from all sources combined, that is from energy combustion and from non-energy sources. The right-hand side column, Total CO_2, shows the prominence of the power sector, followed by the Transport sector, and then Industry. The Agriculture, Forestry and Fishing sector sequesters nearly as much CO_2 as industry emits.

Table 1.a.3 shows emissions of CO_2 (taken from the column of Total CO_2 from the previous table), as well as CH_4 and N_2O. Figures for the last two were derived from McGettigan (1996) and further broken down with the help of our detailed disaggregation of fuel use. (McGettigan's sources are described briefly at the end of Appendix A3.) Whereas our CO_2 emissions were estimated from our table of energy use, the other air emissions in this study are more process specific. Their sub-totals were taken from McGettigan and the breakdowns for sub-sectors were then carried out according to our figures on energy use. These three gases combined make up the bulk of Greenhouse Gases which contribute to global warming. Other emissions for inclusion, agreed at Kyoto, are SF6, PFC and HFCs and these can be added when data become available. The compilation of environmental themes, of which global

Table 1.a.1: Consumption of fuels in TOE, derived from the Census of Industrial Production, using "Energy in Ireland" control totals (dark figures), 1994

SECTOR	NACE-CLIO R25	SOLID FUELS	O GAS/DIES OIL	RFO	Transport oils: PETROL	AUTODIESEL	Veh LPG	GAS	Oth incl o lpg + renewables	TOTAL FUEL	SECTOR
AGRI,FOR,FISH	01	0	259,000	0	0	0	0	0	0	259,000	**AGRI,FOR,FISH 01**
Coal/lig/peat		22,000	2,143	170				0	0	24,313	Coal/lig/peat
Petrol prod/lpg		0	30,057	7,407				4,153	0	41,618	Petrol prod/lpg
Electricity		2,067,000	23,000	637,000				1,007,000	80,000	3,814,000	Electricity
Gas		0	15,234	0				6,793	901	22,929	Gas
Water		0	9,565	1,422				10,054	3,099	24,140	Water
Elec/gas/water		2,087,791	47,800	638,422				1,023,847	84,000	3,881,861	Elec/gas/water
FUEL,POWER,WATER	06	2,089,000	80,000	646,000	0	0	0	1,028,000	84,000	3,927,000	**FUEL,POWER,WATER 06**
Metals and ores	13	94	1,616	438				5,695	1,898	9,742	Metals and ores 13
Non-met min prod	15	52,954	33,066	22,547				19,007	14,384	141,958	Non-met min prod 15
Chemical prod.	17	52	17,253	290,898				171,165	16,197	495,564	Chemical prod. 17
Metal prod excl mc & tr	19	5,592	6,045	5,173				3,268	4,453	24,531	Metal prod excl mc & tr 19
Agr & industr mc	21	2,396	3,378	4,106				1,930	2,164	13,974	Agr & industr mc 21
ODP mc & prec inst	23	828	3,102	16,062				8,972	29,834	58,799	ODP mc & prec inst 23
Electrical goods	25	1,145	2,803	10,265				3,289	6,832	24,334	Electrical goods 25
Transport equipm	28	222	1,846	4,367				3,735	2,443	12,613	Transport equipm 28
Food bev tobac	36	44,918	50,651	123,495				72,846	23,243	315,153	Food bev tobac 36
Textiles cl l & footw	42	7,834	6,395	20,071				2,084	2,828	39,211	Textiles cl l & footw 42
Paper & print prod	47	1,398	3,045	10,457				6,668	2,337	23,905	Paper & print prod 47
Rubber & plastic pr	49	2,425	3,560	12,506				3,946	4,287	26,724	Rubber & plastic pr 49
O. Manufact prod	48	5,132	2,192	4,615				1,393	766	14,099	O. Manufact prod 48
Construction	53	10	80,048						8,334	88,392	Construction 53
INDUSTRY excl FPW	Tot	125,000	215,000	525,000	0	0	0	304,000	120,000	1,289,000	**INDUSTRY**
TRANSPORT inc own acc	61+63+65	0	410,000	25,000	1,049,000	854,000	8,000	0	0	2,346,000	**TRANSPORT**
SERVICES mkt	55,59,67, 69,74	0	445,925	18,000				74,000	14,000	551,925	SERVICES mkt
SERVICES non-mkt (govt)	86	12,000	135,075	166,000				95,000	3,000	411,075	SERVICES non-mkt (govt)
TOT SERVICES excl transp	56,59,67, 74,86	12,000	581,000	184,000	0	0	0	169,000	17,000	963,000	**TOT SERVICES excl transp**
RESIDENTIAL		920,000	444,000	0	0	0	0	239,000	111,000	1,714,000	**RESIDENTIAL**
TOTAL final energy (excl FPW)		1,057,000	1,909,000	734,000	1,049,000	854,000	8,000	712,000	248,000	6,571,000	**TOTAL final (excl FPW)**
TOTAL primary energy		3,146,000	1,989,000	1,380,000	1,049,000	854,000	8,000	1,740,000	332,000	10,498,000	**TOTAL primary energy**
Add fertiliser feedstock to Chems								459,000			Add fertilisers' feedstock to Chemicals

SECTOR	NACE-CLIO R25	SOLID FUELS	O GAS/DIES OIL	RFO	Transport oils: PETROL	AUTODIES	LPG for veh	GAS	Oth incl o lpg + renewables	TOTAL FUEL	SECTOR

Notes:

FPW is Fuel Power and Water. All transport fuels are allocated to the TRANSPORT row in this table.

This sheet excludes an Electricity column because the emissions from electricity are produced by the inputs at generation, i.e. via the electricity row above.

In the Transport row, the 410,000 TOE under Other Gas/diesel is Aviation kerosene, and the 25,000 TOE under RFO is Marine fuel.

See Appendix A1.a for a description of the derivation of this table

Table 1.a.2: Estimated emissions of CO2 from energy combustion and from non-energy sources, 1994, tonnes

SECTOR	NACE-CLIO R25	SOLID FUELS	O GAS/DIES OIL	RFO	Transport oils: PETROL	AUTODIESEL	Veh LPG	GAS	Oth incl o lpg + renewables	TOTAL CO2 from Energy	TOTAL CO2 from non-energy sources	TOTAL CO2
AGRI,FOR,FISH	01	0	792,540	0				0	0	792,540	-5,620,000	-4,827,460
Coal/lig/peat		86,658	6,558	541				0	0	93,757		93,757
Petrol prod/lpg		0	91,975	23,556				9,552	0	125,082		125,082
Electricity		8,141,913	70,380	2,025,660				2,316,100	0	12,554,053		12,554,053
Gas		0	46,617	0				15,624	1,203	63,445		63,445
Water		0	29,270	4,523				23,124	4,137	61,054		61,054
Elec/gas/water		8,141,913	146,267	2,030,183				2,354,848	5,340	12,678,552		12,678,552
FUEL,POWER,WATER	06	8,228,571	244,800	2,054,280				2,364,400	5,340	12,897,391		12,897,391
Metals and ores	13	337	4,946	1,394				13,099	2,534	22,310		22,310
Non-met min prod	15	189,894	101,181	71,700				43,716	19,203	425,694	1,125,000	1,550,694
Chemical prod.	17	185	52,794	925,054				393,679	21,623	1,393,336	702,000	2,095,336
Metal prod excl mc & tr	19	20,053	18,498	16,450				7,516	5,945	68,462		68,462
Agr & industr mc	21	8,592	10,336	13,058				4,439	2,889	39,315		39,315
ODP mc & prec inst	23	2,970	9,492	51,078				20,637	39,829	124,005		124,005
Electrical goods	25	4,104	8,579	32,642				7,566	9,121	62,011		62,011
Transport equipm	28	798	5,648	13,886				8,592	3,261	32,185		32,185
Food bev tobac	36	161,076	154,992	392,714				167,547	31,029	907,358		907,358
Textiles cl l & footw	42	28,091	19,568	63,826				4,793	3,775	120,053		120,053
Paper & print prod	47	5,013	9,317	33,252				15,338	3,119	66,040		66,040
Rubber & plastic pr	49	8,696	10,893	39,769				9,076	5,723	74,158		74,158
O. Manufact prod	48	18,404	6,708	14,676				3,204	1,023	44,015		44,015
Construction	53	36	244,947							244,983		244,983
INDUSTRY excl FPW	Tot	448,250	657,899	1,669,500				699,200	149,074	3,623,923	1,827,000	5,450,923
TRANSPORT inc own acc	61+63+65	0	1,221,800	79,500	3,063,080	2,613,240	21,360	0	0	6,998,980		6,998,980
SERVICES mkt	56,59,67, 69,74	0	1,364,531	57,240				170,200	24,297	1,616,268		1,616,268
SERVICES non-mkt (govt)	86	49,968	413,330	527,880				218,500	5,207	1,214,884	54,000	1,268,884
TOT SERVICES excl transp	56,59,67, 74,86	49,968	1,777,860	585,120				388,700	29,504	2,831,152	54,000	2,885,152
RESIDENTIAL		3,737,040	1,358,640	0				549,700	192,641	5,838,021		5,838,021
TOTAL final energy (excl FPW)		4,235,258	5,808,739	2,334,120	3,063,080	2,613,240	21,360	1,637,600	371,218	20,084,615	-3,739,000	16,345,615
TOTAL primary energy		12,463,829	6,053,539	4,388,400	3,063,080	2,613,240	21,360	4,002,000	376,558	32,982,006	-3,739,000	29,243,006

SECTOR	NACE-CLIO R25	SOLID FUELS	O GAS/DIES OIL	RFO	Transport oils: PETROL	AUTODIES	LPG for veh	GAS	Oth incl o lpg + renewables	TOTAL CO2 from Energy	TOTAL CO2 from non-energy sources	TOTAL CO2

Notes:"Energy" means combustion of energy. Conniffe et al. (1997) is based on 32.7 kt CO2 from Energy. Emissions from fertilisers' feedstock are included in the column "TOTAL CO2 from non-energy sources", which is taken from McGettigan (1997).
Figures in brackets are negatives.

Table 1.a.3: Estimated emissions of CH4, N2O and CO2 and global warming potential, tonnes, 1994

Emissions by electricity generation and transport not attributed to users (i.e. version a.)

SECTOR	NACE-CLIO R25	TOTAL CH4	TOTAL N2O	TOTAL CO2	GWP100	SECTOR
AGRI,FOR,FISH	01	656,457	20,042	-4,827,460	15,171,157	AGRI,FOR,FISH 01
Coal/lig/peat		2	1	93,757	94,109	Coal/lig/peat
Petrol prod/lpg			14	125,082	129,422	Petrol prod/lpg
Electricity			1,633	12,554,053	13,060,283	Electricity
Gas		10,680		63,445	287,725	Gas
Water				61,054	61,054	Water
Elec/gas/water		10,680	1,633	12,678,552	13,409,062	Elec/gas/water
FUEL,POWER,WATER	06	10,682	1,648	12,897,391	13,632,593	FUEL,POWER,WATER 06
Metals and ores	13	0	3	22,310	23,204	Metals and ores 13
Non-met min prod	15	54	42	1,550,694	1,564,840	Non-met min prod 15
Chemical prod.	17	0	2,766	2,095,336	2,952,797	Chemical prod. 17
Metal prod excl mc & tr	19	6	7	68,462	70,830	Metal prod excl mc & tr 19
Agr & industr mc	21	2	4	39,315	40,647	Agr & industr mc 21
ODP mc & prec inst	23	1	17	124,005	129,411	ODP mc & prec inst 23
Electrical goods	25	1	7	62,011	64,266	Electrical goods 25
Transport equipm	28	0	4	32,185	33,345	Transport equipm 28
Food bev tobac	36	46	93	907,358	937,201	Food bev tobac 36
Textiles cl l & footw	42	8	12	120,053	123,815	Textiles cl l & footw 42
Paper & print prod	47	1	7	66,040	68,260	Paper & print prod 47
Rubber & plastic pr	49	2	8	74,158	76,659	Rubber & plastic pr 49
O. Manufact prod	48	5	4	44,015	45,417	O. Manufact prod 48
Construction	53	0	26	244,983	253,082	Construction 53
INDUSTRY excl FPW	Tot	128	3,001	5,450,923	6,383,773	INDUSTRY
TRANSPORT Inc own acc	61+63+65	1,247	461	6,998,980	7,168,077	TRANSPORT
SERVICES mkt	56,59,67, 69,74	0	172	1,616,268	1,669,588	SERVICES mkt
SERVICES non-mkt (govt)	86	136,214	166	1,268,884	4,180,838	SERVICES non-mkt (govt)
TOT SERVICES excl transp	56,59,67, 69,74,86	136,214	338	2,885,152	5,850,426	TOT SERVICES excl transp
RESIDENTIAL		2,461	494	5,838,021	6,042,842	RESIDENTIAL
TOTAL (excl FPW)		796,507	24,336	16,345,615	40,616,274	TOTAL (excl FPW)
TOTAL		807,189	25,984	29,243,006	54,248,867	TOTAL

SECTOR	NACE-CLIO R25	TOTAL CH4	TOTAL N2O	TOTAL CO2	GWP100	SECTOR

Notes: CH4 from Agriculture consists of combustion 36 tonnes, machines 19 tonnes and land use and woodstock change 656,402 tonnes. From Transport the emissions are Road 1227 tonnes, Rail 13 tonnes and Inland water 7 tonnes (McGettigan, 1997).

N2O from Agriculture consists of combustion 71tonnes, machines 112 tonnes, land use and woodstock change 19,859 tonnes. Transport consists of passenger cars 238 tonnes, commercial vehicles 105 tonnes, rail 75 tonnes, inland water 43 tonnes.

Global Warming is expressed as Global Warming Potential with a 100 year time horizon (GWP100). Global warming potential is expressed in CO2 equivalents, for which CH4, N2O and CO2 are multiplied by 21, 310 and 1 respectively.

warming is one, is discussed later in section 5. However this table includes a column on the right hand side for the theme global warming potential, GWP100, so that its derivation can be seen easily.

Table 1.a.4 gives figures on emissions of SO_2, NOx and NH_3. The derivation of these figures is described in Appendix A3. As these three emissions can contribute to acid rain, the compilation of the environmental theme called Acid Rain Precursors is given in the final column of this table. It will be discussed in section 5.

b. With emissions from electricity generation attributed to users of electricity

Fuel use shown in Table 1.b.1 has the same total primary energy use, in the right-hand column, of just under 10.5 million TOE as before. However fuel use is now entered as zero in the Electricity row, which previously totalled 3.814 million TOE. A new column for electricity, with the same total of 3.814 million TOE, attributes the fuels used for electricity generation to electricity users.

Corresponding emissions of CH_4, N_2O and CO_2 are shown in Table 1.b.2. With emissions from electricity generation now attributed to users, there is a predictable rise (compared with Table 1.a.3) in CO_2 emissions emanating, for example, from Industry (particularly from Food and Chemicals) and the Residential sector. The rise is spread roughly equally between the two sectors Industry and Residential.

Corresponding emissions of SO_2, NOx and NH_3 are shown in Table 1.b.3. As most SO_2 emanates from electricity generation, this table shows large rises from large electricity users, compared with figures in Table 1.a.4.

c. With emissions from transport attributed to users of transport and transport services

As with electricity above, a similar exercise is undertaken here in Table 1.c.1 but reallocating transport fuels. Appendix A1.c describes the methods used to attribute transport fuels to users, shown in detail in Appendix Table A1.c.12. The construction of this table presented many difficulties. With numerous sources of information, if there is better linking between them, the task of future updates ought to become simpler. Fuel use by transport services was also attributed to users of the services, on the grounds that whether or not one owns a lorry or employs a freight company, for example, the fuel use would be broadly similar. Fuels in the Transport row in Table 1.a.1 which summed to 2,346,000 TOE (and excluded electricity use by the DART) are now entered as zeros. The sum now appears at the foot of the right-hand side column of total transport fuels in Appendix Table A1.c.12, as 2,352,320 TOE (which equals 2,346,000 plus electricity use of 6,320).

A bigger exercise was entailed here compared with the attribution of electricity to users. The difference is that in the case of electricity, adjustment to the emissions rather than to the energy figures was sufficient, since emissions incurred by electricity generation can be assumed to be homogeneous and unaffected by the nature of use or user. In the case of energy used by the Transport sector however, there is a difference

Table 1.a.4: Estimated emissions of SO2, NOx and NH3 and Acid Rain Precursors theme, tonnes, 1994
Emissions by Transport and Electricity generation not attributed to users (i.e. version a.)

SECTOR	NACE-CLIO R25	SO2	NOx	NH3	Acid rain precursors*
AGRI,FOR,FISH	01	1,517	4,638	123,147	236,556
Coal/lig/peat		0	0		0
Petrol prod/lpg		535	308		749
Electricity		95,540	45,116		126,927
Gas		0	69		48
Water		0	0		0
Elec/gas/water		95,540	45,185		126,975
FUEL,POWER,WATER	06	96,075	45,493	0	127,724
Metals and ores	13	40	41		69
Non-met min prod	15	3,611	1,961		4,975
Chemical prod.	17	18,829	3,183		21,044
Metal prod excl mc & tr	19	575	249		748
Agr & industr mc	21	372	126		460
ODP mc & prec inst	23	1,082	255		1,259
Electrical goods	25	719	147		821
Transport equipm	28	299	66		346
Food bev tobac	36	9,904	2,765		11,828
Textiles cl l & footw	42	1,620	414		1,908
Paper & print prod	47	742	161		854
Rubber & plastic pr	49	915	201		1,055
O. Manufact prod	48	501	200		640
Construction	53	422	354		668
INDUSTRY excl FPW	Tot	39,632	10,125	0	46,676
TRANSPORT inc own acc	61+63+65	8,421	49,458	288	43,371
SERVICES mkt	56,59,67 69,74	8,661	1,636		9,799
SERVICES non-mkt (govt)	86	4,599	988		5,286
TOT SERVICES excl transp	56,59,67 69,74,86	13,260	2,624	0	15,086
RESIDENTIAL		17,680	5,033	0	21,181
TOTAL (excl FPW)		80,510	71,878	123,435	362,870
TOTAL		176,585	117,371	123,435	490,594

SECTOR	NACE-CLIO R25	SO2	NOx	NH3	Acid rain precursors*

Notes: Emissions are derived from McGettigan (1996), and breakdowns are made pro rata his figures for emissions by fuel (26.5.1998).

* Acid rain precursors are a weighted measure expressed in terms of tonnes of SO2 equivalents (tSO2).

The weights used to aggregate SO2, NOx and NH3 were 1, 0.6957 and 1.8824 respectively, as used by Vaze and Balchin (1996).

Table 1.b.1: Consumption of fuels in TOE, with inputs to electricity generation attributed to electricity purchasers, 1994

SECTOR	NACE-CLIO R25	SOLID FUELS	O GAS/DIES OIL	RFO	Transport oils: PETROL	AUTODIESEL	Veh LPG	GAS	Oth incl o lpg + renewables	(Input equiv) ELECTRICITY	TOTAL	SECTOR
AGRI,FOR,FISH	01	0	259,000	0	0	0	0	0	0	132,716	391,716	AGRI,FOR,FISH
Coal/lig/peat		22,000	2,143	170				0	0	1,002	25,315	Coal/lig/peat
Petrol prod/lpg		0	30,057	7,407				4,153	0	4,610	46,228	Petrol prod/lpg
Electricity		0	0	0				0	0	0	0	Electricity
Gas		0	15,234	0				6,793	901	3,131	26,060	Gas
Water		0	9,565	1,422				10,054	3,099	42,393	66,534	Water
Elec/gas/water		0	24,800	1,422				16,847	901	45,525	89,495	Elec/gas/water
FUEL,POWER,WATER	06	22,000	57,000	9,000	0	0	0	21,000	4,000	51,137	164,137	FUEL,POWER,WATER
Metals and ores	13	94	1,616	438				5,695	1,898	75,184	84,926	Metals and ores
Non-met min prod	15	52,954	33,066	22,547				19,007	14,384	131,491	273,449	Non-met min prod
Chemical prod.	17	52	17,253	290,898				171,165	16,197	287,028	782,593	Chemical prod.
Metal prod excl mc & tr	19	5,592	6,045	5,173				3,268	4,453	44,797	69,328	Metal prod excl mc & tr
Agr & industr mc	21	2,396	3,378	4,106				1,930	2,164	23,985	37,959	Agr & industr mc
ODP mc & prec inst	23	828	3,102	16,062				8,972	29,834	81,676	140,475	ODP mc & prec inst
Electrical goods	25	1,145	2,803	10,265				3,289	6,832	86,409	110,743	Electrical goods
Transport equipm	28	222	1,846	4,367				3,735	2,443	20,738	33,351	Transport equipm
Food bev tobac	36	44,918	50,651	123,495				72,846	23,243	369,166	684,319	Food bev tobac
Textiles cl l & footw	42	7,834	6,395	20,071				2,084	2,828	73,435	112,646	Textiles cl l & footw
Paper & print prod	47	1,398	3,045	10,457				6,668	2,337	51,536	75,440	Paper & print prod
Rubber & plastic pr	49	2,425	3,560	12,506				3,946	4,287	84,534	111,258	Rubber & plastic pr
O. Manufact prod	48	5,132	2,192	4,615				1,393	766	58,206	72,305	O. Manufact prod
Construction	53	10	80,048						8,334	31,346	119,738	Construction
INDUSTRY excl FPW	Tot	125,000	215,000	525,000	0	0	0	304,000	120,000	1,419,532	2,708,531	INDUSTRY
TRANSPORT Inc own acc	61+63+65	0	410,000	25,000	1,049,000	854,000	8,000	0	0	6,320	2,352,320	TRANSPORT
SERVICES mkt	56,59,67, 69,74	0	384,000	18,000				74,000	14,000	669,899	1,159,899	SERVICES mkt
SERVICES non-mkt (govt)	86	12,000	197,000	166,000				95,000	3,000	223,038	696,038	SERVICES non-mkt (govt)
TOT SERVICES excl transp	56,59,67, 69,74,86	12,000	581,000	184,000	0	0	0	169,000	17,000	892,937	1,855,937	TOT SERVICES excl transp
RESIDENTIAL		920,000	444,000	0	0	0	0	239,000	111,000	1,311,359	3,025,359	RESIDENTIAL
TOTAL final energy (excl FPW)		1,057,000	1,909,000	734,000	1,049,000	854,000	8,000	712,000	248,000	3,762,863	10,333,863	TOTAL final energy (excl FPW)
TOTAL primary energy		1,079,000	1,966,000	743,000	1,049,000	854,000	8,000	733,000	252,000	3,814,000	10,498,000	TOTAL primary energy
Add Fertilisers' feedstock to Chemicals								459,000				Add Fertilisers' feedstock to Chemicals
SECTOR	NACE-CLIO R25	SOLID FUELS	O GAS/DIES OIL	RFO	Transport oils: PETROL	AUTODIES	Veh LPG	GAS	Oth incl o lpg + renewables	(Input equiv) ELECTRICITY	TOTAL	SECTOR

Notes:

Total primary energy still sums to the same total, but the energy used in generating electricity has been attributed to the sectors consuming the electricity.

Water does not include Waste Water and Sewage Treatment, which are included in Non-market Services. See Appendix for derivation of this table.

Table 1.b.2: Estimated emissions of CO2, N2O and CH4 (tonnes) with emissions from electricity generation allocated to consumers of electricity (i.e. version b.), 1994, and Global Warming Potential (GWP100).

SECTOR	NACE-CLIO R25	TOTAL CH4	TOTAL N2O	TOTAL CO2	GWP100	SECTOR
AGRI,FOR,FISH	**01**	**656,457**	**20,099**	**-4,390,616**	**15,625,616**	**AGRI,FOR,FISH**
Coal/lig/peat		2	1	97,054	97,539	Coal/lig/peat
Petrol prod/lpg		0	16	140,258	145,210	Petrol prod/lpg
Electricity		0	0	0	0	Electricity
Gas		10,680	1	73,752	298,448	Gas
Water		0	18	200,594	206,221	Water
Elec/gas/water		10,680	19	274,346	504,669	Elec/gas/water
FUEL,POWER,WATER	**06**	**10,682**	**37**	**511,658**	**747,417**	**FUEL,POWER,WATER**
Metals and ores	13	0	35	269,782	280,656	Metals and ores
Non-met min prod	15	54	98	1,983,506	2,015,105	Non-met min prod
Chemical prod.	17	0	2,889	3,040,111	3,935,669	Chemical prod.
Metal prod excl mc & tr	19	6	26	215,916	224,230	Metal prod excl mc & tr
Agr & industr mc	21	2	14	118,262	122,777	Agr & industr mc
ODP mc & prec inst	23	1	52	392,847	409,093	ODP mc & prec inst
Electrical goods	25	1	44	346,432	360,155	Electrical goods
Transport equipm	28	0	13	100,446	104,359	Transport equipm
Food bev tobac	36	46	251	2,122,495	2,201,337	Food bev tobac
Textiles cl l & footw	42	8	43	361,770	375,278	Textiles cl l & footw
Paper & print prod	47	1	29	235,673	244,734	Paper & print prod
Rubber & plastic pr	49	2	44	352,407	366,128	Rubber & plastic pr
O. Manufact prod	48	5	29	235,605	244,733	O. Manufact prod
Construction	53	0	40	348,161	360,421	Construction
INDUSTRY excl FPW	**Tot**	**128**	**3,608**	**10,123,413**	**11,244,676**	**INDUSTRY**
TRANSPORT inc own acc	**61+63+65**	**1,247**	**464**	**7,019,782**	**7,189,718**	**TRANSPORT**
SERVICES mkt	56,59,67, 69,74	0	459	3,821,288	3,963,523	SERVICES mkt
SERVICES non-mkt (govt)	86	136,214	261	2,003,031	4,944,589	SERVICES non-mkt (govt)
TOT SERVICES excl transp	**56,59,67, 69,74,86**	**136,214**	**720**	**5,824,318**	**8,908,112**	**TOT SERVICES excl transp**
RESIDENTIAL		2,461	1,055	10,154,451	10,533,328	**RESIDENTIAL**
TOTAL final energy (excl FPW)		**796,507**	**25,947**	**28,731,348**	**53,501,450**	**TOTAL (excl FPW)**
TOTAL primary energy		**807,189**	**25,984**	**29,243,006**	**54,248,867**	**TOTAL**

SECTOR	NACE-CLIO R25	TOTAL CH4	TOTAL N2O	TOTAL CO2	GWP100	SECTOR

Table 1.b.3: Estimated emissions of SO2, NOx and NH3, with emissions by electricity attributed to electricity consumers (i.e. version b), tonnes, and Acid Rain Precursors theme

SECTOR	NACE-CLIO R25	SO2	NOx	NH3	Acid rain precursors*
AGRI,FOR,FISH	01	4,842	6,208	123,147	240,972
Coal/lig/peat		25	12	0	33
Petrol prod/lpg		650	363	0	903
Electricity		0	0	0	0
Gas		78	106	0	152
Water		1,062	501	0	1,411
Elec/gas/water		1,140	608	0	1,563
FUEL,POWER,WATER	06	1,816	982	0	2,499
Metals and ores	13	1,924	930	0	2,571
Non-met min prod	15	6,905	3,517	0	9,351
Chemical prod.	17	26,019	6,578	0	30,596
Metal prod excl mc & tr	19	1,697	779	0	2,239
Agr & industr mc	21	973	410	0	1,258
ODP mc & prec inst	23	3,128	1,221	0	3,978
Electrical goods	25	2,883	1,169	0	3,697
Transport equipm	28	819	312	0	1,036
Food bev tobac	36	19,152	7,132	0	24,114
Textiles cl l & footw	42	3,460	1,283	0	4,352
Paper & print prod	47	2,033	771	0	2,569
Rubber & plastic pr	49	3,033	1,201	0	3,868
O. Manufact prod	48	1,959	888	0	2,577
Construction	53	1,207	725	0	1,711
INDUSTRY excl FPW	Tot	75,191	26,917	0	93,917
TRANSPORT inc own acc	61+63+65	8,579	49,533	288	43,581
SERVICES mkt	56,59,67, 69,74	25,442	9,560	0	32,093
SERVICES non-mkt (govt)	86	10,186	3,626	0	12,709
TOT SERVICES excl transp	56,59,67, 69,74,86	35,628	13,187	0	44,802
RESIDENTIAL		50,529	20,545	0	64,823
TOTAL primary energy		176,585	117,371	123,435	490,594

SECTOR	NACE-CLIO R25	SO2	NOx	NH3	Acid rain precursors*

Notes: Emissions from electricity production are entered as zero in the electricity row and are attributed to users of electricity.

Figures for emissions are derived from McGettigan (1996), and breakdowns are made pro rata his figures of emissions by fuel (McGettigan, personal communication, 26.5.1998).

* Acid rain precursors are a weighted measure expressed in terms of tonnes of SO2 equivalents (tSO2).

The weights used to aggregate SO2, NOx and NH3 were 1, 0.6957 and 1.8824 respectively, as used by Vaze and Balchin (1996).

Table 1.c.1: Consumption of fuels in TOE, with transport fuel use (in addition to electricity use) attributed to users (estimates)

SECTOR	NACE-CLIO R25	Solid fuels	O GAS oil	RFO	Transport fuels: PETROL	AUTODIESEL	Veh LPG	Kerosene air	RFO ships	(input equiv) Electricity	GAS	Oth incl o lpg + renewables	(Input equiv) ELECTRICITY	TOTAL	SECTOR
AGRI,FOR,FISH	**01**	**0**	**259,000**	**0**	**25,000**	**59,376**	**0**	**2,639**	**0**	**0**	**0**	**0**	**132,716**	**478,730**	**AGRI,FOR,FISH**
Coal/lig/peat		22,000	2,143	170	3	953	0	196	0	0	0	0	1,002	26,467	Coal/lig/peat
Petrol prod/lpg		0	30,057	7,407	184	1,361	0	706	0	0	4,153	0	4,610	48,479	Petrol prod/lpg
Electricity		0	0	0	6	119	1,426	0	0	0	0	0	0	1,551	Electricity
Gas		0	15,234	0	559	1,713	0	0	0	0	6,793	901	3,131	28,333	Gas
Water		0	9,565	1,422	145	584	32	0	0	0	10,054	3,099	42,393	67,294	Water
Elec/gas/water		0	24,800	1,422	710	2,416	1,458	0	0	0	16,847	901	45,525	94,079	Elec/gas/water
FUEL,POWER,WATER	**06**	**22,000**	**57,000**	**9,000**	**897**	**4,730**	**1,458**	**902**	**0**	**0**	**21,000**	**4,000**	**51,137**	**172,123**	**FUEL,POWER,WATER**
															0
Metals and ores	13	94	1,616	438	113	7,658	11	1,090	0	0	5,695	1,898	75,184	93,798	Metals and ores
Non-met min prod	15	52,954	33,066	22,547	848	41,955	210	2,184	0	0	19,007	14,384	131,491	318,646	Non-met min prod
Chemical prod.	17	52	17,253	290,898	1,989	19,870	24	21,628	0	0	171,165	16,197	287,028	826,103	Chemical prod.
Metal prod excl mc & tr	19	5,592	6,045	5,173	1,305	8,084	394	1,990	0	0	3,268	4,453	44,797	81,103	Metal prod excl mc & tr
Agr & industr mc	21	2,396	3,378	4,106	822	4,833	156	2,873	0	0	1,930	2,164	23,985	46,642	Agr & industr mc
ODP mc & prec inst	23	828	3,102	16,062	691	15,895	58	24,179	0	0	8,972	29,834	81,676	181,299	ODP mc & prec inst
Electrical goods	25	1,145	2,803	10,265	1,000	18,545	30	16,939	0	0	3,289	6,832	86,409	147,256	Electrical goods
Transport equipm	28	222	1,846	4,367	200	2,671	84	2,044	0	0	3,735	2,443	20,738	38,350	Transport equipm
Food bev tobac	36	44,918	50,651	123,495	2,891	81,097	363	31,228	0	0	72,846	23,243	369,166	799,898	Food bev tobac
Textiles cl l & footw	42	7,834	6,395	20,071	1,076	6,851	166	5,102	0	0	2,084	2,828	73,435	125,840	Textiles cl l & footw
Paper & print prod	47	1,398	3,045	10,457	3,127	11,859	257	2,364	0	0	6,668	2,337	51,536	93,047	Paper & print prod
Rubber & plastic pr	49	2,425	3,560	12,506	704	11,251	252	2,741	0	0	3,946	4,287	84,534	126,205	Rubber & plastic pr
O. Manufact prod	48	5,132	2,192	4,615	1,055	11,134	218	1,099	0	0	1,393	766	58,206	85,811	O. Manufact prod
Construction	53	10	80,048	0	2,000	22,557	100	0	0	0	0	8,334	31,346	144,395	Construction
INDUSTRY excl FPW	**Tot**	**125,000**	**215,000**	**525,000**	**17,820**	**264,259**	**2,323**	**115,460**	**0**	**0**	**304,000**	**120,000**	**1,419,532**	**3,108,393**	**INDUSTRY**
TRANSPORT inc own acc	**61+63+65**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**TRANSPORT**
SERVICES mkt	56,59,67, 69,74	0	384,000	18,000	133,631	160,123	200	31,000	0	0	74,000	14,000	669,899	1,484,853	SERVICES mkt
SERVICES non-mkt (govt)	86	12,000	197,000	166,000	14,790	83,808	0	30,000	0	0	95,000	3,000	223,038	824,636	SERVICES non-mkt (govt)
TOT SERVICES excl transp	**56,59,67, 69,74,86**	**12,000**	**581,000**	**184,000**	**148,421**	**243,931**	**200**	**61,000**	**0**	**0**	**169,000**	**17,000**	**892,937**	**2,309,489**	**TOT SERVICES excl transp**
RESIDENTIAL		**920,000**	**444,000**	**0**	**856,862**	**281,704**	**4,019**	**230,000**	**25,000**	**6,320**	**239,000**	**111,000**	**1,311,359**	**4,429,264**	**RESIDENTIAL**
TOTAL final energy (excl FPW)		1,057,000	1,499,000	709,000	1,048,103	849,270	6,542	409,098	25,000	6,320	712,000	248,000	3,756,544	10,325,877	TOTAL final energy (excl FPW)
TOTAL primary energy		**1,079,000**	**1,566,000**	**718,000**	**1,049,000**	**854,000**	**8,000**	**410,000**	**25,000**	**6,320**	**733,000**	**252,000**	**3,807,680**	**10,498,000**	**TOTAL primary energy**
Add Fertilisers' feedstock to Chemicals											459,000				Add Fertilisers' feedstock to Chemicals
SECTOR	**NACE-CLIO R25**	**Solid fuels**	**O GAS oil**	**RFO**	**Transport fuels: PETROL**	**AUTODIES**	**ERR**	**Kerosene air**	**RFO ships**	**(input equiv) Electricity**	**GAS**	**Oth incl o lpg + renewables**	**(Input equiv) ELECTRICITY**	**TOTAL**	**SECTOR**

Total primary energy still sums to the same total, but the energy used in generating electricity has been attributed to the sectors consuming the electricity. Transport fuels are also allocated to users.
Water does not include Waste Water and Sewage Treatment, which are included in Non-market Services. See Appendix for derivation of this table.

in fuels and in emission factors depending on the mode of transport. A recalculated table of fuel use is therefore necessary.

Table 1.c.1 goes one step further and shows fuel consumption with transport fuels attributed to transport users as well as inputs to electricity generation attributed to consumers of electricity. The transport row sums to zero and the electricity row nearly sums to zero, showing but a small consumption of transport fuels by electricity. Corresponding figures for emissions of CH_4, N_2O and CO_2 are shown in Table 1.c.2. Emissions of SO_2, NOx and NH_3 are given in Table 1.c.3.

Table 1.c.2: Estimated emissions of CH4, N2O and CO2, with emissions from electricity generation and transport attributed to users (i.e. version c) tonnes, and Global Warming Potential (GWP100)

SECTOR	NACE-CLIO R25	TOTAL CH4	TOTAL N2O	TOTAL CO2	GWP100	Sector
AGRI,FOR,FISH	01	656,502	20,117	-4,128,063	15,894,846	**Agri,forest,fish 01**
Coal/lig/peat		2	2	100,563	**101,121**	Coal/lig/peat
Petrol prod/lpg		1	16	147,064	**152,135**	Petrol prod/lpg
Electricity		0	0	4,188	**4,198**	Electricity
Gas		10,681	2	80,628	**305,503**	Gas
Water		0	18	202,887	**208,571**	Water
Elec/gas/water		10,682	20	287,704	**518,271**	Elec/gas/water
FUEL,POWER,WATER	06	**10,685**	**38**	**535,331**	**771,528**	**Fuel,power,water 06**
Metals and ores	13	3	37	296,823	**308,291**	Metals and ores 13
Non-met min prod	15	72	108	2,121,432	**2,156,303**	Non-met min prod 15
Chemical prod.	17	10	2,894	3,171,235	**4,068,480**	Chemical prod. 17
Metal prod excl mc & tr	19	10	28	251,449	**260,491**	Metal prod exmc&tr 19
Agr & industr mc	21	5	16	144,426	**149,380**	Agr & industr mc 21
ODP mc & prec inst	23	8	56	515,714	**533,231**	ODP mc & prec inst 23
Electrical goods	25	9	48	456,654	**471,877**	Electrical goods 25
Transport equipm	28	1	13	115,518	**119,652**	Transport equipm 28
Food bev tobac	36	81	270	2,473,122	**2,558,395**	Food bev tobac 36
Textiles cl l & footw	42	12	45	401,520	**415,643**	Textiles cl l&footw 42
Paper & print prod	47	9	32	288,823	**299,057**	Paper &print prod 47
Rubber & plastic pr	49	8	47	397,731	**412,370**	Rubber & plastic pr 49
O. Manufact prod	48	11	32	276,612	**286,680**	O. Manufact prod 48
Construction	53	11	45	423,292	**437,444**	Construction 53
INDUSTRY excl FPW	Tot	**248**	**3,670**	**11,334,352**	**12,477,295**	**INDUSTRY**
TRANSPORT inc own acc	61+63+65	**0**	**0**	**0**	**0**	**TOTAL TRANSPORT**
SERVICES mkt	56,59,67, 69,74	178	523	4,794,380	**4,960,314**	SERVICES mkt
SERVICES non-mkt (govt)	86	136,260	283	2,392,070	**5,341,289**	SERVICES non-mkt (govt)
TOT SERVICES excl transp	56,59,67, 69,74,86	**136,438**	**806**	**7,186,451**	**10,301,604**	**TOT SERVICES**
RESIDENTIAL		**3,315**	**1,352**	**14,314,935**	**14,803,670**	**RESIDENTIAL**
TOTAL final energy (excl FPW)		**796,504**	**25,946**	**28,707,675**	**53,477,415**	**TOT final energy (excl FPW)**
TOTAL primary energy		**807,189**	**25,984**	**29,243,006**	**54,248,943**	**TOTAL**

SECTOR	NACE-CLIO R25	TOTAL CH4	TOTAL N2O	TOTAL CO2	GWP100	SECTOR

Notes: the small amount of emissions from electricity generation is due to electricity's use of transport fuels.

Table 1.c.3: Estimated emissions of SO2, NOx and NH3, with emissions by electricity and transport attributed to users (i.e. version c.), tonnes, and Acid Rain Precursors theme

SECTOR	NACE-CLIO R25	SO2	NOx	NH3	Acid rain precursors*
AGRI,FOR,FISH	01	5,222	8,131	123,154	242,703
Coal/lig/peat		31	33	0	53
Petrol prod/lpg		659	399	0	936
Electricity		1	55	0	39
Gas		89	157	0	198
Water		1,065	519	0	1,426
Elec/gas/water		1,155	730	0	1,664
FUEL,POWER,WATER	06	1,845	1,162	0	2,653
Metals and ores	13	1,967	1,098	0	2,731
Non-met min prod	15	7,142	4,433	0	10,227
Chemical prod.	17	26,145	7,142	1	31,115
Metal prod excl mc & tr	19	1,745	1,006	0	2,446
Agr & industr mc	21	1,003	551	0	1,387
ODP mc & prec inst	23	3,230	1,680	0	4,399
Electrical goods	25	2,997	1,659	0	4,152
Transport equipm	28	835	385	0	1,103
Food bev tobac	36	19,626	9,054	1	25,927
Textiles cl l & footw	42	3,502	1,483	0	4,535
Paper & print prod	47	2,106	1,122	1	2,889
Rubber & plastic pr	49	3,098	1,476	0	4,126
O. Manufact prod	48	2,024	1,162	0	2,833
Construction	53	1,337	1,253	1	2,210
INDUSTRY excl FPW	Tot	76,759	33,507	5	100,079
TRANSPORT inc own acc	61+63+65	0	0	0	0
SERVICES mkt	56,59,67, 69,74	26,603	16,633	37	38,244
SERVICES non-mkt (govt)	86	10,697	5,906	4	14,813
TOT SERVICES excl transp	56,59,67, 69,74,86	37,301	22,538	41	53,057
RESIDENTIAL		55,459	52,033	235	92,101
TOTAL primary energy		176,585	117,371	123,435	490,594

SECTOR	NACE-CLIO R25	SO2	NOx	NH3	Acid rain precursors*

Notes: emissions from electricity and transport are entered as zeroes in their respective rows and attributed to users of electricity and transport.
In fact a small of amount of emissions due to transport fuels used by the electricity sector appear in the electricity row.
All figures are from McGettigan (1996), and breakdowns are made pro rata his figures for emissions by fuel (26.5.1998).
* Acid rain precursors are a weighted measure expressed in terms of tonnes of SO2 equivalents (tSO2).
The weights used to aggregate SO2, NOx and NH3 were 1, 0.6957 and 1.8824 respectively, as used by Vaze and Balchin (1996).

2. Discharges to water by sector

The discharges to water to be considered are Biological Oxygen Demand (BOD) which arises mainly from sewage, slurry and silage effluent, nitrogen (N) and phosphorus (P) which arise from fertilisers and manure. These discharges are shown in Table 2.1. There are many uncertainties surrounding the impact on water, which include deposition from the atmosphere, N fixed by lightning and bacteria and N and P sequestered by soils. It is also recalled that the extent to which discharges have a polluting effect is highly dependent on the state of the receiving waters and surrounding terrain. In addition it is largely the concentration rather than the quantity of discharges that matters.

Discharges of organic matter, measured in BOD, can have a sharp and fast impact on water quality, as the multiplying bacteria use up the available oxygen. The impact of N and P however tends to be more long-lasting.

The amounts going to water from agricultural sources are very approximate, and the figure for BOD was estimated over a decade ago. The figures for N and P are estimated from nutrient balances which state the inputs to agriculture and then account for the inputs taken up by outputs of milk, meat and so on. In the construction of the nutrient balances, an estimate of losses to water (used here) is also made, though the figures are very approximate. Sizeable unaccounted-for BOD, N and P from agriculture in the balances are given in the notes to the table. Some of this would also find its way to water, but no estimate of the proportion has been made here.

Industrial dischargers effectively have two routes for their waste if they do not recycle it. One is to discharge directly to water. An example is the row for Food, Beverages and Tobacco, where firms in this sector would have licences from the EPA to discharge to waters. The second route is to discharge via municipal sewers, in which case discharges appear in the row for government Services (Municipal works). Note that in all cases discharges are net figures, that is they are net of own recycling.

Discharges from the Residential sector come from septic tanks. The amount from septic tanks actually finding its way to waters is not known and there is no entry in the Residential row. However the total amount going to septic tanks is given in the footnote row denoted "unaccounted for potential from septic tanks". It is estimated on the basis of population served. Some BOD, perhaps 20 per cent, is removed by the septic tank. Further absorption might occur during percolation in some parts of the country, in other parts it may not.

Future analyses might give better information on the quantities arising and the discharges. The quantities of P arising and discharged from household use of detergents, for example, would be of interest. In any event, figures for the quantities finding their way to water from Agriculture and the Residential sectors are incomplete and non-existent, respectively.

Table 2.1: Estimated discharges to water (freshwater and marine), 1994, tonnes,* and Eutrophication Potential

SECTOR Source of discharges to water	NACE-CLIO R25	BOD tonnes	N tonnes	P tonnes	Other tonnes	Eutrophication potential#	SECTOR Source of discharges to water
AGRI, FORESTRY, FISHING	**01**	**10,000**	**148,500**	**3,445**	**136,464 (ammonia)**	**18,295**	**AGRI,FOR,FISH**
Coal/lig/peat							Coal/lig/peat
Petrol prod/lpg							Petrol prod/lpg
Electricity							Electricity
Gas							Gas
Water							Water
Elec/gas/water							Elec/gas/water
FUEL, POWER, WATER	**06**						**FUEL,POWER,WATER**
Metals and ores	13						Metals and ores
Non-met min prod	15						Non-met min prod
Chemical prod.	17	3,650	1,460	73		**219**	Chemical products
Metal prod excl mc & tr	19						Metal prod excl mc & tr
Agr & industr mc	21						Agr & industr mc
ODP mach & prec instrum.	23						ODP mc & prec inst
Electrical goods	25						Electrical goods
Transport equipm	28						Transport equipm
Food bev tobac	36	17,340	1,825	438		**621**	Food bev tobac
Textiles cl l & footw	42	180					Textiles cl l & footw
Paper & print prod	47						Paper & print prod
Rubber & plastic prod.	49						Rubber & plastic pr
Other Manufact prod	48						O. Manufact prod
Construction	53						Construction
INDUSTRY (direct discharges)	**Tot**	**21,170**	**3,285**	**511**	to be estimated	**840**	**INDUSTRY**
TRANSPORT	**61+63+65**				Metals,oil,salt		**TRANSPORT**
SERVICES non-govt	56,59,67, 69,74						SERVICES non-govt
SERVICES govt: Municipal works (mostly treated before discharge)	86	36,000	8,500	2,400		**3,250**	SERVICES govt (municipal works)
TOT SERVICES excl transp	**56,59,67, 69,74,86**	**36,000**	**8,500**	**2,400**		**3,250**	**TOT SERVICES excl transp**
RESIDENTIAL **		**	**	**			**RESIDENTIAL**
ACCOUNTED FOR DISCHARGES TO WATER^		**67,170**	**160,285**	**6,356**		**22,385**	**DISCHARGES ACCOUNTED FOR**

SECTOR Source of discharges to water	NACE-CLIO R25	BOD tonnes	N tonnes	P tonnes	Other tonnes	Eutrophication potential#	SECTOR Source of discharges to water

* Notes: The true levels are very uncertain and figures given here would be subject to a high margin of error.

BOD from Agriculture is taken from footnote, p. 1 of Scott and Lawlor (1994), which in turn derives from Forbairt, An Foras Forbatha et cetera. The figure of 10,000 was calculated in 1983 and is a lower boun to be updated. The "unaccounted for potential from Agriculture" in footnote^ below is estimated by subtracting the 10,000 from the maximum figure of 660,000.

BOD from Municipal, from Scott and Lawlor (1994). Industrial discharges to municipal sewers are included in this row. Only industry's direct discharges to waters are entered in the Industrial rows.

N from Agriculture: the figure of 148,500 tonnes is of the right order of magnitude when cross checked with figures from the Department of the Environment of inputs to the maritime area.
Source: estimated N balance 1994-95, Ryan and Tunney (1997), update of Lee (1996) from Sherwood and Tunney (1991).

P from Agriculture, at 3,445 tonnes, is a minimum figure, though probably of the right order of magnitude. Lee (1996) and Tunney (1990).

** RESIDENTIAL consists mainly of septic tanks. The BOD figure is from the EPA's State of the Environment report p.67. Septic tanks may remove 20 % of BOD and percolation may remove between 0% and and 95% of the remainder. Given this uncertainty, all inputs to septic tanks are classified as unaccounted for, shown below.

^ Additional discharges would emanate from the following:

Unaccounted for potential from agriculture:	650,000 tonnes BOD,	226,388 tonnes N	and 45,991 tonnes P (Sources as above).
Unaccounted for potential from septic tanks:	24,455 tonnes BOD,	3,600 tonnes N	and 1,100 tonnes P (Source EPA 1998).

Eutrophication Potential is measured in tonnes, where P is given a weight of 1 and N is given a weight of 0.1, as in de Haan, Keuning and Bosch (1993).

3. Solid waste arising, broken down by sector

The EPA's National Waste Database Report provides figures on non-agricultural waste arising in 1995 and on waste arising from industry partially broken down by industrial NACE code.

The weight in tonnes of solid waste arising in each sector is shown in Table 3.1. The footnotes to the table describe how some of the more detailed breakdowns were derived.

Ideally the table would show the amounts, net of recovery, which have to be landfilled, that is disposals rather than solid waste arising. However information on recovery is scanty at present, though the situation is expected to improve. The final row gives totals disposed, but there is no breakdown of disposals by sector. This is discussed further under the Themes section below.

Table 3.1: Estimated Solid Waste Arising by category of waste in 1995 (non-agricultural), tonnes

SECTOR where solid waste arises	NACE-CLIO R25	INDUSTRIAL HAZARDOUS	INDUSTRIAL NON-HAZARDOUS	INDUSTRIAL TOTAL	MUNICIPAL incl recycled	OTHER*	HEALTH-CARE	DREDGE SPOILS	TOTAL	SECTOR where solid waste arises
AGRI,FOR,FISH	**01**								Not applicable	**AGRI,FOR,FISH**
Coal/lig/peat										Coal/lig/peat
Petrol prod/lpg		6,886	3,581	10,467		137			10,604	Petrol prod/lpg
Electricity										Electricity
Gas										Gas
Water										Water
Elec/gas/water		1,458	351,849	353,307		13,438			366,745	Elec/gas/water
FUEL,POWER,WATER	**06**	**8,344**	**355,430**	**363,774**		**13,575**			**377,349**	**FUEL,POWER,WATER**
Metals and ores	13	3,791	59,500	63,291		2,272			65,563	Metals and ores
Non-met min prod	15	16,127	3,733,930	3,750,057		142,607			3,892,664	Non-met min prod
Chemical prod.	17	179,808	149,695	329,503		5,717			335,220	Chemical prod.
Metal prod excl mc&tr	19	9,318	145,674	154,992		5,564			160,556	Metal prod excl mc&tr
Agr & industr mc	21	539	35,601	36,140		1,360			37,500	Agr & industr mc
ODP mc & prec inst	23	2,744	29,365	32,109		1,122			33,231	ODP mc & prec inst
Electrical goods	25	1,413	15,127	16,540		578			17,118	Electrical goods
Transport equipm	28	0	1,326	1,326		51			1,377	Transport equipm
Food bev tobac	36	3,653	894,931	898,584		34,179			932,763	Food bev tobac
Textiles cl l & footw	42	120	261,989	262,109		10,006			272,115	Textiles cl l & footw
Paper & print prod	47	221	203,762	203,983		7,782			211,765	Paper & print prod
Rubber & plastic pr	49	1,870	56,051	57,921		2,141			60,062	Rubber & plastic pr
O. Manufact prod	48	1,337	13,125	14,462		501			14,963	O. Manufact prod
Construction	53	1,212	1,318,908	1,320,120		50,372			1,370,492	Construction
INDUSTRY excl FPW	**Tot**	**222,153**	**6,918,984**	**7,141,137**		**264,251**			**7,405,388**	**INDUSTRY excl FPW**
TRANSPORT	**61+63+65**									**TRANSPORT**
SERVICES non-govt	56,59,67, 69,74									SERVICES non-govt
SERVICES govt	86					493,323		784,600		SERVICES govt
of which Street cleaning					46,791					of which Street cleaning
TOT SERVICES excl transp	**56,59,67,69,74,86**				**450,520**	**493,323**	**20,000**	**784,600**	**1,748,443**	**TOT SERVICES excl transp**
Add commercial waste recovered					73,191				73,191	Add commercial waste recovered
Add "Transp, stor & communic'	EPA T3.12	13,257	136,568	149,825					149,825	Add 'Transp, storage + communic'
RESIDENTIAL					**1,279,980**				**1,279,980**	**RESIDENTIAL**
Add residential waste recovered					44,541				44,541	Add residential waste recovered
Add abandoned vehicles						18,720			18,720	Add abandoned vehicles
Unclassified						163,320			**163,320**	**Unclassified**
TOTAL WASTE ARISING		243,754	7,410,982	7,654,736	**1,848,232**	**953,189**	20,000	784,600	**11,260,757**	**TOTAL WASTE ARISING**
of which recovered, incl industrial:				1,324,269	117,732				**1,442,001**	of which recovered, incl industrial:
TOTAL TO BE DISPOSED		243,754	7,410,982	**6,330,467**	**1,730,500**	**953,189**	20,000	784,600	**9,818,756**	**TOTAL TO BE DISPOSED**
SECTOR where solid waste arises	NACE-CLIO R25	INDUSTRIAL HAZARDOUS	INDUSTRIAL NON-HAZARDOUS	INDUSTRIAL TOTAL	MUNICIPAL incl recycled	OTHER*	HEALTH-CARE	DREDGE SPOILS	TOTAL	SECTOR where solid waste arises

Main source of figures is p. 21 and p. 29 of EPA (1996), National Waste Database Report 1995. The most reliable figures are those emanating from the IPC licencing process, such as for Chemicals and ODP.
"Total waste arising" , at 11,260,757 tonnes, is the gross figure for waste, whether recovered or not (Total from Table 3.1 in EPA, 1996).
INDUSTRIAL columns: EPA's 'Basic metals and fabricated metal products' have been split into 'Metals and ores' and 'Metal products' pro rata I-O table GO: 29/71.
Similarly, 'Electrical and optical equipm.' into ODP + prec. instr. /Electr goods by 66/34 split.
MUNICIPAL column: some waste from the Services sector will have been allocated under the Industrial columns. The Services and Residential waste 'recovered' rows include bottles that go to bottle banks etc. Recovered waste is "waste arising", but does not need to be disposed of and is therefore subtracted to give "Total to be disposed" in the bottom line. More information on recovery by sector is needed in order to produce a table of disposals by sector.
*OTHER column: includes collection on behalf of local authorities. The breakdown is given on p 22 of EPA, and that which is 'industrial ' is allocated pro rata the INDUSTRIAL NON-HAZARDOUS column.
HEALTHCARE column: waste has been allocated to Services.
It is not possible to disaggregate 'Transport, storage + communication' in order to allocate these correctly, because the response to the EPA's survey was very low for these sectors (Matthew Crowe EPA).
The penultimate row on Recovery additionally gives Industrial waste recovered, estimated by applying the 17.3% recovery rate (EPA Table 3.15, p 32). The recovery rate would be over 30% if non-metallic mineral products were excluded, because mining waste is all disposed to landfill. There are detailed recovery rates by sector, but derived from a sample only. As the data improve, a detailed recovery column will be feasible.

4. Depletion of resources

The three resources that are covered here are forestry, commercial peat and natural gas. Table 4.1 shows the stocks and depletion (accretion, in the case of forestry) and the length of remaining life of the resource at current rates of extraction.

At quoted 1994 stocks and rates, the length of time that forestry will be in supply is indefinite. For Coillte forests (the forests that are in public ownership), growth in 1994 is estimated to be 3,079 k cu m, with cutting at 1,877 k cu m, giving a net increase of 1,202 k cu m as quoted in the table. For private forests, growth in 1994 is estimated to be 255 k cu m and cutting 100 k cu m, leaving a net increase of 155 k cu m, also quoted in the table.

The supply of commercial peat would last for approximately 42 years at 1994 rates of extraction. Peatland, in particular raised bog, performs an additional function as a species-rich habitat, though this aspect of the resource is not tabulated here. Ireland has 51 per cent of the European resource of intact raised bog which is worthy of conservation, but the rate of loss of area in Ireland is double the rate of conservation (IPCC 1992, 1998). Turf extraction gives rise to CH_4 emissions and afforestation has implications for the stock of habitat. However information on this, much of which would need to be qualitative, is not to hand.

The natural gas supply would run out within 7 further years at 1994 rates of extraction, as shown in the table.

Table 4.1: Natural resources, initial stock, usage and number of years' supply

Resource	Unit	Stock at start of 1994	Usage in 1994 (or increase)	Years' supply at 1994 rate of usage
Forestry:				
Standing timber				
Coillte	k cu m	34,011	(1,202)	Indefinite
Conifer		33,190		
Broadleaf		821		
Private	k cu m	3,270	(155)	Indefinite
Conifer		2,310		
Broadleaf		960		
Peat, commercial:				
(in the ground)	k TOE	50,000	1,192	42 approx
Natural gas:	k TOE	14,000	2,198	6.5

Sources: Coillte, Bord na Mona and An Bord Gais.

5. Four environmental themes

Among the environmental issues attracting attention at present are global warming, acidification which harms water, land and buildings, declining water quality and disposal of solid waste. Though data assembly relating to these issues needs to improve, it is sufficiently advanced for preliminary themes to be constructed. The themes constructed here are (1) Global Warming, (2) Acid Rain Precursors, (3) Eutrophication Potential and (4) Solid Waste Disposal. They are shown in Tables 5.1 and 5.2 to which data on total numbers at work and on value added (which is close to GDP arising) have been added in the last two columns. These two columns enable one to relate the sectoral emissions with economic activity. Other potential themes are discussed in the next section.

The first two themes, which refer to emissions to air, have been constructed here for the version in which electricity inputs and transport fuels are attributed to users of electricity and transport. Therefore the emissions from electricity and transport are zero (or virtually zero). For versions in which electricity and transport emissions are not attributed to users, see Tables 1.a.3, and 1.a.4. For versions in which only electricity emissions are attributed, see Tables 1.b.2 and 1.b.3.

(1) Theme: Global Warming

CO_2, N_2O, CH_4, HFC, PFC and SF6 have the potential to cause global warming and are the basket of greenhouse gases covered by the agreement signed at Kyoto. The first three gases are the main focus of attention and have been collected in the tables above. They have different global warming potentials and different residence times in the atmosphere. A procedure for aggregating them into so-called 100 year global warming potentials by application of weights is used, resulting in the column for Global Warming Potential, or GWP100. This was shown in the final column of Table 1.c.2 which is reproduced here as the first column in Table 5.1

The percentage breakdown is given in the first column of Table 5.2, which shows the prominent role played by agriculture in potential global warming. It contributes about 29 per cent of the national total and in this respect Ireland is unusual in the EU. The residential sector comes next, at 27 per cent, followed by Industry at 23 per cent. Within industry, chemicals, food and non-metallic minerals stand out, as shown in Figure 5.1.

The weights that were used for combining the gases to global warming potential were those given by the Department of the Environment (1997) and Vaze *op. cit.*, in turn taken from IPPC (1995). They are given in Table 5.3. As can be seen, owing to the high weight given to CH_4 and an even higher weight to N_2O, the resulting Global Warming Potential (GWP100) of their relatively low emissions is considerable.

It should be pointed out that de Haan and Keuning (1996) use the weights 1, 11 and 270, instead of weights 1, 21 and 310 which are used here.

Table 5.1: Tentative compilation of four environmental themes (tonnes), numbers employed and gross value added (£m)
Emissions from electricity generation and transport are attributed to users of electricity and transport (i.e. version c).

SECTOR	Global warming potential	Acid rain precursors	Eutrophication potential	Solid waste arising	Numbers at work **	Gross value added at factor cost***
AGRI,FOR,FISH	**15,894,846**	**242,703**	**18,295**		**146,901**	**2,668.3**
Coal/lig/peat	101,121	53				0.5
Petrol prod/lpg	152,135	936		10,604		62.5
Electricity (emissions allocated to users)*	4,198	39				367.7
Gas	305,503	198				95.8
Water	208,571	1,426				42.1
Elec/gas/water	518,271	1,664		366,745		505.6
FUEL,POWER,WATER	**771,528**	**2,653**		**377,349**	**13,721**	**568.7**
Metals and ores	308,291	2,731		65,563	4,524	85.6
Non-met min prod	2,156,303	10,227		3,892,664	15,106	613.8
Chemical prod.	4,068,480	31,115	219	335,220	17,630	2,341.7
Metal prod excl mc&tr	260,491	2,446		160,556	16,502	281.2
Agr & industr mc	149,380	1,387		37,500	11,687	285.8
ODP mc & prec inst	533,231	4,399		33,231	22,683	935.4
Electrical goods	471,877	4,152		17,118	22,407	996.6
Transport equipm	119,652	1,103		1,377	6,583	152.3
Food bev tobac	2,558,395	25,927	621	932,763	47,365	2,267.9
Textiles cl l & footw	415,643	4,535		272,115	24,294	333.7
Paper & print prod	299,057	2,889		211,765	20,142	486.4
Rubber & plastic pr	412,370	4,126		60,062	9,844	314.5
O. Manufact prod	286,680	2,833		14,963	24,544	239.8
Construction	437,444	2,210		1,370,492	78,419	1,634.0
INDUSTRY excl FPW	**12,477,295**	**100,079**	**840**	**7,405,388**	**321,730**	**10,968.7**
TRANSPORT (emissions allocated to users)					**47,038**	**1,070.0**
SERVICES non-govt	4,960,314	38,244			451,914	12,424.2
SERVICES govt	5,341,289	14,813	3,250		239,258	3,570.7
TOT SERVICES excl transp	**10,301,604**	**53,057**	**3,250**	**1,971,459**	**691,172**	**15,994.9**
RESIDENTIAL	**14,803,670**	**92,101**		**1,343,241**		
Unclassified				163,320		
TOTAL	**54,248,943**	**490,594**	**22,385**	**11,260,757**	**1,220,562**	**31,270.6**

SECTOR	Global warming potential	Acid rain precursors	Eutrophication potential	Solid waste arising	Numbers at work	Gross value added at factor cost

Notes: Figures refer to the year 1994, except those for Solid waste arising which refer to 1995.

Global warming potential measures the net change in radiation over 100 years due to a unit of gas expressed in CO2 equivalent, Acid rain precursors are measured in tonnes of SO2 equivalent, Eutrophication potential is measured in tonnes P equivalent, Solid waste arising is non-agricultural waste, in tonnes.

* A small amount of transport fuels is used by the electricity sector.

** Numbers at work on ILO basis, source: Labour Force Survey 1997

*** The Gross Value Added quoted in the above table is equivalent to the Gross Domestic Product in Tables 2 and 3 of National Income and Expenditure 1997.

Table 5.2: Tentative compilation of four environmental themes, with numbers employed and gross value added, per cent
Emissions from electricity generation and transport are attributed to users of electricity and transport (i.e. version c.).

SECTOR	Global warming potential	Acid rain precursors	Eutrophication potential	Solid waste arising	Numbers at work	Gross value added at factor cost
AGRI,FOR,FISH	29.30	49.47	81.73		12.04	8.53
Coal/lig/peat	0.19	0.01				0.00
Petrol prod/lpg	0.28	0.19		0.09		0.20
Electricity (emissions allocated to users)*	0.01	0.01				1.18
Gas	0.56	0.04				0.31
Water	0.38	0.29				0.13
Elec/gas/water	0.96	0.34		3.26		1.62
FUEL,POWER,WATER	1.42	0.54		3.35	1.12	1.82
Metals and ores	0.57	0.56		0.58	0.37	0.27
Non-met min prod	3.97	2.08		34.57	1.24	1.96
Chemical prod.	7.50	6.34	0.98	2.98	1.44	7.49
Metal prod excl mc&tr	0.48	0.50		1.43	1.35	0.90
Agr & industr mc	0.28	0.28		0.33	0.96	0.91
ODP mc & prec inst	0.98	0.90		0.30	1.86	2.99
Electrical goods	0.87	0.85		0.15	1.84	3.19
Transport equipm	0.22	0.22		0.01	0.54	0.49
Food bev tobac	4.72	5.28	2.77	8.28	3.88	7.25
Textiles cl l & footw	0.77	0.92		2.42	1.99	1.07
Paper & print prod	0.55	0.59		1.88	1.65	1.56
Rubber & plastic pr	0.76	0.84		0.53	0.81	1.01
O. Manufact prod	0.53	0.58		0.13	2.01	0.77
Construction	0.81	0.45		12.17	6.42	5.23
INDUSTRY excl FPW	23.00	20.40	3.75	65.76	26.36	35.08
TRANSPORT (emissions allocated to users)					3.85	3.42
SERVICES non-govt	9.14	7.80			37.03	39.73
SERVICES govt	9.85	3.02	14.52		19.60	11.42
TOT SERVICES excl transp	18.99	10.81	14.52	17.51	56.63	51.15
RESIDENTIAL	27.29	18.77		11.93		
Unclassified				1.45		
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00
SECTOR	Global warming potential	Acid rain precursors	Eutrophication potential	Solid waste arising	Numbers at work	Gross value added at factor cost

See notes to Table 5.1 for explanation.

Table 5.3: Weights, emissions and global warming potential over 100 year horizon

	CO_2	CH_4	N_2O	Total
Emissions ('000 t):	29,243	807	26	
GWP100 weights:	1	21	310	
Global warming potential: ('000 t CO_2 equiv)	29,243	16,950	8,055	54,249

(2) Theme: Acid Rain Precursors

The main agents leading to acidification are SO_2 (sulphur dioxide), NOx (nitrogen oxides), and NH_3 (ammonia). Wet or dry deposition of acid substances, called acid rain, can cause damage to ecosytems, water quality, buildings and crops. The potential contribution of these substances can be combined into the theme called Acid Rain Precursors, expressed in tonnes of sulphur dioxide equivalents. The weights used here to aggregate SO_2, NOx and NH_3 are those used by Vaze and Balchin (1996), namely 1, 0.6957 and 1.8824 respectively.

The theme Acid Rain Precursors is shown in the second column of Table 5.1 and in percentage terms in Table 5.2. A major producer is in fact electricity, distributed here to users of electricity, which produces 26 per cent (as seen in Table 1.a.4). It is however dwarfed by the Agriculture sector which produces nearly one half of the national total. Acidification from Transport is an issue but more in terms of concentrations in urban areas. It too is distributed in Table 5.1 to users. A graph of acid rain precursors is shown in Figure 5.2.

(3) Theme: Eutrophication Potential

As mentioned in section 2, while discharges of BOD can have a dramatic effect on water quality, the nutrients N and P can have long-lasting effect and, depending on the state of the receiving waters, can cause eutrophication. The theme Eutrophication Potential is derived by weighting N by 0.1 and P by 1, as used by de Haan, Keuning and Bosch (1993). The prominent role played by agriculture, followed by government services (municipal works, mainly) is shown in Tables 5.1 and 5.2 and Figure 5.3.

(4) Theme: Solid Waste Arising

As mentioned in Section 3, information available on solid waste gives "waste arising", broken down by sector. Recovery is not broken down in such detail, and therefore it is not yet possible to show waste that goes to disposal from each sector. The column of "solid waste arising" on the right-hand side of Tables 5.1 and 5.2 therefore merely represents the current state of our knowledge on this theme. However, given the low level of recovery at present, existing figures on waste arising are in fact close approximations to disposals.

The non-metallic minerals sector features prominently, as Figure 5.4 shows. This is largely mining waste, all of which is disposed to landfill.

Figure 5.1: Global warming potential, tonnes CO2 equivalent (version c)

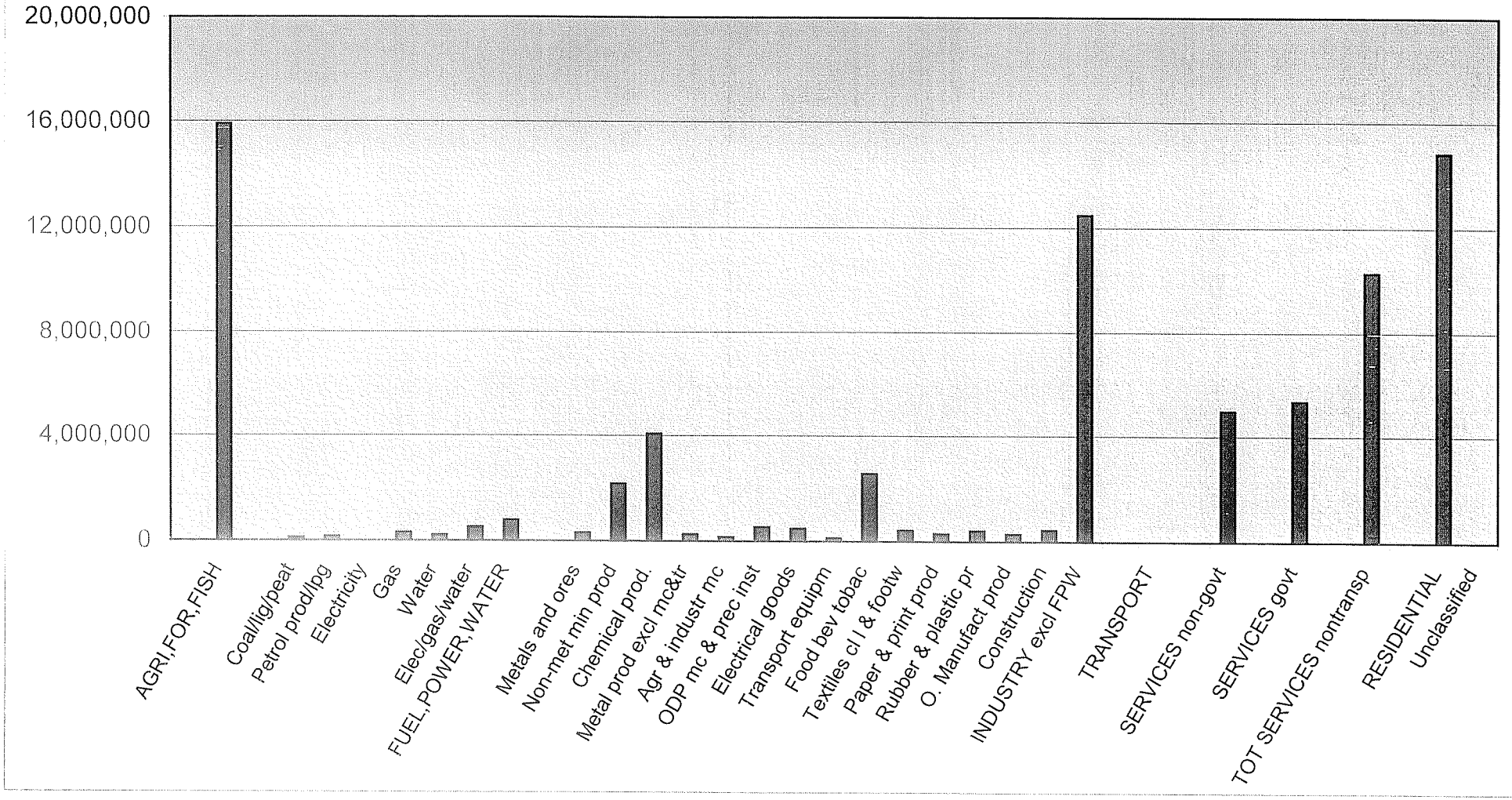


Figure 5.2: Estimated acid rain precursors, tonnes SO_2 equivalent version c.

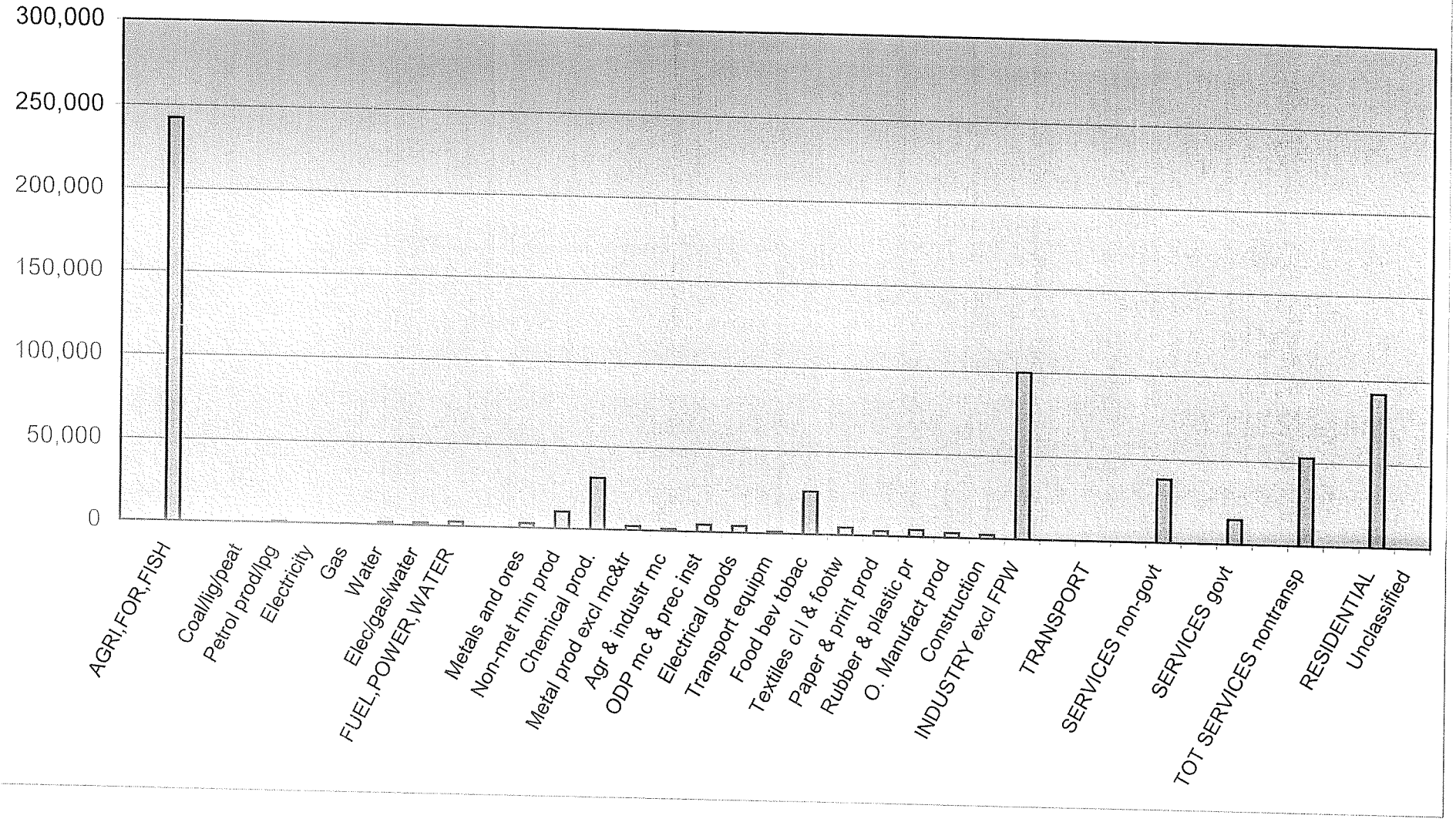


Figure 5.3: Estimated eutrophication potential, tonnes P equivalent. NB: see text and notes to Table 2.1

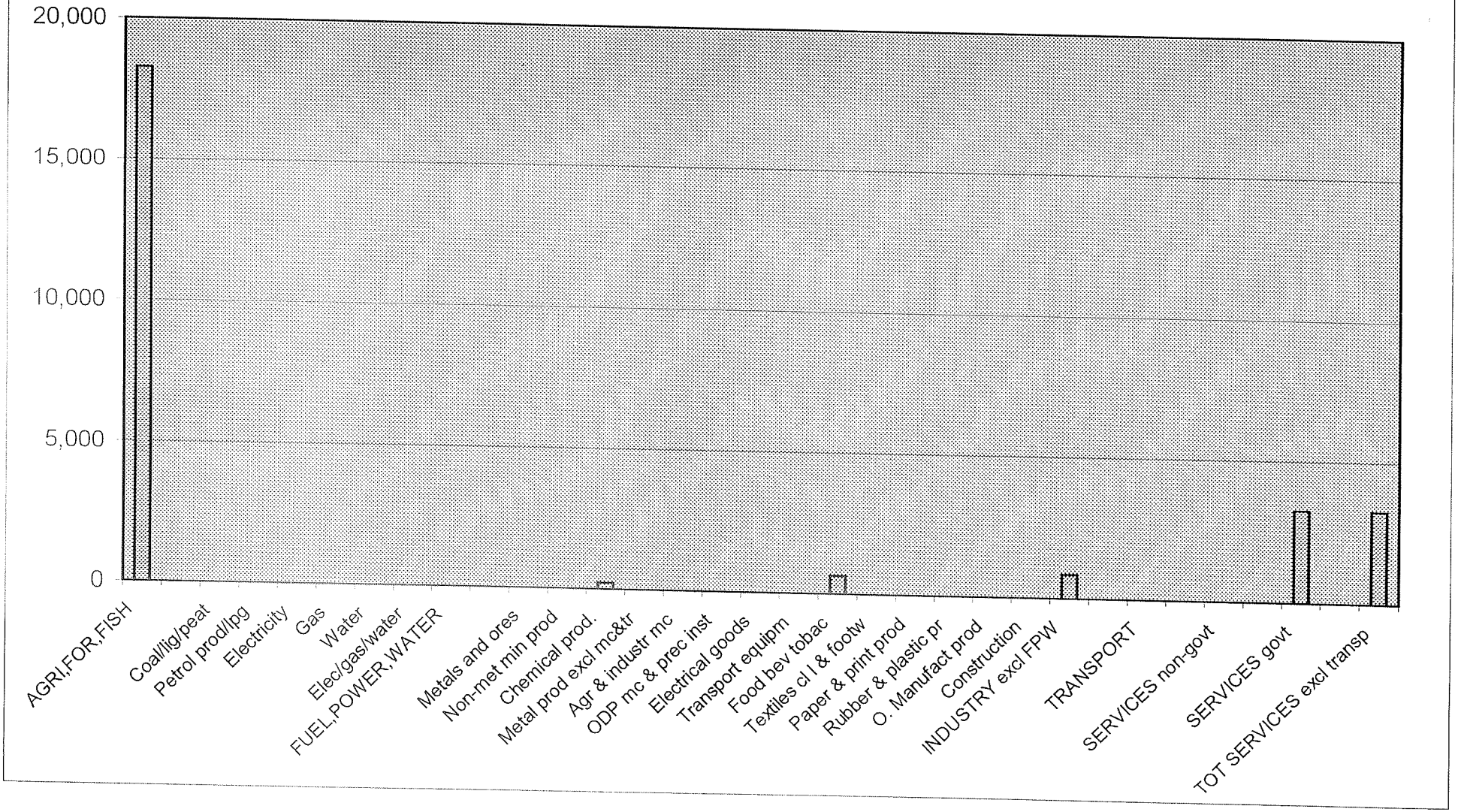
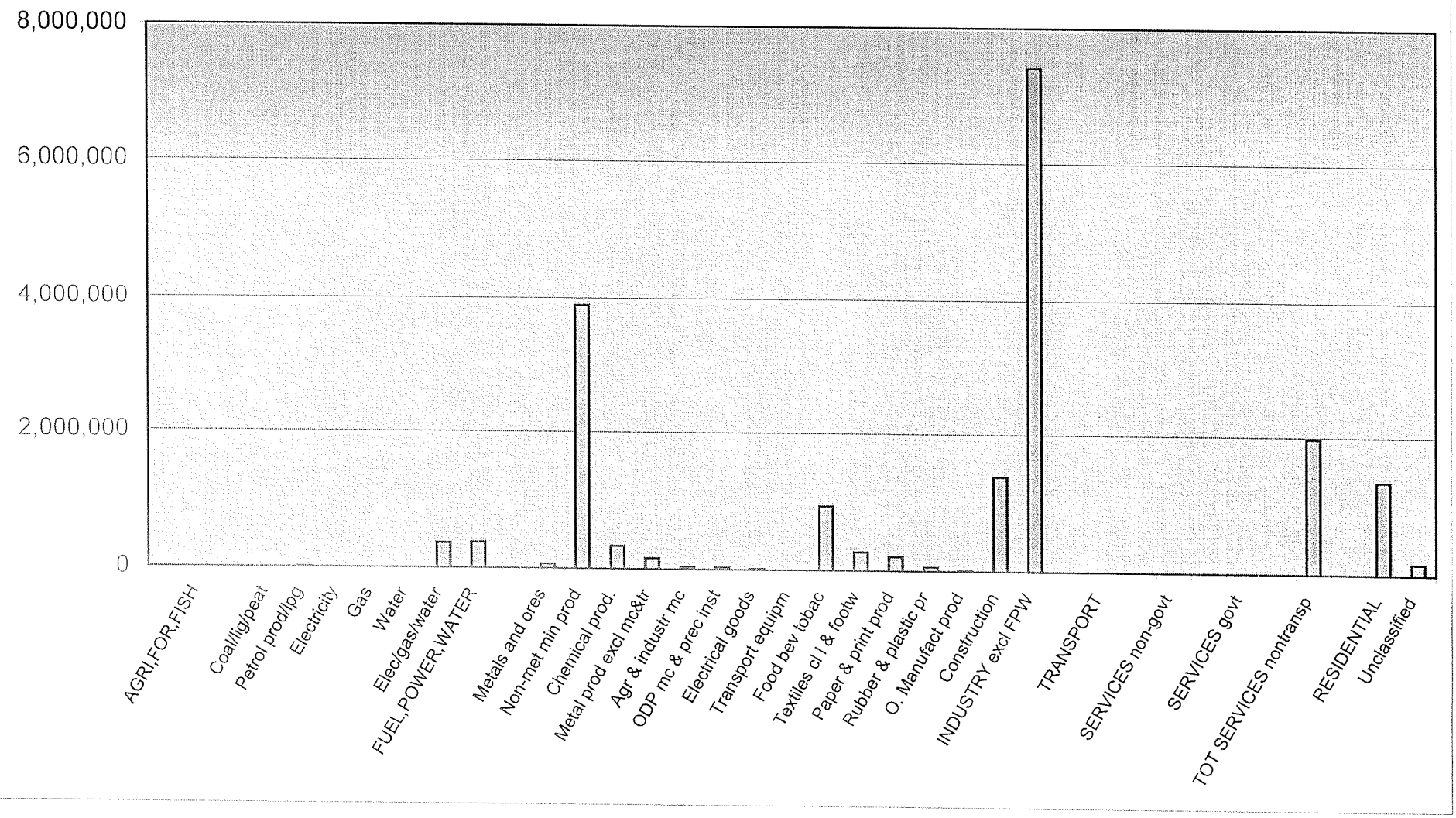


Figure 5.4: Estimated solid waste arising (non-agricultural), tonnes.



6. Future developments

An exercise such as this one serves to highlight deficiencies of method and of data. Before describing developments in relation to the data, we start by discussing some of the conceptual issues, which affect the method.

As pointed out at the start, environmental quality is not merely determined by emissions, because the level of concentrations and the state of the receiving medium matter a great deal. However, data on emissions and discharges are obviously an essential part of the picture.

Better representation could be achieved by giving breakdowns that have regard to differences in receiving medium. For example, the discharges to water would have more significance if they were split into coastal and inland discharges. Of greater interest would be a further breakdown by water catchment area.

Similar considerations arise in connection with any future theme such as urban air quality. The effects of emissions from traffic in particular are localised and a useful disaggregation could be carried out to give rural and urban emissions.

On the subject of data, the data obtainable from the EPA deserve mention. Contrary to expectations, the EPA licensing process did not feed data into this project directly, for two reasons. The first is that a small number of firms have been licensed to date. Secondly and more importantly, the licensing process entails collecting information on concentrations at particular times, rather than on annual total quantity of emissions. Concentrations are indeed what affect environmental quality but the method of their incorporation into accounts such as these is only beginning to be addressed. In the absence of comprehensive licensing data, work on this project resorted to the Census of Industrial Production (conducted by CSO), as described in the first Appendix. In the event, it has become clear that the Census is a potentially good source of information.

Two developments in the EPA Licensing process are of interest. The recently established Pollution Emissions Register (PER), though not providing a comprehensive coverage of pollutants, will produce annual emissions data. Approximately 20 PER reports had been submitted by mid-1998. Secondly, it is expected that revisions to section 94 of the 1992 Act by the Waste Management Act of 1996 will result in more comprehensive information on annual emissions.

An indispensible role was played by the EPA in the supply of figures for emissions to air by major sector and activity (McGettigan, 1996). Once the task of breaking down energy use had been achieved, this source enabled the themes Global Warming Potential and Acid Rain Precursors to be derived. Information on Discharges to Water was more widely sourced and the gaps in our knowledge about discharges from agriculture and from septic tanks need to be remedied. On solid waste, as mentioned, the data are expected to improve over the next few years. Further work on the National Waste Database, aided by more widespread licensing under the IPC licensing procedure, should yield good information and enable disposal, and not merely waste arising, to be covered in the theme.

With the surge in collection and recording of environmental data by bodies newly charged with the task, there is an opportunity to ensure that information gathered from different sources and for different purposes is compatible. For example, the bridge (CSO, 1997a) between the NACE Rev 1 classification codes used in recent Censuses of Industrial Production and the listed activities to be licensed in the EPA's First Schedule, will help promote reconciliation of data. Given the cross-disciplinary nature of environmental analysis and policy, unnecessary effort will be saved by co-ordination between the data gathering agencies.

The co-ordination of energy data is a large task needing to be tackled. The sources relating to energy that have to be accessed and linked in a study such as this are listed in Table 6.1.

Table 6.1: Data sources on energy to be accessed

Quantity or expenditure data	Price data
CSO:	
The Census of Industrial Production	Consumer Price Indices
Household Budget Survey	
Road Freight Transport Survey	Wholesale price indices
Census of Construction	
Trade Statistics	
Teagasc:	
National Farm Survey	
Revenue Commissioners:	
Statistical Report	
Department of Public Enterprise:	
Energy in Ireland	IEC Comparisons of Energy Costs
Forbairt's industrial breakdown (1990)	
Department of the Environment:	
Bulletin of Vehicle and Driver Statistics	

To be able to take account of the information contained in these sources requires a practitioner with good understanding of all the data gathering processes.

The exercise undertaken here has been restricted by the manner in which information is collected or grouped. If the question on fuels in the Census of Industrial Production could revert to the earlier breakdown of purchases of Petroleum, the disaggregation between transport and non-transport would be facilitated. Given the expected growth and an emerging perception of the polluting potential of transport, better attribution of transport use will become a priority.

It has also not been feasible to break down use of solid fuels into peat and coal, because these are aggregated in the Census. As they have different emissions, consideration

might be given to separating them in the Census. A separate question on the use of renewable energy might also be inserted. Any company using renewables is likely to have the information readily available.

A further important breakdown would be the separation of agriculture, forestry and fishing. Each of these has specific environmental repercussions. Furthermore, as shown by some of the themes, this sector's impacts are sizeable and would merit disaggregation on that score alone. The new convention of counting the changes in stock of wood, rather than the total stock itself, might also be employed.

A final word should be added on the compilation of other themes to be tackled by satellite environment accounts in the future. There are at least three themes which would be worth considering. These are water use, emissions of ozone depleting substances, and biodiversity or habitat change. It would be especially worth breaking down the first, water use, by water catchment area.

It is hoped that the satellite accounts will be upgraded and supplemented along the lines described above. The satellite accounts should become increasingly useful in a number of analyses. These could cover a variety of topics, ranging from the environmental implications of trade (for example as undertaken by Vaze et al. 1998), to the estimation of the sectoral impacts of environmental tax reform.

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Appendix A1.a: Derivation of energy use broken down by sector

General

This appendix describes the derivation of Table 1.a.1 in the main text. Figures written in bold type in this appendix are those that are entered in that table and some are also entered in Table 1.b.1 and Appendix Table A1.c.12.

As stated in the Introduction the sectors to be used were selected by CSO and based on the NACE70 classification system. In Table 1.a.1 figures in bold type are the control totals which were derived from the updated tables for the document *Energy in Ireland,* produced by the Department of Energy (DoE, now the Energy Division of the Department of Public Enterprise). The decision to use DoE's data as control totals was based on the fact that these are the official figures and on the desire to establish a procedure for the routine construction of annual environmental accounts.

DoE tend to obtain their figures on energy consumption from energy importers and suppliers and they break down consumption or Total Primary Energy Requirement (TPER) into the following sectors:

Agriculture
Energy Transformation
Industry (excluding Energy Transformation. This is the meaning attached to the word Industry here)
Transport
Commercial and Public sector
Residential

It is assumed that these breakdowns are broadly consistent with the NACE70 classifications selected for this study. One difference would be the inclusion of Water Supply by DoE in the Commercial and Public sector (presumably), whereas in the CIP Water Supply is included in the grouping Gas, Electricity and Water. Therefore the sector Transformation and Energy does not strictly conform to the sector Fuel Power and Water. Consumption of most fuels by Water Supply is very small so this difference is ignored at this stage. However, consumption of electricity by Water Supply is significant and is addressed in the construction of Table 1.b.1 (see Appendix A1.b), where consumption of electricity is given explicitly.

There were some other differences which were small and therefore ignored for now, but mention will be made here. Peat Briquette production may be included in sector 239 in the CIP so that its fuel inputs of Other Gas/diesel Oil and Electricity would be in the Industrial sector, which is probably correct for our purposes. In *Energy in Ireland* fuels used in briquette manufacture might theoretically be entered in the Transformation and Energy sector and therefore have to be transferred, but in fact they are not itemised by DoE.

DoE tend to base some of their breakdowns on a detailed analysis undertaken by Forbairt for the year 1990. Forbairt undertook a wideranging inquiry of the major sectors. In certain cases the shares of the components will have altered since 1990, so that without the aid of another analysis their breakdowns will be approximate.

Some explanation of the choice of fuels for this project should be given. Owing to the fact that the CIP was to play a prominent role here, the same major categories of fuels as those entered in CIP90 were used. It might, however, be worthwhile breaking down solid fuel into coal and peat, at a later stage. Other Gas/diesel Oil includes the small categories of refinery gas and kerosene.

Agriculture, Forestry and Fishing

Figures on fuels used in agriculture, forestry and fishing were taken as given in *Energy in Ireland.*

Fuel, Power and Water

The control totals for Fuel Power and Water were taken from Energy Transformation (Total Primary Energy Requirement minus Total Final Consumption) in DoE's publication *Energy in Ireland.* The figures for inputs to electricity generation were also taken from *Energy in Ireland.* Quantities of fuel used by the remaining subsectors (that is excluding Electricity) in this group, were allocated pro rata expenditure in the CIP94. The results will be approximations because the Energy and Transformation sector in *Energy in Ireland* is different from the Fuel, Power and Water sector in the CIP. Resources could usefully be spent reconciling these two sources. Fortunately the figures are mainly small in absolute terms.

An exception to the above procedure was made in the case of solid fuel where use by electricity and by coal/lignite/peat were entered directly from *Energy in Ireland.* The latter use, which consists of briquette manufacture, entails compression rather than combustion and therefore the emissions, calculated later, will overstate the environmental effects of this activity.

As mentioned, fuel use by Water Supply, subsector 170 in the CIP, ought to be added to the DoE control total and subtracted from Services but, not being large (Waste water and sewage treatment being excluded in the CIP classification "Water"), this was not carried out at this stage.

Industry (less Fuel, Power and Water)

- *Manufacturing (excluding fuel, power and water)*

Industry consists of manufacturing, on which there is information on expenditure on fuels from the CIP, and Construction, on which there is expenditure data from a sample. We do not know the total fuel use by these two components, only the total for industry from DoE. So an ad hoc approach was used. We first discuss manufacturing where the method employed was to break down the estimated total fuel use pro rata subsectoral expenditure on fuels, given in the CIP.

The manufacturing expenditure shares were derived from two source documents, CIP90 and CIP94. The latter could not be used on its own owing to the fact that the 4 questions concerning expenditure on petrol, autodiesel, other gas/diesel oil (i.e. non-transport), and residual fuel oil were amalgamated from 1991 into one question which combined these four fuels. In addition, the 2 questions concerning expenditure on LPG for vehicles and on other fuels were combined into one question on other fuels

including all LPG (that is, CIP90 on page 197 has nine categories of fuel, while CIP94 on page 196 has fuel broken down into five categories).

Detailed results of expenditure on fuels from the CIP90 and CIP94 (converted to NACE70 classification) were supplied by CSO. For 1990 the data are derived from Question 10 on Form B – Industrial Establishments with 3 or more persons engaged. For 1994 the CIP data are derived from Question 5 of the Enterprise survey, with adjustment for stock changes derived from the Local Units survey.

In order to derive the same detail as given in CIP90, the fuel expenditures in 1994 for each subsector (at 3-digit classification level) were broken down pro rata the 1990 proportions derived from CIP90. We thus had derived CIP94 expenditure on fuels at the same level of detail as given in CIP90. It would be helpful if future CIPs, at a minimum, separated expenditure on oils into transport and non-transport categories, given the foreseeable increased attention that will be accorded to transport policy.

For interest, a rough consistency check was carried out on the CIP90 data, 1990 having the nine fuel categories. The check entailed dividing the expenditure data by estimated prices in 1990 to see if the derived quantities related well to the quantities for industry given in *Energy in Ireland.* Remembering that the expenditure data cover manufacturing and therefore exclude Construction we expect the derived quantities to be lower than those given for industry in *Energy in Ireland.* Table A1.a.1 shows the results of the consistency check.

In the absence of a comprehensive dataset of prices consistent with the quantities of end-use energy, the price data from Shortall et al (1998) were used in the above exercise. It has been noted before that resources need to be made available for the assembly of time series of annual prices of the major fuels to end-users broken down by main end-user type, in order to reduce resort to unofficial and ad hoc data. Enquiries addressed to various sectoral or trade associations elicit a wide variation in prices paid. The wide variation may in fact be correct and it points to the need for comprehensive gathering of price data, differentiated by relevant category of fuel user.

Turning to the consistency check in Table A1.a.1, one would expect that derived quantities (which exclude construction) would be smaller than the DoE figures for industry in *Energy in Ireland.* This is the case. The fuels grouped under Other are however not well accounted for in CIP90, amounting to only a quarter of the DoE figure. Given the nature of this category it is hardly surprising and the category is very small in any case. There may be a tendency in the CIP to classify non-vehicle LPG with some of the oil categories.

It is not possible to derive much information from the consistency check relating to transport fuels in particular, since DoE do not break down use of transport fuels by sector. The study for 1990 by Forbairt broke down transport fuels into air, road rail and navigation, but not by industrial sector.

Given the figure of total use of fuels by Industry, estimated by DoE, and after setting aside a quantity of fuel used by construction (see below) quantities for each

Table A1.a.1: 1990 Consistency check to see if CIP90 expenditures by Manufacturing relate well to the quantities used by Industry given by DoE:

	Unit	SOLID FUELS	PETROL	O.GAS/D. OIL	ELECTRICITY	AUTODIESEL	RES FUEL OIL	PIPED GAS	Veh LPG	OTHER	TOTAL FUEL
Expenditure £											
CIP90 Tot Ind (ie Man incl FPW)	£	152,001,373	13,131,708	38,708,923	211,216,066	36,506,657	57,183,463	100,046,434	847,497	14,368,438	624,010,559
less Electricity NACE 161	£	136,291,000	82,434	1,940,000	0	1,293,873	23,079,007	63,458,000	10,226	34,061	226,188,601
Remainder	£	15,710,373	13,049,274	36,768,923	211,216,066	35,212,784	34,104,456	36,588,434	837,271	14,334,377	397,821,958
								12,700,000	: ie fertiliser		
								23,888,434			
Price of fuel charged											
to industry:	£/TOE	73.00	770.70	253.00	600.00	516.00	96.00	95.80	521.00	487.00	
(Source of price)		(IEC)	(IEA)	ERR	(IEC)	(IEA)	(IEA	(BGE)	ERR		
Derived quantity							ie HFO price)	ie ind+bulk)			
(ie remainder/price):	TOE	215,211	16,932	145,332	352,027	68,242	355,255	249,357	1,607	29,434	1,433,396
Compare with DoE quantities:											
Industry	TOE	245,000	0	152,000	397,000	0	420,000	372,000	0	122,000	1,722,000
All transport (Ag+Ind+Serv+Dom)	TOE		943,000			680,000		272,000	7,000		2,025,000
								i.e. excl fert IFI "fuel"			
Ratio											
Derived/DoE quantity	TOE	0.878		0.956	0.887		0.846	0.917		0.241	0.832
Comments:		reasonable		reasonable	reasonable		reasonable	reasonable		76% too low	

Notes: "ind + bulk" price for gas is the weighted average of two prices: the commercial/industrial price and the bulk/development price. IEC = Irish energy Centre. IEA = International Energy Agency.
CIP data in row 1 on solid fuel and residual fuel oil differ from the published results owing to a later revision.

manufacturing subsector were then calculated pro rata expenditures in the derived CIP94. A few alterations had to be made to this procedure in some cases, where 1994 quantities were known from other sources, as follows.

By contrast with CIP90, the figure in CIP94 for expenditure on gas (£6.3 million) by Basic Industrial Chemicals (sector 251, which includes the fertiliser industry), would appear to consist of that spent on fuel for combustion only. The fertiliser industry would pay a subsidised price for the sizeable quantity of combustion fuel, though the rest of the sector would not. Therefore a single gas price cannot be used and the quantity is derived separately in two parts, with the help of other information to hand:

Fertiliser:	spends £2.863 m	@ £26.51/TOE	∴ 108 kTOE
Remainder sector 251	∴ spends £3.426 m	@ £78.01/TOE (bulk)	∴ 44 kTOE
Total sector 251	spends £6.289 m		∴ 152 kTOE

As can be seen the derived consumption of gas in 1994 by sector 251 is estimated to be 152 kTOE.

Turning to the split between manufacturing and construction, probably the most important breakdown is for the fuel Other Gas/diesel Oil, which we know to be a significant fuel for construction, from discussions with the construction industry. A simple assumption was made that the £3.17 million expenditure by manufacturing, at a price of £240/TOE,[1] represented **135,000** TOE. With Industry's total estimated by DoE to be 215,000 TOE, this leaves 80,000 TOE for Construction. It will be seen to what extent this is compatible with the information derived separately for construction, below.

- *Construction*

Fuel use by the construction industry is given in the *Census of Building and Construction* (Statistical Bulletin December 1996, page 702) which shows the results of a survey of some 300 firms with 20 or more persons engaged. It is emphasised that there is much contracting-out of work so that the survey would underestimate the level of activity. Another source of information is the *Construction Industry Review and Outlook 1994-5*, page 54. The first question to be addressed is by how much should the construction industry's expenditure on fuel as given in the survey be grossed up to give the national total quantities? The grossing factor 4.2 which we decided to use was derived as follows.

Table A1.a.2: The construction industry in 1994

Actual (Review and Outlook):	
Gross Output	£4251.4 m (1)
Employment	77,400
Census:	
Gross Output	£1003 m
Employment	17,479
Potential Grossing factors:	

[1] This price is probably on the high side because many firms negotiate rebates for buying large quantities. However there would be delivery charges to be added.

Gross Output	4.2	i.e. 4251.4/1003
Employment	4.52	i.e. 77400/17479

(1) revised, source Paul Crowley in CSO. Advice was also obtained from Annette Hughes of DKM, Martin Howley of the Irish Energy Centre and George Hennessy of the Construction Industry Federation.

As shown in the table, the grossing factor 4.2 is derived from the Gross Output figures and is the lower of the two potential grossing factors. Grossing of the census figures for fuel expenditures and ensuing derivation of quantities is summarised in Table A1.a.3.

Table A1.a.3: Derivation of quantities of fuels used by the construction industry

	£m	Price# £/TOE	∴ TOE	Grossed up TOE
Census expenditure on "fuel"	12.77			
Of which: Assume* 5% LPG	0.64	321.8	1984	**8334**
Assume* 5% autodiesel	0.64	516.5	1236	**5192**
Assume* 90% gas oil	11.49	290	39631	166,450
Census expenditure on electricity	2.721	1152	2362	**9920**

* Assumptions as to the breakdown of expenditure on fuel have to be made here. More information would be useful. # Prices exclude VAT and are taken from the IEA, except LPG which is from the trade, and electricity which was given by the ESB for "unrestricted space heating tariff" as apparently Construction would not generally be on the Maximum Demand tariff.

The LPG figure of 8334 TOE is entered in Table 1.a.1. The electricity figure of 9920 TOE (entered as input equivalent of 31,346 TOE) is entered in Table 1.b.1. The figure 9920 is some four times larger than the ESB's figure (see Appendix Table A1.b.1) and may be too high, though it is small in absolute terms. The figure for gas oil had to be radically reduced owing to the constraints imposed by the control totals, as will be seen.

In particular since the total industrial non-transport use of Other Gas/diesel (including refinery gas and kerosene) is but 215,000 TOE from *Energy in Ireland*, the figure of 166,450 TOE was cut back to 80,048 TOE, which is the remainder after the manufacturing total was subtracted. More investigation of the breakdown of "fuel" used by the construction industry would be helpful, with a view to producing consistent data on national fuel use. It is possible that the official control total of 215,000 TOE for industrial use of Other Gas/diesel is too small. It is noted that it is about half the figure of 412,000 TOE + 15,000 TOE (kerosene) estimated for 1995 by the ESBI Strategic Consultancy Group in their five-yearly statistics *Energy Supply and Demand in Ireland.* ESBI show a correspondingly smaller figure for use by Services. Their breakdown between Services and Industry derives from data produced by OECD in the late 1980s.

Transport
Fuel use totals were taken from *Energy in Ireland.*

Services
In order to disaggregate Services into the two components (non-government services and government services), the breakdown by Forbairt, into Commercial and Public for

1990, was used pro rata. In the case of gas oil, however, the figure from CSO for Government Services, shown in Table A1.c.4 below, was used.

Residential
Fuel use totals were taken from *Energy in Ireland.*

Appendix A1.b: Attribution of fuels used by electricity generation to electricity purchasers

The task here is to create a column of electricity use broken down by consuming sector, shown in Table 1.b.1. *Energy in Ireland* gives electricity consumption by the main sectoral aggregates. Electricity consumption by Construction was estimated in Appendix A1.a above, and CIP94 data enable one to break down the remainder of industry's electricity consumption pro rata expenditure. The result of this exercise is the first column in Table A1.b.1.

An alternative source of information is the detailed breakdown of sales into 36 customer categories, from the ESB. These were converted to the classification used here and are entered as the second column, in k kWh, and in the third column, in TOE (one thousand kWh = 0.086 TOE). The final two columns give the information in percentage terms, for the DoE/CIP data and the ESB customer data, respectively, so that they can be compared and discussed. The main contrasts between DoE/CIP data and ESB data are now described.

Agriculture, forestry and fishing

Consumption of electricity by agriculture, forestry and fishing estimated by DoE includes an additional 9.16 per cent of total residential electricity consumption. (This was to allow for the fact that many farms do not purchase electricity on an agricultural tariff.) It is therefore to be expected that the DoE figures would be higher than those of the ESB, though whether the 9.16 per cent adjustment is sufficiently accurate is another matter. The National Farm Survey by Teagasc suggests a figure for agriculture by itself (excluding contractors and broiler industry et cetera) of some 30,000 TOE which is consistent with the DoE figure.

Fuel, Power and Water

The CIP94 expenditure figures were applied pro rata to the total for Fuel Power and Water. A zero is entered for own use of electricity, as in the CIP.

Industry

The totals for industry are reassuringly similar. The major discrepancy lies in the figures for Metals and Ores and for Chemical Products. It is probable that the ESB consider that production of Alumina is in the former category, whereas CSO classify Alumina as Chemical Products, because the product is still in fact a chemical when it is exported.

Transport

The ESB's figure is larger, possibly because the transport sector's use of electricity other than for motive power is included.

Residential

The lower DoE figure corresponds to the addition made to Agriculture (above).

Table A1.b.1: Comparing two breakdowns of electricity consumption, using DoE/CIP data and ESB customer data

Information sources:	DoE/CIP	ESB	ESB	DoE/CIP	ESB	
SECTOR	TOE pro rata Elec expen	k kWh	Converted to TOE	% (TOE pro rata Elec expen)	% (k kWh)	Comments
AGRI,FOR,FISH 01	**42,000**	**87,000**	**7,482**	**3.48**	**0.62**	ESB figure is smaller
Coal/lig/peat	317		0	0.03	0.00	
Petrol prod/lpg	1,459	19,000	1,634	0.12	0.14	
Electricity	0		0	0.00	0.00	
Gas	991		0	0.08	0.00	
Water	13,416		0	1.11	0.00	
Elec/gas/water	14,407	100,000	8,600	1.19	0.71	
FUEL,POWER,WATER 06	**16,183**	**119,000**	**10,234**	**1.34**	**0.85**	
Metals and ores 13	23,793	623,000	53,578	1.97	4.44	ESB figure is bigger
Non-met min prod 15	41,612	574,000	49,364	3.45	4.09	
Chemical prod. 17	90,835	854,000	73,444	7.53	6.08	
Metal prod exmc&tr 19	14,177	118,000	10,148	1.17	0.84	
Agr & industr mc 21	7,590	66,000	5,676	0.63	0.47	
ODP mc & prec inst 23	25,848	180,000	15,480	2.14	1.28	
Electrical goods 25	27,345	321,000	27,606	2.27	2.29	
Transport equipm 28	6,563	67,000	5,762	0.54	0.48	
Food bev tobac 36	116,828	1,269,000	109,134	9.68	9.03	
Textiles cl l&footw 42	23,240	251,000	21,586	1.93	1.79	
Paper &print prod 47	16,309	282,000	24,252	1.35	2.01	
Rubber & plastic pr 49	26,752	351,000	30,186	2.22	2.50	
O. Manufact prod 48	18,420	76,000	6,536	1.53	0.54	ESB figure is smaller
Construction 53	9,920	27,000	2,322	0.82	0.19	ESB figure is smaller
INDUSTRY	**449,233**	**5,059,000**	**435,074**	**37.22**	**36.02**	
TRANSPORT	**2,000**	**367,000**	**31,562**	**0.17**	**2.61**	ESB figure is bigger
SERVICES mkt	212,000	2,172,000	186,792	17.56	15.46	ESB figure is smaller
SERVICES non-mkt (govt)	70,584	928,000	79,808	5.85	6.61	
TOT SERVICES exc transp	**282,584**	**3,100,000**	**266,600**	**23.41**	**22.07**	
RESIDENTIAL	**415,000**	**5,314,000**	**457,004**	**34.38**	**37.83**	ESB figure is bigger
TOT final	**1,207,000**	**14,046,000**	**1,207,956**	**100.00**	**100.00**	

* Sector totals for the DoE/CIP column come from DoE's Energy in Ireland except that the figure for Industry excludes electricity used by FPW, which is entered higher up.

Industry plus FPW add to 452,000, DoE's total for Industry and the Energy sector (electricity's own use is netted out here).

1 k kWh = 0.086 TOE. Derivation of the figure of 9920 TOE for Construction is described in Appendix A1.a.

In keeping with the approach used in this paper, the official figures from DoE were used. No adjustment has been made for the different classification of water supply. Water Supply's expenditure on electricity amounts to £8.58 million according to CIP94. At an average price of 5.5 pence per kWh, or £639 per TOE, for this type of customer, it amounts to some 13,416 TOE. Expressed in terms of input to electricity generation this amounts to some 42,400 TOE. If this were to be entered in the Water Supply row, a corresponding amount would need to be subtracted from Non-market Services.

In Table 1.b.1, the electricity column equals column 1 from Appendix Table A1.b.1 multiplied by 3.16. The figure 3.16 is the ratio of inputs to outputs for electricity generation. This maintains the same grand total TOE at the bottom of the right hand column in Table 1.a.1 and in Table 1.b.1. The emission factor that will need to be applied will be the average for electricity inputs.

Appendix A1.c: Attribution of transport fuels to users of both transport and transport services

This appendix describes the derivation of Appendix Table A1.c.12, in which transport fuels are attributed to users of transport and of transport services. (It in turn is used to derive Table 1.c.1 in the main text.) Figures in bold type are those that are entered in Tables 1.a.1 and Appendix Table A1.c.12. Owing to gaps in the data encountered in the construction of Appendix Table A1.c.12, the task is approached from several angles, making first attempts by sector and then by fuel. The table should be viewed as preliminary. Some improvements ought to be possible in the future as pointed out in the text below.

In this first attempt at constructing a table in which transport fuels are attributed to the users, it is logical to break down the column for Autodiesel into Own Account use and use via Transport Services. Whether one hires transport or uses one's own vehicle is (largely) immaterial, as far as fuel use is concerned. Furthermore the data suggested this breakdown. The same breakdown into Own Account and consumption via use of Transport Services was not done for petrol, because use of petrol in Transport Services does not feature prominently, though this might be undertaken at some future date.

Control totals
The control totals along the base of this table are taken from the Transport row in Table 1.a.1, except that the 2,000 TOE of electricity used by transport is also included for completeness (6,320 TOE when expressed in input terms). In Table 1.a.1 end-use of electricity is not given, because only the inputs to electricity generation are shown. The control totals thus conform to the Transport row of DoE's Energy Balance tables for 1994, but with the use of electricity added. There is no official breakdown of these totals into major sectoral groups, so that, unlike with non-transport fuels, Appendix Table A1.c.12 has to be built with few sub-totals as guidelines.

As stated, figures from the DoE are used because their tables are the official ones. They present the most comprehensive information and would be the obvious source in a future routine exercise of this sort. There is evident need however for more resources than heretofore to be afforded to the construction of the official energy balances, having regard for the other sources of information on energy use, as described in Section 6 of the main text.

Discrepancies
From the outset it should be noted that the figure of 854,000 TOE for the control total for autodiesel is not in line with the figure of 921,360 TOE (1052.8 M litres on page 33) in the Revenue Commissioners Statistical Report 1994, which furthermore excludes trains. The total discrepancy could be in the region of 12 per cent.

Sectors
AGRI, FORESTRY, FISH:
Information on expenditure on fuels from the *National Farm Survey* in *1996* (from a separate calculation) can be used to estimate 1994 quantities, as follows:

Table A1.c.1: Derived quantities of fuel (Non-transport and Transport) used by the Agriculture, Forestry and Fishing sector.

	Expenditure data (NFS 1996)	**Quantity data (NFS 1996)**	**Quantity TOE (ie agri alone, 1996)**	**AGRI,FOR,FISH in 1994 **, TOE**
Non-transport: Fuel for tractors and machinery: other gas/ diesel (ie non-transport gas/diesel):	£66m	250 M litres (implicit price £26.4p/litre or £301.67/TOE)	218,780 TOE*	181,476 for agri alone #. DoE fig **259,000** is reasonable.
Electricity excl. household use:	£29 m	n.av. (Assume price £889.542/TOE + £2.5m st.charge)	29,800 TOE	24,711 for agri alone. DoE fig **42,000** is quite high
Transport: Car fuel: mainly DERV and petrol	£40.3m. Assume: 20% of expend. is DERV VAT regd. 40% DERV not VAT regd. 40% petrol.	n.av. Assume prices: £516.50/TOE £625.00/TOE £730.00/TOE	15,605 TOE 25,792 TOE (TotDERV 41,400) 22,082 TOE	34,341 **TotDERV** for agri alone. Add 20% for forestry + fishing, giving **41,209**. 18,317 **petrol** for agri alone. Use **25,000**.

NFS = National Farm Survey, Teagasc.
** Agricultural expenditure on Energy and Lubricants (Statistical Bulletin, Sept 1997, p.581) grew 20.556% between 1994 and 1996 and this growth rate is applied to the 1996 figures to derive figures for 1994.
# excluding agriculture contractors.
* 1 TOE = 1142.7 litres gas/diesel oil.

The figures in bold in the final column relating to non-transport are entered in Tables1.a.1 and Table 1.b.1 (electricity is entered as the input equivalent), and those relating to transport are entered in Appendix Table A1.c.12. As stated in the table above, the figure of 42,000 TOE of electricity is quite high but this may be due to the fact that the DoE add on 9.16% of total household electricity.

There are no DoE figures for transport fuels used by agriculture. The figures above, 29,260 TOE of DERV and 20,000 TOE of petrol are estimates, the DERV figure being constrained by the need to fit into the total for all sectors (see discussion of autodiesel, ie DERV, below).

[Note: A possible check on the above is the figure for total expenditure by Agriculture, on Energy and Lubricants (Statistical Bulletin, Sept 1997, p.581) of £172.7m. If we subtract estimated expenditure on non-transport fuels, namely electricity and tractor fuel, we are left with an estimate of expenditure on transport fuels, shown as the residual in Table A1.c.2.

Table A1.c.2: Derived expenditure on fuels by Agriculture

	DoE quantity, TOE	Price £/TOE	Derived expenditure
Electricity	42,000	889.542 excl. standing charge	£37.36 m + £2.5m for st.charge = £40m
Non-Transp: Tractor diesel	259,000	£268 (oil co.) £243.82 (DoE p.c.) £301.67 (NFS 1996	£78.13m using NFS price.
Transport Fuels	N.av.	implicit price)	£54.6m = **RESIDUAL**
Total			£172.7m.

p.c. = personal communication. There are several estimates of price that could be used.
NFS = National Farm Survey. The price probably includes delivery charge.
The standing charge is about £22 per year, the night-rate standing charge is higher. It is assumed that there are 100,000 farms in the state.

The residually derived figure of £54.6m spent by the sector on transport fuels can be compared with the figure of £40.3 m in the first column of Table A1.c.1. The latter excludes contractors, the broiler industry and horticulture, so the two figures are fairly consistent. However, with more investigation it may be possible to obtain a greater degree of consistency between the sources.]

Fuel, Power and Water + Manufacturing
Own account expenditure from the CIP94 can be used to derive quantities, as follows.

Petrol	£11,868,066	@730/TOE	gives	**16,258** TOE
Autodiesel	£34,148,339	@516.5/TOE	gives	**66,115** TOE
Vehicle LPG	£1,653,749	@521/TOE	gives	3,174 TOE

Residential Sector
The residential sector's consumption of transport fuels is derived from figures in the Household Budget Survey 1994-95, page 45, tabulated in the first column of Table A1.c.3.

Table A1.c.3: Derivation of quantities of transport fuels bought by the residential sector

	£/week/househ	National* £m	Price incl VAT £/TOE	TOE
Petrol	9.75	573.265	730.46	**784,800**
Diesel	1.90	111.713	570.78**	**195,720**
LPG	0.04	2.352	630.55	**3,733**

* There are 1,130,700 households in the state, according to the Labour Force Survey. ** One half is assumed to be bought excluding VAT, via the businesses which employ the residents.

Figures in the right hand column are entered (with minor adjustments) in Appendix Table A1.c.12.

Tourists
Tourists' consumption of fuels are added to the Residential sector's use. According to

Bord Failte, about 700,000 cars were brought to Ireland and 500,000 cars were hired in 1994. Assuming that each car is driven 500 miles at 35 miles per gallon, their petrol consumption is 17.143 m gallons. At 4.54609 litres to the gallon, this is 77.933 m litres. For petrol, 1267.6 litres = 1 TOE, so that the total use of petrol by tourists is estimated at **61,481** TOE.

Services non-market (i.e. government)
Figures for Government (Central and Local) expenditure on oil fuels for non-transport and transport purposes were obtained from CSO (Joe McNeill) and were converted as follows:

Table A1.c.4: Government Services' use of fuels

	Central Govt expend. £m	**LA expend. £m**	**Total Govt £m**	**Price incl VAT £/TOE**	**Derived quantity TOE**
Non-transport: CH oil, i.e. gas oil	4	32.2	36.2	268	**135,075**
Transport:	21 Assume 25/75% split petrol/autod:	21 25/75% split:	42		
Petrol	5.25	5.25	10.5	730	**14,384**
Autodiesel	15.75	15.75	31.5	625	**50,400**

The figure in the right hand column for Central Heating oil is entered in Table 1.a.1. Similarly the figures for petrol and autodiesel are entered in Appendix Table A1.c.12.

Construction
See estimation of fuel use by *Construction* in Appendix A1.a.

Miscellaneous
Business motor fuel: households' purchases of motor fuel which is refunded can be derived from the Household Budget Survey (Paddy McDonald). These amount to some 15% over and above households' consumption of motor fuels and are refunds claimed off business by people who are self-employed, who are employees or who have some other livelihood status. The total sum is £104.46 m and we assume a 70/30% split between expenditure on petrol and expenditure on autodiesel. If the respective prices are £730.46/TOE (which includes VAT, because it is not deductible on petrol), and 516.50/TOE (which excludes VAT), this gives a figure for petrol of 100,100 TOE and for autodiesel of 50,140 TOE. These figures refer to business use and will be borne in mind in allocating petrol and autodiesel below.

CIE Group
Personal communication (from Dermot Mills) yielded the following information:

Table A1.c.5: Use of autodiesel by the CIE Group and by national passenger and freight services

	CIE Tonnes	CIE TOE**	CIE's market share	National TOE
Passenger Road Transport: Bus Eirean	18,220	18,847	69%	27,314
Dublin Bus	24,013	24,839	99%	25,090 Tot bus 52,404
Passenger Rail Transport	23,760	24,577	100%	24,577
Rail Freight Transport*	12,800	13,240	100%	13,240 (rail 12,578 road 662)
TOTAL	78,793	81,503		90,221

* Rail Freight Transport actually includes CIE road freight, which is small, say, 5 per cent.
** 1 tonne autodiesel = 1.0344 TOE

The right hand column was broken down by sectoral use, approximately, as follows:

Table A1.c.6: CIE autodiesel allocated to sectoral users of CIE's transport services

	TOE
Passenger Road Transport: (Bus Eirean + Dublin Bus)	52,404 Assume all used by Residential sector
Passenger Rail Transport	24,577 Assume: **17,200** Residential 7,377 Business
Freight Transport	13,240 Assume non-residential
TOTAL	90,221

Taxis

The *Irish Bulletin of Vehicle Driver Statistics* published by the Department of the Environment, gives numbers of taxis, called "small public service vehicles". Their estimated mileage and fuel consumption are shown in Table A1.c.7.

Table A1.c.7: Fuel consumption by taxis

	No of taxis	Miles driven per year	mpg	Derived TOE
Petrol	2529	50,000	30	**15,117:** 10,582 priv, 4535 busin
Autodiesel	4344	50,000	37	**23,400:** 16,380 priv, 7020 busin

4.54609 litres = 1 gallon.
1267.6 litres petrol (unleaded 95) = 1TOE. 1142.7 litres autodiesel = 1 TOE.

It appears that there are only 50 taxis running on auto LPG according to the *Bulletin*, which would suggest that some 266 TOE of LPG is used. This is very approximate and should be investigated further.

Some 30% of taxi customers are business customers, the remainder are private customers.

Petrol

Oil consumption in 1994 broken down from CIP94 in the manner described above

gives a figure of £11,868,060 for the expenditure on petrol by Fuel, Power and Water + Manufacturing. At a price of £730/TOE this gives 16,258 TOE. From this and information given above, petrol consumption has been allocated as shown in Table A1.c.8. Petrol consumption by taxis, given in the second column, is added.

Table A1.c.8: Preliminary allocation of petrol consumption

	TOE	**Distributing taxis**	**TOTAL**
Agriculture, Forestry and Fishing	25,000		**25,000**
FPW + Manufacturing	16,258	459	**16,717**
Construction (say:)	2,000		**2,000**
Services market **remainder**	129,961	3,670	**133,631**
Services non-market (ie govt)	14,384	406	**14,790**
Residential	784,800	10,582	**856,862***
Taxis	15,117		0
Tourists	61,480	0	0
CONTROL TOTAL:	1049,000	15117	**1,049,000**

* Tourists consumption of petrol is included with Residential.

As the table shows, the remainder was allocated to Market Services. Taxis in Table A1.c.7 were split 70%, 10,582 TOE, to Residential and 30%, 4535 TOE, to Business. The latter, Business use, was allocated pro rata FPW+Manufacturing, Non-market Services and Market Services. In turn, petrol consumed by FPW+Manufacturing was broken down pro rata CIP94 expenditure on petrol. Further down, Table A5.13 shows this operation for petrol and other transport fuels.

Autodiesel

There are several ways to approach the allocation of consumption of transport diesel, which totals 854,000 TOE, and some components have been estimated above. A large amount of diesel is used by transport services on which there is some information. It was therefore decided to split the use of autodiesel into two columns: own account consumption and consumption via use of transport services. However, figures from the various sources are not easily reconciled. Two global approaches, with advice from B. Feeney (of Goodbody's stockbrokers), are as follows.

Approach 1. The Revenue Commissioners' statistical report for 1994 (page 33, col. 1) gives total consumption of autodiesel as 1,052,835 k litres or 921,360 TOE, on which duty paid amounted to £236,383,304, giving average duty of 22.452 pence per litre. This consumption includes use by (1) vehicles other than buses ("non-buses") paying duty at 23.549 pence per litre, and (2) buses paying 1.79 pence per litre. In order to work out the split of quantity into these two components:

Let S = the share of litres on which 23.549 pence per litre was paid, that is the share bought by vehicles other than buses. Then:

$$[S \times 23.549] + [(1 - S) \times 1.79] = 22.452$$

which yields S = .9496 ie the share of autodiesel used by non-buses = 999,772 k l = 874,921 TOE, but this will be scaled down (owing to the higher figure from CIE for buses, see below) to 868,956 TOE.

and 1 – S = .0504 ie buses' share of autodiesel = 53,063 k l = 46,437 TOE, but the higher figure of 52,404 TOE from CIE in Table A5.6 above, should be used.

Autodiesel used by non-buses, 868,956 TOE, needs to be broken down into use by diesel cars, taxis, private coaches and freight, as follows:

Private diesel cars number 124,000 (Table 13 of *Irish Bulletin of Vehicle Driver Statistics*, Department of the Environment), and at 15,000 miles per year and 37 miles per gallon gives a use of 228.533 m l or 200,000 TOE. This is too small, since it should include business use as well as residential use, but we saw that residential use derived from the Household Budget Survey (above) amounts to 195,000 TOE and business use must be at least 50,000 TOE (business refunds, above). Therefore a minimum figure for diesel cars is 240,000 TOE.

Road freight can be taken as the residual after subtraction of private diesel cars and taxis:

Road freight: 868,956 - 240,000 - 23,400 = 605,556 TOE.

The procedure needs to structure in the breakdown between Own Account and Transport Services and the following approach was considered to offer more promise.

Approach 2. Another approach, using the DoE control total of 854,000 TOE, is now given. There is (a) passenger transport and (b) freight, and we wish to find the split between them. Dealing with each in turn (all figures in TOE):

Table A1.c.9: Breakdown of Autodiesel

	Own Account	**Transport Services**	**Total**
(a) Passenger transport:			
private diesel cars	195,720		
business refunds	50,140		
buses		52,404	
trains		24,577	
		(17,200priv,7377business)	
taxis		23,400	
		(16380priv,7020business)	
Total Passenger	245,860	100,381	346,241
(b) TOT Freight: (residual from 854,000 TOE)			507,759
trains (95% of CIE figure in Table A5.5 above)		12,578	

therefore, road freight (residual)			495,181
Divide road freight pro rata RFTS Table 1:			
	35.1%	64.9%	100%
∴ Total freight incl trains	173,809	333,950	507,759
Total	**419,669**	**434,331**	**854,000**

Note: RFTS is the *Road Freight Transport Survey,* published by the CSO.

Now we have separate control totals for Autodiesel used by Own account and Transport services. The breakdown is based on the RFTS (*Road Freight Transport Survey)* proportions merely and more precision should be sought in future. It remains now to allocate the totals for Own account and Transport services to the detailed sectors and subsectors.

Starting with Own account, Table A1.c.10 shows the procedure, using figures already obtained in the analysis above.

Table A1.c.10: Breakdown of Own Account Autodiesel

	TOE
Agriculture, forestry and fishing	**41,209**
Fuel,P,W + Manufacturing	**66,115***
Construction	**5,192**
Services, mkt (Distribution)	**61,033 Residual**
Services, non-mkt (Govt+LA)	**50,400**
Residential	**195,720**
Total	**419,669**

* To be distributed pro rata own account expenditure on Autodiesel in the CIP94, shown in Appendix Table A1.c.12.

The business refunds are absorbed by the non-residential sectors. It is not clear to what extent recorded business fuel consumption includes this element of fuel. In the table it may be materialising in the residual which is market services.

Finally, the breakdown of Transport Services has to be made. As Table A1.c.11 shows, the total of 333,950 TOE used by freight is allocated first, by means of the RFTS breakdown (percentages derived from Table 1, Total Tonne-km, excluding the transport sector's own use). The other transport services, are added subsequently, in the final column. Trains and taxis used by business (7377 + 7020 = 14,397) are added pro rata diesel use on own account by FPW+Manufacturing, Market Services and Non-market Services (37.24%, 34.38% and 28.39% respectively, derived from Table A1.c.10 above). Buses and private use of trains and taxis (52,404 + 17,200 + 16,380 = 85,984) are all added to Residential.

Table A1.c.11: Breakdown of Transport Services use of Autodiesel

	Freight TOE	Add	Total TOE
Agriculture, forestry and fishing	5.44% = 18,167		**18,167**
Fuel, P,W + Manufacturing	52.39% = 174,956	5,361	**180,317***
Construction	5.2% = 17,365		**17,365**
Services Mkt (Distribution)	28.19% = 94,141	4,949	**99,090**
Services non-mkt (Govt + LA)	8.78% = 29,321	4,087	**33,408**
Residential		85,984	**85,984**
Total	100% = 333,950	100,381	**434,331**

*To be distributed pro rata expenditure on freight services given by CIP94.

The breakdown of use by Fuel, Power and Water + Manufacturing is made pro rata the expenditure of Freight Services in the CIP94, shown in Appendix Table A1.c.12.

Vehicle LPG

Vehicle LPG use by cars owned by the Residential sector was estimated above in Table A1.c.3 at 3,733 TOE. Use by taxis was crudely estimated at 266 TOE. Some 20 TOE were used by tour buses in 1994 (according to Calor Kosangas), though much less since. These total 4,019 TOE, which are attributed to the residential sector. In addition some 3,174 TOE were used by industry, though this is an approximation. It is based on CIP94 (in which the category of Vehicle LPG had to be estimated pro rata the CIP90 proportions). As DoE's Total of 8,000 TOE of LPG is to be used as the control total, there is a residual of 3,981 TOE to be allocated, of which Industry takes up 3,174 TOE, leaving 807 TOE still to be distributed. The amount of vehicle LPG used by the Construction industry is simply assumed to be 100 TOE. It is also assumed that 200 TOE are used by Market Services. The remaining 507 TOE (along with the 3,174 TOE, making 3,681 TOE) are attributed to Fuel, Power and Water plus Manufacturing, and distributed pro rata their expenditure in CIP94 on vehicle LPG on own account, shown in Table A1.c.12.

Aircraft kerosene

The 410,000 TOE of air kerosene is allocated pro rata weight transported. The weight of cargo in and out of Dublin on Aer Lingus planes is 107,000 tonnes, 36,000 in and out of Shannon and 4,000 in and out of Cork. The total cargo weighs, say, 150,000 tonnes. A passenger, including luggage and food, weighs 100 kg, so that 8,277,000 passenger movements (ISB Sept 1995 page 514) weigh 827,700 tonnes.

The 15% cargo and 85% passengers breakdown can be further divided into 15% cargo, 56% private passenger and 29% business passenger (passengers break down 66% private and 34% business according to Aer Lingus). Assume that the business passengers break down into 14% industrial and 15% services sector. A plausible sectoral breakdown therefore is shown in Table A1.c.13.

Table A1.c.12: Transport fuels in TOE attributed to users of transport and of transport services, 1994, (estimated)

Transport fuels are used directly (ie on own account) or indirectly (via use of transport services, eg by use of bus services).

SECTOR	NACE-CLIO R25	PETROL	AUTODIESEL Own account	AUTODIESEL Transp. serv.	Vehicle LPG	Kerosene (air)	RFO ships	Electricity (Input equiv)	TOTAL	Sector
AGRI,FOR,FISH	01	25,000	41,209	18,167	0	2,639			87,015	Agri,forest,fish
Coal/lig/peat		3	864	89	0	196			1,152	Coal/lig/peat
Petrol prod/lpg		184	768	593	0	706			2,251	Petrol prod/lpg
Electricity		6	119	0	1,426	0			1,551	Electricity
Gas		559	804	909	0	0			2,273	Gas
Water		145	584	0	32	0			760	Water
Elec/gas/water		710	1,507	909	1,458	0			4,583	Elec/gas/water
FUEL,POWER,WATER	06	897	3,140	1,590	1,458	902			7,987	Fuel,power,water
Metals and ores	13	113	2,226	5,432	11	1,090			8,872	Metals and ores
Non-met min prod	15	848	20,196	21,759	210	2,184			45,197	Non-met min prod
Chemical prod.	17	1,989	2,697	17,173	24	21,628			43,511	Chemical prod.
Metal prod exmc&tr	19	1,305	3,339	4,744	394	1,990			11,774	Metal prod exmc&tr
Agr & industr mc	21	822	1,019	3,814	156	2,873			8,683	Agr & industr mc
ODP mc & prec inst	23	691	193	15,703	58	24,179			40,824	ODP mc & prec inst
Electrical goods	25	1,000	537	18,008	30	16,939			36,513	Electrical goods
Transport equipm	28	200	752	1,919	84	2,044			4,999	Transport equipm
Food bev tobac	36	2,891	23,593	57,504	363	31,228			115,579	Food bev tobac
Textiles cl l & footw	42	1,076	815	6,035	166	5,102			13,194	Textiles cl l&footw
Paper & print prod	47	3,127	2,435	9,424	257	2,364			17,607	Paper &print prod
Rubber & plastic pr	49	704	1,673	9,578	252	2,741			14,948	Rubber & plastic pr
O. Manufact prod	48	1,055	3,501	7,633	218	1,099			13,506	O. Manufact prod
Construction	53	2,000	5,192	17,365	100	0			24,657	Construction
INDUSTRY (excl FPW)	Tot	17,820	68,167	196,092	2,323	115,460			399,862	INDUSTRY
TOTAL TRANSPORT	61+63+65	0	0	0	0	0	0	0	0	TOTAL TRANSPORT
SERVICES mkt	56,59,67, 69,74	133,631	61,033	99,090	200	31,000			324,954	SERVICES mkt
SERVICES non-mkt (govt)	86	14,790	50,400	33,408		30,000			128,598	SERVICES non-mkt (govt)
TOT SERVICES	56,59,67, 69,74,86	148,421	111,433	132,498	200	61,000			453,552	TOT SERVICES
RESIDENTIAL		856,862	195,720	85,984	4,019	230,000	25,000	6,320	1,403,905	RESIDENTIAL
TOTAL final energy (excl FPW)		1,048,103	416,529	432,741	6,542	409,098	25,000	6,320	2,344,333	TOT final energy (excl FPW)
TOTAL transport fuel allocated		1,049,000	419,669	434,331	8,000	410,000 410,000	25,000	6,320	2,352,320	TOTAL
TOTAL autodiesel check				854,000						

SECTOR	NACE-CLIO R25	PETROL	AUTODIESEL Own account	AUTODIESEL Transp. serv.	Vehicle LPG	Kerosene air	RFO ships	Electricity (Input equiv)	TOTAL	SECTOR

Notes:

Autodiesel total from DoE of 854,000 TOE disagrees with Revenue Commissioners' Report 1994 p.33 figure of 921.36ktoe, or 1052.8 m l, which furthermore excludes diesel used by trains.

Ships: not included here are 40 ktoe that go to ships' bunkers. The 25 ktoe is assumed to be used mainly by pleasure craft, of which 1/3 is by tourism.

Air: Used weight to allocate fuel use.

See appendix A1.c for a description of the derivation of this table.

Table A1.c.13: Allocation of kerosene used by aircraft, TOE

Industry etc	29%	**119,000**
Services	15%	
Of which mkt	8%	**31,000**
Non-market	7%	**30,000**
Residential	56%	**230,000**
TOTAL air kerosene	100%	**410,000**

These figures are duly entered in Table A1.c.12.

RFO Ships

The 25,000 TOE is assumed to be used mainly by pleasure craft, of which one third is by tourism. Another 40,000 TOE is in fact used in ships' bunkers, but it is not included here as it does not appear in *Energy in Ireland.*

Electricity

Electricity is used mainly in the DART and is therefore assumed to be used by the Residential sector. However a small amount is also used in electric vehicles, such as milk delivery vans, which have not been allowed for here.

Appendix A2: CO2 Emission factors

The following emission factors were obtained from McGettigan, EPA.

	Tonnes of CO2 per TOE
Solid fuel: power	3.939
Solid fuel: Ind	3.586
Solid fuel: Comm	4.164
Solid fuel: Resid	4.062
Other Gas/Diesel	3.060
RFO	3.180
Petrol	2.920
Autodiesel	3.060
Veh lpg	2.670
Gas	2.300
O lpg & renewables 50/50	1.335
Kerosene (air)	2.980
Electricity/toe in	3.290
Electricity/toe out	10.401
Hydro	0.000
O lpg & renewables 65/35	1.736

Note: Use of Kerosene (air) is entered in Other Gas/Diesel column, transport row. O lpg & renewables 50/50 is other (non-tranpsort) LPG and renewables, 50 per cent each.

Appendix A3: Sources of data on acidifying emissions

Emissions of SO_2 (sulfur dioxide), NOx (nitrous oxide) and NH_3 (ammonia) have been estimated by McGettigan (1996) in accordance with the UNECE classification. Many entries in his table were immediately usable in the construction of the tables in this project. For the remainder, the breakdown according to the classification used in this document was achieved by undertaking two main tasks. The first entailed obtaining a disaggregation by fuel from McGettigan of those emissions which required to be broken down into our sectoral detail. The second task was to break down the emissions according to our sectoral detail pro rata detailed fuel use, which had already been estimated in this project.

The first task, the disaggregation of emissions of SO_2, and NOx by fuel, is shown in Table A3.1.

Table A3.1: Disaggregation of emissions of SO_2 and NOx (in tonnes) by fuel

Fuels	Commercial		Industry		Road Transport	
	SO_2	NOx	SO_2	NOx	SO_2	NOx
Peat	132	46	0	0		
Coal	24	2	4685	3660		
Gasoil	3403	1215	1072	766		
Fuel oil	0	0	33,814	3750		
Kerosene*	9700	924	60	134		
Nat gas	0	354	0	1272		
LPG	0	23	0	264	0	293
Petrol					1970	28,130
Diesel					4550	15,810
Subtotal	13,259	2564	39,631	9846	6520	44,233
Waste incin.		60				
Fertilisers				280		
O. mobile+mc					2422	9507
Less agric.					-521	-4282
TOTAL	13,259	2,624	39,631	10,126	8,421	49,458

Source: McGettigan, private communication, 26.5.1998.

Kerosene was allocated pro rata gas oil, because the CIP does not itemise kerosene. Waste incineration is assumed to be 80 per cent by private industry and 20 per cent by the state sector. The breakdown of the Commercial (i.e. Services) sector was made pro rata fuel use.

In the second task, the figures for industry in the above table were broken down in to subsectors pro rata the use of the various fuels by industry. For the table in which emissions from transport are attributed to transport users, the residual fuel oil used by inland water craft and the electricity used by the DART were attributed to the Residential sector. Emissions from other transport fuels were distributed pro rata figures already calculated for use of transport fuels. NH_3 emitted by transport is the result of petrol use and was therefore distributed accordingly.

Finally, as to information on other emissions including CH_4 and N_2O, their derivation is described by McGettigan (1993) in the *Corinair 1990 Emissions Inventory*. The

emission factors from combustion are given in his Tables 3.3, 3.4, 3.5 and 3.6. He too depended on the energy balances given in *Energy in Ireland* by DoE for the energy figures which were used to calculate the emissions related to combustion. Figures from power generation were however supplied by the ESB. Emissions of CH_4 due to gas losses were estimated with information supplied by Bord Gais. Emissions due to waste treatment and disposal were estimated with information from the then Foras Forbatha and a report by consultants ERL. Estimation of emissions from agriculture had recourse to various sources including Teagasc and default emission factors from the CORINAIR handbook. Statistics relating to agriculture and forestry relied on data from CSO publications and from the Forest Service.