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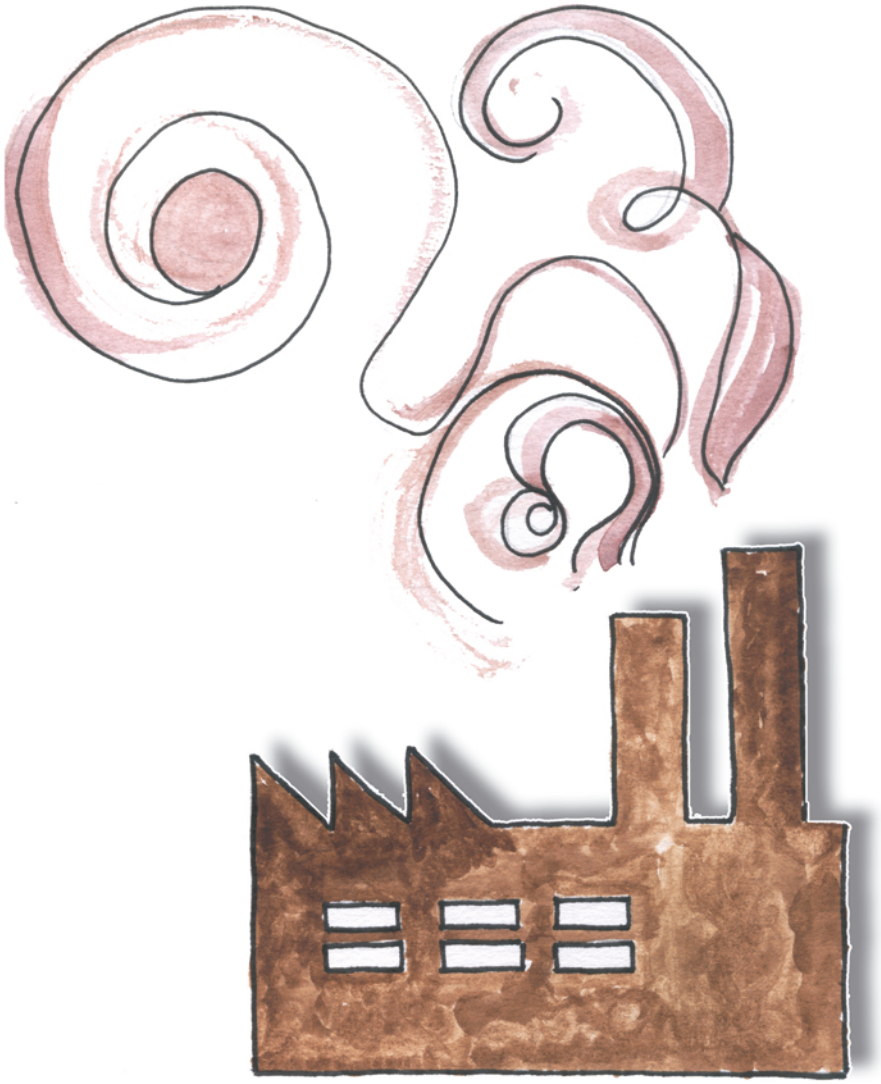
Italian Emission Inventory 1990 - 2006

Informative Inventory Report 2008



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Protection and Research

Italian Emission Inventory
1990-2006

Informative Inventory Report 2008

Daniela Romano, Antonella Bernetti, Rocío D. Cóndor,
Riccardo De Lauretis, Marina Vitullo

ISPRA - Institute for Environmental Protection and Research

Annual Report for submission under the UNECE Convention
on Long-range Transboundary Air Pollution

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This publication refers to activities carried out prior to the unification of the three institutions and, therefore, individual reference is still made to them.

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EXECUTIVE SUMMARY

This report is the first Italian Informative Inventory Report (IIR) in the framework of the United Nations Economic Commission for Europe (UNECE) Convention on Long Range Transboundary Air Pollution (CLRTAP). It contains information on the Italian inventory up to the year 2006, including an explanation of methodologies, data sources, QA/QC activities and verification processes carried out during the inventory compilation, with an analysis of emission trends and a description of key categories.

The aim of the document is to facilitate understanding of the calculation of the Italian air pollutant emission data, hence providing a common means for comparing the relative contribution of different emission sources and helping in the identification of reduction policies.

The Agency for Environmental Protection and Technical Services (APAT) has the overall responsibility for the emission inventory submission to CLRTAP, as well as to the United Nations Framework Convention on Climate Change (UNFCCC), and is in charge of all work related to inventory compilation.
In particular, in compliance with the LRTAP Convention, Italy has to submit annually data on national emissions of SO_X, NO_X, NMVOC, CO and NH_3, and various heavy metals and POPs. The submission consists of the national emission inventory, communicated through compilation of the Nomenclature Reporting Format (NRF), and the informative inventory report (IIR) to ensure the properties of transparency, consistency, comparability, completeness and accuracy.

In the period 1990-2006 emissions from most pollutants described in this report show a downward trend. Reductions are especially relevant for the main pollutants (SO_X -78%; NO_X -45%; CO -50%; NMVOC -41%) and lead (-94%) whereas a significant raise is observed for polycyclic aromatic hydrocarbons (+46%).
The major drivers for the trend are reductions in the industrial and road transport sectors, due to the implementation of various European Directives which introduced new technologies, plant emission limits, the limitation of sulphur content in liquid fuels and the shift to cleaner fuels. Emissions have also decreased for the improvement of energy efficiency as well as the promotion of renewable energy.
The energy sector is the main source of emissions in Italy with a share of more than 80% in many pollutants (SO_X 93%; NO_X 98%; CO 88%; $PM_{2.5}$ 82%). The industrial processes sector is an important source of emissions specifically from the iron and steel production, at least regarding particulate matter, heavy metals and POPs, whereas significant emissions of SO_X and particulate matter derive from cement production; on the other end, the solvent and other product use sector is characterized by NMVOC emissions. The agriculture sector is the main source of NH_3 emissions in Italy with a share of more than 94% in national total. Finally, the waste sector, specifically waste incineration, is a relevant source for HCB, PAH and dioxin emissions (39%, 24% and 13%, respectively).

Emission figures of the Italian emission inventory and other related documents are publicly available at http://www.sinanet.apat.it/it/sinanet/serie_storiche_emissioni.

1 INTRODUCTION

1.1 Background information on the Convention on Long-range Transboundary Air Pollution

The 1979 Geneva Convention on Long-range Transboundary Air Pollution, contributing to the development of international environmental law, is one of the fundamental international means for the protection of the human health and the environment through the intergovernmental cooperation.

The fact that air pollutants could travel several thousands of kilometres before deposition and damage occurred outlined the need for international cooperation.

In November 1979, in Geneva, 34 Governments and the European Community (EC) signed the Convention. The Convention on Long-range Transboundary Air Pollution was ratified by Italy in the year 1982 and entered into force in 1983. It has been extended by the following eight specific protocols:

- The 1984 Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP); 42 Parties. Entered into force on 28th January 1988.
- The 1985 Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent; 23 Parties. Entered into force on 2nd September 1987.
- The 1988 Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes; 31 Parties. Entered into force on 14th February 1991.
- The 1991 Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes; 22 Parties. Entered into force on 29th September 1997.
- The 1994 Protocol on Further Reduction of Sulphur Emissions; 27 Parties. Entered into force on 5th August 1998.
- The 1998 Protocol on Heavy Metals; 28 Parties. Entered into force on 29 December 2003.
- The 1998 Protocol on Persistent Organic Pollutants (POPs); 28 Parties. Entered into force on 23rd October 2003.
- The 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone; 23 Parties. Entered into force on 17th May 2005. (Guidance documents to Protocol adopted by decision 1999/1).

As regards Italy, the following table shows the dates of signature and ratification of both Convention and Protocols.

	Signature	**Ratification**
1979 Convention	14/11/1979	15/07/1982
1984 EMEP Protocol	28/09/1984	12/01/1989
1985 Sulphur Protocol	09/07/1985	05/02/1990
1988 NO_X Protocol	01/11/1988	19/05/1992
1991 VOC Protocol	19/11/1991	30/06/1995
1994 Sulphur Protocol	14/06/1994	14/09/1998
1998 Heavy Metals Protocol	24/06/1998	
1998 POPs Protocol	24/06/1998	20/06/2006
1999 Multi-effect Protocol	01/12/1999	

Table 1.1 Dates of signature and ratification of the UNECE Convention and Protocols by Italy

The following classes of pollutants should be included in the emission inventory:

Main Pollutants

- Sulphur oxides (SO_X), in mass of SO_2;
- Nitrous oxides (NO_X), in mass of NO_2;
- Carbon monoxide (CO);
- Non-methane volatile organic compounds (NMVOC);
- Ammonia (NH_3).

Particulate matter

- PM_{10}, particulate matter less than 10 microns in diameter;
- $PM_{2.5}$, particulate matter less than 2.5 microns in diameter.

Heavy Metals

- Priority Metals: Lead (Pb), Cadmium (Cd) and Mercury (Hg);
- Other metals: Arsenic (As), Chrome (Cr), Copper (Cu), Nickel (Ni), Selenium (Se) and Zinc (Zn).

Persistent organic pollutants (POPs)

- As specified in Annex I of the POPs Protocol;
- As specified in Annex II of the POPs Protocol, including Polychlorinated Biphenyls (PCBs);
- As specified in Annex III of the POPs Protocol: Dioxins (Diox), Polycyclic Aromatic Hydrocarbons (PAHs), Hexachlorobenzene (HCB);
- Other POPs.

1.2 National Inventory

As a Party to the United Nations Economic Commission for Europe (UNECE) Convention on Long Range Transboundary Air Pollution (CLRTAP), Italy has to submit annually data on emissions of air pollutants in order to fulfil obligations, in compliance with the implementation of Protocols under the Convention. Parties are required to report on annual national emissions of SO_X, NO_X, NMVOC, CO and NH_3, and various heavy metals and POPs according to the Guidelines for Estimating and Reporting Emission Data under the Convention on Long-range Transboundary Air Pollution (UNECE, 2003).
Specifically, the submission consists of the national LRTAP emission inventory, communicated through compilation of the Nomenclature Reporting Format (NRF) and the informative inventory report (IIR).
The Italian informative inventory report contains information on the national inventory for the year 2006, including descriptions of methods, data sources, QA/QC activities carried out and a trend analysis. The inventory accounts for anthropogenic emissions of the following substances: sulphur oxides (SO_X), nitrogen oxides (NO_X), ammonia (NH_3), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), particulate matter, particles of size <10 μm, (PM_{10}), particulate matter, particles of size < 2.5μm, ($PM_{2.5}$), lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As), chromium (Cr), copper (Cu), nickel (Ni), selenium (Se), zinc (Zn), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAH), dioxins (Diox), hexachlorobenzene (HCB). Other pollutants are reported either as not estimated or not occurring, further investigation is planned to verify these emissions.

Detailed information on emission figures of primary pollutants, particulate matter, heavy metals and persistent organic pollutants as well as estimation procedures are provided in order to improve the transparency, consistency, comparability, accuracy and completeness of the inventory provided.
The national inventory is updated annually in order to reflect revisions and improvements in the methodology and the availability of new information. Adjustments are applied retrospectively to earlier years, which accounts for any difference in previously published data.
Total emissions from 1990 to 2006 are reported in Table 1.2 by pollutant.

		1990	1995	2000	2001	2002	2003	2004	2005	2006
SO_X	*Mg*	1,794,116	1,319,865	754,770	704,373	622,223	525,304	488,250	407,593	388,610
NO_X	*Mg*	1,941,196	1,808,166	1,373,121	1,351,615	1,258,122	1,249,435	1,180,152	1,111,646	1,061,273
NMVOC	*Mg*	1,978,853	2,004,682	1,496,175	1,425,098	1,330,000	1,288,547	1,258,765	1,212,379	1,173,962
NH_3	*Mg*	464,367	446,653	441,247	444,348	433,935	429,423	422,684	411,418	408,468
CO	*Mg*	7,123,484	7,155,215	5,122,783	5,057,746	4,445,979	4,345,689	4,182,407	3,807,657	3,576,275
As	*kg*	37,339	27,495	45,716	46,208	42,035	42,617	42,071	40,658	41,631
Cd	*kg*	10,052	9,383	8,841	8,738	7,011	7,262	7,894	8,171	8,372
Cr	*kg*	87,715	69,126	46,352	46,909	47,092	49,434	51,818	53,344	54,554
Cu	*kg*	52,983	52,802	47,521	46,779	45,630	47,017	48,426	50,578	51,533
Hg	*kg*	11,784	10,699	9,592	9,810	9,593	9,515	10,338	10,383	10,708
Ni	*kg*	168,766	159,600	154,702	161,340	162,956	164,093	164,011	162,383	159,895
Pb	*kg*	4,378,388	1,928,291	935,221	701,940	236,809	241,638	256,127	265,700	274,348
Se	*kg*	10,072	10,421	11,351	11,640	11,676	12,205	12,565	12,693	12,764
Zn	*kg*	870,021	844,387	802,842	804,255	802,839	818,983	864,907	871,363	942,556
PM_{10}	*Mg*	245,311	240,537	199,848	199,376	187,452	184,172	184,895	173,802	171,198
$PM_{2.5}$	*Mg*	209,677	204,714	165,726	163,560	152,386	148,924	149,281	138,813	136,556
PAH	*kg*	92,098	111,222	119,752	120,726	110,619	115,663	134,091	129,902	134,362
Dioxin	*g I T_{eq}*	473	460	369	293	283	282	290	294	302
HCB	*kg*	19	20	20	30	32	32	23	21	22
PCB	*kg*	242	252	226	231	237	240	245	237	246

Table 1.2 Emission time series by pollutant

The NRF files and other related documents can be found on website at the following address: http://www.sinanet.apat.it/it/sinanet/serie_storiche_emissioni.

1.3 Institutional arrangements

The Agency for Environmental Protection and Technical Services (APAT) has the overall responsibility for the emission inventory and submissions to CLRTAP; the agency is also responsible for the communication of the pollutants under the NEC directive as well as to carry out scenarios, jointly with the Agency for Energy, New technologies and Environment (ENEA), as established by the Legislative Decree n. 171 of 21st May 2004. Moreover, APAT is the single entity in charge of the development and compilation of the national greenhouse gas emission inventory as indicated by the Legislative Decree n. 51 of 7th March 2008. The Ministry for the Environment, Land and Sea is responsible for the endorsement of the inventory and for the communication to the Secretariat of the different conventions.

The Italian National System, currently in place, is fully described in the document 'National Greenhouse Gas Inventory System in Italy' (APAT, 2008 [a]).

A specific unit of the Agency is responsible for the compilation of the Italian Atmospheric Emission Inventory and the Italian Greenhouse Gas Inventory in the framework of both the Convention on Climate Change and the Convention on Long Range Transboundary Air Pollution. The whole inventory is compiled by the agency; scientific and technical institutions and consultants may help in improving information both on activity data and emission factors of specific activities. All the measures to guarantee and improve the transparency, consistency, comparability, accuracy and completeness of the inventory are undertaken.

APAT bears the responsibility for the general administration of the inventory, co-ordinates participation in review processes, publishes and archives the inventory results.

Specifically, APAT is responsible for all aspects of national inventory preparation, reporting and quality management. Activities include the collection and processing of data from different data sources, the selection of appropriate emissions factors and estimation methods consistent with the EMEP/CORINAIR guidelines, IPCC 1996 Revised Guidelines, the IPCC Good Practice Guidance and Uncertainty management and the IPCC Good Practice Guidance for land use, land-use change and forestry, the compilation of the inventory following the QA/QC procedures, the preparation of the Informative Inventory Report and the reporting through the Nomenclature Reporting Format, the response to review checks, the updating and data storage.

Different institutions are responsible for statistical basic data and data publication, which are primary to APAT for carrying out emission estimates. These institutions are part of the National Statistical System (Sistan), which provides national official statistics, and therefore are asked periodically to update statistics; moreover, the National Statistical System ensures the homogeneity of the methods used for official statistics data through a coordination plan, involving the entire public administration at central, regional and local levels.

The main Sistan products, which are primarily necessary for the inventory compilation, are:

- National Statistical Yearbooks, Monthly Statistical Bulletins, by ISTAT (National Institute of Statistics);
- Annual Report on the Energy and Environment, by ENEA (Agency for New Technologies, Energy and the Environment);
- National Energy Balance (annual), Petrochemical Bulletin (quarterly publication), by MSE (Ministry of Economic Development);
- Transport Statistics Yearbooks, by MINT (Ministry of Transportation);
- Annual Statistics on Electrical Energy in Italy, by TERNA (National Independent System Operator);
- Annual Report on Waste, by APAT;

- National Forestry Inventory, by MIPAAF (Ministry of Agriculture, Food and Forest Policies).

The national emission inventory itself is a Sistan product.
Other information and data sources are used to carry out emission estimates, which are generally referred to in Table 1.3 in the following section 1.5.

1.4 Inventory preparation process

APAT has established fruitful cooperation with a number of governmental and research institutions as well as industrial associations, which helps improving some leading categories of the inventory. Specifically, these activities aim at the improvement of provision and collection of basic data and emission factors, through plant-specific data, and exchange of information on scientific researches and new sources. Moreover, when in depth investigation is needed and a high uncertainty in the estimates is present, specific sector analyses are committed to ad hoc research teams or consultants.
APAT also coordinates with different national and regional authorities and private institutions for the cross-checking of parameters and estimates, as well as with ad hoc expert panels, in order to improve the completeness and transparency of the inventory.
The main basic data needed for the preparation of the national emission inventory are energy statistics, published by the Ministry of Economic Development (MSE) in the National Energy Balance (BEN), statistics on industrial and agricultural production, published by the National Institute of Statistics (ISTAT), statistics on transportation, provided by the Ministry of Transportation (MINT), and data supplied directly by the relevant professional associations.
Emission factors and methodologies used in the estimation process are consistent with the EMEP/CORINAIR Guidebook, the IPCC Good Practice Guidance as well as supported by national experiences and circumstances. Final decisions are up to inventory experts, taking into account all the information available.
For the industrial sector, emission data collected through the National Pollutant Emission Register (EPER), the Large Combustion Plant (LCP) Directive and in the framework of the European Emissions Trading Scheme have yielded considerable developments in the inventory of the relative sectors. In fact, these data, even if not always directly used, are taken into account as a verification of emission estimates and improve national emissions factors as well as activity data figures.
In addition, final estimates are checked and verified also in view of annual environmental reports by industries.
For large industrial point sources, emissions are registered individually, when communicated, based upon detailed information such as fuel consumption.
Other small plants communicate their emissions which are also considered individually.
Emission estimates are drawn up for each sector. Final data are communicated to the UNECE Secretariat filling in the NRF files.
The process of the inventory preparation is carried out annually. In addition to a new year, the entire time series is checked and revised during the annual compilation of the inventory. In particular, recalculations are elaborated on account of changes in the methodologies used to carry out emission estimates, changes due to different allocation of emissions as compared to previous submissions and changes due to error corrections. The inventory may also be expanded by including categories not previously estimated if sufficient information on activity data and suitable emission factors have been identified and collected. Information on the major

recalculations is provided in the sectoral chapter of the report.
All the reference material, estimates and calculation sheets, as well as the documentation on scientific papers and the basic data needed for the inventory compilation, are stored and archived at the Agency. After each reporting cycle, all database files, spreadsheets and electronic documents are archived as 'read-only-files' so that the documentation and estimates could be traced back during the review process or the new year inventory compilation.
Technical reports and emission figures are publicly accessible on the web at the address http://www.sinanet.apat.it/it/sinanet/serie_storiche_emissioni.

1.5 Methods and data sources

An outline of methodologies and data sources used in the preparation of the emission inventory for each sector is provided in the following. In Table 1.3 a summary of the activity data and sources used in the inventory compilation is reported.
Methodologies are consistent with the EMEP-CORINAIR Emission Inventory Guidebook, Revised 1996 IPCC Guidelines and IPCC Good Practice Guidance and (EMEP/CORINAIR, 2005; IPCC, 1997; IPCC, 2000); national emission factors are used as well as default emission factors from international guidebooks, when national data are not available. The development of national methodologies is supported by background documents.
The most complete document describing the national methodologies used in the emission inventory compilation is the National Inventory Report, submitted in the framework of the UN Convention on Climate Change and the Kyoto Protocol (APAT, 2008 [b]).

SECTOR	ACTIVITY DATA	SOURCE
1 Energy 1A1 Energy Industries	Fuel use	Energy Balance - Ministry of Economic Development Major national electricity producers
1A2 Manufacturing Industries and Construction	Fuel use	Energy Balance - Ministry of Economic Development Major National Industry Corporation
1A3 Transport	Fuel use Number of vehicles Aircraft landing and take-off cycles and maritime activities	Energy Balance - Ministry of Economic Development Statistical Yearbooks - National Statistical System Statistical Yearbooks - Ministry of Transportation
1A4 Residential-public-commercial sector	Fuel use	Energy Balance - Ministry of Economic Development
1B Fugitive Emissions from Fuel	Amount of fuel treated, stored, distributed	Energy Balance - Ministry of Economic Development Statistical Yearbooks - Ministry of Transportation Major National Industry Corporation
2 Industrial Processes	Production data	National Statistical Yearbooks- National Institute of Statistics International Statistical Yearbooks-UN Sectoral Industrial Associations
3 Solvent and Other Product Use	Amount of solvent use	National Environmental Publications - Sectoral Industrial Associations International Statistical Yearbooks - UN
4 Agriculture	Agricultural surfaces Production data Number of animals Fertiliser consumption	Agriculture Statistical Yearbooks - National Institute of Statistics Sectoral Agriculture Associations
5 Land Use, Land Use Change and Forestry	Forest and soil surfaces Amount of biomass Biomass burnt Biomass growth	Statistical Yearbooks - National Institute of Statistics State Forestry Corps National and Regional Forestry Inventory Universities and Research Institutes
6 Waste	Amount of waste	National Waste Cadastre - Agency for Environmental Protection and Technical Services, National Waste Observatory

Table 1.3 Main activity data and sources for the Italian Emission Inventory

Activity data used in emission calculations and their sources are briefly described herebelow.
In general, for the energy sector, basic statistics for estimating emissions are fuel consumption published in the Energy Balance by the Ministry of Economic Development. Additional information for electricity production is provided by the major national electricity producers and by the major national industry corporation. On the other hand, basic information for road transport, maritime and aviation, such as the number of vehicles, harbour statistics and aircraft landing and take-off cycles are provided in statistical yearbooks published both by the National Institute of Statistics and the Ministry of Transportation. Other data are communicated by different category associations.
The analysis of data from the Italian Emissions Trading Scheme database is used to develop country-specific emission factors and check activity data levels. In fact, APAT is also responsible for developing, operating and maintaining the national registry under Directive 2003/87/CE as instituted by the Legislative Decree 51 of March 7th 2008; the Agency performs this tasks under the supervision of the national Competent Authority for the implementation of directive 2003/87/CE, jointly established by the Ministry for Environment, Land and Sea and the Ministry for Economic Development.
For the industrial sector, the annual production data are provided by national and international statistical yearbooks. Emission data collected through the National Pollutant Emission Register (EPER) are also used in the development of emission estimates or taken into account as a

verification of emission estimates for some specific categories. According to the Italian Decree of 23 November 2001, data from the Italian EPER are validated and communicated by APAT to the Ministry for the Environment, Land and Sea and to the European Commission within October of the current year for data referring to the previous year. These data are not always directly used for the compilation of the inventory because industries communicate figures only if they exceed specific thresholds; furthermore, basic data such as fuel consumption are not supplied and production data are not split by product but reported as an overall value. Anyway, EPER is a good basis for data checks and a way to facilitate contacts with industries which, in many cases, supply, under request, additional information as necessary for carrying out sectoral emission estimates.
In addition, final emissions are checked and verified also taking into account figures reported by industries in their annual environmental reports.
Both for energy and industrial processes, emissions of large industrial point sources are registered individually; communication also takes place in the framework of the European Directive on Large Combustion Plants, based upon detailed information such as fuel consumption. Other small plants communicate their emissions which are also considered individually.
For the other sectors, i.e. for solvents, the amount of solvent use is provided by environmental publications of sector industries and specific associations as well as international statistics.
For agriculture, annual production data and number of animals are provided by the National Institute of Statistics and other sectoral associations.
For waste, the main activity data are provided by the Agency for Environmental Protection and Technical Services and the Waste Observatory.

In case basic data are not available proxy variables are considered; unpublished data are used only if supported by personal communication and confidentiality of data is respected.
All the material and documents used for the inventory emission estimates are stored at the Agency for Environmental Protection and Technical Services. The inventory is composed by spreadsheets to calculate emission estimates; activity data and emission factors as well as methodologies are referenced to their data sources.
A ‘reference’ database has also been developed to increase the transparency of the inventory; at the moment, it is complete as far as references to greenhouse gas emissions are concerned.

1.6 Key categories

A key category analysis of the Italian inventory is carried out according to the Tier 1 method described in the IPCC Good Practice (IPCC, 2000). According to these guidelines, a key category is defined as an emission category that has a significant influence on a country’s inventory in terms of the absolute level in emissions. Key categories are those which, when summed together in descending order of magnitude, add up to over 95% of the total emissions.
National emissions have been disaggregated into the categories reported in the National Format Report; details vary according to different pollutants in order to reflect specific national circumstances. The level analysis has been applied to the last submitted inventory, as for 2006. Results are reported in the following table by pollutant.

Component	Key categories												Total (%)
SO_x	1A1a (29.8%)	1A2 (16.7%)	1A3d ii (14.9%)	1A1b (13.8%)	1B2 (8.9%)	1A1c (3.8%)	2A1 (3.7%)	1A4b (2.8%)	2B (2%)				96.4
NO_x	1A3b iii (18.7%)	1A3b i (18.4%)	1A2 (15.7%)	1A4c (7.8%)	1A3 d ii (7.5%)	1A1a (7.4%)	1A3b ii (6.8%)	1A4b (4.8%)	1A4a (3.7%)	1A1b (2.1%)	6C (1.3%)	1A1c (1.0%)	95.3
NH_3	4D1 (40.5%)	4B1b (16.4%)	4B1a (16.0%)	4B8 (9.0%)	4B9 (7.3%)	1A3b i (3.6%)	4B13 (2.6%)						95.4
NMVOC	3A (19%)	3D (16.1%)	1A3b iv (10.3%)	1A3d ii (9.5%)	1A3b i (8.1%)	1A3b v (5.4%)	3C (4.6%)	1B2a (4.0%)	1A4b (3.5%)	1A3b iii (2.8%)	1B2b (2.4%)	2D2 (2.4%)	95.6
	3B (1.9%)	1A4c (1.9%)	1A4a (1.4%)	6C (1.3%)	1A2 (1.1%)								
CO	1A3b i (31.7%)	1A3b iv (16.8%)	1A4b (12.8%)	1A2 (9.4%)	6C (7.9%)	1A3d ii (7.2%)	1A4c (3.1%)	2C (3.1%)	1A3b ii (1.9%)	1A3b iii (1.8%)			95.7
PM_{10}	1A2 (14.3%)	1A4b (10.9%)	1A3b i (8.5%)	1A4c (7.4%)	6C (7.3%)	1A3b vi (6.8%)	1A3b iii (6.4%)	1A3d ii (5.4%)	4B9 (4.9%)	1A3b ii (4.4%)	2C (4.4%)	2A1 (3.6%)	95.4
	4B8 (2.1%)	1A1a (1.9%)	2A6 (1.8%)	4F (1.3%)	1A3b iv (1.2%)	2A2 (1.2%)	1A1b (0.8%)	4B1b (0.8%)					
$PM_{2.5}$	1A2 (17.1%)	1A4b (13.0%)	1A3b i (10.6%)	1A4c (9.2%)	1A3b iii (8%)	6C (7.8%)	1A3d ii (6.8%)	1A3b ii (5.6%)	2C (4.3%)	1A3b vi (3.1%)	1A1a (2.2%)	4F (1.6%)	95.3
	1A3b i v (1.5%)	1A1b (0.9%)	1A5b (1.0%)	1A4a (1.0%)	4B9 (0.8%)	1B1 (0.7%)							
Pb	1A2 (51.5%)	2C (28.6%)	1A4a (15.0%)										95.1
Cd	1A2 (39.9%)	1A4a (26.2%)	2C (15.6%)	1A4b (8.4%)	1B1b (2.8%)	6C (1.8%)	1A1a (1.6%)						96.3
Hg	1A2 (30.9%)	2C (28.0%)	1A4a (16.7%)	1A1a (8.6%)	1A4b (6.6%)	2B5 (4.3%)							95
PAH	1A4b (35.0%)	2C (33.1%)	6C (24.2%)	1A4c (4.5%)									96.7
Dioxin	1A2 (38.3%)	2C (29.1%)	6C (12.6%)	1A4b (10.4%)	1A1a (3.1%)	1A4a (3.0%)							96.4
HCB	6C (39.3%)	1A4a (24.8%)	1A3b i (18.2%)	1A3b ii (5.6%)	1A2 (4.0%)	1A3b iii (3.9%)							95.9
PCB	2C (46.4%)	1A1a (36.0%)	1A4a (10.7%)	1A2 (4.6%)									97.7

Color codes

1 Energy	3 Solvent and product use	6 Waste
2 Industry	4 Agriculture	7 Other

Table 1.4 Key categories for the Italian Emission Inventory

1.7 QA/QC and Verification methods

APAT has elaborated an inventory QA/QC procedures manual which describes specific QC procedures to be implemented during the inventory development process, facilitates the overall QA procedures to be conducted, as far as possible, on the entire inventory and establishes quality objectives (APAT, 2006). Specific QA/QC procedures and different verification activities implemented thoroughly the current inventory compilation are figured out in the annual QA/QC plans (APAT, 2008 [c]).

Quality control checks and quality assurance procedures together with some verification activities are applied both to the national inventory as a whole and at sectoral level. Future planned improvements are prepared for each sector, by the relevant inventory compiler; each expert identifies areas for sectoral improvement based on his own knowledge and in response to different inventory review processes.

In addition to *routine* general checks, source specific quality control procedures are applied on a case by case basis, focusing on key categories and on categories where significant methodological and data revision have taken place or new sources.

Checklists are compiled annually by the inventory experts and collected by the QA/QC coordinator. These lists are also registered in the 'reference' database.

General QC procedures also include data and documentation gathering. Specifically, the inventory analyst for a source category maintains a complete and separate project archive for that source category; the archive includes all the materials needed to develop the inventory for that year and is kept in a transparent manner.

Quality assurance procedures regard some verification activities of the inventory as a whole and at sectoral level.

Feedbacks for the Italian inventory derive from communication of data to different institutions and/or at local level. Emission figures are also subjected to a process of re-examination once the inventory, the inventory related publications and the national inventory reports are posted on website, specifically www.apat.gov.it.

The preparation of environmental reports where data are needed at different aggregation levels or refer to different contexts, such as environmental and economic accountings, is also a check for emission trends. At national level, for instance, emission time series are reported in the Environmental Data Yearbooks published by the Agency, in the Reports on the State of the Environment by the Ministry for the Environment, Land and Sea and moreover, figures are communicated to the National Institute of Statistics to be published in the relevant Environmental Statistics Yearbooks as well as used in the framework of the EUROSTAT NAMEA Project.

Comparisons between national activity data and data from international databases are usually carried out in order to find out the main differences and an explanation to them. Emission intensity indicators among countries (e.g. emissions per capita, industrial emissions per unit of added value, road transport emissions per passenger car, emissions from power generation per kWh of electricity produced, emissions from dairy cows per tonne of milk produced) can also be useful to provide a preliminary check and verification of the order of magnitude of the emissions. Additional comparisons between emission estimates from industrial sectors and those published by the industry itself in the Environmental reports are carried out annually in order to assess the quality and the uncertainty of the estimates.

The quality of the inventory has also improved by the organization and participation in sector specific workshops.

A specific procedure undertaken for improving the inventory regards the establishment of national expert panels (in particular, in road transport, land use change and forestry and energy sectors)

which involve, on a voluntary basis, different institutions, local agencies and industrial associations cooperating for improving activity data and emission factors accuracy.
Moreover, activities in the framework of the improvement of local inventories are carried out together with local authorities; the first meetings have already taken place concentrating on the comparison between top down and bottom up approaches identifying the main critical issues. This work is also relevant to carry out regional scenarios, for the main pollutants, within the Rains Italy project implemented by ENEA supported by APAT and the regional authorities.
In addition to these expert panels, APAT participates in technical working groups within the National Statistical System. These groups, named *Circoli di qualità*, coordinated by the National Institute of Statistics, are constituted by both producers and users of statistical information with the aim of improving and monitoring statistical information in specific sectors such as transport, industry, agriculture, forest and fishing. These activities should improve the quality and details of basic data, as well as enable a more organized and timely communication.
Other specific activities relating to improvements of the inventory and QA/QC practises in the last year regarded the progress on the building of a unique database where information collected in the framework of different European directives, Large Combustion Plant, EPER and Emissions Trading, are gathered together thus highlighting the main discrepancies in information and detecting potential errors.

A proper archiving and reporting of the documentation related to the inventory compilation process is also part of the national QA/QC programme.
All the material and documents used for the inventory preparation are stored at the Agency for Environmental Protection and Technical Services.
Information relating to the planning, preparation, and management of inventory activities are documented and archived. The archive is organised so that any skilled analyst could obtain relevant data sources and spreadsheets, reproduce the inventory and review all decisions about assumptions and methodologies undertaken. A master documentation catalogue is generated for each inventory year and it is possible to track changes in data and methodologies over time. Specifically, the documentation includes:

- electronic copies of each of the draft and final inventory report, electronic copies of the draft and final NFR tables;
- electronic copies of all the final, linked source category spreadsheets for the inventory estimates (including all spreadsheets that feed the emission spreadsheets);
- results of the reviews and, in general, all documentation related to the corresponding inventory year submission.

After each reporting cycle, all database files, spreadsheets and electronic documents are archived as ‘read-only’ mode.
A ‘reference’ database is also compiled every year to increase the transparency of the inventory. This database consists of a number of records that references all documentation used during the inventory compilation, for each sector and submission year, the link to the electronically available documents and the place where they are stored as well as internal documentation on QA/QC procedures.

1.8 General uncertainty evaluation

An overall uncertainty analysis for the Italian inventory related to the pollutants described in this report has not been assessed yet. Nevertheless, different studies on uncertainty have been carried

out (Romano et al., 2004) and a quantitative assessment of the Italian GHG inventory is performed by the Tier 1 method defined in the IPCC Good Practice Guidance (IPCC, 2000) which provides a calculation based on the error propagation equations. Details on the results of the GHG inventory uncertainty figures can be found in the National Inventory Report 2008 (APAT, 2008 [b]).

It should be noted that different levels of uncertainty pertain to different pollutants. Estimates of the main pollutants are generally of high level, but PM emissions, especially those of small particle sizes, heavy metal and POP estimates are more uncertain. For this reason, even though not quantified in terms of uncertainty, improvements are planned especially for the specified pollutants.

Nevertheless, since quantitative uncertainty assessments constitute a means to either provide the inventory users with a quantitative assessment of the inventory quality or to direct the inventory preparation team to priority areas, a planned improvement for the next submission is the completion of such analysis.

1.9 General Assessment of Completeness

The inventory covers all major sources, as well as all main pollutants, included in the EMEP CORINAIR guidelines.
NFR sheets are complete as far as the details of basic information are available.
Allocation of emissions is not consistent with the guidelines only where there are no sufficient data available to split the information. For instance, emissions from combustion in manufacturing industries and construction are not split among the relevant production sectors but included in the total category; emissions from category 1.A.5.a other, stationary are reported and included under category 1A4a commercial and institutional emission estimates. PAH emissions are not detailed in the four indicator compounds but accounted for as a total.
There are only a few source emissions not assessed yet: NO_X emissions from manure management, from cattle, buffalo, swine and other livestock categories, and NO_X emissions from direct soil emission, from the use of fertilizers in soils.

Other not estimated emissions are PCPs and SCCP from solvent use, deriving from wood preservation and some manufacturing industries, and pesticides in agriculture. No information on activity data and emission factors are available for these sources at the moment and verification is needed to assess if these emissions actually occur within the national area.
Further investigation will be carried out about these source categories and pollutants in order to calculate and improve figures.

2 ANALYSIS OF KEY TRENDS BY POLLUTANT

2.1 Main pollutants

In the following sections, Italian emission series of sulphur oxides, nitrogen oxides, non-methane volatile organic compounds, carbon monoxide and ammonia are presented.

2.1.1 Sulphur dioxide (SO_X)

The national atmospheric emissions of sulphur oxides have significantly decreased in recent years, as occurred in almost all countries of the UNECE.

Figure 2.1 and Table 2.1 show the emission trend from 1990 to 2006. Figure 2.1 also illustrates the share of SO_X emissions by category in 1990 and 2006 as well as the total and sectoral variation from 1990 to 2006.

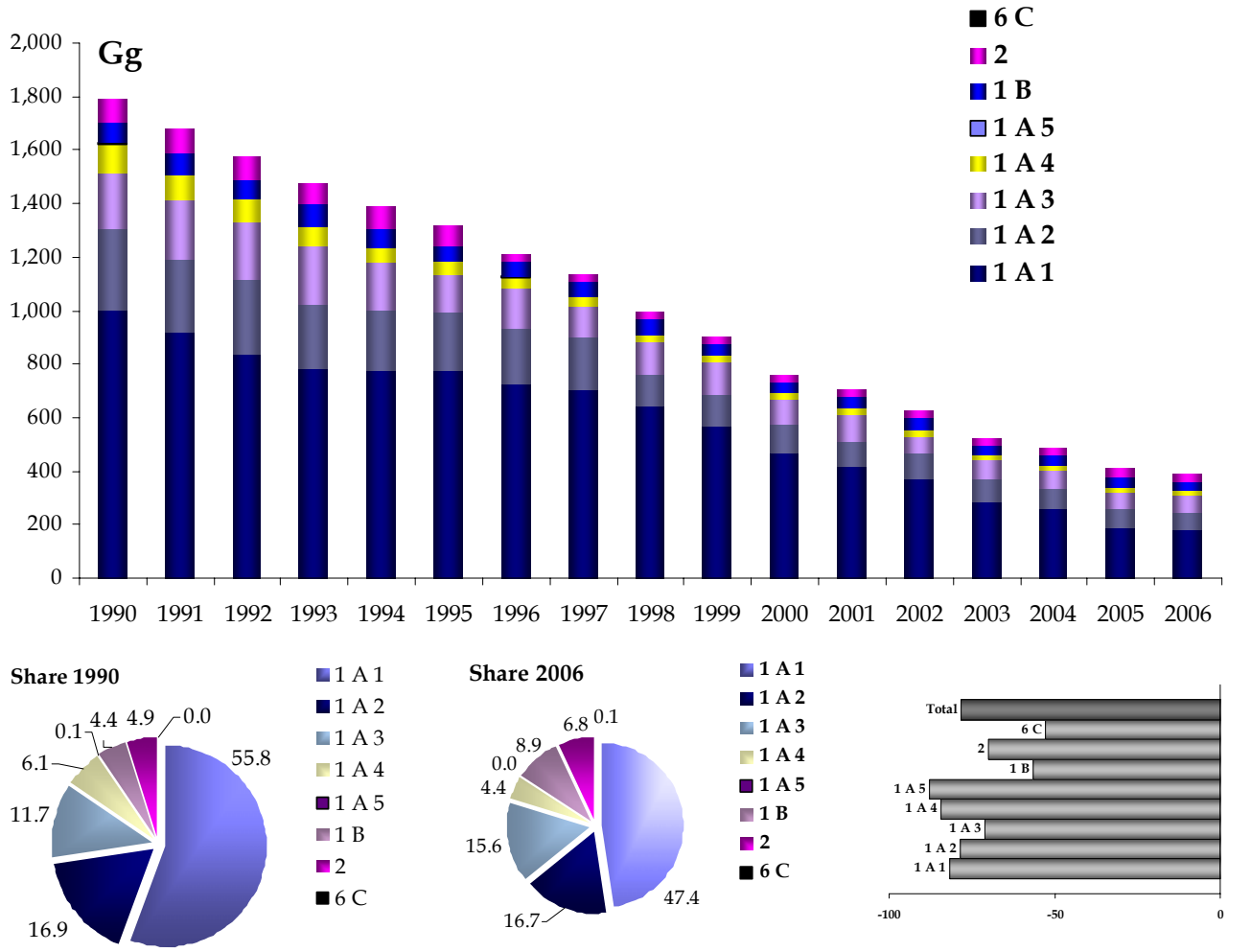

Figure 2.1 SO_X emission trend 1990-2006, percentage share by sector and variation 1990-2006

	1990	1995	2000	2001	2002	2003	2004	2005	2006
					Gg				
Combustion in energy and transformation industries	1,000.78	776.36	466.85	414.80	373.34	283.40	258.26	187.01	184.06
Non industrial combustion plants	95.82	34.82	22.07	23.46	20.32	20.07	19.19	18.97	16.92
Combustion - Industry	297.56	214.76	104.46	95.05	90.90	87.45	76.52	72.51	65.02
Production processes	155.94	124.61	49.61	59.69	60.79	56.44	55.03	58.92	53.09
Road transport	131.17	71.94	11.96	12.32	11.21	11.52	11.75	2.39	2.07
Other mobile sources and machinery	100.03	85.91	90.06	89.53	56.97	58.07	58.95	59.10	59.01
Waste treatment and disposal	12.82	11.45	9.76	9.53	8.69	8.36	8.55	8.70	8.44
Total	***1,794.12***	***1,319.86***	***754.77***	***704.37***	***622.22***	***525.30***	***488.25***	***407.59***	***388.61***

Table 2.1 SO_X emission trend from 1990 to 2006 (Gg)

Figures show a general decline of SO_X emissions during the period, from 1,794 Gg in 1990 to 389 Gg in 2006. The national target of SO_X emissions amounts to 480 Gg for 2010, as set by the National Emission Ceilings Directive.
The decreasing trend is determined mainly by the reduction in emissions from *combustion in energy* (-82%) and *industrial sectors* (-78%), representing in 2006 about 47% and 17% of the total, respectively. Emissions deriving from *non industrial combustion plants* (-82%) and *road transport* (-98%) show a strong decrease too, but these emissions represent only about 4% and 1% of the total in 2006, respectively. *Production processes* and *other mobile sources and machiner*y also present a significant decreasing trend, showing an influence on the total of 14% and 15% and dropping by about -66% and -41%, respectively.
Since SO_X emissions are included in the NEC directive, an explanation of the sectoral decreasing trend, starting from the early eighties, is outlined more in details in the following.

Combustion in energy and transformation industries
The trend of emissions of this sector shows a reduction in the early eighties mainly due to the use, in the energy production, of natural gas in place of coal, and to the implementation of the Directive EEC 75/716 which introduces more restrictive constraints in the sulphur content of liquid fuels.
During the years 1985-1990, there was an increase of energy consumption that, not sufficiently hampered by additional measures, led to an increase in the emissions of the sector and consequently of total SO_X levels.
However in the nineties, there was an inverse trend due to the introduction of two regulatory instruments: the DPR 203/88, laying down rules concerning the authorisation of plants, and the DM

of 12th July 1990, which introduced plant emission limits. Also the European Directive 88/609/EEC concerning the limitation of specific pollutants originated from large combustion plants (transposed in Italy by the DM of 8th May 1989), gave a contribution to the reduction of emissions in the sector. Finally, in recent years, a further shift to natural gas in place of fuel oil has contributed to a decrease in emissions.

Non industrial combustion plants

The declining of the emissions occurred mainly as a result of the increase in natural gas and LPG as fuel alternative to coal and fuel oil for heating; furthermore, a number of European Directives on the sulphur content in fuels were adopted. In accordance with national legislation, the sulphur content allowed in diesel fuel has decreased from 0.8% in 1980 to 0.2% in 1995, while in fuel oil for heating from 3% in 1980 to 0.3% in 1998.

Combustion in industry

Emissions from this sector show the same trend of reduction in the area previously analyzed, as both submitted to the same rules.

Production processes

Emissions from refineries have been reduced as a result of compliance with the DM 12th July 1990, which introduces limit values. The reduction of emissions from chemical industry is due to the drop off of the sulphuric acid production and to the decrease of emissions in the production of carbon black. Furthermore, there was a reduction in emissions in the production of cement with regard to the type of fuel used in the process and the respective sulphur content.

Road transport

The reduction of emissions is mainly due to the introduction of Directives regulating the sulphur content in liquid fuels.

Other mobile sources and machinery

As regards off roads, emissions mainly derive from maritime transport, which shows a decrease due the introduction of Directives regulating the sulphur content in fuels.

2.1.2 Nitrogen oxides (NO_x)

The national atmospheric emissions of nitrogen oxides show a decreasing trend in the period 1990-2006, from 1,941 Gg to 1,061 Gg. Figure 2.2 and Table 2.2 show the emission figures from 1990 to 2006. Figure 2.2 also illustrates the share of NO_X emissions by category in 1990 and 2006 as well as the total and sectoral variation from 1990 to 2006.

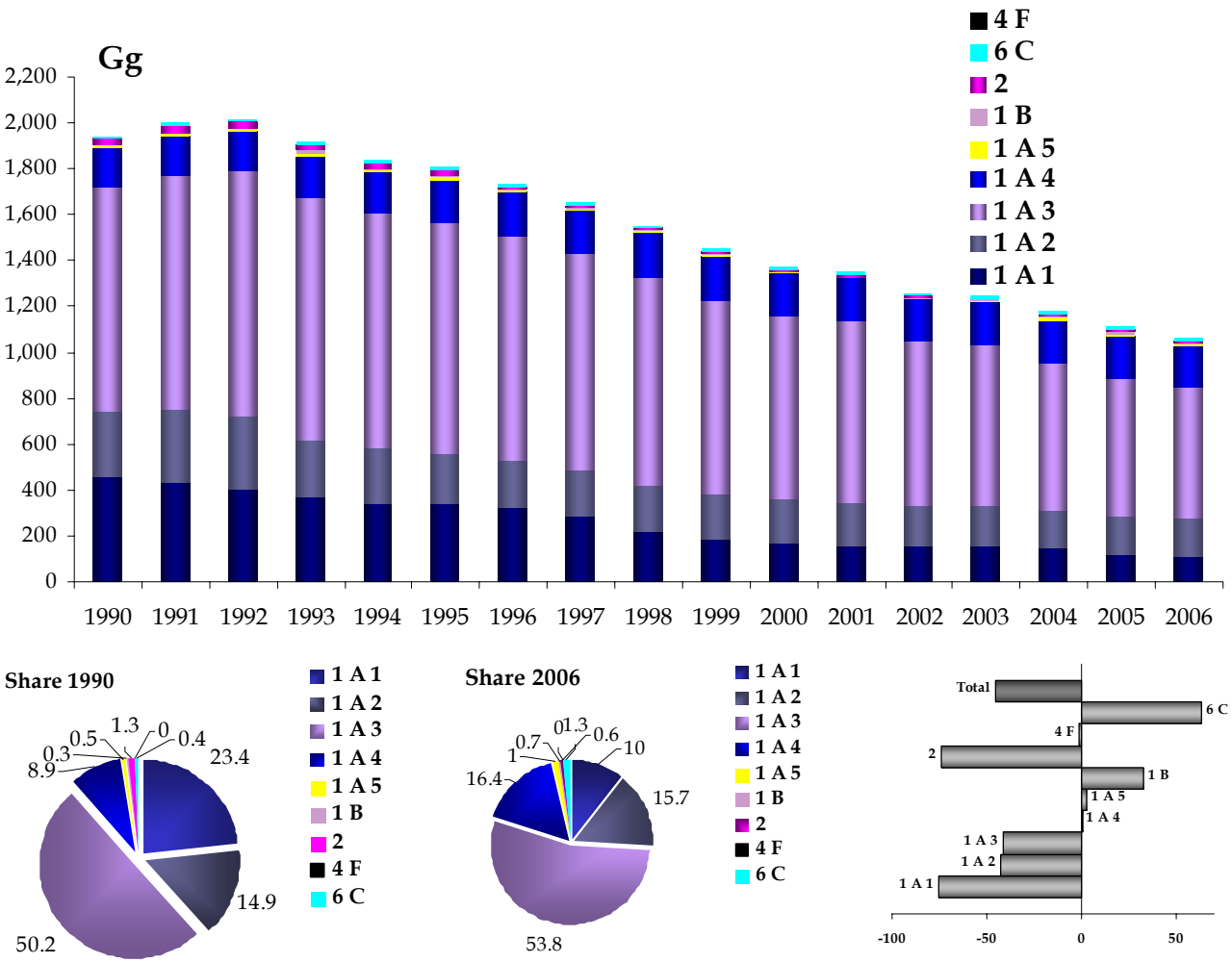

Figure 2.2 NO_X emission trend 1990-2006, percentage share by sector and variation 1990-2006

	1990	1995	2000	2001	2002	2003	2004	2005	2006
					Gg				
Combustion in energy and transformation industries	457.37	344.31	172.60	160.35	159.46	159.49	147.00	117.16	114.02
Non industrial combustion plants	62.12	63.56	74.83	79.06	77.85	85.87	90.58	95.02	92.19
Combustion - Industry	244.15	176.22	147.63	148.17	140.12	139.65	135.62	144.46	140.89
Production processes	29.78	30.83	9.07	9.23	11.99	13.49	14.15	15.93	13.10
Road transport	889.30	922.97	703.62	695.43	618.39	599.49	540.74	498.96	472.53
Other mobile sources and machinery	249.31	255.84	252.40	245.25	236.54	237.53	234.76	224.83	213.99
Waste treatment and disposal	8.70	13.95	12.53	13.71	13.31	13.50	16.79	14.81	14.09
Agriculture	0.47	0.46	0.44	0.41	0.46	0.42	0.50	0.47	0.46
Total	***1,941.20***	***1,808.1***	***1,373.12***	***1,351.61***	***1,258.12***	***1,249.43***	***1,180.15***	***1,111.65***	***1,061.27***

Table 2.2 NO_X emission trend from 1990 to 2006 (Gg)

Total emissions show a reduction of about 45% from 1990 to 2006, with a marked decrease between 1995 and 2000, especially in the road transport and energy combustion sectors. The target value of emissions, fixed for 2010 by the National Emission Ceilings Directive, amounts to 990 Gg. Even though national figures are at the moment not far from compliance, it should be noted that a revision of NO_X emissions is expected for the road transport sector, on account of the use of COPERT IV model instead of the previous version COPERT III (EEA, 2000) and recalculations should result in an increase of about 100 Gg in 2006.

The main source of emissions is *road transport* (about 45% in 2006), which shows a reduction of 47% between 1990 and 2006; *other mobile sources and machinery* in 2006 contributes to the total emissions for 20% and have reduced by 14% from 1990. Combustion in energy and in industry shows a decrease of about 75% and 42%, respectively, having a share on the total of about 11% and 13%, respectively. Among the sectors concerned, the only ones which highlight an increase in emissions are: *waste treatment and disposal* and *non industrial combustion plants*, showing an increase by 62% and 48%, respectively, but accounting only for 1% and 9% of the total, respectively.

As SO_X, NO_X emissions are also included in the NEC directive. Details on the sectoral emission trend and respective variation are outlined in the following sections, starting from the early eighties.

Combustion in energy and transformation industries

Emissions from this sector show an upward trend until 1988 due to an increase in energy consumption, not prevented by reduction measures. From 1988 onwards, emissions present a gradual reduction due, mainly, to the introduction of the two regulatory instruments already mentioned for sulphur dioxide: the DPR 203/88, laying down rules for the authorization of facilities and the DM of 12th July 1990, which introduces plant emission limits. The adoption of these regulations, as the DM 8th May 1989 on large combustion plants, has led to a shift in energy consumption from oil with high sulphur content to oil with lower sulphur content and to natural gas. In recent years, the conversion to the use of natural gas to replace fuel oil, has intensified, thanks to incentives granted for the improvement of energy efficiency. These measures, together with those of promoting renewable energy and energy saving, have led to a further reduction of emissions in the sector.

Non industrial combustion plants

The increase in emissions is explained by the growing trend of energy consumption during the period considered. This is due the fact that from the last twenty years all the new buildings are equipped with heating system and old buildings were modernized.

Combustion in industry

Emissions from this sector show a decreasing trend, motivated by the same reasons as the energy industry, having undergone the same legislation.

Road transport

The decrease is the result of two opposing trends: an increase in emissions in the early years of the historical series, with a peak in 1992, due to the increase in the fleet and in the total mileage of both passengers and goods transported by road, and a subsequent reduction in emissions. This decrease is, once more, the result of two opposing trends: on the one hand, the growth of both the fleet and the mileage, on the other the introduction of technologies to reduce vehicle emissions, as the catalytic converter, provided by European Directives, in particular the Directives 91/441/EC, 94/12/EC and 98/69/EC on light vehicles.

To encourage the reduction of emissions, different policies have also been implemented, including incentives to renew the public and private fleet and for the purchase of electric vehicles, promotion for the integrated expansion of rail, maritime and urban transport system, and programmes of sustainable mobility.

Other mobile sources and machinery

From 1980, emissions have a slightly rising trend until 1998 and then decrease slightly until arriving in 2006 to lower levels. Emissions in the sector are characterized predominantly by maritime transport, by machinery used in agriculture and industry and to a lesser extent, by air transport.

Regarding mobile machinery used in agriculture and industry, these sectors were not governed by any legislation until the Directive 97/68/EC, which provides for a reduction in NO_X limits from 1st January 1999, with a following decreasing trend particularly in recent years. Regarding aviation, in the absence of specific legislation up to now, emissions have increased in relation to the growth in air traffic.

2.1.3 Ammonia (NH_3)

The national atmospheric emissions of ammonia show a slight decline in the period 1990-2006, from 464 Gg to 408 Gg. Figure 2.3 and Table 2.3 report the emission figures from 1990 to 2006. Figure 2.3 also illustrates the share of NH_3 emissions by category in 1990 and 2006 as well as the total and sectoral variation from 1990 to 2006.

According to the National Emission Ceilings Directive, the target value of emissions for 2010 amounts to 420 Gg.

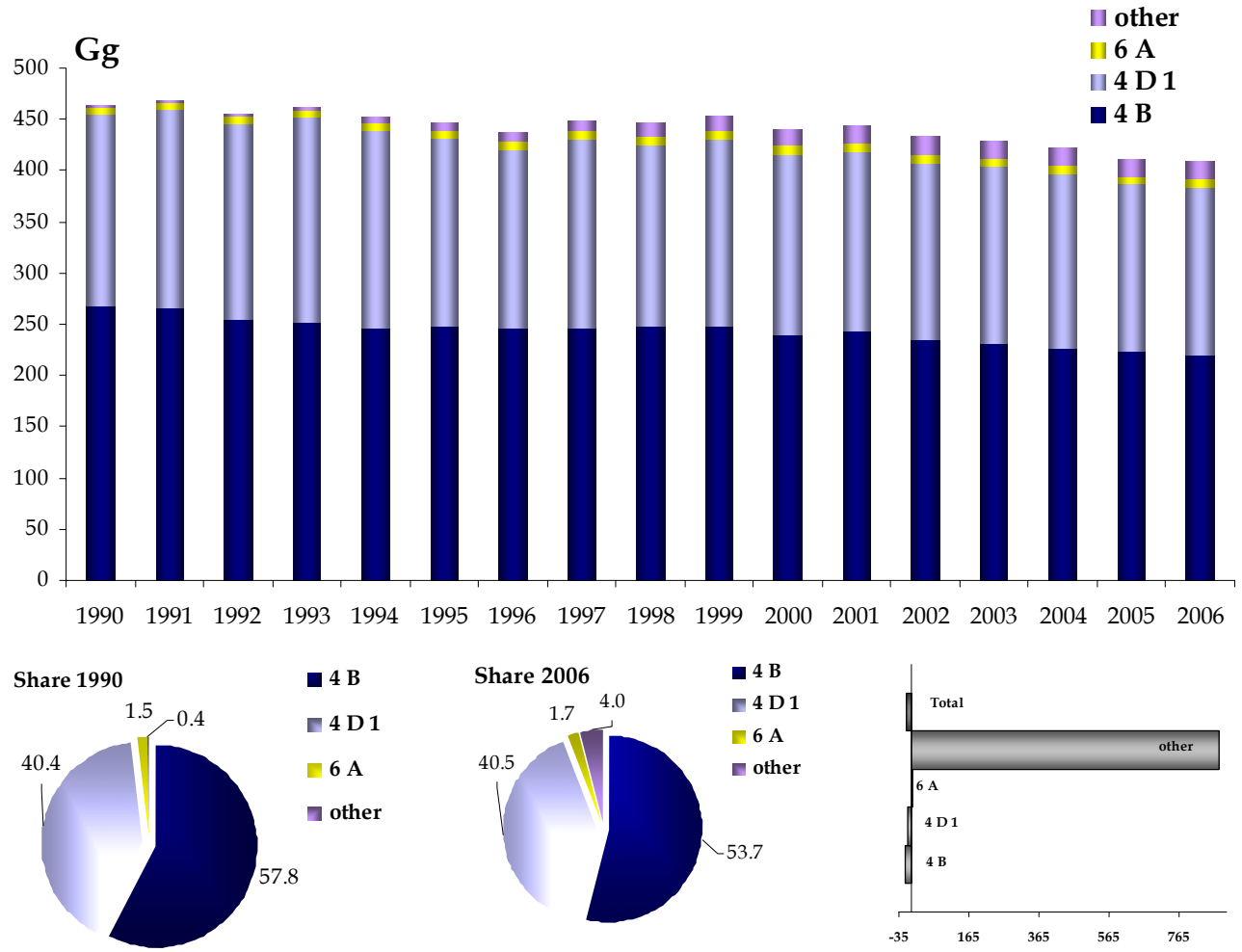

Figure 2.3 NH_3 emission trend 1990-2006, percentage share by sector and variation 1990-2006

	1990	1995	2000	2001	2002	2003	2004	2005	2006
					Gg				
Combustion in energy and transformation industries	0.15	0.11	0.12	0.14	0.16	0.18	0.21	0.20	0.20
Non industrial combustion plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Combustion - Industry	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Production processes	0.76	0.45	0.35	0.28	0.23	0.21	0.19	0.19	0.17
Road transport	0.68	6.15	15.34	16.42	17.27	16.14	16.17	15.45	15.24
Other mobile sources and machinery	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Waste treatment and disposal	6.99	8.35	9.07	9.16	8.90	8.60	8.19	8.25	7.93
Agriculture	455.68	431.50	416.27	418.24	407.27	404.20	397.82	387.24	384.83
Total	***464.37***	***446.65***	***441.25***	***444.35***	***433.94***	***429.42***	***422.68***	***411.42***	***408.47***

Table 2.3 NH_3 emission trend from 1990 to 2006 (Gg)

In 2006 *agriculture* is the main source of emissions, with a contribution by 94% out of the total NH_3 emissions; from 1990 to 2006 emissions from this sector decrease of about 16%. Emissions from *road transport* show a strong increase, but the share on the total is only about 4%. Emissions from *waste treatment and disposa*l, accounting only for 2% of the total, increase of about 13%. Emissions from *combustion in energy* and *transformation industries* show an increase of about 38%, but in 2006 the contribution to total emissions is almost zero. Emissions from *non industrial combustion plants* decrease of about 81%, but the contribution to total emissions is negligible. Emissions from *combustion in industry* and *production processes* show a reduction of about 17% and 78% respectively, but also this contribution is insignificant.

Specifically, emissions from agriculture have decreased for both the merging of animal farms in large companies and the introduction of abatement technologies due to the implementation of the EU IPPC Directive. Emissions related to production processes, mainly the production of nitrogenous fertilizers and ammonia, dropped as a result of a lower production, whereas emissions from the waste sector have increased as a result of the greater amount of waste disposed in landfills. Emissions from road transport have increased as a result of the introduction of catalytic converter.

2.1.4 Non methane volatile organic compounds (NMVOC)

The national atmospheric emissions of NMVOC show a decreasing trend in the period 1990-2006. Figure 2.4 and Table 2.4 illustrate the emissions values from 1990 to 2006. Figure 2.4 also illustrates the share of NMVOC emissions by category in 1990 and 2006 as well as the total and sectoral variation from 1990 to 2006.

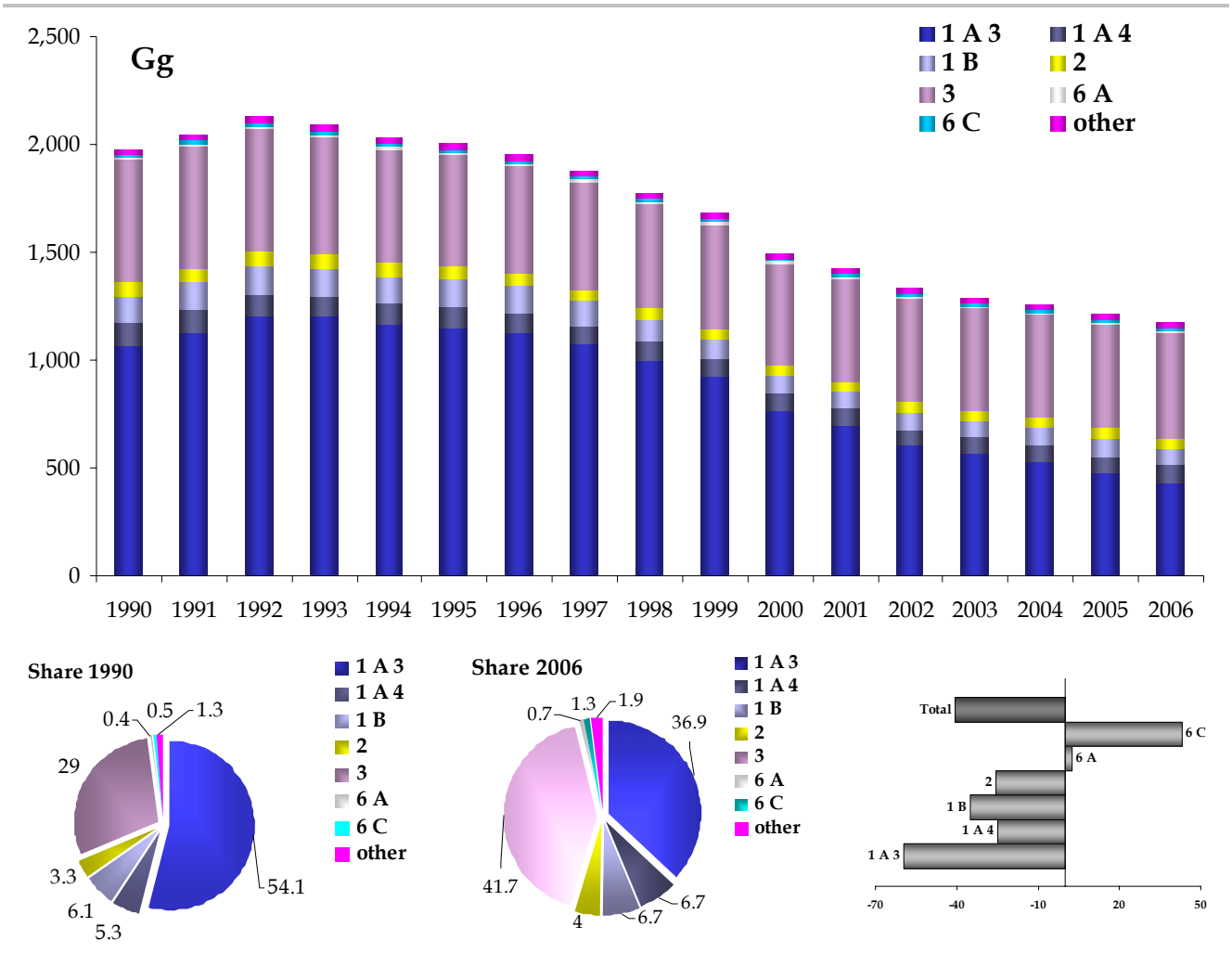

Figure 2.4 NMVOC emission trend 1990-2006, percentage share by sector and variation 1990-2006

	1990	1995	2000	2001	2002	2003	2004	2005	2006
					Gg				
Combustion in energy and transformation industries	7.61	7.39	6.27	5.64	5.75	5.65	5.53	5.59	5.62
Non industrial combustion plants	24.88	32.99	43.41	46.20	40.64	45.69	56.27	55.00	58.94
Combustion - Industry	7.17	8.10	8.21	7.91	7.74	7.82	8.03	8.01	8.30
Production processes	94.98	85.62	70.65	72.91	78.41	72.34	74.97	76.05	75.21
Extraction and distrib. of fossil fuels / geothermal energy	90.38	103.67	56.20	51.01	55.30	54.07	52.42	52.66	51.22
Solvent and other product use	572.23	515.85	469.63	473.86	476.83	474.72	474.93	479.13	489.29
Road transport	962.53	1029.96	649.01	579.66	486.24	453.62	414.42	366.83	321.23
Other mobile sources and machinery	198.78	194.15	167.63	161.69	153.32	149.16	143.92	142.63	138.92
Waste treatment and disposal	18.99	25.68	23.93	25.07	24.56	24.32	27.01	25.25	24.05
Agriculture	1.30	1.27	1.23	1.16	1.21	1.16	1.27	1.22	1.20
Total	***1,978.85***	***2,004.62***	***1,496.17***	***1,425.1***	***1,330***	***1,288.55***	***1,258.76***	***1,212.38***	***1,173.96***

Table 2.4 NMVOC emission trend from 1990 to 2006 (Gg)

The global emission trend shows a reduction of about 41% between 1990 and 2006, from 1,979 Gg to 1,174 Gg. In the framework of the National Emission Ceilings Directive, the target value of NMVOC for 2010 has been fixed to 1,160 Gg.

Solvent and other product use is the main source of emissions, contributing to the total with 42% and showing a decrease of about 14%. The biggest reductions relate to the sector of *road transport* (-67%), accounting for 27% of the total and the sector of *extraction and distribution of fossil fuels/geothermal energy* (-43%), accounting only for 4%. Emissions from *non industrial combustion plants* show the biggest increase, but this is not relevant on total emissions, accounting only for 5%. Emissions from *waste treatment and disposal*, and *from combustion in industry*, accounting only for 2% and 1% of the total, show increase of about 27% and 16% respectively. Emissions from *other mobile sources and machinery*, accounting for 12% of the total, decrease of about 30%.
Details on the sectoral emission trend and respective variation are outlined in the following sections.

Solvent and other product use
Emissions from this sector stem from numerous activities such as painting both domestic and

industrial, degreasing and dry cleaning, manufacturing and processing chemicals, other use of solvents and related activities including the use of household products that contain solvents, such as cosmetics, household products and toiletries.
Significant reductions occurred in the nineties by the introduction in the market of products with low solvent content in paints, and the reduction of the total amount of organic solvent used for metal degreasing and in glues and adhesives; furthermore, there was a replacement of open loop with closed loop laundry machines. The gradual application of the EU Directive 99/13/EC will lead to further reductions in the coming years.

Road transport

The trend of emissions in this sector is characterized by a first stage of reduction in the early eighties, occurred despite the increase of consumption and mileage because of the gradual adjustment of the fleet to Community legislation, ECE Regulation 15 and subsequent amendments, which introduced stricter emission limits for passenger cars. Subsequently, in the early nineties, an increase in emissions is observed, with a peak in 1992, due to a high increase in gasoline consumption not efficiently opposed by the replacement of the fleet. With the introduction of Directive 91/441/EC and following, which provide for cars the catalytic device to reduce exhaust and evaporative emissions, NMVOC emissions were gradually reduced.
A different explanation of the emission trend pertains to the nineties. In fact, in this period an increase of the fleet and of the mileage is observed in Italy, especially for the emergent use of mopeds for urban mobility, which, until 1999, were not subject to any national emission regulation. Thereafter, various measures were introduced in order to facilitate the reduction of NMVOC emissions, including incentives for replacement of both the fleet of passenger cars and of mopeds and motorcycles with low-emission vehicles; incentives were also provided for the use of fuels different from gasoline, such as LPG and natural gas. In addition, funds were allocated for the implementation of urban traffic plans, for the establishment of restricted traffic areas and car-free days, for checks on exhaust pipes of cars, for the implementation of voluntary agreements with manufacturers of mopeds and motorcycles in order to anticipate the timing provided by the European Directive 97/24/EC as regards the placing on the market of mopeds with low emissions.

Other mobile sources and machinery

The reduction in emissions is explained by the reduction of gasoline consumption in the sector, largely for two-stroke engines used in agriculture and in maritime activities.

As regards the other sectors, a decrease in emissions from production processes is observed, mainly in the food industries, in the chemical sector and in the processes in the refineries. The emissions concerning the extraction and distribution of fuels, even in the presence of an increase in quantity treated, have been reduced as a result of the application of the DM 16th May 1996, concerning the adoption of devices for the recovery of vapours and of the applications of measures on deposits of gasoline provided by the DM 21st January 2000.
The emissions from other sectors are not subject to specific regulations.

2.1.5 Carbon monoxide (CO)

The national CO emissions show a decreasing trend in the period 1990-2006, from 7,123 Gg to 3,576 Gg. The emission figures from 1990 to 2006 are shown in Figure 2.5 and Table 2.5. Figure 2.5 also illustrates the share of CO emissions by category in 1990 and 2006, as well as the total and sectoral variation from 1990 to 2006.

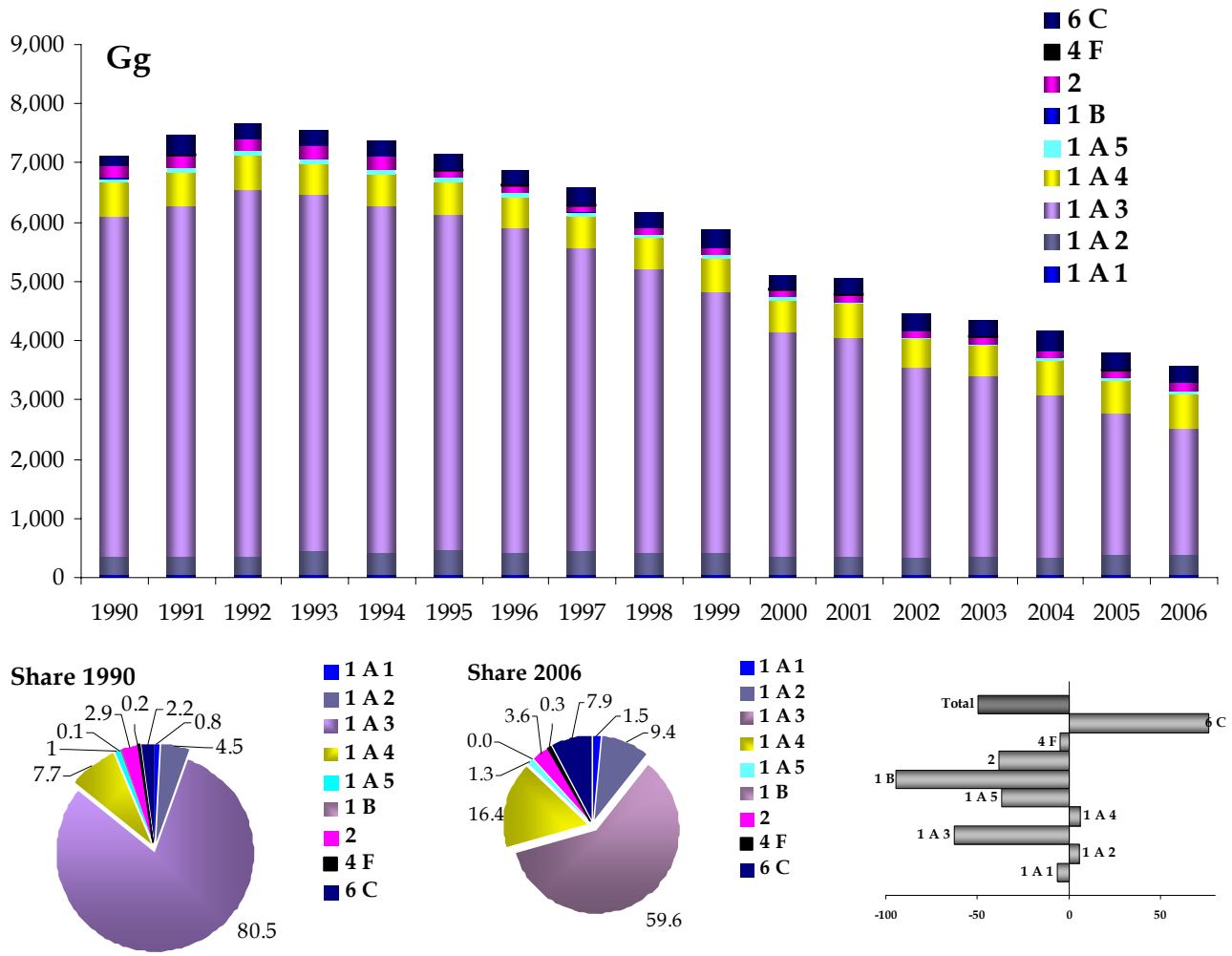

Figure 2.5 CO emission trend 1990-2006, percentage share by sector and variation 1990-2006

	1990	1995	2000	2001	2002	2003	2004	2005	2006
					Gg				
Combustion in energy and transformation industries	58.75	54.27	55.62	57.66	54.66	51.32	50.94	53.74	54.45
Non industrial combustion plants	256.36	348.17	450.07	469.29	395.06	427.79	505.87	478.95	523.81
Combustion - Industry	303.45	408.35	309.83	306.95	282.98	292.01	283.96	328.20	322.18
Production processes	214.54	123.74	114.16	110.17	106.39	112.75	116.61	120.76	128.05
Road transport	5,500.69	5,389.26	3,478.20	3,398.47	2,928.00	2,787.02	2,478.03	2,113.75	1,869.08
Other mobile sources and machinery	617.58	549.50	453.83	433.15	403.53	394.78	394.49	403.72	385.28
Waste treatment and disposal	159.19	269.30	249.23	271.12	263.01	268.75	338.76	295.74	281.10
Agriculture	12.93	12.64	11.84	10.93	12.34	11.26	13.75	12.80	12.32
Total	***7,123.48***	***7,155.21***	***5,122.78***	***5,057.75***	***4,445.98***	***4,345.69***	***4,182.41***	***3,807.66***	***3,576.27***

Table 2.5 CO emission trend from 1990 to 2006 (Gg)

The decrease in emissions (-50%) is mostly due to the trend observed for the transport sector (including road, railways, air and maritime transport) which show a global reduction from 1990 to 2006 of about 63%. Specifically by sector, emissions from *road transport* and *other mobile sources and machinery*, accounting in 2006 for 52% and 11% of the total, respectively, show a decrease from 1990 to 2006 of about 66% and 38%. On the other hand, emissions from *non industrial combustion plants*, representing about 15% of the total, show a strong increase between 1990 and 2006, equal to 104% due to the increase of wood combustion for heating; figures show a strong increase in emissions from *waste treatment and disposal* too (77%), which share 8% of the total.

2.2 Particulate matter

2.2.1 PM_{10}

The national atmospheric emissions of PM_{10} show a slight decreasing trend in the period 1990-2006, from 245 Gg to 171 Gg. Figure 2.6 and Table 2.6 illustrate the emission trend from 1990 to 2006. Figure 2.6 also illustrates the share of PM_{10} emissions by category in 1990 and 2006 as well as the total and sectoral variation from 1990 to 2006.

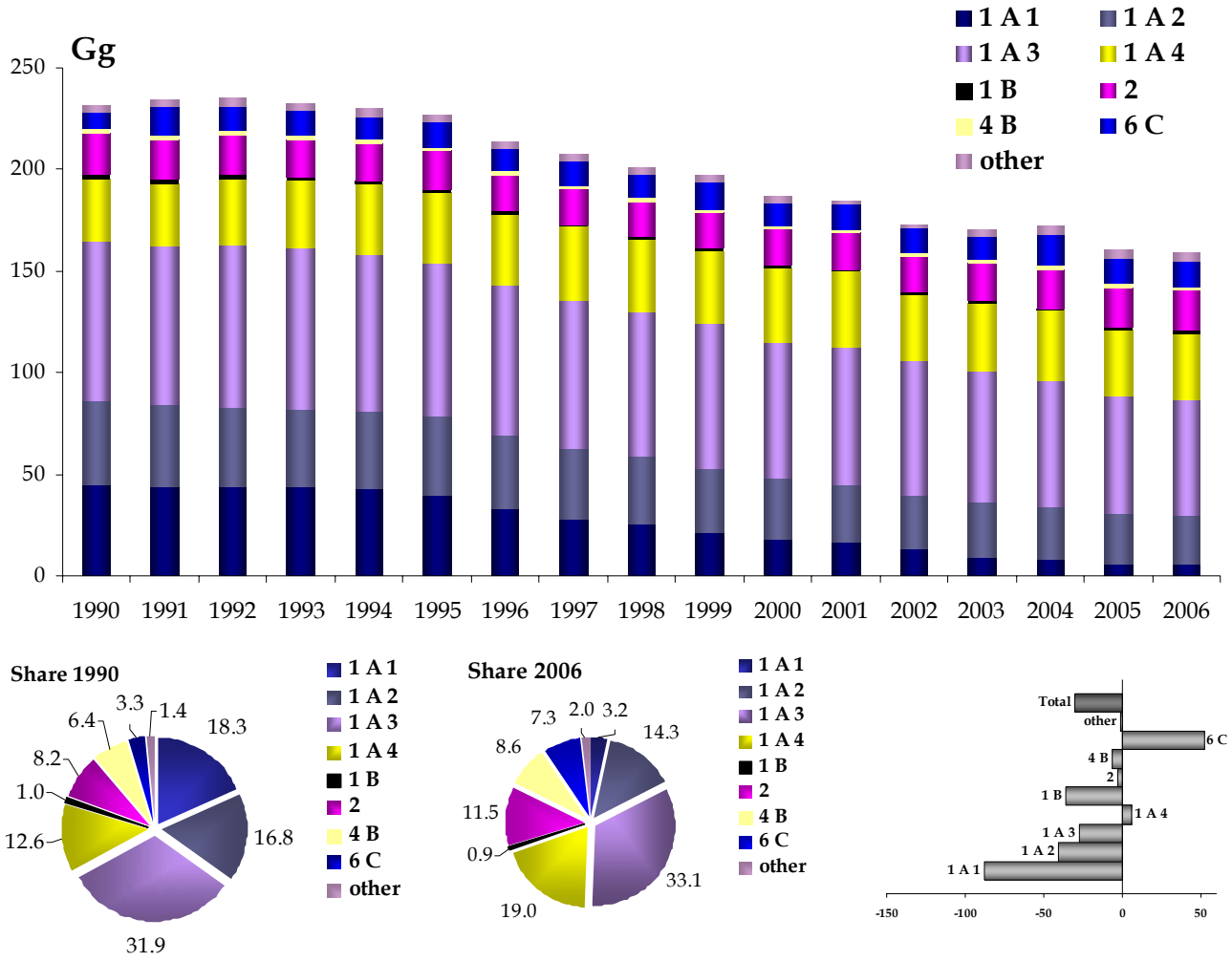

Figure 2.6 PM_{10} emission trend 1990-2006, percentage share by sector and variation 1990-2006

	1990	1995	2000	2001	2002	2003	2004	2005	2006
					Gg				
Combustion in energy and transformation industries	44.84	39.60	18.42	16.31	12.91	8.96	8.41	5.87	5.57
Non industrial combustion plants	13.95	16.30	20.09	21.06	17.34	18.63	21.69	20.49	22.15
Combustion - Industry	35.65	33.26	24.20	23.48	22.84	23.40	21.92	21.86	22.15
Production processes	22.06	20.23	18.52	18.53	18.37	19.11	19.84	19.92	20.46
Extraction and distrib. of fossil fuels / geothermal energy	0.68	0.59	0.57	0.61	0.63	0.67	0.77	0.76	0.78
Solvent and other product use	0.04	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Road transport	69.05	65.96	57.94	58.52	56.04	54.87	52.16	48.17	46.82
Other mobile sources and machinery	32.93	34.81	31.54	30.44	29.28	28.90	27.77	26.07	23.95
Waste treatment and disposal	8.21	11.98	11.37	12.02	11.68	11.69	14.55	13.05	12.49
Agriculture	17.90	17.78	17.17	18.39	18.33	17.93	17.78	17.59	16.81
Total	*245.31*	*240.54*	*199.85*	*199.38*	*187.45*	*184.17*	*184.89*	*173.80*	*171.20*

Table 2.6 PM_{10} emission trend from 1990 to 2006 (Gg)

A considerable amount of emissions is mostly to be attributed to *road transport* (30% in 2006); from 1990 to 2006 the trend shows a reduction of about 32%. In 2006 *other mobile sources and machinery* account for 15% of the total and show a reduction of about 27%. Both emissions from *non industrial combustion plants* and from *combustion in industry* account for about 14% of the total, but while the former show an increase of about 59%, the latter decrease of about 38%. Emissions from *production processes*, accounting for 13% of the total in 2006, decrease of about 7% between 1990 and 2006. The largest decrease (-88%) is observed in emissions deriving from *combustion in energy* and *transformation industries*, which contribution to total emissions is equal to 4%.

2.2.2 $PM_{2.5}$

The trend of the national atmospheric emissions of $PM_{2.5}$ is slightly decreasing between 1990 and 2006, with a variation from 210 Gg to 137 Gg. Figure 2.7 and Table 2.7 illustrate the emission trend from 1990 to 2006. Figure 2.7 also illustrates the share of $PM_{2.5}$ emissions by category in 1990 and 2006 as well as the total and sectoral variation from 1990 to 2006.

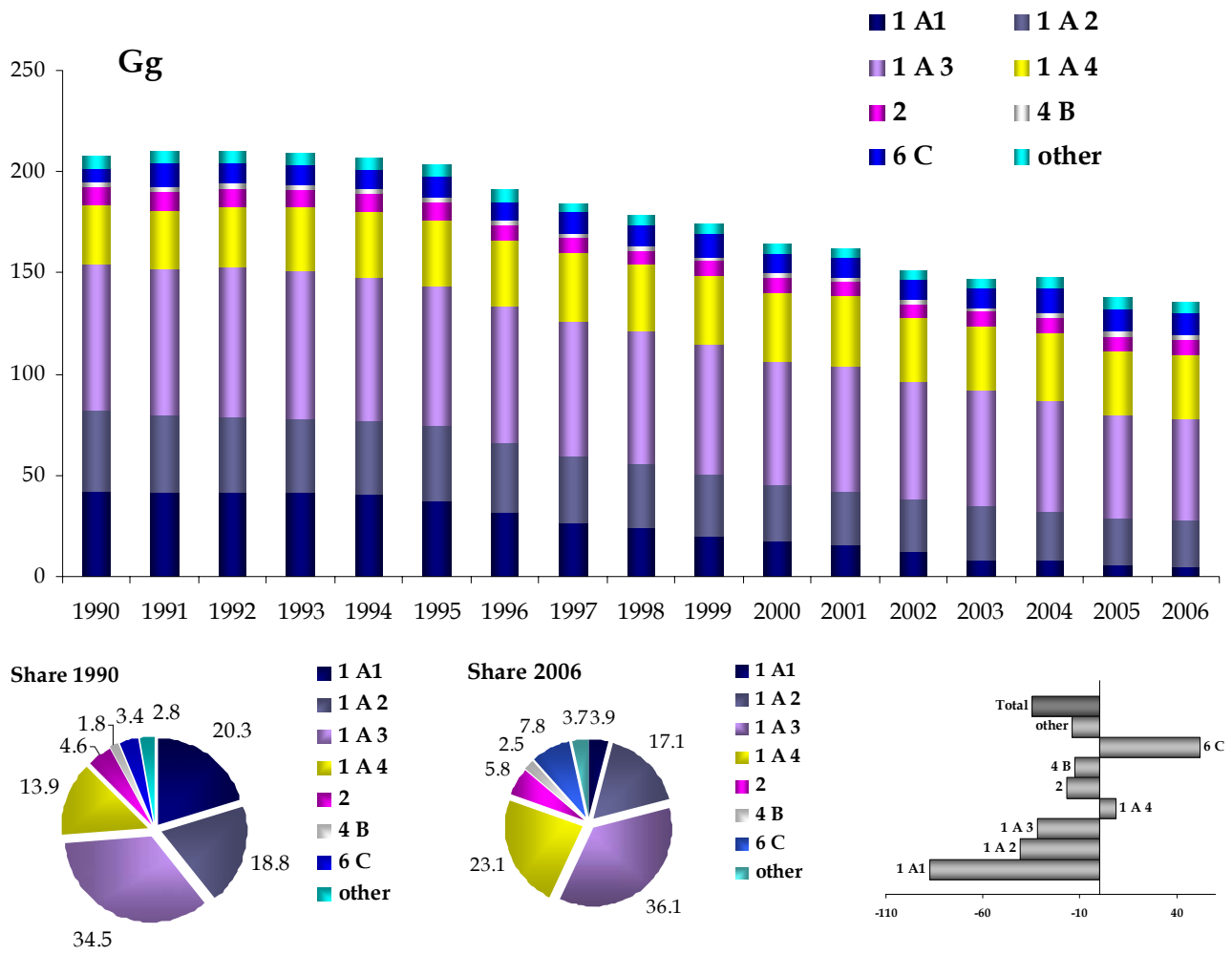

Figure 2.7 $PM_{2.5}$ emission trend 1990-2006, percentage share by sector and variation 1990-2006

	1990	1995	2000	2001	2002	2003	2004	2005	2006
					Gg				
Combustion in energy and transformation industries	42.60	37.62	17.50	15.50	12.27	8.52	7.99	5.58	5.30
Non industrial combustion plants	12.18	14.43	18.58	19.43	16.36	17.61	20.63	19.49	21.10
Combustion - Industry	33.87	31.60	22.99	22.31	21.70	22.23	20.83	20.77	21.05
Production processes	11.23	10.15	8.11	7.88	7.58	7.85	8.17	8.39	8.74
Extraction and distrib. of fossil fuels / geothermal energy	0.68	0.59	0.57	0.61	0.63	0.67	0.77	0.76	0.78
Solvent and other product use	0.04	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Road transport	63.02	59.32	51.00	51.41	48.74	47.55	44.78	40.84	39.39
Other mobile sources and machinery	32.93	34.81	31.54	30.44	29.28	28.90	27.77	26.07	23.95
Waste treatment and disposal	7.05	10.28	9.75	10.31	10.02	10.02	12.48	11.19	10.71
Agriculture	6.08	5.88	5.65	5.65	5.78	5.57	5.86	5.70	5.52
Total	*209.68*	*204.71*	*165.73*	*163.56*	*152.39*	*148.92*	*149.28*	*138.81*	*136.56*

Table 2.7 $PM_{2.5}$ emission trend from 1990 to 2006 (Gg)

Total emissions show a global reduction from 1990 to 2006 of about 38%.
Specifically, emissions from *road transport*, accounting for 30% of total emissions, decrease of about 37%. Emissions from *other mobile sources and machinery* show a reduction of 27%, accounting in 2006 for 18% of total emissions. Analogously to PM_{10}, both emissions from *non industrial combustion plants* and from *combustion in industry* have the same influence on the total (in this case of about 16% of the total), but while the former show an increase of about 73%, the latter decrease of about 38%. Emissions from *waste treatment and disposal*, accounting for 8% of the total in 2006, show an increase of about 52%. The largest decrease is observed for *combustion in energy* and *transformation industries* (-88%), being the influence on the total in 2006 equal to 4%.

2.3 Heavy metals (Pb, Cd, Hg)

This section provides an illustration of the most significant developments between 1990 and 2006 of lead, cadmium and mercury emissions.

2.3.1 Lead (Pb)

The national atmospheric emissions of lead show a strong decreasing trend (-94%) between 1990 and 2006, varying from 4,378 Mg to 274 Mg. Figure 2.8 and Table 2.8 illustrate the emission trend from 1990 to 2006. Figure 2.8 also illustrates the share of Pb emissions by category in 1990 and 2006 as well as the total and sectoral variation from 1990 to 2006.

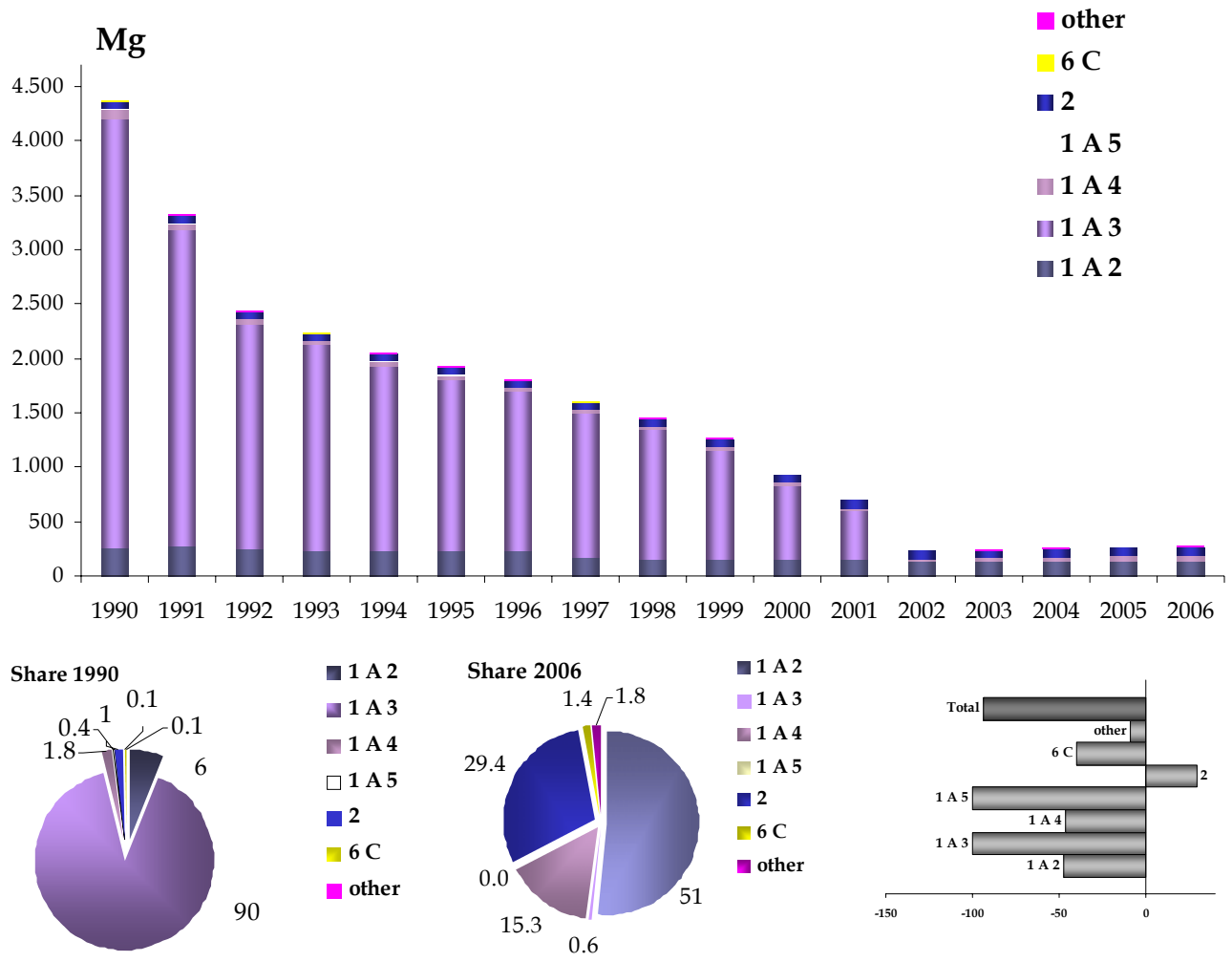

Figure 2.8 Pb emission trend 1990-2006, percentage share by sector and variation 1990-2006

	1990	1995	2000	2001	2002	2003	2004	2005	2006
					Mg				
Combustion in energy and transformation industries	4.01	4.02	3.75	3.89	4.24	4.17	4.16	3.92	3.88
Non-industrial combustion plants	10.79	12.15	16.91	21.06	18.70	25.08	38.72	40.60	42.01
Combustion in manufacturing industry	263.19	234.94	153.40	149.53	138.68	137.27	134.80	141.62	141.39
Production processes	63.71	68.15	67.32	68.82	69.77	70.32	73.98	74.18	81.67
Road transport	3,885.98	1,557.20	677.36	445.85	0.00	0.00	0.00	0.00	0.00
Other mobile sources and machinery	144.42	45.93	13.94	9.71	1.53	1.61	1.56	1.55	1.61
Waste treatment and disposal	6.29	5.88	2.54	3.09	3.89	3.18	2.91	3.83	3.79
Total	***4,378.39***	***1,928.29***	***935.22***	***701.94***	***236.81***	***241.64***	***256.13***	***265.70***	***274.35***

Table 2.8 Pb emission trend from 1990 to 2006 (Mg)

In 2006 emissions from processes with contact have the most significant impact on the total (51%) and show a reduction of about 38%. Emissions from processes in iron and steel industries and collieries, increasing of about 27%, represent 29% of the total. Emissions from commercial and institutional plants show a strong increase and, in 2006, represent the 15% of the total. As regard emissions from transport activities, because of changes occurred in the legislation regarding fuels, trends show a sharp reduction in emissions from 2002 onwards. Emissions from process furnaces without contact show a strong decrease (-97%) but the contribution to total emissions in 2006 is negligible (equal to 0.4%).

2.3.2 Cadmium (Cd)

The national atmospheric emissions of cadmium show a slight decreasing trend. Figure 2.9 and Table 2.9 illustrate the emission trend from 1990 to 2006. Figure 2.9 also illustrates the share of Cd emissions by category in 1990 and 2006 as well as the total and sectoral variation from 1990 to 2006.

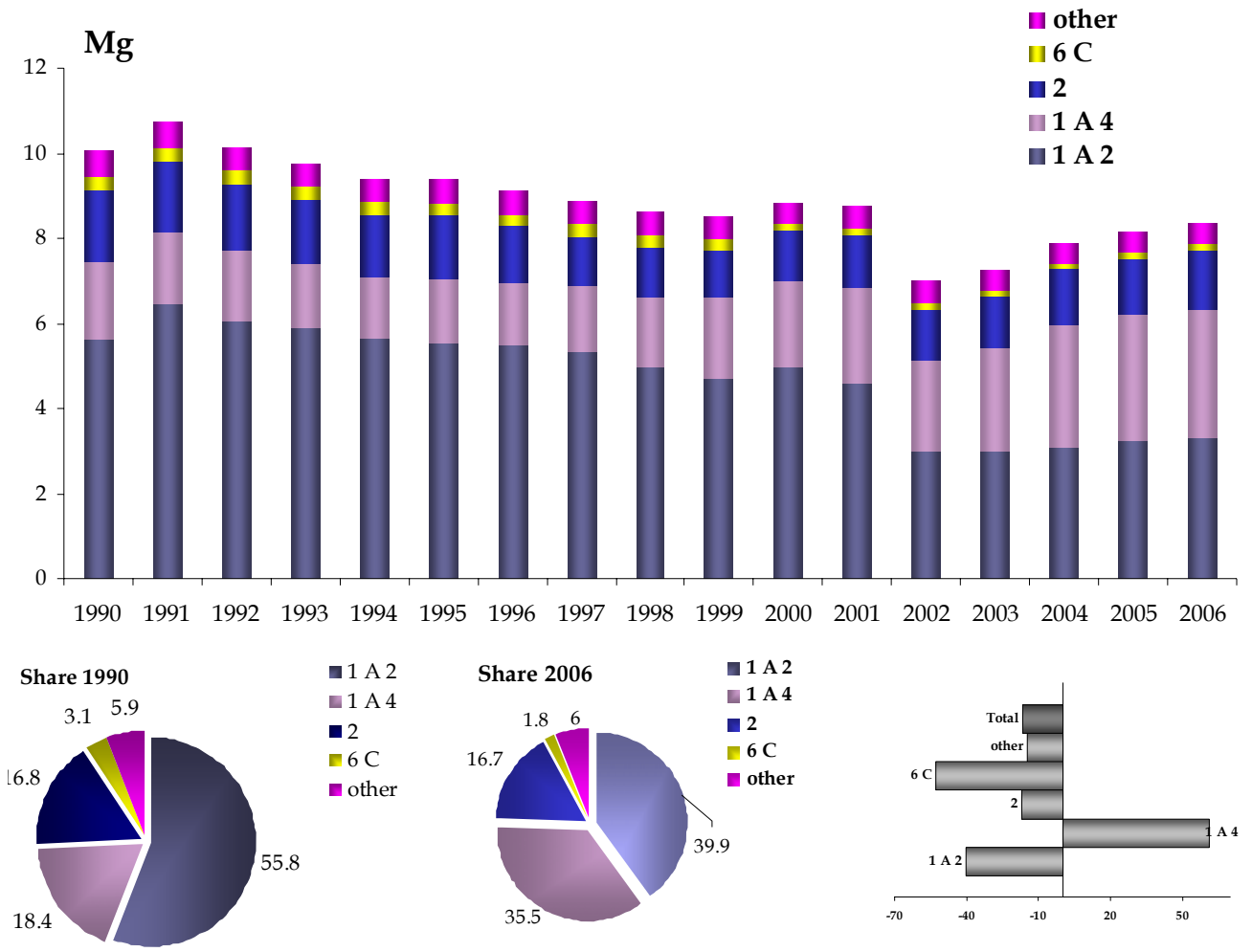

Figure 2.9 Cd emission trend 1990-2006, percentage share by sector and variation 1990-2006

	1990	1995	2000	2001	2002	2003	2004	2005	2006
					Mg				
Combustion in energy and transformation industries	0.19	0.20	0.18	0.18	0.20	0.19	0.18	0.17	0.17
Non-industrial combustion plants	1.84	1.47	2.02	2.28	2.12	2.40	2.90	2.94	2.96
Combustion in manufacturing industry	5.61	5.56	4.98	4.58	3.00	3.01	3.07	3.26	3.34
Production processes	2.01	1.78	1.42	1.44	1.41	1.41	1.49	1.52	1.63
Road transport	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05
Other mobile sources and machinery	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07
Waste treatment and disposal	0.31	0.27	0.14	0.16	0.18	0.14	0.13	0.16	0.15
Total	***10.05***	***9.38***	***8.84***	***8.74***	***7.01***	***7.26***	***7.89***	***8.17***	***8.37***

Table 2.9 Cd emission trend from 1990 to 2006 (Mg)

Emissions show a global reduction of 17% between 1990 and 2006, from 10 Mg to 8 Mg. Among the most significant variations, emissions from processes with contact and from commercial and institutional plants represent the 38% and 26% of the total, showing the former a decrease (-41%) and the latter a strong increase. Emissions from processes in iron and steel industries and collieries decrease of about 7% and represent the 18% of the total. Emissions from residential plants, representing the 8% of total emissions, show a reduction of about 23%. Emissions from waste incineration, accounting for 2% of the total, register a reduction of about 53%. The share of other subsectors on the total is irrelevant.

2.3.3 Mercury (Hg)

The national atmospheric emissions of mercury show a quite stable trend in the period 1990-2006. Figure 2.10 and Table 2.10 illustrate the emission trend from 1990 to 2006. Figure 2.10 also illustrates the share of Hg emissions by category in 1990 and 2006 as well as the total and sectoral variation from 1990 to 2006.

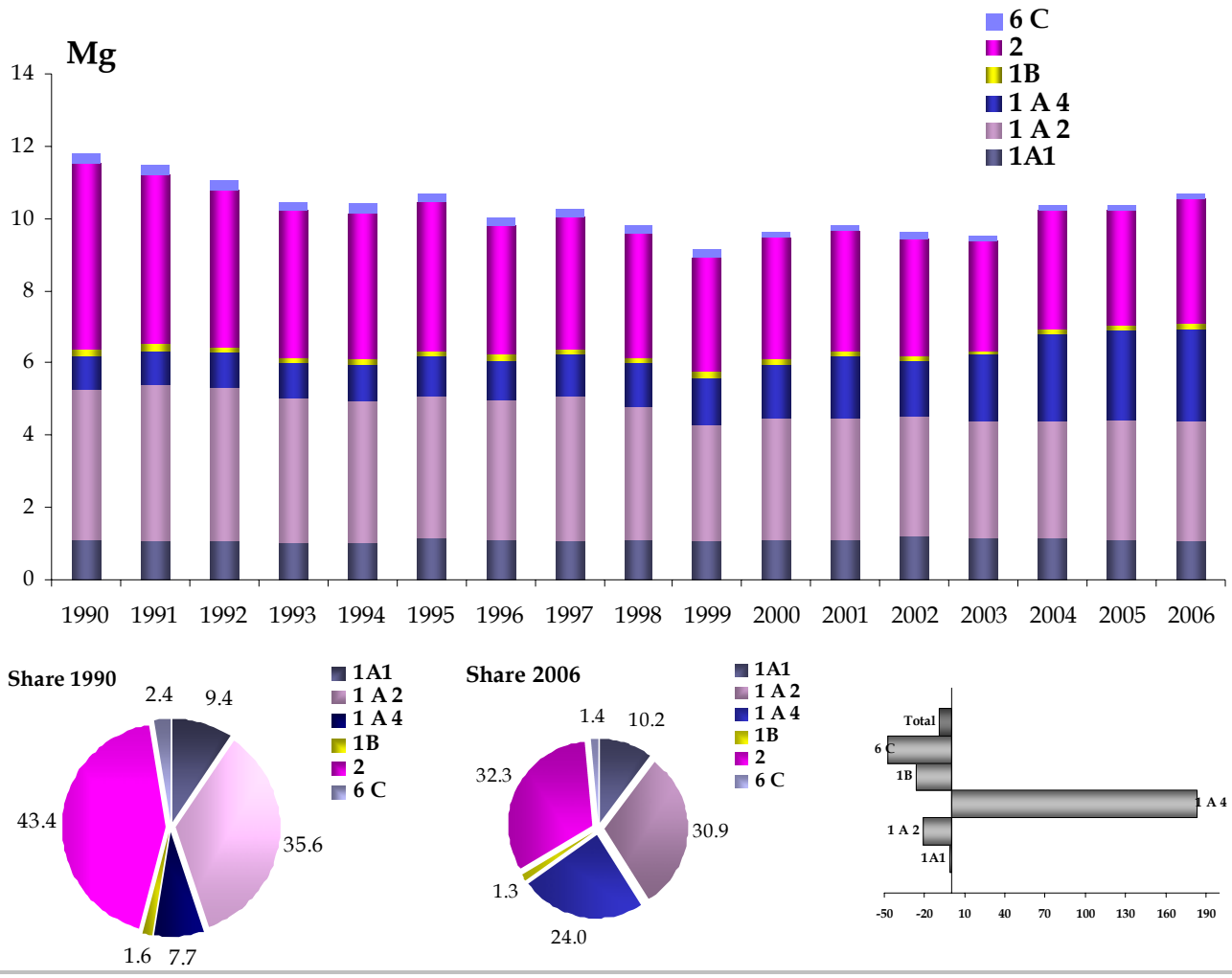

Figure 2.10 Hg emission trend 1990-2006, percentage share by sector and variation 1990-2006

	1990	1995	2000	2001	2002	2003	2004	2005	2006
					Mg				
Combustion in energy and transformation industries	1.10	1.15	1.10	1.12	1.21	1.18	1.15	1.10	1.09
Non-industrial combustion plants	0.90	1.08	1.50	1.71	1.57	1.86	2.42	2.48	2.57
Combustion in manufacturing industry	4.19	3.95	3.37	3.37	3.31	3.20	3.24	3.35	3.31
Production processes	5.31	4.26	3.50	3.47	3.34	3.13	3.40	3.31	3.59
Waste treatment and disposal	0.28	0.25	0.12	0.14	0.17	0.14	0.13	0.15	0.15
Total	***11.78***	***10.70***	***9.59***	***9.81***	***9.59***	***9.51***	***10.34***	***10.38***	***10.71***

Table 2.10 Hg emission trend from 1990 to 2006 (Mg)

Emission trend shows a global reduction of about 9% from 1990 to 2006, varying from 12 Mg to 11 Mg. The main variations concern: emissions from processes in iron and steel industries and collieries, representing 29% of the total and increasing of 26%; emissions from processes with contact, accounting for 26% and decreasing of 22%; emissions from commercial and institutional plants which represent 17% of the total and showing the strongest increase. Emissions deriving from public power, accounting for 9%, show a reduction of 7%; emission from residential plants account for 7% of the total and register a growth of 62%. Emissions from processes in inorganic chemical industries, contributing to the total only for 4%, show the largest reduction, equal to 84%.

2.4 Persistent organic pollutants (POPs)

In this section, the most significant peculiarities occurred between 1990 and 2006 of polycyclic aromatic hydrocarbons and dioxins will be presented.

2.4.1 Polycyclic aromatic hydrocarbons (PAH)

The national atmospheric emissions of polycyclic aromatic hydrocarbons show an increasing trend between 1990 and 2006, from 92 Mg to 134 Mg. Figure 2.11 and Table 2.11 illustrate the emission trend from 1990 to 2006. Figure 2.11 also illustrates the share of PAH emissions by category in 1990 and 2006 as well as the total and sectoral variation from 1990 to 2006.

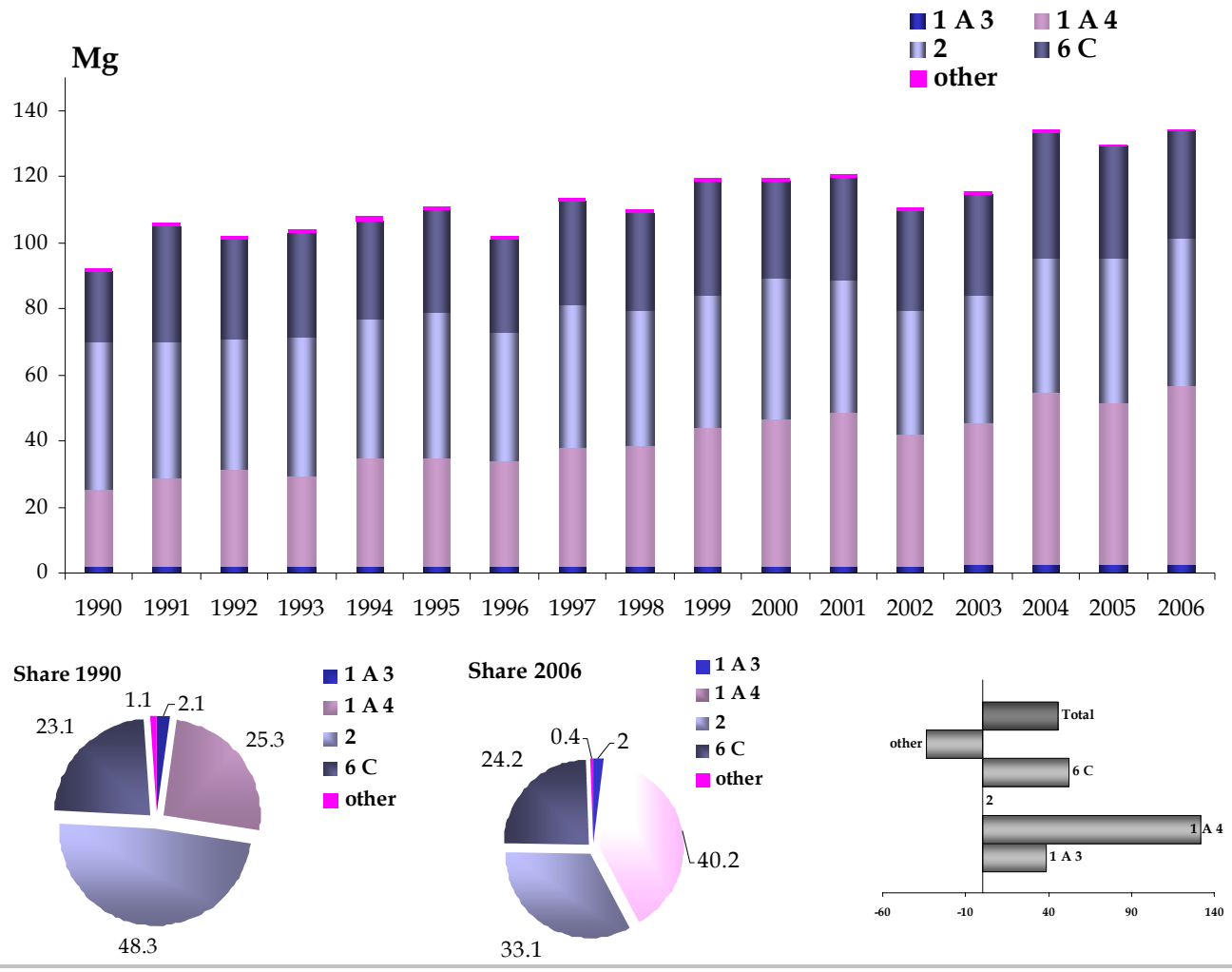

Figure 2.11 PAH emission trend 1990-2006, percentage share by sector and variation 1990-2006

	1990	1995	2000	2001	2002	2003	2004	2005	2006
					Mg				
Combustion in energy and transformation industries	0.84	0.95	0.69	0.66	0.69	0.65	0.55	0.47	0.47
Non-industrial combustion plants	23.11	32.72	44.56	46.38	39.59	42.93	51.81	48.68	53.80
Combustion in manufacturing industry	0.20	0.18	0.19	0.19	0.19	0.18	0.19	0.19	0.19
Production processes	44.48	44.06	42.44	39.90	37.27	38.88	40.93	43.81	44.49
Road transport	1.84	1.85	1.97	2.02	2.18	2.28	2.43	2.48	2.58
Other mobile sources and machinery	0.37	0.37	0.36	0.36	0.36	0.37	0.37	0.37	0.37
Waste treatment and disposal	21.28	31.10	29.54	31.22	30.34	30.36	37.81	33.90	32.45
Total	*92.10*	*111.22*	*119.75*	*120.73*	*110.62*	*115.66*	*134.09*	*129.90*	*134.36*

Table 2.11 PAH emission trend from 1990 to 2006 (Mg)

Between 1990 and 2006, global emissions show a growth of about 46%. Among the most significant changes, emissions from *residential plants* account for 35% of the total and show a strong increase (about 107%) due to the increase in wood consumption for heating; emissions from *processes in iron* and *steel industries* and *collieries* account for 33% of the total and show values quite stable between 1990 and 2006; emissions from *open burning of agricultural wastes* (except 10.03), accounting for 24% of the total, show an increase of 53%. Emissions from *plants in agriculture, forestry and aquaculture*, accounting for 4% in 2006, show a large growth from 2000 onwards, due to the use of biomass in plants. The share of other subsectors on the total varies between 0.0001% and 1%.

2.4.2 Dioxins

The national atmospheric emissions of dioxins show a decreasing trend between 1990 and 2006, with values varying from 473 g I Teq to 302 g I Teq. Figure 2.12 and Table 2.12 illustrate the emission trend from 1990 to 2006. Figure 2.12 also illustrates the share of dioxin emissions by category in 1990 and 2006 as well as the total and sectoral variation from 1990 to 2006.

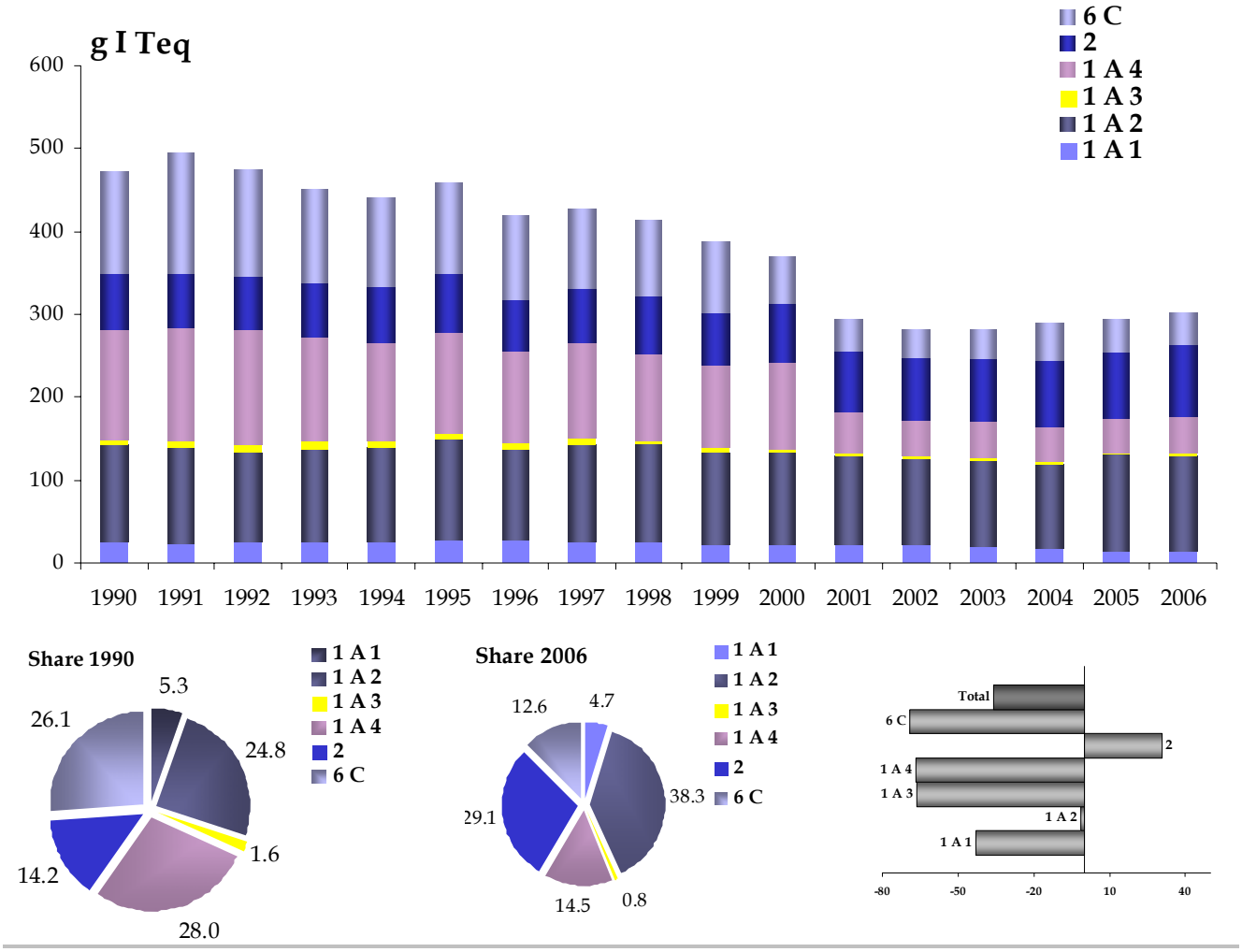

Figure 2.12 Dioxin emission trend 1990-2006, percentage share by sector and variation 1990-2006

	1990	1995	2000	2001	2002	2003	2004	2005	2006
					g I Teq				
Combustion in energy and transformation industries	24.97	28.34	21.89	21.26	22.69	20.28	16.99	14.73	14.28
Non-industrial combustion plants	132.21	120.49	106.49	49.92	43.05	43.18	43.02	41.84	43.78
Combustion in manufacturing industry	117.29	121.13	110.65	108.40	103.03	103.87	102.87	116.25	115.69
Production processes	67.20	71.68	70.66	73.22	75.32	75.84	79.58	78.59	87.80
Road transport	7.41	7.48	4.19	3.80	3.27	3.27	2.90	2.68	2.49
Waste treatment and disposal	123.51	110.54	55.58	36.50	35.46	35.48	44.15	39.59	37.90
Total	***472.59***	***459.64***	***369.46***	***293.10***	***282.82***	***281.92***	***289.50***	***293.69***	***301.95***

Table 2.12 Dioxin emission trend from 1990 to 2006 (g I Teq)

The general trend shows a decrease from 1990 to 2006 equal to 36%, with a noticeable decline between 1995 and 2000. The most considerable reductions, between 1990 and 2006, are observed in *non-industrial combustion plants* and *waste treatment disposal* (-33% and -31%, respectively). Specifically, the reduction is principally due to the cut of emissions from the combustion of municipal waste both with energy recovery, reported under the non industrial sector, and without recovery, reported under the waste sector due to the introduction of regulations establishing more stringent limits of dioxin emissions from stacks.
In 2006, the subsector which has contributed most to total emissions is *combustion in manufacturing industries*, accounting for 38% of the total and showing a decrease of 1.4% in the period 1990-2006. *Production processes* account for 29% of the total emissions in 2006 showing an increase of about 31% in the period 1990-2006.

2.4.3 Hexachlorobenzene (HCB)

The national atmospheric emissions of hexaclorobenzene show a slight increasing trend in the period 1990-2006, varying from 19 kg to 22 kg. Figure 2.13 and Table 2.13 illustrate the emission trend from 1990 to 2006. Figure 2.13 also illustrates the share of HCB emissions by category in 1990 and 2006 as well as the total and sectoral variation from 1990 to 2006.

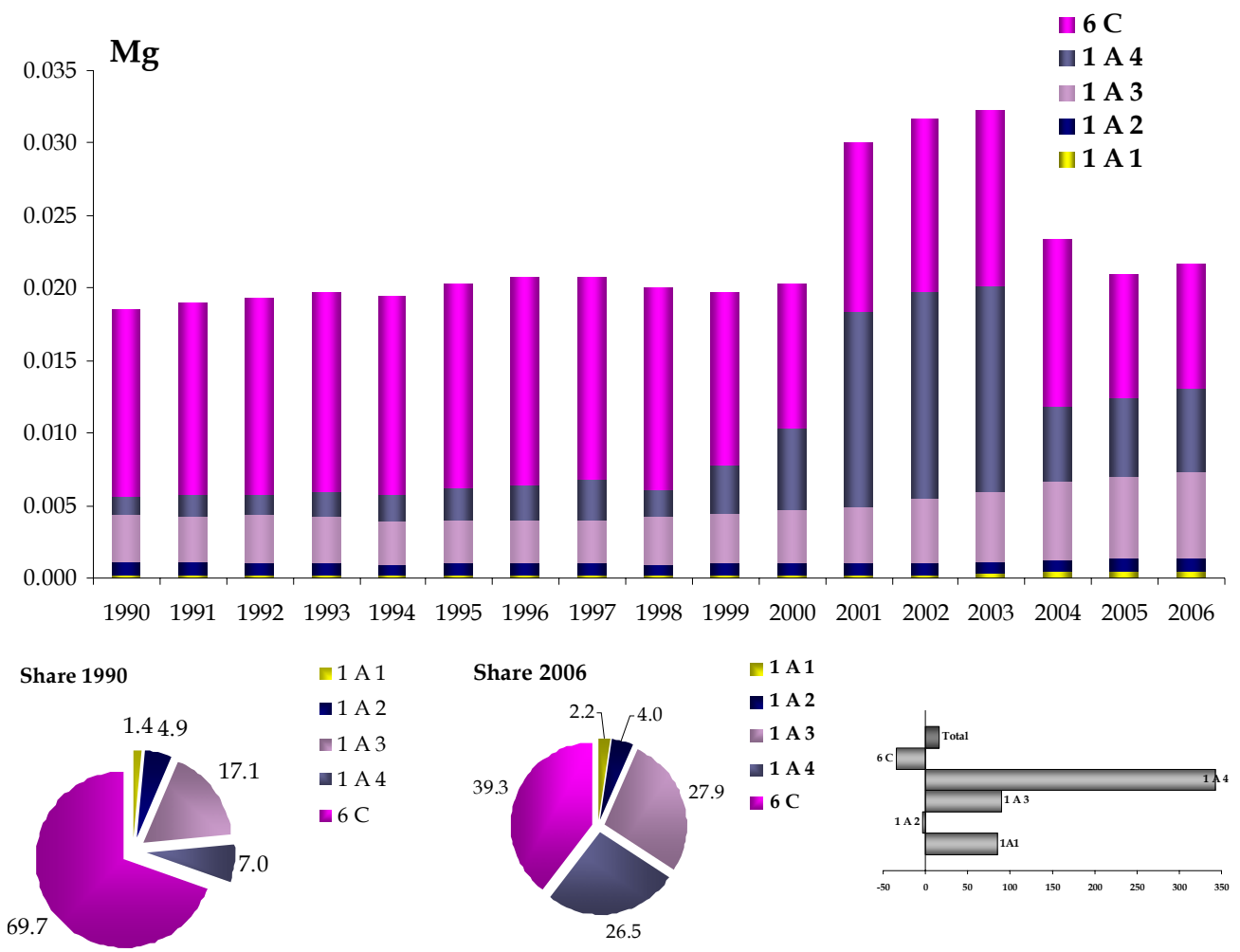

Figure 2.13 HCB emission trend 1990-2006, percentage share by sector and variation 1990-2006

	1990	1995	2000	2001	2002	2003	2004	2005	2006
					Mg				
Combustion in energy and transformation industries	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Non-industrial combustion plants	0.001	0.002	0.006	0.014	0.014	0.014	0.005	0.005	0.006
Combustion in manufacturing industry	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Road transport	0.003	0.003	0.004	0.004	0.004	0.005	0.005	0.006	0.006
Waste treatment and disposal	0.013	0.014	0.010	0.012	0.012	0.012	0.012	0.009	0.009
Total	*0.019*	*0.020*	*0.020*	*0.030*	*0.032*	*0.032*	*0.023*	*0.021*	*0.022*

Table 2.13 HCB emission trend from 1990 to 2006 (Mg)

The sector contributing most to the general trend is *waste incineration*, with the exception of the years 2001-2003 where peaks are observed because of the relevant weight of the commercial sector due to the considerable increase of the amount of sludge incineration with energy recovery (which are accounted for in this sector) burnt in a specific incinerator. The other two relevant sectors are *transport* and *commercial* and *residential*, accounting for 28% and 27%, respectively; both sectors show a significant increase between 1990 and 2006.

2.4.4 Polychlorinated biphenyl (PCB)

The national atmospheric emissions of polychlorinated biphenyl show a slight decreasing trend in the period 1990-2006, about 1.5%, from 242 kg to 246 kg. Figure 2.14 and Table 2.14 illustrate the emission trend from 1990 to 2006. Figure 2.14 also illustrates the share of PCB emissions by category in 1990 and 2006 as well as the total and sectoral variation from 1990 to 2006.

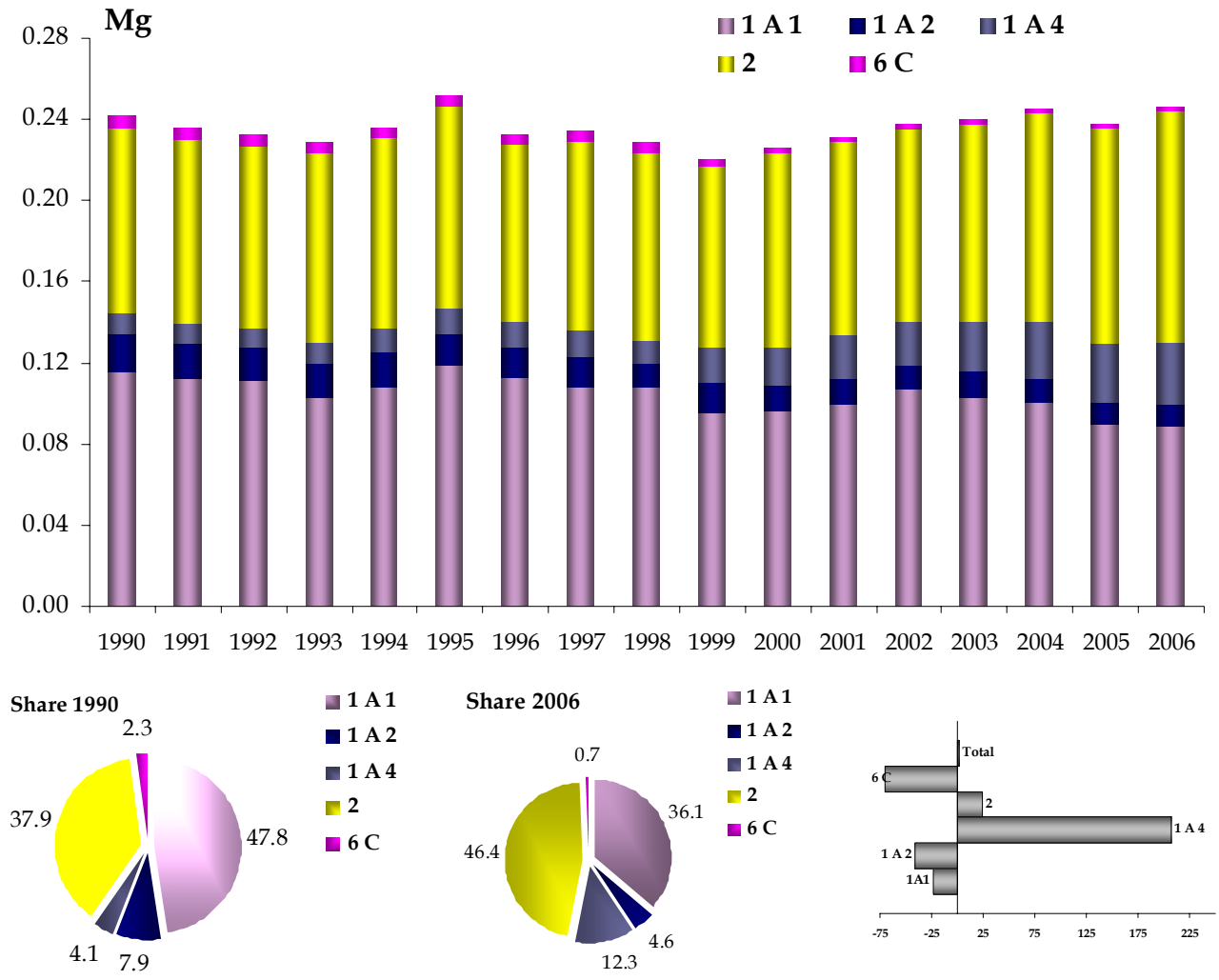

Figure 2.14 PCB emission trend 1990-2006, percentage share by sector and variation 1990-2006

	1990	1995	2000	2001	2002	2003	2004	2005	2006
					Mg				
Combustion in energy and transformation industries	0.12	0.12	0.10	0.10	0.11	0.10	0.10	0.09	0.09
Non-industrial combustion plants	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03
Combustion in manufacturing industry	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Production processes	0.09	0.10	0.10	0.10	0.09	0.10	0.10	0.11	0.11
Waste treatment and disposal	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	*0.24*	*0.25*	*0.23*	*0.23*	*0.24*	*0.24*	*0.25*	*0.24*	*0.25*

Table 2.14 PCB emission trend from 1990 to 2006 (Mg)

The subsector contributing most to the general trend is the *energy production* sector, accounting for 67% of the total emissions and showing a reduction by 23%. The other relevant subsectors are *commercial* and *residential* and *manufacturing industries* and *construction*, accounting for 23% and 13%, respectively; both sectors show an increase between 1990 and 2006.

3 ANALYSIS OF KEY TRENDS BY SECTOR

3.1 Energy (NFR SECTOR 1)

3.1.1 Methodological issues

Methodologies used for estimating emissions from this source category are based on and conform to the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2005), the IPCC Guidelines (IPCC, 1997) and the Good Practice Guidance (IPCC, 2000).
Specifically, for road transport, COPERT III programme is used to calculate emissions (EEA, 2000); the updated version of the model will be used in the next submission even though some problems regarding NO_X emission factors and resulting increasing in emission levels have already been dealt with.
A detailed description on the methods and national specific circumstances as well as reference material is documented in the national inventory report of the Italian greenhouse gas inventory (APAT, 2008[b]). At national level, trends of the CLRTAP pollutants are described in the environmental data yearbook published by APAT (APAT, 2007).

The National Energy Balance, published by the Ministry of Economic Development, is the main source of information to estimate emissions from the energy sector as it reports fuel consumption for different sectors at national levels. Additional information for electricity production is provided by the major national electricity producers and by the major national industry corporation. On the other hand, basic activity data for road transport, maritime and aviation, such as the number of vehicles, harbour statistics and aircraft landing and take-off cycles are provided in statistical yearbooks published both by the National Institute of Statistics and the Ministry of Transportation. Other data are communicated by different category associations.

The Agency, specifically the same unit responsible for the inventory compilation, also collects data in the framework of the European Emissions Trading Scheme, the National Pollutant Emission Register (EPER) and the Large Combustion Plants (LCP) Directives.

A unique database is being completed for the analysis of this information, so that figures are cross checked and used to develop country-specific emission factors and input activity data levels. These processes have improved the efficiency in collecting data and exchange of information, and whenever data cannot be straight used for the inventory compilation, they are taken into account as verification.

A complete description of methodological and activity data improvements are documented every year in a QA/QC plan (APAT, 2008[c]).

The following sections present an outline of the main key categories in the energy sector. Table 3.1 reports the key categories identified in the sector.

Pollutant	1A1a	1A1b	1A1c	1A2	1A3a ii (i)	1A3a ii (ii)	1A3b i	1A3b ii	1A3b iii	1A3b iv	1A3b v	1A3b vi	1A3c	1A3d ii	1A3e	1A4a	1A4b	1A4c	1A5b	1B1a	1B1b	1B2
											%											
SO_x	29.78	13.77	3.81	16.75	0.05	0.17	0.28	0.08	0.15	0.01			0.00	14.86	0.00	1.60	2.76	0.04	0.04			8.94
NO_x	7.38	2.10	1.00	15.69	0.24	0.93	18.41	6.79	18.73	0.58			0.42	7.47	0.25	3.73	4.81	7.84	1.00			0.66
NH_3	0.05	0.00	0.00	0.02			3.60	0.08	0.03	0.02			0.00	0.00		0.00	0.00	0.00	0.00			
NMVOC	0.35	0.08	0.05	1.06	0.04	0.03	8.06	0.77	2.82	10.26	5.45		0.04	9.45	0.00	1.37	3.47	1.88	0.22		0.20	6.47
CO	0.86	0.12	0.53	9.42	0.07	0.03	31.75	1.88	1.80	16.83			0.03	7.17	0.02	0.51	12.76	3.13	1.31			0.01
PM_{10}	1.88	0.83	0.53	14.30	0.07		8.49	4.44	6.40	1.21		6.79	0.30	5.40	0.02	0.73	10.91	7.38	0.77	0.46	0.14	0.35
$PM_{2.5}$	2.24	0.98	0.63	17.11	0.09		10.65	5.57	8.03	1.52		3.07	0.38	6.77	0.02	0.87	12.97	9.25	0.96	0.57	0.14	0.44
Pb	1.22	0.18	0.01	51.54	0.13	0.39	0.00	0.00	0.00	0.00			0.00	0.07		14.98	0.31	0.02	0.00		0.38	
Cd	1.63	0.34	0.02	39.94	0.00	0.00	0.29	0.10	0.21	0.01			0.00	0.63		26.15	8.42	0.95	0.00		2.80	
Hg	8.57	1.46	0.18	30.88												16.72	6.60	0.64			1.31	
PAH	0.32	0.02	0.01	0.19	0.00	0.00	1.15	0.30	0.42	0.06			0.01	0.06		0.80	34.93	4.45	0.01			
Dioxin	3.05	1.67	0.01	38.32			0.32	0.04	0.15	0.32						2.97	10.40	1.14				
HCB	2.24			4.03			18.22	5.56	3.91	0.19						24.81	1.52					
PCB	36.00	0.03	0.04	4.60												10.74	1.39	0.16				

Note: grey shaded are key sources

Table 3.1 Key categories in the energy sector in 2006

The *energy* sector is the main source of emissions in Italy with a share of more than 80% in different pollutants under the UNECE convention; specifically, for the main pollutants, in 2006 the sector accounts for:

- 98% in national total NO_X emissions;
- 88% in national total CO emissions;
- 93% in national total SO_X emissions.

Moreover, the sector comprises 82% of total $PM_{2.5}$ emissions and is also an important source for heavy metals; specifically in 2006 energy sector is responsible for 82% of total Cd emissions and accounts for a high share of other heavy metals, i.e As (99.5%), Cu (85.5%), Ni (96.8), Se (92%).
There are no particular differences as compared the sectoral share in 1990, except for lead whose contribution in 1990 was about 30% higher than 2006, accounting for 98% of total emissions.

The most important source of emissions in the sector, in 2006, is represented by *road transport* at least for the main pollutants: NO_X (44.5%), CO (52.3%), NMVOC (27.4%), particulate matter (PM_{10} 27.3%, $PM_{2.5}$ 28.8%) and HCB (27.9%). There has been a strong reduction of lead emissions from 1990 to 2006 in road transport due to replacement of lead gasoline.

Manufacturing industries and *construction* is the main source for heavy metals, accounting for more than 50% of lead total emissions, 40% for cadmium and 31% for mercury, and dioxin (38%). The source is also relevant for PM_{10} and $PM_{2.5}$, as well as SO_X and NO_X, about 15% of total emissions.
Public electricity and *heat production* is the main source of SO_X emissions in 2006 with a share of 29.8%, followed by *manufacturing industries and construction*, as already reported, national *navigation* (14.9%) and *petroleum refining* (13.8%); the source is also important for PCB emissions (36%).

A sector which seems of increasing importance is the *non-industrial combustion*, especially for NO_X, PM, accounting for 15-20%, and PAH (40%), in relation to *biomass combustion* and *off road machinery in agriculture and fishing* and taking into account that they occur especially during the winter period becoming critical for air quality issues. This source is a key source for heavy metals, HCB and PCB due to the increase of combustion of waste with energy recovery reported under the sector.

3.2 Industrial Processes (NFR SECTOR 2)

3.2.1 Methodological issues

Methodologies used for estimating emissions from this source category are based on and conform to the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2005), the IPCC Guidelines (IPCC, 1997) and the Good Practice Guidance (IPCC, 2000).
Moreover, as for the *energy* sector, a lot of information derives from data collected in the framework of the EPER registry, Large Combustion Plant directive and European Emissions Trading Scheme. Other small plants communicate their emissions which are also considered individually.

These processes have improved the efficiency in collecting data and exchange of information, and whenever data cannot be straight used for the inventory compilation, they are taken into account as verification practice.

Environmental Reports published by industrial associations are also considered in the verification process.

A detailed description on the methods and national specific circumstances as well as reference material is documented in the national inventory report of the Italian greenhouse gas inventory (APAT, 2008[b]). At national level, trends of the CLRTAP pollutants are described in the environmental data yearbook published by APAT (APAT, 2007).

A complete description of methodological and activity data improvements are documented every year in a QA/QC plan (APAT, 2008[c]).
The following sections present an outline of the main key categories in the *industrial processes* sector. Table 3.2 reports the key categories identified in the sector.

	2A1	2A2	2A5	2A6	2B1	2B2	2B3	2B5	2C	2D1	2D2	2G
Pollutant						*%*						
SO_x	3.70				0.00			2.02	1.05	0.1	0.1	
NO_x					0.07	0.04	0.00	0.18	0.30	0.01		
NH_3					0.00	0.00		0.04				
NMVOC			0.00	0.93	0.01			0.31	0.32	0.16	2.39	
CO					0.00			0.48	3.08			
PM_{10}	3.64	1.21	0.06	1.76				0.42	4.36	0.01	0.01	
$PM_{2.5}$	0.68	0.23	0.01	0.33				0.25	4.32	0.00	0.00	
Pb									28.56			0.8
Cd								1.12	15.61			
Hg								4.25	28.00			
PAH									33.11			
Dioxin									29.08			
HCB												
PCB									46.36			

Note: grey shaded are key sources

Table 3.2 Key categories in the industrial processes sector in 2006

There is a general reduction of emissions in the period for most of the pollutants due to the implementation of different directives at European and national level. A strong decrease is observed especially in the *chemical industry* due to the introduction of relevant technological improvements; this sector is still a key source for Hg emissions from chlorine production.

The most important source of emissions in the sector, in 2006, is represented by *metal production*, specifically iron and steel, at least for particulate matter, heavy metals and POPs.
For SO_X and particulate matter, significant emissions derive from *cement production*.

3.3 Solvent and other product use (NFR SECTOR 3)

3.3.1 Methodological issues

Methodologies used for estimating emissions from this source category are based on and conform to the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2005), the IPCC Guidelines (IPCC, 1997) and Good Practice Guidance (IPCC, 2000).
The sector is characterized by a multitude of activities which means that the collection of activity data and emission factors is laborious. A lot of contacts have been established in different sectors with industrial associations and documentation collected even though improvements are still needed especially in some areas.
Country specific emission factors provided by several accredited sources are used, together with some data provided by the national EPER Registry. Specific surveys based on local and regional inventories have been funded by APAT to check NMVOC emission factors and update emission estimates.

A detailed description on the methods and national specific circumstances, as well as reference material, is documented in the national inventory report of the Italian greenhouse gas inventory (APAT, 2008[b]). At national level, trends of the CLRTAP pollutants are described in the environmental data yearbook published by APAT (APAT, 2007).

	3A	3B	3C	3D
Pollutant		*%*		
SO_x				
NO_x				
NH_3				
NMVOC	19.04	1.92	4.63	16.09
CO				
PM_{10}			0.01	
$PM_{2.5}$			0.01	
Pb				
Cd				
Hg				
PAH				0.01
Dioxin				
HCB				
PCB				

Note: grey shaded are key sources

Table 3.3 Key categories in the solvent and other product use sector in 2006

The general reduction observed in the emission trend of the sector is due to the implementation of the European Directive 1999/13/EC on the limitation of emissions of volatile organic compounds due to the use of organic solvents, entered into force in Italy in January 2004, which establishes a reduction of the solvent content in products.

The main source of emissions, for NMVOC, is *paint application* where emissions derive mainly from construction and building and wood application. The second source of emissions, *other paint*, is for the most part characterized by emissions deriving from domestic solvent use.

3.4 Agriculture (NFR SECTOR 4)

3.4.1 Methodological issues

Methodologies used for estimating national emissions from this source category are based on and conform to the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2005), the IPCC Guidelines (IPCC, 1997; IPCC, 2006) and the Good Practice Guidance (IPCC, 2000). Therefore, consistency among methodologies for the preparation of the agriculture emission inventory under the CLRTAP and UNFCCC is guaranteed and synergies among international conventions/European directives are implemented (Cóndor and De Lauretis, 2007).

The procedure for estimation NH_3 emissions has been initially reported in APAT (APAT, 2005). However, a detailed and updated description of the methodologies for the estimation of NH_3 emissions, as well as of national specific circumstances and reference material, is reported in the National Inventory Report for greenhouse gases (APAT, 2008[b]). At national level, trends of the CLRTAP pollutants are described in the environmental data yearbook published by APAT (APAT, 2007).

Since the 2006 submission, results from a specific project on Mediterranean area, the *MeditAIRaneo* project, have been included in the preparation of the CLRTAP/UNFCCC agriculture emission inventory (CRPA, 2006[a]). Moreover, outcomes from the convention signed between APAT and the Ministry for the Environment, Land and Sea on NH_3 emission scenarios have been incorporated (CRPA, 2006[b]; ENEA, 2006).

In the future, the implementation of an *ad hoc* survey on "Agricultural Production Methods", regulated by the European Commission will be crucial for improving the preparation of the national agriculture inventory. This survey will be carried out in Italy during the 2010 General Agricultural Census. Information such as animal grazing period, animal housing and storage systems characteristics, and use of manure/slurry for land application will be collected. Some information at provincial level has been already collected with the incorporation of specific queries in the Farm Structure Survey (FSS) from 2005 and 2007.

Besides, a complete description of methodological and activity data improvements are documented every year in a QA/QC plan (APAT, 2008[c]).

The following sections present an outline of the main key categories in the agriculture sector. Table 3.4 reports the key categories identified in the agriculture sector.

	4B1a	4B1b	4B2	4B3	4B4	4B5	4B6	4B7	4B8	4B9	4B13	4C	4D1	4F	4G
Pollutant								*%*							
SO_x															
NO_x														0.04	
NH_3	15.97	16.43	1.65	0.44	0.05		0.23	0.02	9.03	7.28	2.61		40.50		
NMVOC	0.01	0.02	0.00	0.00	0.00		0.00	0.00	0.01					0.05	
CO														0.34	
PM_{10}	0.64	0.77	0.05				0.04	0.00	2.13	4.93				1.26	
$PM_{2.5}$	0.51	0.64	0.04				0.03	0.00	0.44	0.80				1.57	
Pb															
Cd															
Hg															
PAH															
Dioxin															
HCB															
PCB															

Note: grey shaded are key sources

Table 3.4 Key categories in the agriculture sector

The agriculture sector is the main source of NH_3 emissions in Italy with a share of more than 94%; for the main pollutants, in 2006 the sector accounts for:

- 94% in national total NH_3 emissions;
- 10% in national total PM_{10} emissions;
- 4% in national total $PM_{2.5}$ emissions.

Moreover, the sector comprises 0.3% of total CO emissions, 0.1% of NMVOC and a 0.04% of NO_x. There are no particular differences as compared the sectoral share in 1990.

Concerning NH_3 emissions, the category *Manure Management (4B*) represent, in 2006, 54% of ammonia emissions (58% in 1990). In particular, NH_3 emissions from *cattle* (4B1) stand for 60% of the category emissions, while emissions from *swine* (4B8) and *poultry* (4B9) represent 17% and 14%, respectively. *Direct soil emissions*, especially for the use of chemical fertilizers, represent 40% in 2006 (40% in 1990).

Regarding PM_{10} emissions, the category *Manure Management (4B*) accounts for 9% in 2006 (6% in 1990). *Poultry* (4B9) and *swine* (4B8) represent the major contributors to the total PM_{10} emissions from category 4B (58% and 25%, respectively). The presence of large poultry and swine farms in the Po river basin assume a particular relevance, at regional level, for air quality issues especially for the specific meteorological conditions for that regional area.

Similar consideration may be done for $PM_{2.5}$ emissions; the category *Manure Management* (4B) contributes for 2.5% in 2006 (1.8% in 1990). *Cattle* (4B1) accounts for 47%, while *poultry* (4B9) stands for 32% to the total $PM_{2.5}$ emissions from category 4B.

3.5 Waste (NFR SECTOR 6)

3.5.1 Methodological issues

Methodologies used for estimating emissions from this source category are based on and conform to the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2005), the IPCC Guidelines (IPCC, 1997) and the Good Practice Guidance (IPCC, 2000).

Activity data are derived by national statistics from the waste cadastre, formed by a national branch hosted by APAT and regional and provincial divisions, and other national statistics. A complete database of the national incineration plants is available, update annually, which reports the year of the construction and possible upgrade, the typology of combustion chamber and gas treatment section, if it is provided of energy recovery (thermal or electric), and the type and amount of waste incinerated (municipal, industrial, etc.).

Emission parameters and emission factors are derived by national studies or default figures, according to data availability.

A detailed description on the methods and national specific circumstances as well as reference material is documented in the National Inventory Report on the Italian greenhouse gas inventory (APAT, 2008 [b]).

The following sections present an outline of the main key categories in the waste sector.

	6A	6B	6C	6D
Pollutant		*%*		
SO_x			0.06	
NO_x			1.30	
NH_3	1.70			0.24
NMVOC	0.73		1.27	0.03
CO			7.86	
PM_{10}			7.30	
$PM_{2.5}$			7.85	
Pb			1.38	
Cd			1.77	
Hg			1.37	
PAH			24.15	
Dioxin			12.55	
HCB			39.33	
PCB			0.68	

Note: grey shaded are key sources

Table 3.5 Key categories in the waste sector

The waste sector, and in particular *Waste incineration* (6C), is a relevant source of different

pollutants; for the main pollutants, in 2006 the sector accounts for:

- 39% in national total HCB emissions;
- 24% in national total PAH emissions.
- 13% in national total Dioxin emissions;

Moreover, the sector comprises more than 7% of total PM_{10} and $PM_{2.5}$ emissions, 7.9% of CO, 1.3% of NO_X, and more than 1% of heavy metals (HM). Comparing the sectoral 1990 emissions, it's possible to note a severe reduction of the share of HCB (69.7% in 1990), and a decrease in the share of dioxin emissions (26% in 1990) as a consequence of the introduction of more stringent limits of these emissions for incineration plants.

The European Council Directive 99/31/EC on the landfill of waste transposed by the Legislative Decree 13 January 2003 n.36, has been applied to the Italian landfills since July 2005, but the effectiveness of the policies will be significant in the future.

4 Recalculations and Improvements

4.1 Recalculations

To meet the requirements of transparency, consistency, comparability, completeness and accuracy of the inventory, the entire time series from 1990 onwards is checked and revised every year during the annual compilation of the inventory. Measures to guarantee and improve these qualifications are undertaken and recalculations should be considered as a contribution to the overall improvement of the inventory.

Recalculations are elaborated on account of changes in the methodologies used to carry out emission estimates, changes due to different allocation of emissions as compared to previous submissions, changes due to error corrections and in consideration of new available information.

The complete NFR files from 1980 to 2006 have been submitted.

The percentage difference between the time series reported in the 2007 submission and the series reported this year (2008 submission) are shown in Table 4.1 by pollutant.

Improvements in the calculation of emission estimates have led to a recalculation of the entire time series of the national inventory. Considering the total emissions, the emission levels for the year 2005 showed a decrease especially for SO_X , dioxins, PM_{10} and $PM_{2.5}$.

Relevant changes in time series regarded dioxin emissions, where a double counting has been detected in the estimation of emissions from urban solid *waste incineration*. Minor changes affect the PM_{10} and $PM_{2.5}$ emissions from *swine* and *poultry* breeding where emission factors have been revised on the basis of the results of a study funded by APAT and carried out by the University of Milan. Information collected in the framework of EPER registry lead to a revision of Cu, Zn, Pb and Ni emissions from non ferrous metal production and manufacturing processes.

For the last two years, 2004 and 2005, NO_X and SO_X emissions have been revised for large combustion point sources on the basis of the joint analysis of data collected in the framework of the LCP and EPER European obligations.

	SO_X	NO_X	NH_3	NMVOC	CO	PM_{10}	$PM_{2.5}$	Pb	Hg	Cd	DIOX	PAH
						%						
1980	0.0	0.0	0.5	0.1	0.0							
1981	0.0	0.0	0.5	0.1	0.0							
1982	0.0	0.0	0.5	0.1	0.0							
1983	0.0	0.0	0.5	0.1	0.0							
1984	0.0	0.0	0.5	0.1	0.0							
1985	0.0	0.0	0.5	0.1	0.0							
1986	0.0	0.0	-0.7	0.1	0.0							
1987	0.0	0.0	-0.7	0.1	0.0							
1988	0.0	0.0	-0.9	0.1	0.0							
1989	0.0	0.0	-0.3	0.1	0.0							
1990	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.1	0.0	-0.1	-10.4	0.0
1991	0.0	0.0	0.0	0.1	0.0	0.4	0.2	0.1	0.0	-0.1	-10.1	0.0
1992	-0.1	0.0	0.0	0.1	0.0	0.4	0.2	0.1	0.0	-0.1	-10.6	0.0
1993	0.0	0.0	0.0	0.1	0.0	0.5	0.4	0.1	0.0	-0.1	-8.1	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.1	0.0	-0.1	-7.7	0.0
1995	0.0	0.0	0.0	0.1	0.0	0.5	0.3	0.2	0.0	-0.1	-8.6	-0.1
1996	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.2	0.0	-0.1	-7.7	-0.1
1997	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.2	0.0	-0.1	-8.4	-0.1
1998	0.0	0.0	0.0	0.2	0.0	0.4	0.2	0.1	0.0	-0.1	-7.3	-0.2
1999	0.0	0.0	0.0	0.0	-0.1	0.3	0.1	0.1	0.0	-0.1	-6.5	-0.1
2000	0.0	0.0	0.0	0.0	-0.1	0.3	0.1	0.3	0.3	-0.1	-6.7	-0.1
2001	0.0	0.0	-0.9	0.0	-0.1	0.3	0.0	0.1	0.0	-0.1	-4.7	-0.2
2002	0.0	0.0	0.0	0.0	-0.2	0.3	0.0	0.5	0.0	-0.1	-3.4	-0.1
2003	0.0	0.0	0.0	-0.2	-0.2	0.4	0.2	0.7	0.4	0.1	-3.2	-0.1
2004	-1.3	-1.0	-0.2	-0.1	-0.2	-0.7	-1.1	0.8	0.3	0.0	-1.6	0.0
2005	-2.3	-0.2	-0.3	0.5	-0.3	-1.2	-1.8	0.9	0.3	0.1	-1.5	0.0

Table 4.1 Recalculation between 2007 and 2008 submissions.

4.2 Planned improvements

Specific improvements are specified in the 2008 QA/QC plan; they can be summarized as follows.
For the *energy* sector, a revision will be carried out for both the aviation and marine sectors, aiming at a proper allocation of fuel between domestic and international. Emissions for all the pollutant will be calculated for the years 2005, 2006 and 2007 with a Tier 3 movements methodology. A major revision is also expected for road transport, due to the use of COPERT IV model instead of

the previous version, COPERT III (EEA, 2000); recalculation should regard especially NO_X emissions resulting in about 15% higher levels in the sector in 2006. Both for energy and industrial sectors, a major progress will regard the building of a unique database where information collected in the framework of different directives, Large Combustion Plant, EPER and Emissions Trading, are gathered together thus highlighting the main discrepancies in information and detecting potential errors.

For the *agriculture* and *waste* sectors, improvements will be related to the availability of new information on emission factors, activity data as well as parameters necessary to carry out the estimates; specifically, a study on the best available technologies used in agriculture practises and availability of information on waste composition and other parameters following the entering into force of the European landfill directive.

Finally, efforts will be addressed to the comparison between local inventories and national inventory.

Further analyses will concern the collection of statistical data and information to estimate uncertainty in specific sectors.

5 Projections

The national projections reported within the UNECE Convention are calculated by the model RAINS Italy, the Italian version of the RAINS Europe model (Amman et al., 1999; IIASA, 2008). The estimations of SO_2, NO_X, NMVOC and NH_3 are based on an assessment of economic activities and a control strategy, explained by economic sector, set of abatement technologies planned in terms of rates of application for the current and future years (Pignatelli et al., 2007). Emission factors are those used for the national emission inventory estimations as well as national references and personal communication with sectoral experts.

In order to assess future economic activities levels two scenarios are developed:

- an energy scenario to estimate emissions from energy sources. The Markal (MARket Allocation) model (Goldstein et al., 1999) is used to implement the scenario at 2010. Actually, this model has been modified at the beginning of the 1990s to take into consideration the Italian circumstances and evaluate potential and costs of emissions reduction of CO_2, NO_x e SO_x. Markal Italy (Gracceva and Contaldi, 2004) is also used to develop the energy mitigation scenario also for the Fourth National Comunication under the UN Convention on Climate Change (MATTM, 2007).
- a scenario on production activities to estimate emissions from non energy sources. National statistics and projections of non energy economic activities are used to this end.

In addition to these scenarios, the national control strategy, that's the whole set of abatement technological measures to be implemented in the time interval considered, need to be defined.

Other documentation on emission scenarios in Italy can be found in Vialetto et al. (2005), Zanini et al. (2005).

Emission projections at 2010 for the pollutants regulated by the National Emission Ceilings (NEC) Directive (2001/81/EC) are reported in Table 5.1.

Moreover in Table 5.2, the national emission ceilings for Italy established by the D.Lgs. 171/2004 according to Annex I of the NEC directive are reported.

NFR2 codes	NO_X	SO_X	NH_3	NMVOC
		kt		
1A1a: Public electricity and heat	124.03	57.73	3.18	6.96
1A1b,c: Other energy industries	31.70	72.16	0.09	1.13
1A2: Manufacturing industries & construction	88.53	46.08	0.21	6.10
1A2a: Iron and steel	5.07	8.87		
1A2f: Other manufacturing industry	49.53	23.73		
1A3a: Civil aviation (LTO)	7.25	31.29		1.21
1A3b: Road transportation	424.97	0.56	5.87	225.73
1A3c: Railways	2.44	0.71	0.00	0.33
1A3d: Navigation	125.17	66.94	0.05	8.51
1A4a: Commercial / Institutional	73.56	10.61	1.77	
1A4b: Residential	0.29	2.35	0.01	113.32
1A4c: Agriculture & forestry	107.39	38.81	0.06	47.97
1B2a: Oil	8.63	1.11		44.64
1B2b: Natural gas				30.31
1B2c: Flaring in oil and gas extraction	1.11	8.86	0.00	
2B: Chemical industry	1.50	3.26	0.89	4.46
2D: Other production				34.69
3A: Paint application				155.71
3B: Degreasing and dry cleaning				2.92
3C: Chemical products, manufacturing and processing				33.76
3D: Other				201.56
4B1: Cattle			184.41	
4B3-7 & 13: Other			18.71	
4B8: Swine			47.97	
4B9: Poultry			51.74	
4D1: Direct soil emissions			89.61	
4F: Field burning of agricultural waste	4.97	2.18		12.34
6A: Solid waste disposal on land				9.34
6B: Waste water handling			4.95	
6C: Waste incineration	0.66	0.29		
7: Other			6.93	
Total	**1,056.77**	**375.50**	**416.45**	**940.97**

Table 5.1 Emission projections for the year 2010

NO_X	SO_X	NH_3	NMVOC
		kt	
990	475	419	1159

Table 5.2 National emission ceilings for Italy

The latest projections show that the 2010 emissions ceilings will be reached for all the pollutants except for NO_X. Nevertheless, if the same methodology, as that for the 1998 negotiated for the NEC directive, is used NO_X projections would be 865 kt, whereas taking into account the successive modifications in the EMEP CORINAIR methodology figures reach 1,057 kt.

An accurate comparative analysis of the possible further measure, in terms of cost/efficacy, has been carried out sector by sector. In particular, studies showed that a significant margin of reduction can be obtained in the following sectors:

- *industrial sector*. Adoption of best available technologies in the old large plants according to authorisation (environmental permit), as required in 2007 by Annex I of Directive 96/61/EC concerning integrated pollution prevention and control (IPCC).
- *transport sector*. Implementation of technical measures according to Directives on additional measures on light and heavy duty vehicles and non-technical measures, such as rationalization and promotion of public transport for the general population and goods.
- *tertiary industrial and residential sector*. Measures to increase the usage of more efficient household heating plants and appliances and the energy efficiency of buildings; adoption of innovative technologies, usage of low pollution fuels and energy renewable sources.

Results of the studies are reported on the website of the Ministry for the Environment, Land and Sea http://www2.minambiente.it/sito/settori_azione/iar/iam/emissioni/.

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Annex: NFR codes

1 A 1	Energy industries
1 A 1 a	Public Electricity and Heat Production
1 A 1 b	Petroleum refining
1 A 1 c	Manufacture of Solid Fuels and Other Energy Industries
1 A 2	Manufacturing Industries and Construction
1 A 2 a	Iron and Steel
1 A 2 b	Non-ferrous Metals
1 A 2 c	Chemicals
1 A 2 d	Pulp, Paper and Print
1 A 2 e	Food Processing, Beverages and Tobacco
1 A 2 f	Other
1 A 3	Transport
1 A 3 a ii (i)	Civil Aviation (Domestic, LTO)
1 A 3 a ii (ii)	Civil Aviation (Domestic, Cruise)
1 A 3 b	Road Transportation
1 A 3 b i	R.T., Passenger cars
1 A 3 b ii	R.T., Light duty vehicles
1 A 3 b iii	R.T., Heavy duty vehicles
1 A 3 b iv	R.T., Mopeds & Motorcycles
1 A 3 b v	R.T., Gasoline evaporation
1 A 3 b vi	R.T., Automobile tyre and brake wear
1 A 3 b vii	R.T., Automobile road abrasion
1 A 3 c	Railways
1 A 3 d ii	National Navigation
1 A 3 e	Other
1 A 3 e i	Pipeline compressors
1 A 3 e ii	Other mobile sources and machinery
1 A 4	Other Sectors
1 A 4 a	Commercial / Institutional
1 A 4 b	Residential
1 A 4 b i	Residential plants
1 A 4 b ii	Household and gardening (mobile)
1 A 4 c	Agriculture / Forestry / Fishing
1 A 4 c i	Stationary
1 A 4 c ii	Off-road Vehicles and Other Machinery
1A 4 c iii	National Fishing

1 A 5 a	Other, Stationary (including Military)
1 A 5 b	Other, Mobile (Including military)
1B 1	Fugitive Emissions from Solid Fuels
1 B 1 a	Coal Mining and Handling
1 B 1 b	Solid fuel transformation
1 B 1 c	Other
1 B 2	Oil and natural gas
1 B 2 a	Oil
1 B 2 a i	Exploration Production, Transport
1 B 2 a iv	Refining / Storage
1 B 2 a v	Distribution of oil products
1 B 2 a vi	Other
1 B 2 b	Natural gas
1 B 2 c	Venting and flaring
2 A	**Mineral Products**
2 A 1	*Cement Production*
2 A 2	*Lime Production*
2 A 3	*Limestone and Dolomite Use*
2 A 4	*Soda Ash Production and use*
2 A 5	*Asphalt Roofing*
2 A 6	*Road Paving with Asphalt*
2 A 7	*Other including Non Fuel Mining & Construction*
2 B	**Chemical industry**
2 B 1	*Ammonia Production*
2 B 2	*Nitric Acid Production*
2 B 3	*Adipic Acid Production*
2 B 4	*Carbide Production*
2 B 5	*Other*
2 C	**Metal Production**
2 D	**Other Production**
2 D 1	*Pulp and Paper*
2 D 2	*Food and Drink*
2 G	**Other**
3 A	**Paint Application**
3 B	**Degreasing and dry cleaning**
3 C	**Chemical products, manufacture and processing**
3 D	**Other including products containing HMs and POPs**

4 B	**Manure management**
4 B 1	*Cattle*
4 B 1 a	*Dairy*
4 B 1 b	*Non-Dairy*
4 B 2	*Buffalo*
4 B 3	*Sheep*
4 B 4	*Goats*
4 B 5	*Camels and Llamas*
4 B 6	*Horses*
4 B 7	*Mules and Asses*
4 B 8	*Swine*
4 B 9	*Poultry*
4 B 13	*Other*
4 C	**Rice cultivation**
4 D 1	*Direct Soil Emission*
4 F	**Field burning of agricultural wastes**
4 G	**Other**
5 B	**Forest and grassland conversion**
6 A	**Solid waste disposal on land**
6 B	**Waste-water handling**
6 C	**Waste incinerator**
6 D	**Other waste**