



**ISPRA**

Istituto superiore per la protezione  
e la ricerca ambientale

# Italian Emission Inventory 1990-2009

## Informative Inventory Report 2011



Rapporti xxx/2011

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## EXECUTIVE SUMMARY

The *Italian Informative Inventory Report* (IIR) is edited 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 2009, 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 Institute for Environmental Protection and Research (ISPRA) 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<sub>x</sub>, NO<sub>x</sub>, NMVOC, CO and NH<sub>3</sub>, 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 1990-2009, emissions from most pollutants described in this report show a downward trend. Reductions are especially relevant for the main pollutants (SO<sub>x</sub> -87%; NO<sub>x</sub> -51%; CO -63%; NMVOC -45%) and lead (-95%) whereas a significant raise is observed for polycyclic aromatic hydrocarbons (+20%) and hexachlorobenzene (+30%).

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%, including fugitive emissions, in many pollutants (SO<sub>x</sub> 91%; NO<sub>x</sub> 98%; CO 85%; PM<sub>2.5</sub> 85%; Cd 83%). The industrial processes sector is an important source of emissions specifically related to the iron and steel production, at least for particulate matter, heavy metals and POPs, whereas significant emissions of SO<sub>x</sub> and particulate matter derive from cement production; on the other hand, the solvent and other product use sector is characterized by NMVOC emissions. The agriculture sector is the main source of NH<sub>3</sub> emissions in Italy with a share of 95% in national total. Finally, the waste sector, specifically waste incineration, is a relevant source for HCB, PAH and dioxin emissions (48%, 27% and 16%, 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](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 28<sup>th</sup> 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 2<sup>nd</sup> September 1987.
- The 1988 Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes; 31 Parties. Entered into force on 14<sup>th</sup> February 1991.
- The 1991 Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes; 22 Parties. Entered into force on 29<sup>th</sup> September 1997.
- The 1994 Protocol on Further Reduction of Sulphur Emissions; 27 Parties. Entered into force on 5<sup>th</sup> 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 23<sup>rd</sup> October 2003.
- The 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone; 23 Parties. Entered into force on 17<sup>th</sup> 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 <sub>x</sub> 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**

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

### Main Pollutants

- Sulphur oxides (SO<sub>x</sub>), in mass of SO<sub>2</sub>;
- Nitrous oxides (NO<sub>x</sub>), in mass of NO<sub>2</sub>;
- Carbon monoxide (CO);
- Non-methane volatile organic compounds (NMVOC);
- Ammonia (NH<sub>3</sub>).

### Particulate matter

- TSP, total suspended particulate;
- PM<sub>10</sub>, particulate matter less than 10 microns in diameter;
- PM<sub>2.5</sub>, 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<sub>x</sub>, NO<sub>x</sub>, NMVOC, CO and NH<sub>3</sub>, and various heavy metals and POPs according to the *Guidelines for Reporting Emission Data under the Convention on Long-range Transboundary Air Pollution* (UNECE, 2008).

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 2009, 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<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), ammonia (NH<sub>3</sub>), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), total suspended particulate (TSP), particulate matter, particles of size <10 µm, (PM<sub>10</sub>), particulate matter, particles of size < 2.5µm, (PM<sub>2.5</sub>), 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. Changes are applied retrospectively to earlier years, which accounts for any difference in previously published data.

Total emissions by pollutant from 1990 to 2009 are reported in Table 1.2.

		1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
<b>SO<sub>x</sub></b>	<i>Gg</i>	1,794	1,320	749	697	617	519	481	402	380	337	282	231
<b>NO<sub>x</sub></b>	<i>Gg</i>	2,015	1,895	1,431	1,405	1,349	1,330	1,294	1,215	1,163	1,132	1,061	981
<b>NMVOC</b>	<i>Gg</i>	2,021	2,094	1,620	1,536	1,465	1,399	1,349	1,273	1,245	1,219	1,161	1,107
<b>NH<sub>3</sub></b>	<i>Gg</i>	468	449	449	452	439	435	427	416	411	419	409	391
<b>CO</b>	<i>Gg</i>	7,131	7,096	4,857	4,563	4,173	3,953	3,759	3,364	3,153	3,003	2,865	2,617
<b>As</b>	<i>Mg</i>	37	27	45	45	41	42	41	40	41	41	42	33
<b>Cd</b>	<i>Mg</i>	10	9	9	9	7	7	8	8	8	8	8	6
<b>Cr</b>	<i>Mg</i>	93	75	52	53	53	56	58	60	61	61	60	49
<b>Cu</b>	<i>Mg</i>	183	200	199	201	205	206	209	209	210	212	206	189
<b>Hg</b>	<i>Mg</i>	12	10	9	9	9	9	10	10	10	10	10	8
<b>Ni</b>	<i>Mg</i>	123	114	105	110	113	113	112	111	109	105	102	95
<b>Pb</b>	<i>Mg</i>	4,412	2,013	944	711	250	255	270	279	288	291	282	210
<b>Se</b>	<i>Mg</i>	10	10	11	11	11	12	12	12	12	12	12	10
<b>Zn</b>	<i>Mg</i>	927	909	870	873	874	891	937	943	1,014	1,009	989	715
<b>TSP</b>	<i>Gg</i>	291	292	254	254	237	235	241	226	223	230	225	215
<b>PM10</b>	<i>Gg</i>	244	243	209	208	193	191	196	182	179	185	180	173
<b>PM2.5</b>	<i>Gg</i>	211	210	179	176	161	159	164	150	148	154	150	144
<b>PAH</b>	<i>Mg</i>	49	39	19	18	16	14	13	11	10	9	9	8
<b>Dioxin</b>	<i>g IT<sub>q</sub></i>	99	113	115	116	106	110	126	123	126	134	134	119
<b>HCB</b>	<i>kg</i>	473	462	374	298	288	287	294	298	305	318	308	233
<b>PCB</b>	<i>kg</i>	23	24	23	33	34	35	26	24	30	31	31	29

**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](http://www.sinanet.apat.it/it/sinanet/serie_storiche_emissioni).

### 1.3 Institutional arrangements

The Institute for Environmental Protection and Research (ISPRA) has the overall responsibility for the emission inventory and submissions to CLRTAP; the institute 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 New Technologies, Energy and Sustainable Economic Development (ENEA), as established by the Legislative Decree n. 171 of 21<sup>st</sup> May 2004. Moreover, ISPRA 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 7<sup>th</sup> 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*' (ISPRA, 2011[a]).

A specific unit of the Institute 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 institute; 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.

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

Specifically, ISPRA 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, the *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*, and the *IPCC 2006 Guidelines*, 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 ISPRA 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 ISPRA;

- 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**

ISPRA 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. ISPRA 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 Guidelines and 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 (E-PRTR), 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 Institute. 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 new year inventory compilation or a review process.

Technical reports and emission figures are publicly accessible on the web at the address [http://www.sinanet.apat.it/it/sinanet/serie\\_storiche\\_emissioni](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.

SECTOR	ACTIVITY DATA	SOURCE
<b>1 Energy</b>		
1A1 Energy Industries	Fuel use	Energy Balance - Ministry of Economic Development Major national electricity producers European Emissions Trading Scheme
1A2 Manufacturing Industries and Construction	Fuel use	Energy Balance - Ministry of Economic Development Major National Industry Corporation European Emissions Trading Scheme
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 Statistical Yearbooks - Italian Civil Aviation Authority (ENAC) Maritime and Airport local authorities
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
<b>2 Industrial Processes</b>	Production data	National Statistical Yearbooks- National Institute of Statistics International Statistical Yearbooks-UN European Emissions Trading Scheme European Pollutant Emission Registry Sectoral Industrial Associations
<b>3 Solvent and Other Product Use</b>	Amount of solvent use	National Environmental Publications - Sectoral Industrial Associations International Statistical Yearbooks - UN
<b>4 Agriculture</b>	Agricultural surfaces Production data Number of animals Fertiliser consumption	Agriculture Statistical Yearbooks - National Institute of Statistics Sectoral Agriculture Associations
<b>5 Land Use, Land Use Change and Forestry</b>	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
<b>6 Waste</b>	Amount of waste	National Waste Cadastre - Institute for Environmental Protection and Research , National Waste Observatory

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

Methodologies are consistent with the *EMEP-CORINAIR Emission Inventory Guidebook, Revised*

1996 and 2006 IPCC Guidelines, and IPCC Good Practice Guidance (EMEP/CORINAIR, 2007; EMEP/EEA, 2009; IPCC, 1997; IPCC, 2006; 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 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* (ISPRA, 2011 [b]).

Activity data used in emission calculations and their sources are briefly described here below.

In general, for the energy sector, basic statistics for estimating emissions are fuel consumption published in the national 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.

Data from ETS are incorporated into the national inventory whenever the sectoral coverage is complete; in fact, not always do these figures entirely cover the energy categories whereas national statistics, such as the national energy balance and the energy production and consumption statistics, provide the complete basic data needed for the Italian emission inventory. However, 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 this context, ISPRA 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 7<sup>th</sup> 2008; the Institute 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 (E-PRTR) 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 E-PRTR are validated and communicated by ISPRA 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 used for the compilation of the inventory whenever they are complete in terms of sectoral information; in fact, 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, E-PRTR is a good basis for data checks and a way to facilitate contacts with industries which 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 Institute for Environmental Protection and Research 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 Institute for Environmental Protection and Research. 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 EMEP/EEA Guidebook (EMEP/EEA, 2009). 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 80% 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 inventories, as for 2007, 2008 and 2009, and to the 1990. Results are reported in the following tables for the year 1990 (Table 1.4) and 2009 (Table 1.5) by pollutant.

The trend analysis has also been applied considering 1990 and 2009. The results are reported in the Table 1.6.



	Key categories in 1990												Total (%)
<b>SO<sub>x</sub></b>	1A1a (42.9%)	1A2 (16.6%)	1A1b (10.7%)	1A3d ii (4.3%)	1B2a iv (3.8%)	1A3b i (3.4%)							81.7
<b>NO<sub>x</sub></b>	1A3b i (26.3%)	1A1a (20.3%)	1A3b iii (16.8%)	1A2 (12.2%)	1A4c ii (5.1%)								80.6
<b>NH<sub>3</sub></b>	4B1a (29.6%)	4B1b (25.5%)	4D1a (15.7%)	4B8 (10.4%)									81.2
<b>NMVOC</b>	1A3b i (24.2%)	1A3b iv (12.2%)	1A3b v (8.9%)	3A1 (7.6%)	3A2 (5.8%)	3D2 (5.8%)	1A3d ii (4.7%)	3C (3.8%)	1A4c ii (3.3%)	3D3 (3.3%)	1B2a v (3.0%)		82.6
<b>CO</b>	1A3b i (67.3%)	1A3b iv (7.0%)	1A2 (4.3%)	1A4c ii (3.8%)									82.3
<b>PM10</b>	1A1a (15.5%)	1A2 (14.6%)	1A4b i (10.9%)	1A3b i (8.0%)	1A4c ii (6.5%)	1A3b iii (5.7%)	1A3b ii (4.2%)	4B9b (3.3%)	6C e (3.3%)	1A3b vi (3.2%)	2C1 (3.0%)	1A3d ii (3.0%)	81.1
<b>PM2.5</b>	1A1a (17.0%)	1A2 (16.0%)	1A4b i (12.1%)	1A3b i (9.2%)	1A4c ii (7.6%)	1A3b iii (6.6%)	1A3b ii (4.9%)	1A3d ii (3.4%)	6Ce (3.3%)				80.0
<b>Pb</b>	1A3b i (77.5%)	1A2 (6.0%)											83.4
<b>Cd</b>	1A2 (55.5%)	2C1 (13.1%)	1A4a i (7.9%)	1A4b i (6.9%)									83.5
<b>Hg</b>	1A2 (36.4%)	2B5a (24.4%)	2C1 (19.9%)										80.7
<b>PAH</b>	2C1 (44.9%)	6Ce (21.4%)	1A4b i (18.7%)										84.9
<b>Dioxin</b>	1A2 (24.8%)	1A4a i (23.2%)	2C1 (14.2%)	6Cc (9.0%)	6Cb (7.3%)	6Ce (5.2%)							83.7
<b>HCB</b>	6Cb (46.1%)	1A2 (21.5%)	6Ca (9.5%)	1A3b i (7.6%)									84.8
<b>PCB</b>	1A1a (40.7%)	2C1 (32.9%)	1A2 (20.1%)										93.7
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 in 1990**

	Key categories in 2009												Total (%)
<b>SO<sub>x</sub></b>	1A1a (19.7%)	1A2 (18.5%)	1A1b (16.5%)	1A3d ii (16.4%)	1B2a iv (10.5%)								81.5
<b>NO<sub>x</sub></b>	1A3b iii (22.6%)	1A3b i (20.7%)	1A2 (10.4%)	1A3d ii (8.4%)	1A3b ii (7.9%)	1A4c ii (5.6%)	1A1a (5.1%)						80.8
<b>NH<sub>3</sub></b>	4B1a (23.3%)	4B1b (22.9%)	4D1a (14.3%)	4B8 (12.5%)	4B9b (4.2%)	4B2 (3.7%)							80.9
<b>NMVOC</b>	1A3b iv (15.6%)	3A1 (12.4%)	3D2 (9.5%)	1A3d ii (7.9%)	1A4b i (8.0%)	3C (6.6%)	3A2 (6.1%)	1A3b i (5.5%)	3D3 (2.8%)	2D2 (2.6%)	1B2b (2.5%)	1A3b v (1.8%)	81.5
<b>CO</b>	1A3b i (23.1%)	1A3b iv (19.0%)	1A4b i (18.0%)	6Ce (10.8%)	1A3d ii (6.7%)	1A2 (5.9%)							83.7
<b>PM<sub>10</sub></b>	1A4b i (32.5%)	6C e (7.2%)	1A2 (6.9%)	1A3b i (5.7%)	1A3b vi (5.5%)	4B9b (5.2%)	1A3b ii (3.9%)	1A3d ii (3.5%)	1A4c ii (3.4%)	1A3b iii (3.2%)	2C1 (2.8%)	2A1 (2.7%)	82.6
<b>PM<sub>2.5</sub></b>	1A4b i (38.7%)	1A2 (7.9%)	6Ce (7.4%)	1A3b i (6.8%)	1A3b ii (4.7%)	1A3d ii (4.1%)	1A4c ii (4.1%)	1A3b iii (3.8%)	1A3b vi (3.6%)				81.2
<b>Pb</b>	1A2 (42.5%)	2C1 (25.4%)	1A4a i (19.8%)										87.7
<b>Cd</b>	1A4a i (34.2%)	1A2 (32.2%)	2C1 (13.5%)	1A4b i (3.8%)									83.6
<b>Hg</b>	1A2 (30.0%)	2C1 (27.0%)	1A4a i (23.3%)										80.4
<b>PAH</b>	1A4b i (39.4%)	6Ce (27.4%)	2C1 (20.3%)										87.0
<b>Dioxin</b>	1A2 (27.4%)	2C1 (26.7%)	1A4b i (17.4%)	6Ce (16.2%)									87.7
<b>HCB</b>	6Cb (44.5%)	1A4a i (17.0%)	1A3b i (15.9%)	1A2 (7.8%)									85.2
<b>PCB</b>	2C1 (38.0%)	1A1a (36.0%)	1A4a i (14.2%)										88.2
1 Energy		3 Solvent and product use			6 Waste								
2 Industry		4 Agriculture			7 Other								

**Table 1.5 Key categories for the Italian Emission Inventory in 2009**

	Key categories in trend											Total (%)
<b>SO<sub>x</sub></b>	1A1a (32.5%)	1A3 d ii (16.8%)	1B2 a iv (14.7%)	1A1b (8.1%)	2A1 (4.9%)	1A3 b i (4.6%)						81.8
<b>NO<sub>x</sub></b>	1A1a (32.1%)	1A3b iii (12.4%)	1A3b i (11.8%)	1A3b ii (9.5%)	1A3d ii (7.8%)	1A4a i (7.0%)						80.7
<b>NH<sub>3</sub></b>	4B1a (27.5%)	4B2 (12.1%)	4B1b (11.4%)	1A3b i (10.2%)	4B8 (9.1%)	4D1 a (6.0%)	4B9 d (4.5%)					80.9
<b>NMVOC</b>	1A3b i (28.8%)	1A3b v (10.9%)	1A4b i (9.4%)	3A1 (7.4%)	3D2 (5.8%)	1A3b iv (5.3%)	1A3d ii (4.9%)	3C (4.4%)	1A4c ii (1.8%)			80.2
<b>CO</b>	1A3b i (46.0%)	1A4b i (15.9%)	1A4b iv (18.0%)	6Ce (9.0%)								83.5
<b>PM10</b>	1A4b i (30.7%)	1A1a (20.6%)	1A2 f i (10.9%)	6Ce (5.5%)	1A4c ii (4.4%)	1A3b iii (3.5%)	1A3b vi (3.4%)	1A3b i (3.3%)				82.2
<b>PM2.5</b>	1A4b i (35.2%)	1A1 a (21.0%)	1A2 f i (10.7%)	6C e (5.4%)	1A4c ii (4.5%)	1A3b iii (3.6%)						80.5
<b>Pb</b>	1A3 b i (42.2%)	1A2 f i (19.9%)	2C 1 (13.1%)	1A4a i (10.7%)								85.8
<b>Cd</b>	1A4a i (42.5%)	1A2 f i (37.8%)										80.3
<b>Hg</b>	2B5 a (37.7%)	1A4a i (32.4%)	2C 1 (11.8%)									81.9
<b>PAH</b>	2C1 (37.6%)	1A4b i (31.6%)	6Ce (9.1%)	1A1 c (8.2%)								86.5
<b>Dioxin</b>	1A4 a i (23.2%)	1A4b i (14.6%)	2C1 (14.3%)	6Ce (12.7%)	6Cc (10.3%)	6Cb (8.3%)						83.5
<b>HCB</b>	1A2 f i (28.3%)	1A4a i (24.7%)	1A3b i (17.0%)	6Ca (12.2%)								82.2
<b>PCB</b>	1A2 f i (34.9%)	1A4a i (31.4%)	2C1 (13.4%)	1A1a (12.3%)								92.0
1 Energy		3 Solvent and product use			6 Waste							
2 Industry		4 Agriculture			7 Other							

**Table 1.6 Key categories for the Italian Emission Inventory in trend 1990-2009**

## 1.7 QA/QC and Verification methods

ISPRA 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 (ISPRA, 2011 [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 different verification activities of the inventory.

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.isprambiente.it](http://www.isprambiente.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 Institute, 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.

Furthermore, activities in the framework of the improvement of local inventories are carried out together with local authorities concentrating on the comparison between top down and bottom up approaches and identifying the main critical issues. In 2008, ISPRA finalised the provincial inventory at local scale for the years 1990, 1995, 2000 and 2005 (ISPRA, 2009) applying a top down approach. Methodologies and results were checked out by regional and local environmental agencies and authorities, and are also available at ISPRA web address <http://www.sinanet.apat.it/it/inventaria>. This work is also relevant to carry out regional scenarios, for the main pollutants, within the Rains Italy project implemented by ENEA and supported by ISPRA and the regional authorities.

In addition to these expert panels, ISPRA 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, E-PRTR and Emissions Trading, are gathered together thus highlighting the main discrepancies in information and detecting potential errors. In fact, ISPRA personally collects these data from the industrial associations and the inventory team manages all this information and makes use of it in the preparation of the national inventory ensuring the consistency of the time series. The database is still under finalization but all the figures are considered in an overall approach and used in the compilation of the inventory.

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 Institute for Environmental Protection and Research.

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 2011* (ISPRA, 2011 [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 next submissions 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 category 1.A.2.f i as a total; emissions from category 1.A.5.a other stationary are reported and included under category 1.A.4.a i commercial and institutional emission estimates. PAH emissions are not detailed in the four indicator compounds but accounted for as a total. Emissions from 4.B.9.c turkeys are included in 4.B.9.d other poultry.

There are a few emission sources not assessed yet: NO<sub>x</sub> emissions from manure management, from cattle, buffalo, swine and other livestock categories, and NO<sub>x</sub> emissions from direct soil emission, from the use of fertilizers in soils, PM non exhaust emissions from road abrasion.

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.

Emissions from the new categories reported in the NFR under 2.A.7, quarrying and mining of minerals other than coal, construction and demolition and storage, handling and transport of mineral products, are not estimated because no information on activity data is still available.

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<sub>x</sub>)

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 2009. Figure 2.1 also illustrates the share of SO<sub>x</sub> emissions by category in 1990 and 2009 as well as the total and sectoral variation from 1990 to 2009.

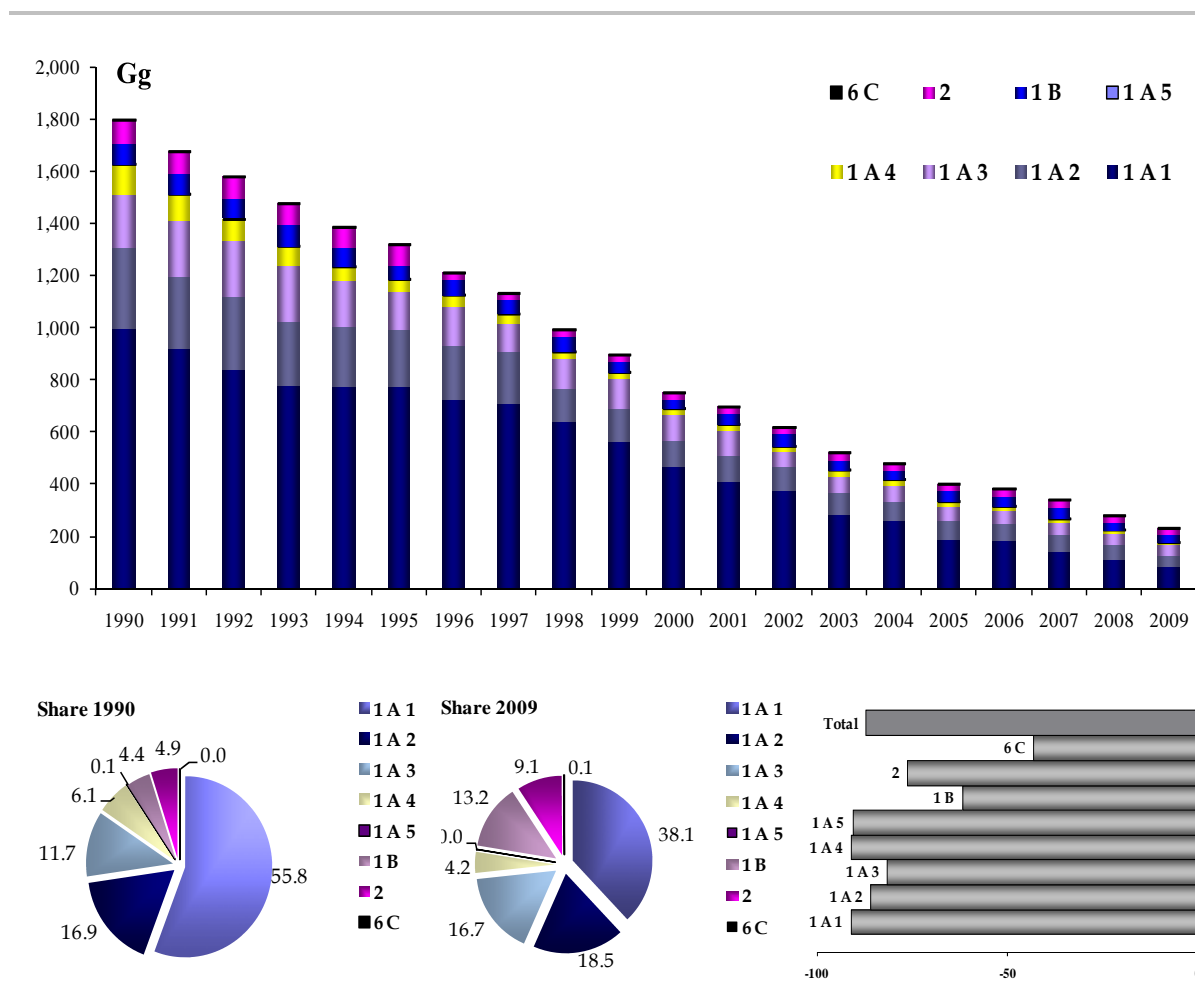


Figure 2.1 SO<sub>x</sub> emission trend, percentage share by sector and variation 1990-2009

	1990	1995	2000	2005	2006	2007	2008	2009
<i>Gg</i>								
Combustion in energy and transformation industries	1,001	776	467	187	184	139	112	88
Non industrial combustion plants	96	35	23	20	18	15	10	10
Combustion - Industry	299	215	104	73	66	67	59	43
Production processes	156	125	50	59	53	59	51	45
Road transport	130	72	12	2	2	2	2	0
Other mobile sources and machinery	100	86	84	51	48	46	39	38
Waste treatment and disposal	13	11	10	11	9	9	8	6
<b>Total</b>	<b>1,794</b>	<b>1,320</b>	<b>749</b>	<b>402</b>	<b>380</b>	<b>337</b>	<b>282</b>	<b>231</b>

**Table 2.1 SO<sub>x</sub> emission trend from 1990 to 2009 (Gg)**

Figures show a general decline of SO<sub>x</sub> emissions during the period, from 1,794 Gg in 1990 to 231 Gg in 2009. The national target of SO<sub>x</sub> emissions amounts to 475 Gg for 2010, as set by the National Emission Ceilings Directive (EC, 2001).

The decreasing trend is determined mainly by the reduction in emissions from *combustion in energy* (-91%) and in *industry* (-86%), representing in 2009 about 38%, and 19% of the total, respectively. Emissions deriving from *non industrial combustion plants* (-90%) and *road transport* (-99.6%) show a strong decrease too, but these emissions represent only about 4% and 0.2% of the total in 2009, respectively. *production processes* and *other mobile sources and machinery* also present a significant decreasing trend, showing an influence on the total of 20% and 17% and dropping by about -71% and -62%, respectively.

Since SO<sub>x</sub> 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 (EC, 1975) 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<sub>x</sub> levels.

However in the nineties, there was an inverse trend due to the introduction of two regulatory instruments: the DPR 203/88 (Decree of President of the Republic 24 May 1988), laying down rules concerning the authorisation of plants, and the DM of 12<sup>th</sup> July 1990 (Ministerial Decree 12 July



1990), which introduced plant emission limits. Also the European Directive 88/609/EEC (EC, 1988) concerning the limitation of specific pollutants originated from large combustion plants (transposed in Italy by the DM of 8<sup>th</sup> May 1989 (Ministerial Decree 8 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, diesel 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 12<sup>th</sup> July 1990 (Ministerial Decree 12 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 to the introduction of Directives regulating the sulphur content in fuels.

### **2.1.2 Nitrogen oxides (NO<sub>x</sub>)**

The national atmospheric emissions of nitrogen oxides show a decreasing trend in the period 1990-2009, from 2,105 Gg to 981 Gg. Figure 2.2 and Table 2.2 show the emission figures from 1990 to 2009. Figure 2.2 also illustrates the share of NO<sub>x</sub> emissions by category in 1990 and 2009 as well as the total and sectoral variation from 1990 to 2009.

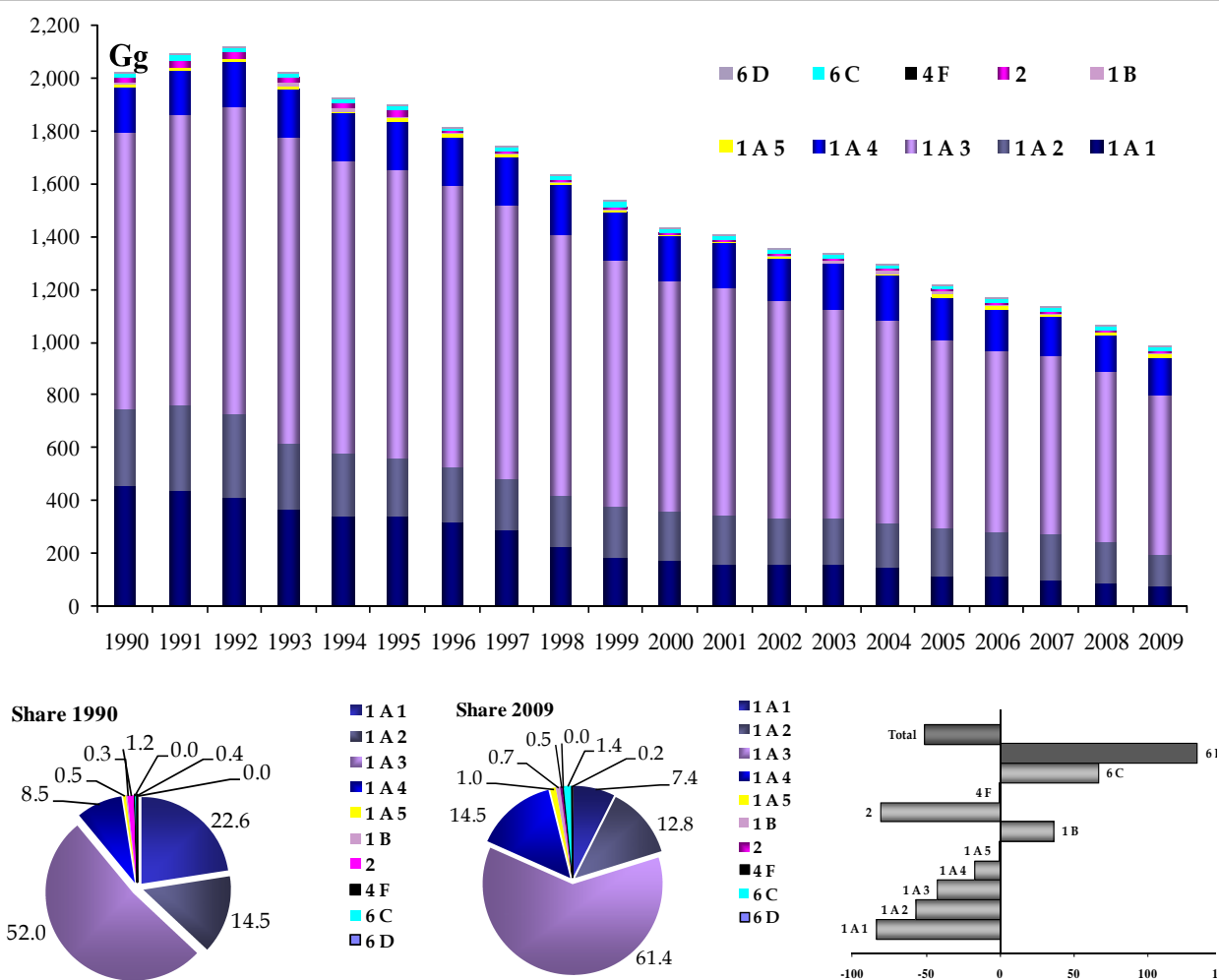


Figure 2.2 NO<sub>x</sub> emission trend, percentage share by sector and variation 1990-2009

	1990	1995	2000	2005	2006	2007	2008	2009
<i>Gg</i>								
Combustion in energy and transformation industries	457	344	173	117	114	102	92	74
Non industrial combustion plants	61	61	64	75	73	72	75	78
Combustion - Industry	246	177	148	148	146	147	128	102
Production processes	30	31	9	16	13	11	9	12
Road transport	941	991	756	611	586	583	552	512
Other mobile sources and machinery	270	275	268	231	216	201	190	187
Waste treatment and disposal	9	15	14	16	15	15	15	16
Agriculture	0	1	0	0	0	0	0	0
<b>Total</b>	<b>2,015</b>	<b>1,895</b>	<b>1,431</b>	<b>1,215</b>	<b>1,163</b>	<b>1,132</b>	<b>1,061</b>	<b>981</b>

**Table 2.2 NO<sub>x</sub> emission trend from 1990 to 2009 (Gg)**

Total emissions show a reduction of about 51% from 1990 to 2009, 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 (EC, 2001), amounts to 990 Gg.

The main source of emissions is *road transport* (about 52% in 2009), which shows a reduction of 46% between 1990 and 2009; *other mobile sources and machinery* in 2009 contributes to the total emissions for 19% and have reduced by 31% from 1990. Combustion in energy and in industry shows a decrease of about 84% and 58%, respectively, having a share on the total of about 8% and 10%, 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 69% and 27%, respectively, but accounting only for 2% and 8% of the total, respectively.

As SO<sub>x</sub>, NO<sub>x</sub> 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 (Decree of President of the Republic 24 May 1988), laying down rules for the authorization of facilities and the DM of 12<sup>th</sup> July 1990 (Ministerial Decree 12 July 1990), which introduces plant emission limits. The adoption of these regulations, as the DM 8<sup>th</sup> May 1989 (Ministerial Decree 8 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 (EC, 1991), 94/12/EC (EC, 1994) and 98/69/EC (EC, 1998) 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 2009 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 (EC, 1997 [b]), which provides for a reduction in NO<sub>x</sub> limits from 1<sup>st</sup> 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<sub>3</sub>)

The national atmospheric emissions of ammonia show a slight decline in the period 1990-2009, from 468 Gg to 391 Gg. Figure 2.3 and Table 2.3 report the emission figures from 1990 to 2009. Figure 2.3 also illustrates the share of NH<sub>3</sub> emissions by category in 1990 and 2009 as well as the total and sectoral variation from 1990 to 2009.

According to the National Emission Ceilings Directive, the target value of emissions for 2010 amounts to 419 Gg.

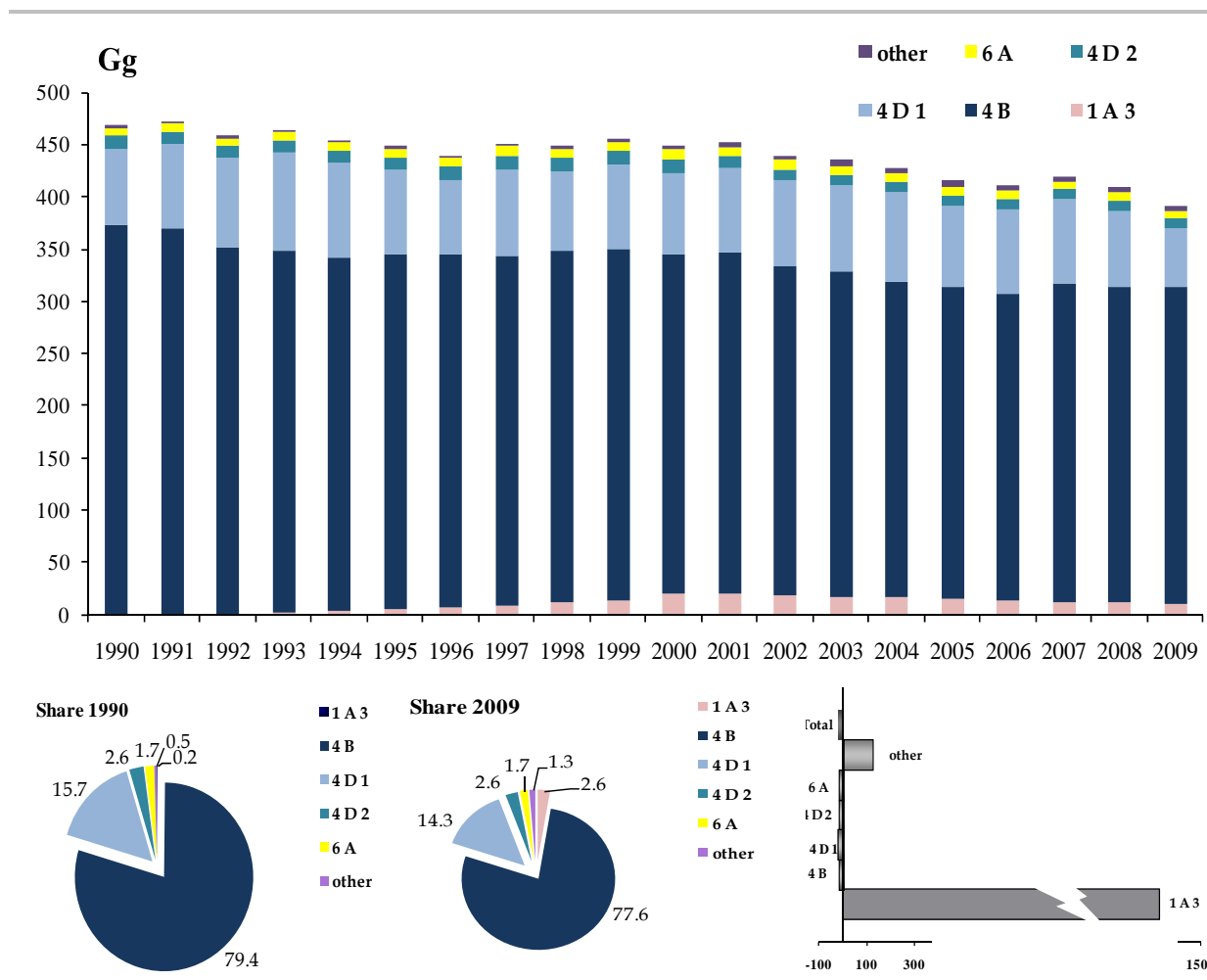


Figure 2.3 NH<sub>3</sub> emission trend, percentage share by sector and variation 1990-2009

	1990	1995	2000	2005	2006	2007	2008	2009
<i>Gg</i>								
Combustion in energy and transformation industries	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
Non industrial combustion plants	0.2	0.3	0.3	0.3	0.4	0.5	0.5	0.6
Combustion - Industry	0.1	0.1	0.1	3.4	2.3	1.6	1.8	1.5
Production processes	0.8	0.4	0.3	0.5	0.6	0.5	0.4	0.3
Road transport	0.7	5.5	19.4	14.9	14.2	12.6	11.1	10.1
Other mobile sources and machinery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste treatment and disposal	8.7	9.6	11.5	9.8	9.2	9.0	8.7	8.9
Agriculture	457.5	432.5	416.7	386.6	383.9	395.0	385.8	369.6
<b>Total</b>	<b>468</b>	<b>449</b>	<b>449</b>	<b>416</b>	<b>411</b>	<b>419</b>	<b>409</b>	<b>391</b>

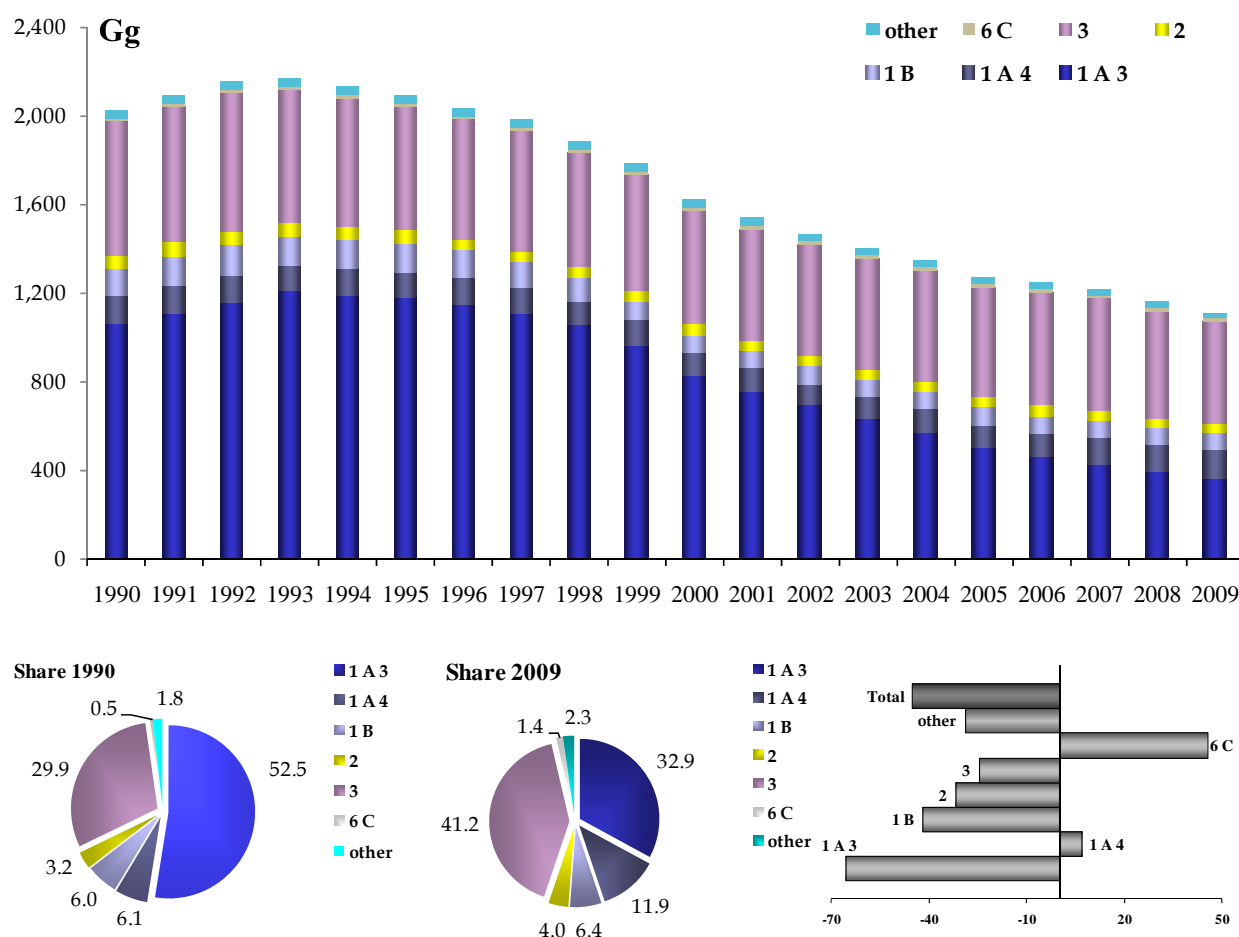
**Table 2.3 NH<sub>3</sub> emission trend from 1990 to 2009 (Gg)**

In 2009 *agriculture* is the main source of emissions, with a contribution by 95% out of the total NH<sub>3</sub> emissions; from 1990 to 2009 emissions from this sector decrease of about 19%. Emissions from *road transport* show a strong increase, but the share on the total is only about 3%. Emissions from *waste treatment and disposal*, accounting only for 2% of the total, decrease of about 8%. Emissions from *combustion in energy and transformation industries* show an increase of about 26%, but in 2009 the contribution to total emissions is almost zero. Emissions from *non industrial combustion plants* decrease of about 135%, but the contribution to total emissions is negligible. Emissions from *combustion in industry* show a significant increase, but the contribution to total emissions is negligible. Emissions from *production processes* show a reduction of about 64%, but also this contribution is irrelevant.

Specifically, emissions from *agriculture* have decreased because of the reduction in the number of animals and the trend in agricultural production, and the introduction of abatement technologies due to the implementation of the EU IPPC Directive (EC, 1996). 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 1990-2009. Figure 2.4 and Table 2.4 illustrate the emissions values from 1990 to 2009. Figure 2.4 also illustrates the share of NMVOC emissions by category in 1990 and 2009 as well as the total and sectoral variation from 1990 to 2009.



**Figure 2.4 NMVOC emission trend, percentage share by sector and variation 1990-2009**

The global emission trend shows a reduction of about 44% between 1990 and 2009, from 2,021 Gg to 1,107 Gg. In the framework of the National Emission Ceilings Directive (EC, 2001), the target value of NMVOC for 2010 has been fixed to 1,159 Gg.

*Solvent and other product use* is the main source of emissions, contributing to the total with 41% and showing a decrease of about 25%. The biggest reductions relate to the sector of *road transport* (-72%), accounting for 25% of the total and the sector of *extraction and distribution of fossil fuels/geothermal energy* (-46%), accounting only for 4%. Emissions from *other mobile sources and machinery*, accounting for 10% of the total, decrease of about 41%. Emissions from *non industrial combustion plants* show the biggest increase (169%), accounting for 11%. Emissions from *waste treatment and disposal*, accounting only for 2%, show increase of about 17%, while emissions from *combustion in industry* decrease of about 24%, accounting for less than 1%.

Details on the sectoral emission trend and respective variation are outlined in the following sections.

	1990	1995	2000	2005	2006	2007	2008	2009
<i>Gg</i>								
Combustion in energy and transformation industries	8	7	6	6	6	6	5	5
Non industrial combustion plants	43	55	69	80	85	104	109	116
Combustion - Industry	7	8	8	8	8	8	7	6
Production processes	95	86	71	76	77	76	68	66
Extraction and distrib. of fossil fuels / geothermal energy	91	104	57	54	51	48	49	49
Solvent and other product use	604	558	513	495	506	502	483	456
Road transport	964	1,066	716	397	360	328	298	275
Other mobile sources and machinery	187	184	155	130	126	123	116	110
Waste treatment and disposal	20	26	25	26	25	24	24	24
Agriculture	1	1	1	1	1	1	1	1
<b>Total</b>	<b>2,021</b>	<b>2,094</b>	<b>1,620</b>	<b>1,273</b>	<b>1,245</b>	<b>1,219</b>	<b>1,161</b>	<b>1,107</b>

**Table 2.4 NMVOC emission trend from 1990 to 2009 (Gg)**

### ***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 (EC, 1999) 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 (EC, 1991) 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 (EC, 1997 [a]) 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 16<sup>th</sup> May 1996 (Ministerial Decree 16 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 21<sup>st</sup> January 2000 (Ministerial Decree 21 January 2000).

Emissions from the 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 1990-2009, from 7,131 Gg to 2,617 Gg. The emission figures from 1990 to 2009 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 2009, as well as the total and sectoral variation from 1990 to 2009.

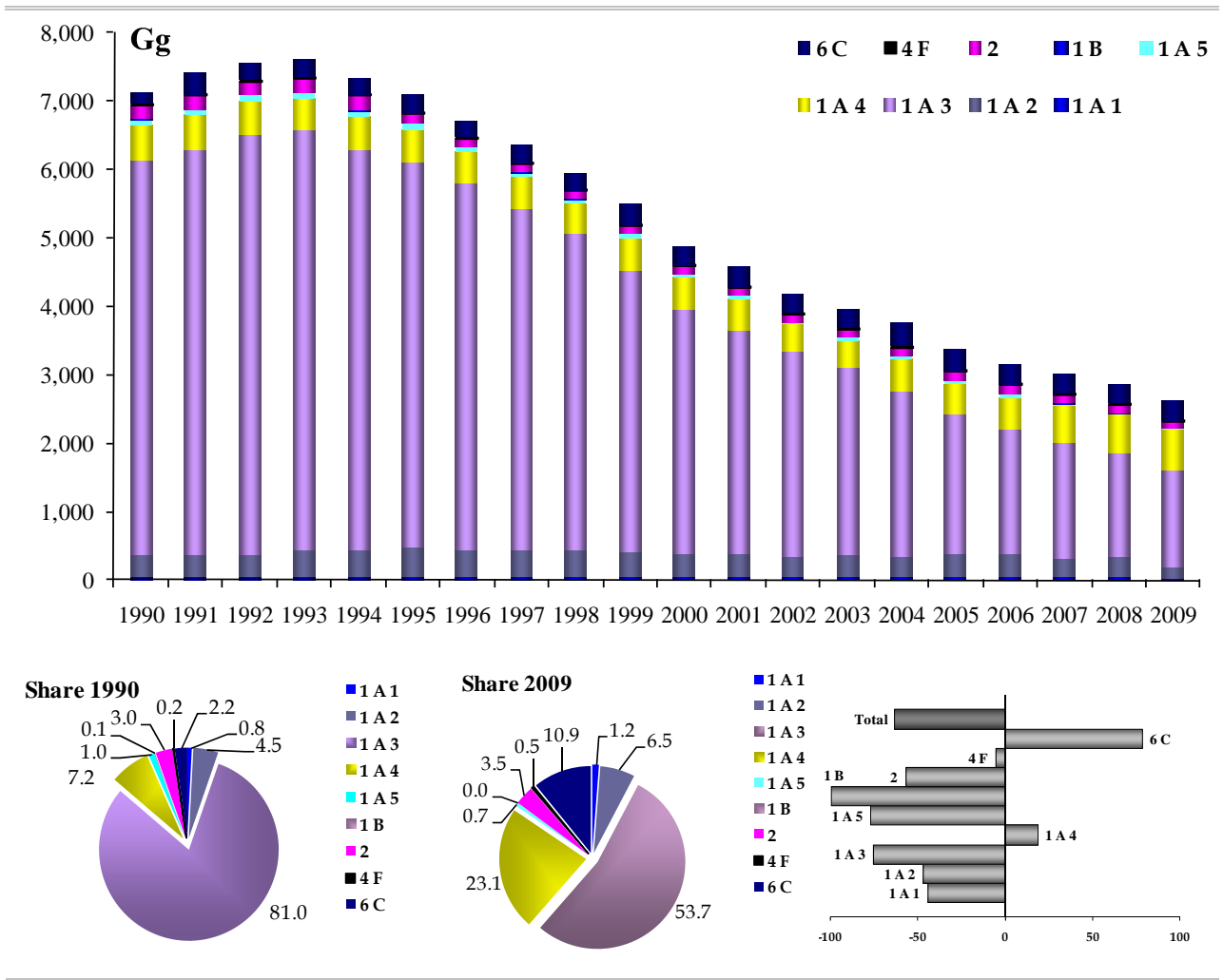


Figure 2.5 CO emission trend, percentage share by sector and variation 1990-2009

	1990	1995	2000	2005	2006	2007	2008	2009
<i>Gg</i>								
Combustion in energy and transformation industries	59	54	56	54	54	40	38	32
Non industrial combustion plants	215	282	347	358	388	484	507	550
Combustion - Industry	306	411	312	326	323	267	283	155
Production processes	224	140	129	144	149	141	136	92
Road transport	5,589	5,424	3,355	1,827	1,618	1,474	1,323	1,223
Other mobile sources and machinery	567	503	396	346	327	315	284	267
Waste treatment and disposal	159	269	249	296	281	269	281	284
Agriculture	13	13	12	13	12	13	13	12
<b>Total</b>	<b>7,131</b>	<b>7,096</b>	<b>4,857</b>	<b>7,131</b>	<b>3,364</b>	<b>3,153</b>	<b>3,003</b>	<b>2,865</b>

**Table 2.5 CO emission trend from 1990 to 2009 (Gg)**

The decrease in emissions (-63%) is mostly due to the trend observed for the transport sector (including road, railways, air and maritime transport) which show a total reduction from 1990 to 2009 of about 78%. Specifically by sector, emissions from *road transport* and *other mobile sources and machinery*, accounting in 2009 for 47% and 10% of the total, respectively, show a decrease from 1990 to 2009 of about 78% and 53%. On the other hand, emissions from *non industrial combustion plants*, representing about 21% of the total, show a strong increase between 1990 and 2009, equal to 156% due to the increase of wood combustion for heating; figures show a strong increase in emissions from *waste treatment and disposal* too (78%), which share 11% of the total.

## 2.2 Particulate matter

### 2.2.1 PM10

The national atmospheric emissions of PM10 show a slight decreasing trend in the period 1990-2009, from 244 Gg to 173 Gg. Figure 2.6 and Table 2.6 illustrate the emission trend from 1990 to 2009. Figure 2.6 also illustrates the share of PM10 emissions by category in 1990 and 2009 as well as the total and sectoral variation from 1990 to 2009.

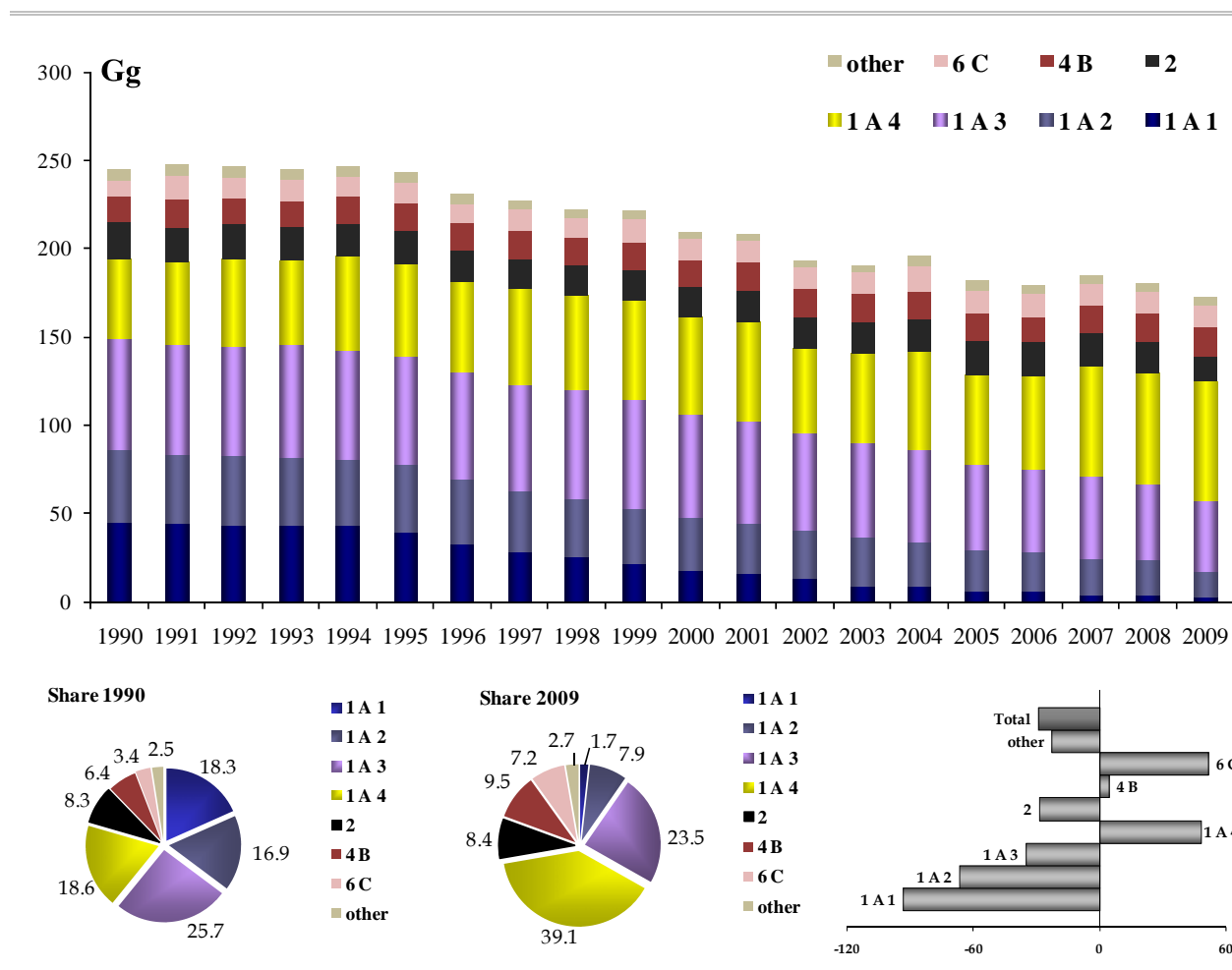


Figure 2.6 PM10 emission trend, percentage share by sector and variation 1990-2009

	1990	1995	2000	2005	2006	2007	2008	2009
Gg								
Combustion in energy and transformation industries	45	40	18	6	6	4	4	3
Non industrial combustion plants	29	34	39	39	42	53	56	61
Combustion - Industry	36	33	24	20	20	18	18	12
Production processes	22	20	19	20	20	20	18	15
Extraction and distribution of fossil fuels / geothermal energy	1	1	1	1	1	1	1	1
Solvent and other product use	0	0	0	0	0	0	0	0
Road transport	55	53	50	42	39	39	37	34
Other mobile sources and machinery	32	33	30	24	21	19	17	16
Waste treatment and disposal	8	12	11	13	13	12	12	12
Agriculture	18	18	17	18	17	18	18	18
<b>Total</b>	<b>244</b>	<b>243</b>	<b>209</b>	<b>182</b>	<b>179</b>	<b>185</b>	<b>180</b>	<b>173</b>

**Table 2.6 PM10 emission trend from 1990 to 2009 (Gg)**

A considerable amount of emissions is mostly to be attributed to *road transport* (20% in 2009); from 1990 to 2009 the trend shows a reduction of about 37%. In 2009 *other mobile sources and machinery*, accounting for 9% of the total, show a reduction of about 49%. Emissions from *non industrial combustion plants* and from *combustion in industry* account for about 35% and 7% of the total, respectively, but while the former show an increase of about 112%, the latter decrease of about 67%. Emissions from *production processes* accounting for 9% of the total in 2009 decrease of about 32% between 1990 and 2009. The largest decrease (-93%) is observed in emissions deriving from *combustion in energy and transformation industries*, which contribution to total emissions is equal to 2%.

### 2.2.2 PM2.5

The trend of the national atmospheric emissions of PM2.5 is slightly decreasing between 1990 and 2009, with a variation from 211 Gg to 144 Gg. Figure 2.7 and Table 2.7 illustrate the emission trend from 1990 to 2009. Figure 2.7 also illustrates the share of PM2.5 emissions by category in 1990 and 2009 as well as the total and sectoral variation from 1990 to 2009.

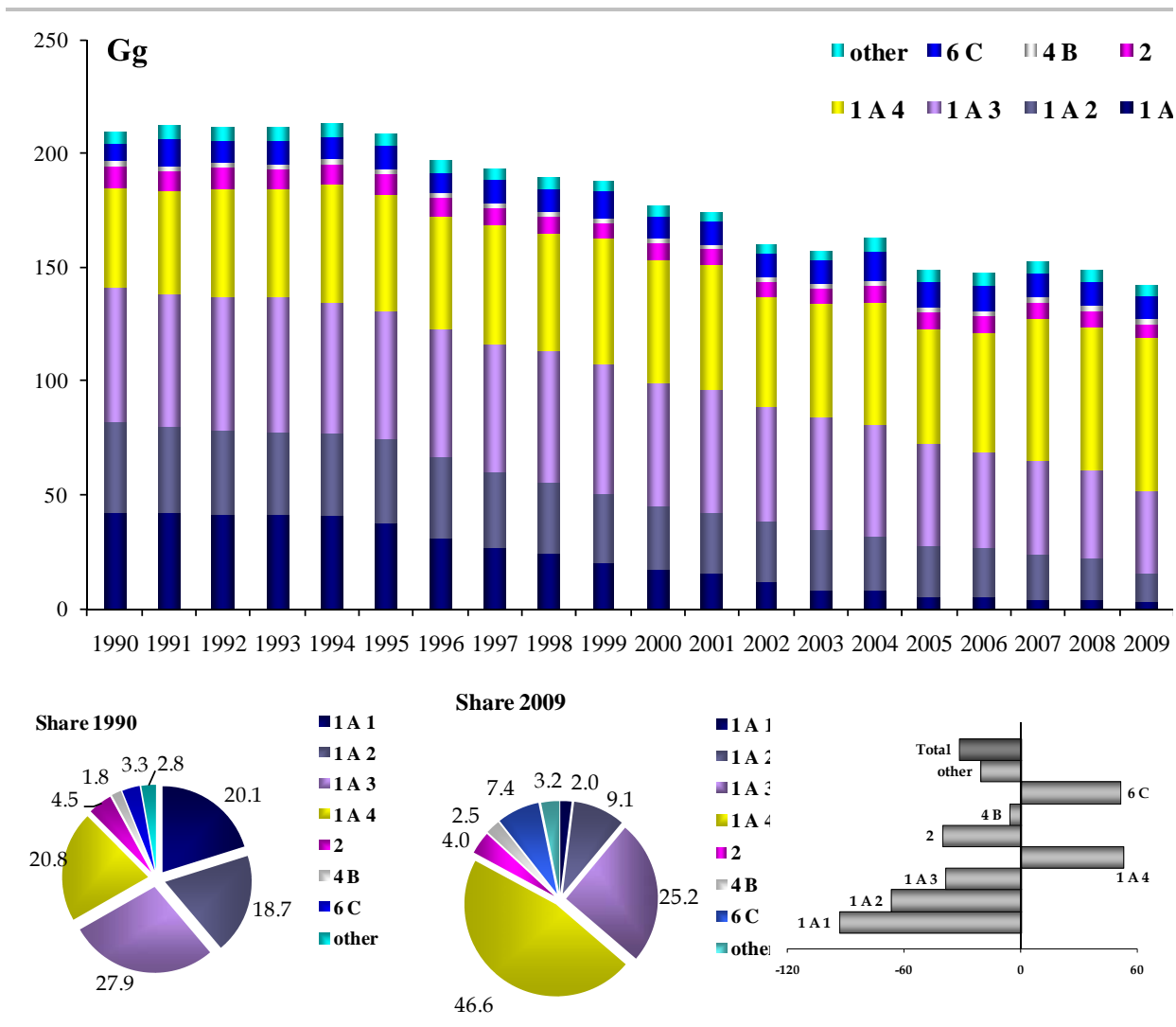


Figure 2.7 PM2.5 emission trend, percentage share by sector and variation 1990-2009

	1990	1995	2000	2005	2006	2007	2008	2009
<i>Gg</i>								
Combustion in energy and transformation industries	43	38	18	6	5	4	3	3
Non industrial combustion plants	27	33	38	39	42	53	55	60
Combustion - Industry	34	32	23	19	19	18	17	11
Production processes	11	10	8	8	9	9	8	6
Extraction and distribution of fossil fuels / geothermal energy	1	1	1	1	1	1	1	1
Solvent and other product use	0	0	0	0	0	0	0	0
Road transport	51	49	46	37	35	35	32	30
Other mobile sources and machinery	32	33	30	24	21	19	17	16
Waste treatment and disposal	7	10	10	11	11	10	11	11
Agriculture	6	6	6	6	6	6	6	6
<b>Total</b>	<b>211</b>	<b>210</b>	<b>179</b>	<b>150</b>	<b>148</b>	<b>154</b>	<b>150</b>	<b>144</b>

**Table 2.7 PM2.5 emission trend from 1990 to 2009 (Gg)**

Total emissions show a global reduction from 1990 to 2009 of about 32%.

Specifically, emissions from *road transport*, accounting for 21% of total emissions, decrease of about 41%. Emissions from *other mobile sources and machinery* show a reduction of 49%, accounting in 2009 for 11% of total emissions. Emissions from *non industrial combustion plants* and from *combustion in industry* account for 42% and 8% of the total, but while the former show an increase of about 122%, the latter decrease of about 66%. Emissions from *waste treatment and disposal*, accounting for 7% of the total in 2009, show an increase of about 51%. The largest decrease is observed for *combustion in energy and transformation industries* (-93%), being the influence on the total in 2009 equal to 2%.

## 2.3 Heavy metals (Pb, Cd, Hg)

This section provides an illustration of the most significant developments between 1990 and 2009 of lead, cadmium and mercury emissions.

### 2.3.1 Lead (Pb)

The national atmospheric emissions of lead show a strong decreasing trend (-95%) between 1990 and 2009, varying from 4,412 Mg to 216Mg. Figure 2.8 and Table 2.8 illustrate the emission trend from 1990 to 2009. Figure 2.8 also illustrates the share of Pb emissions by category in 1990 and 2009 as well as the total and sectoral variation from 1990 to 2009.

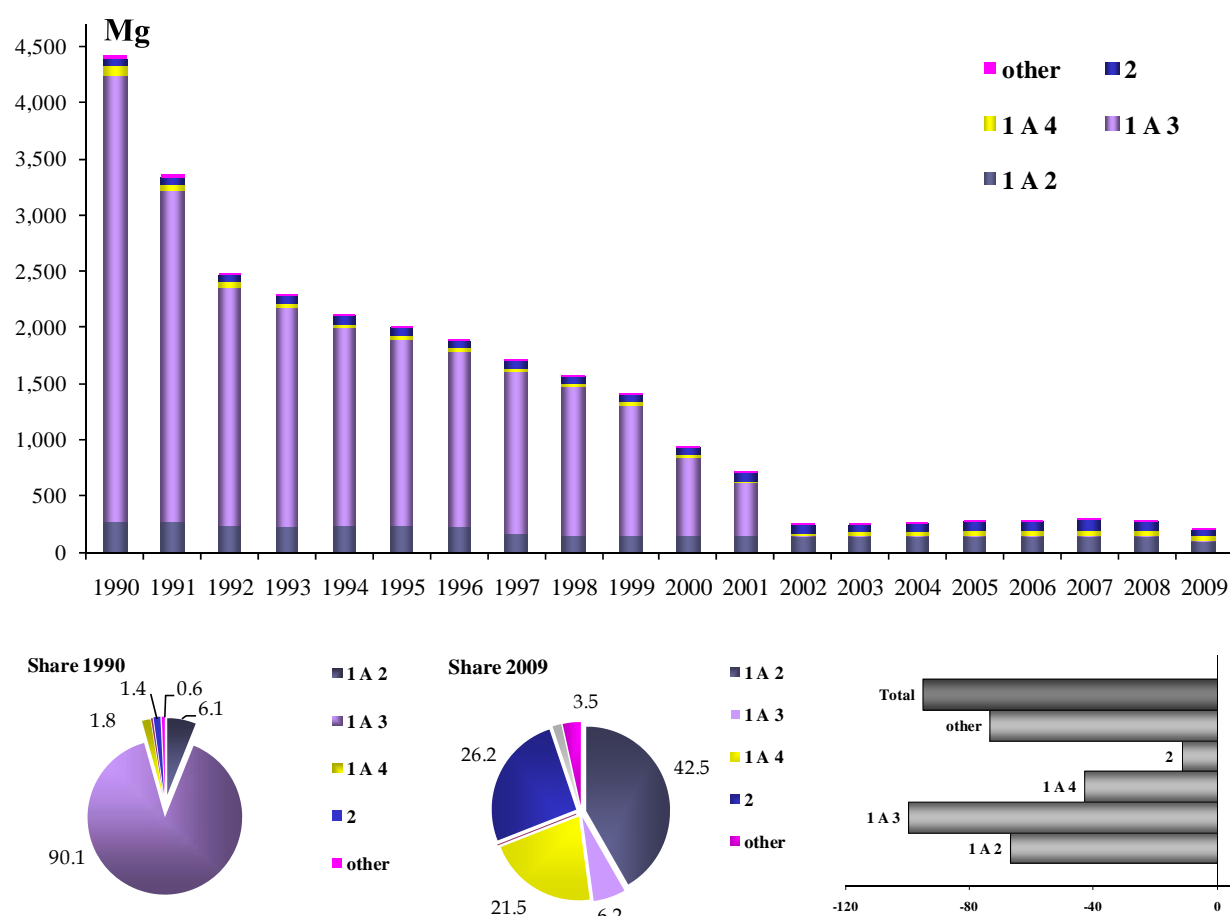


Figure 2.8 Pb emission trend, percentage share by sector and variation 1990-2009



	1990	1995	2000	2005	2006	2007	2008	2009
<i>Mg</i>								
Combustion in energy and transformation industries	4	4	4	4	4	4	4	3
Non-industrial combustion plants	12	13	18	42	43	45	47	45
Combustion - industry	263	235	153	142	142	142	134	89
Production processes	64	68	67	74	82	82	80	56
Road transport	3,920	1,629	685	13	12	13	12	12
Other mobile sources and machinery	144	46	13	1	1	1	1	1
Waste treatment and disposal	6	6	3	4	4	3	4	4
<b>Total</b>	<b>4,412</b>	<b>2,013</b>	<b>944</b>	<b>279</b>	<b>288</b>	<b>291</b>	<b>282</b>	<b>210</b>

**Table 2.8 Pb emission trend from 1990 to 2009 (Mg)**

In 2009 emissions from *combustion in industry - processes with contact* have the most significant impact on the total (42%) and show a reduction of about 61%. Emissions from *production processes*, and in particular processes in iron and steel industries and collieries, decreased of about 13%, and represent 27% of the total. Emissions from *non industrial combustion plants* show a strong increase and represent, in 2009, the 22% 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 *combustion in industry - process furnaces without contact* show a strong decrease (-98%) but the contribution to total emissions in 2009 is negligible (equal to 0.3%).

### 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 2009. Figure 2.9 also illustrates the share of Cd emissions by category in 1990 and 2009 as well as the total and sectoral variation from 1990 to 2009.

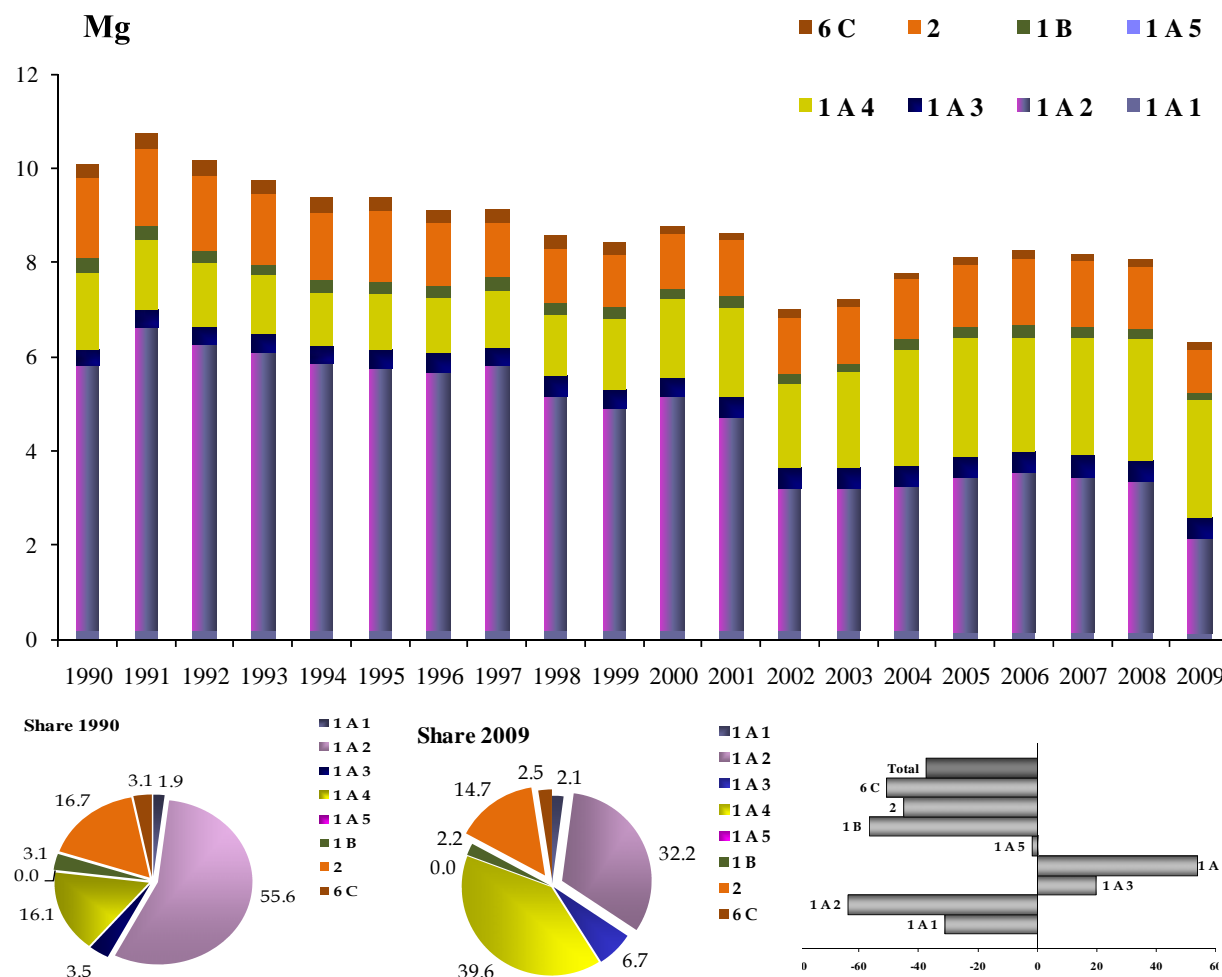


Figure 2.9 Cd emission trend, percentage share by sector and variation 1990-2009

	1990	1995	2000	2005	2006	2007	2008	2009
	<i>Mg</i>							
Combustion in energy and transformation industries	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Non-industrial combustion plants	1.6	1.2	1.6	2.5	2.4	2.5	2.6	2.5
Combustion - industry	5.6	5.6	5.0	3.3	3.4	3.3	3.2	2.0
Production processes	2.0	1.8	1.4	1.5	1.6	1.6	1.6	1.1
Road transport	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Other mobile sources and machinery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste treatment and disposal	0.3	0.3	0.1	0.2	0.2	0.1	0.2	0.2
<b>Total</b>	<b>10.1</b>	<b>9.4</b>	<b>8.8</b>	<b>8.1</b>	<b>8.2</b>	<b>8.2</b>	<b>8.1</b>	<b>6.3</b>

**Table 2.9 Cd emission trend from 1990 to 2009 (Mg)**

Emissions show a global reduction of 38% between 1990 and 2009, from 10.1 Mg to 6.3 Mg. Among the most significant variations, emissions from *combustion in industry* and from *non industrial combustion plants* represent the 32% and the 40% of the total, respectively, showing the former a decrease (-64%) and the latter a strong increase (54%). Emissions from *production processes* decrease of about 47% and represent the 17% of the total. Emissions from *waste treatment and disposal*, waste incineration, accounting for 3% of the total, register a reduction of about 51%. 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 1990-2009. Figure 2.10 and Table 2.10 illustrate the emission trend from 1990 to 2009. Figure 2.10 also illustrates the share of Hg emissions by category in 1990 and 2009 as well as the total and sectoral variation from 1990 to 2009.

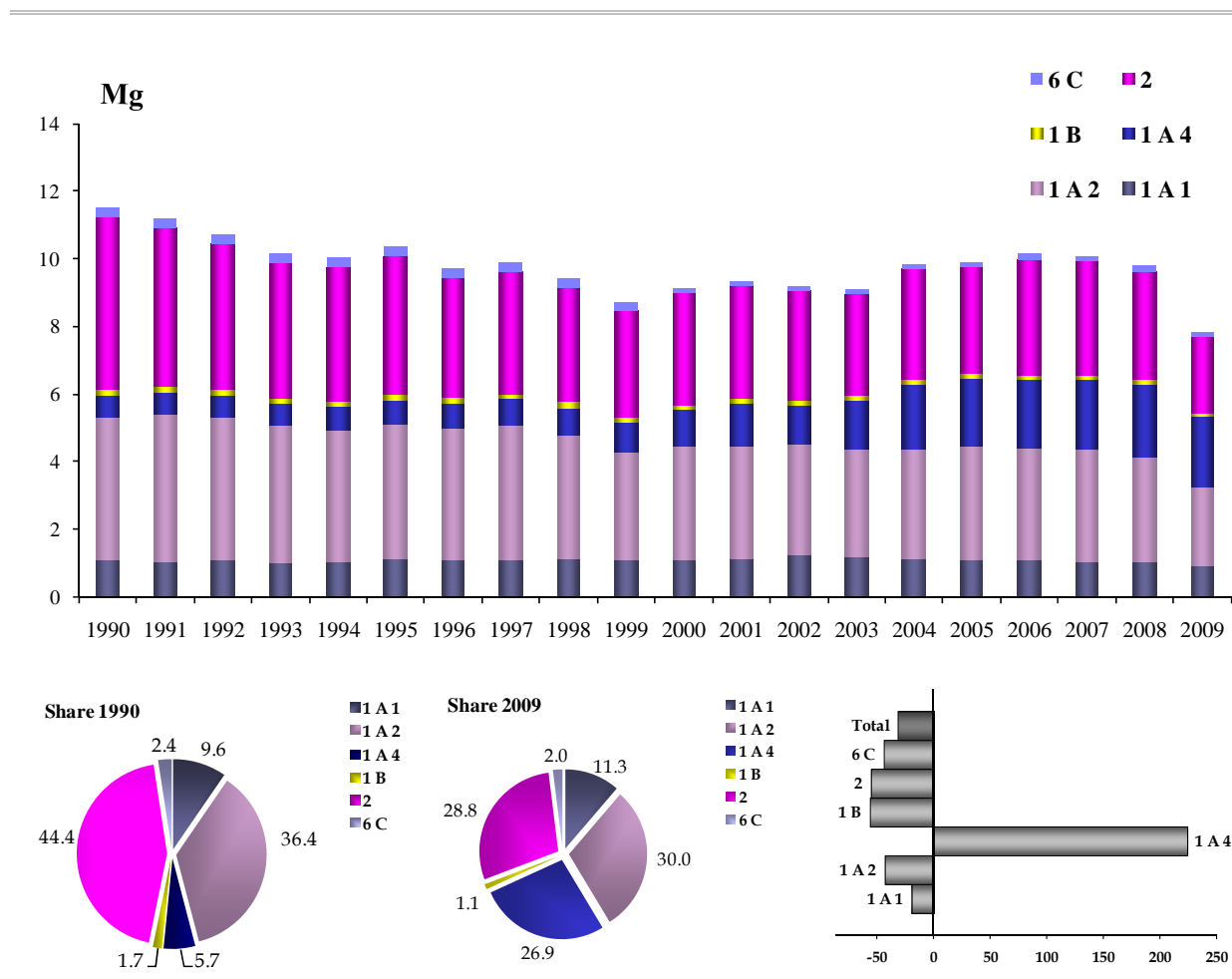


Figure 2.10 Hg emission trend, percentage share by sector and variation 1990-2009

	1990	1995	2000	2005	2006	2007	2008	2009
<i>Mg</i>								
Combustion in energy and transformation industries	1.1	1.1	1.1	1.1	1.1	1.1	1.0	0.9
Non-industrial combustion plants	0.7	0.7	1.1	2.0	2.0	2.1	2.2	2.1
Combustion - industry	4.2	4.0	3.4	3.4	3.3	3.3	3.1	2.4
Production processes	5.3	4.3	3.5	3.3	3.6	3.5	3.3	2.3
Waste treatment and disposal	0.3	0.3	0.1	0.2	0.2	0.1	0.2	0.2
<b>Total</b>	<b>11.5</b>	<b>10.3</b>	<b>9.1</b>	<b>9.9</b>	<b>10.2</b>	<b>10.1</b>	<b>9.8</b>	<b>7.8</b>

**Table 2.10 Hg emission trend from 1990 to 2009 (Mg)**

Emission trend shows a global reduction of about 32% from 1990 to 2009, varying from 11.5 Mg to 7.8 Mg. The main variations concern: emissions from *production process - processes in iron and steel industries and collieries*, representing 28% of the total and decreasing of 12%; emissions from *combustion in industry - processes with contact*, accounting for 26% and decreasing of 42%; emissions from *non industrial combustion plants* which represent 27% of the total and showing the strongest increase (223%). Emissions deriving from *combustion in energy and transformation industries*, accounting for 11%, show a reduction of 20%. Emissions from *production process - processes in inorganic chemical industries*, contributing to the total only for 2%, show a large reduction, equal to 95%. Emissions from *waste treatment and disposal*, contributing to the total only for 2%, show a large reduction, equal to 45%.

## 2.4 Persistent organic pollutants (POPs)

In this section, the most significant peculiarities of polycyclic aromatic hydrocarbons and dioxins, occurred between 1990 and 2009, 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 2009, from 99 Mg to 119 Mg. Figure 2.11 and Table 2.11 illustrate the emission trend from 1990 to 2009. Figure 2.11 also illustrates the share of PAH emissions by category in 1990 and 2009 as well as the total and sectoral variation from 1990 to 2009.

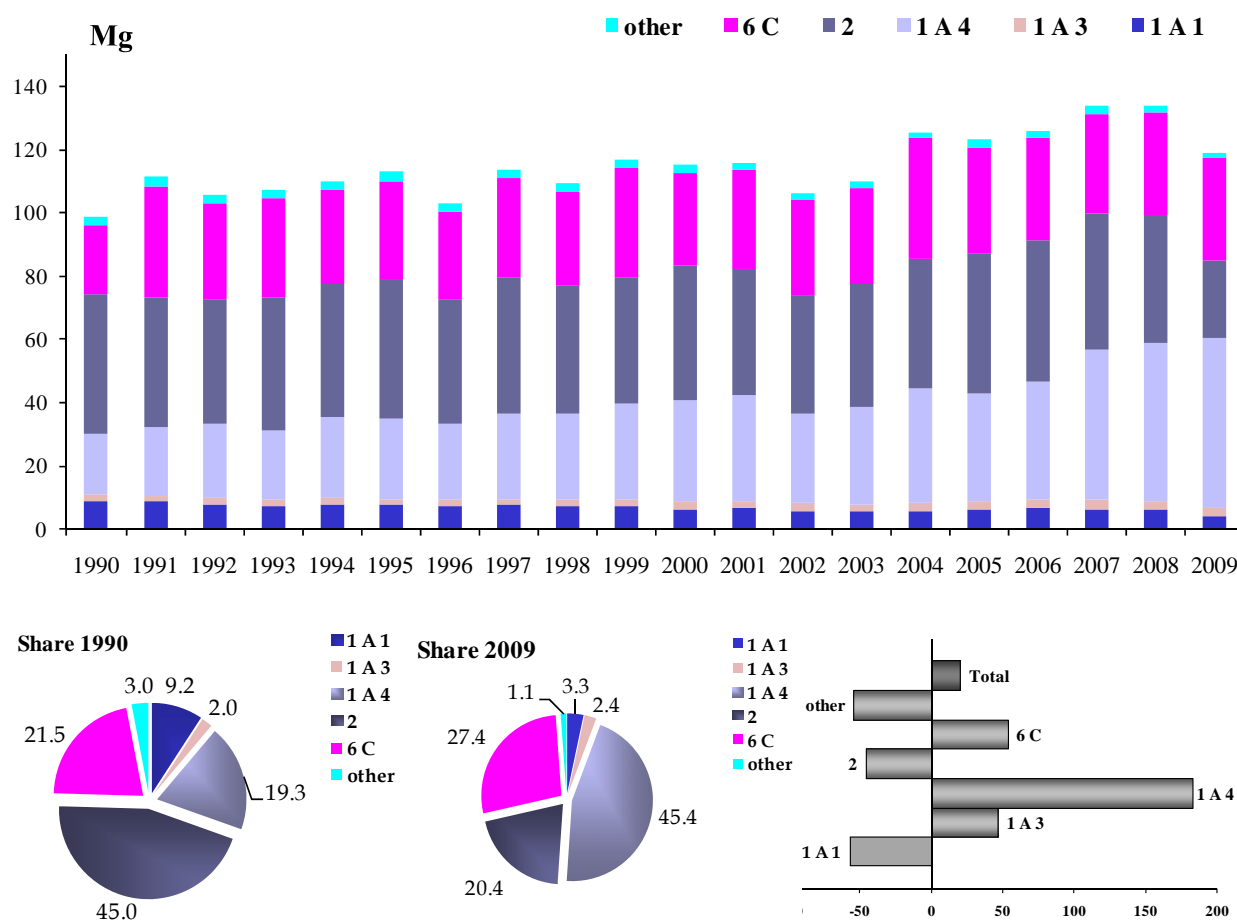


Figure 2.11 PAH emission trend, percentage share by sector and variation 1990-2009

	1990	1995	2000	2005	2006	2007	2008	2009
<i>Mg</i>								
Combustion in energy and transformation industries	9	8	7	6	7	7	6	4
Non-industrial combustion plants	19	25	32	34	37	47	49	54
Combustion - industry	3	3	2	2	2	2	2	1
Production processes	44	44	42	44	45	43	41	24
Road transport	2	2	2	3	3	3	3	3
Other mobile sources and machinery	0	0	0	0	0	0	0	0
Waste treatment and disposal	21	31	30	34	33	31	32	33
<b>Total</b>	<b>99</b>	<b>113</b>	<b>115</b>	<b>123</b>	<b>126</b>	<b>134</b>	<b>134</b>	<b>119</b>

**Table 2.11 PAH emission trend from 1990 to 2009 (Mg)**

Between 1990 and 2009, total emissions show a growth of about 20%. Among the most significant changes, emissions from *non industrial combustion plants - residential plants* account for 40% of the total and show a strong increase (about 153%) due to the increase in wood consumption for heating; emissions from *production processes - processes in iron and steel industries and collieries* account for 20% of the total and show a decrease of 46%; emissions from *waste treatment and disposal - open burning of agricultural wastes*, except stubble burning, accounting for 27% of the total, show an increase of 54%. Emissions from *plants in agriculture, forestry and aquaculture*, accounting for 5% in 2009, show a large growth from 2000 onwards, due to the use of biomass in plants. Emissions from combustion in iron and steel integrated plants account for 3 % of the total and show a decrease by 57%. The share of other subsectors is less than 1.5%.

### 2.4.2 Dioxins

The national atmospheric emissions of dioxins show a decreasing trend between 1990 and 2009, with values varying from 473 g I Teq to 233 g I Teq. Figure 2.12 and Table 2.12 illustrate the emission trend from 1990 to 2009. Figure 2.12 also illustrates the share of dioxin emissions by category in 1990 and 2009 as well as the total and sectoral variation from 1990 to 2009.

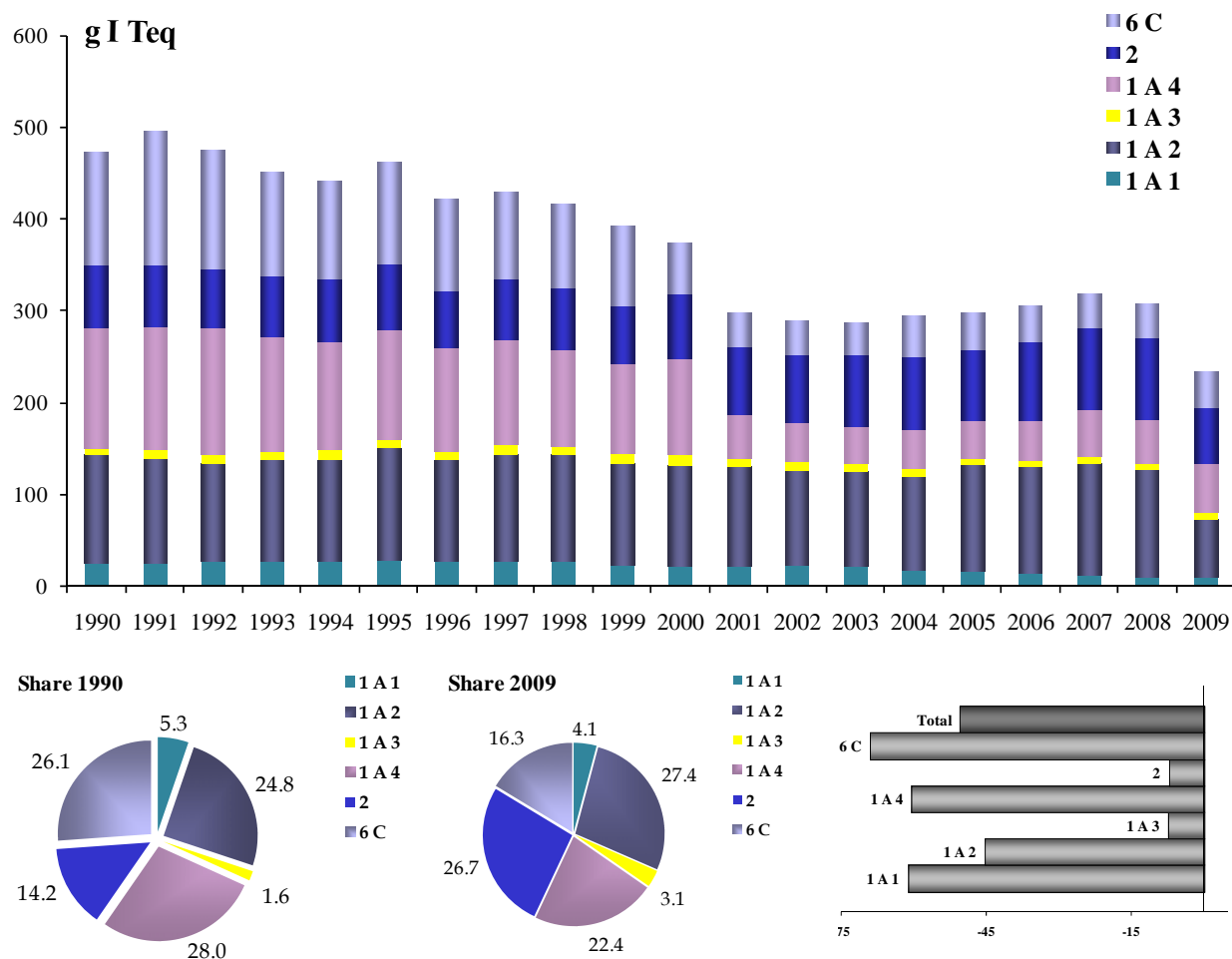


Figure 2.12 Dioxin emission trend, percentage share by sector and variation 1990-2009



	1990	1995	2000	2005	2006	2007	2008	2009
<i>g I Teq</i>								
Combustion in energy and transformation industries	25	28	22	15	14	12	11	10
Non-industrial combustion plants	132	120	105	40	41	51	50	52
Combustion - industry	117	121	111	116	116	122	115	64
Production processes	67	72	71	79	88	89	87	62
Road transport	8	10	10	9	8	8	7	7
Waste treatment and disposal	124	111	56	40	38	36	38	38
<b>Total</b>	<b>473</b>	<b>462</b>	<b>374</b>	<b>298</b>	<b>305</b>	<b>318</b>	<b>308</b>	<b>233</b>

**Table 2.12 Dioxin emission trend from 1990 to 2009 (g I Teq)**

The general trend shows a decrease from 1990 to 2009 equal to 51%, with a noticeable decline between 1995 and 2001. The most considerable reductions, between 1990 and 2009, are observed in *non-industrial combustion plants* and *waste treatment disposal* (-61% and -69%, 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 2009, the subsectors which have contributed most to total emissions are *combustion in industry* and *production processes*, both accounting for 27% of the total, and showing a decrease of 46% and 7%, respectively, in the period 1990-2009.

### 2.4.3 Hexachlorobenzene (HCB)

The national atmospheric emissions of hexachlorobenzene show an increasing trend in the period 1990-2009, varying from 23 kg to 29 kg. Figure 2.13 and Table 2.13 illustrate the emission trend from 1990 to 2009. Figure 2.13 also illustrates the share of HCB emissions by category in 1990 and 2009 as well as the total and sectoral variation from 1990 to 2009.

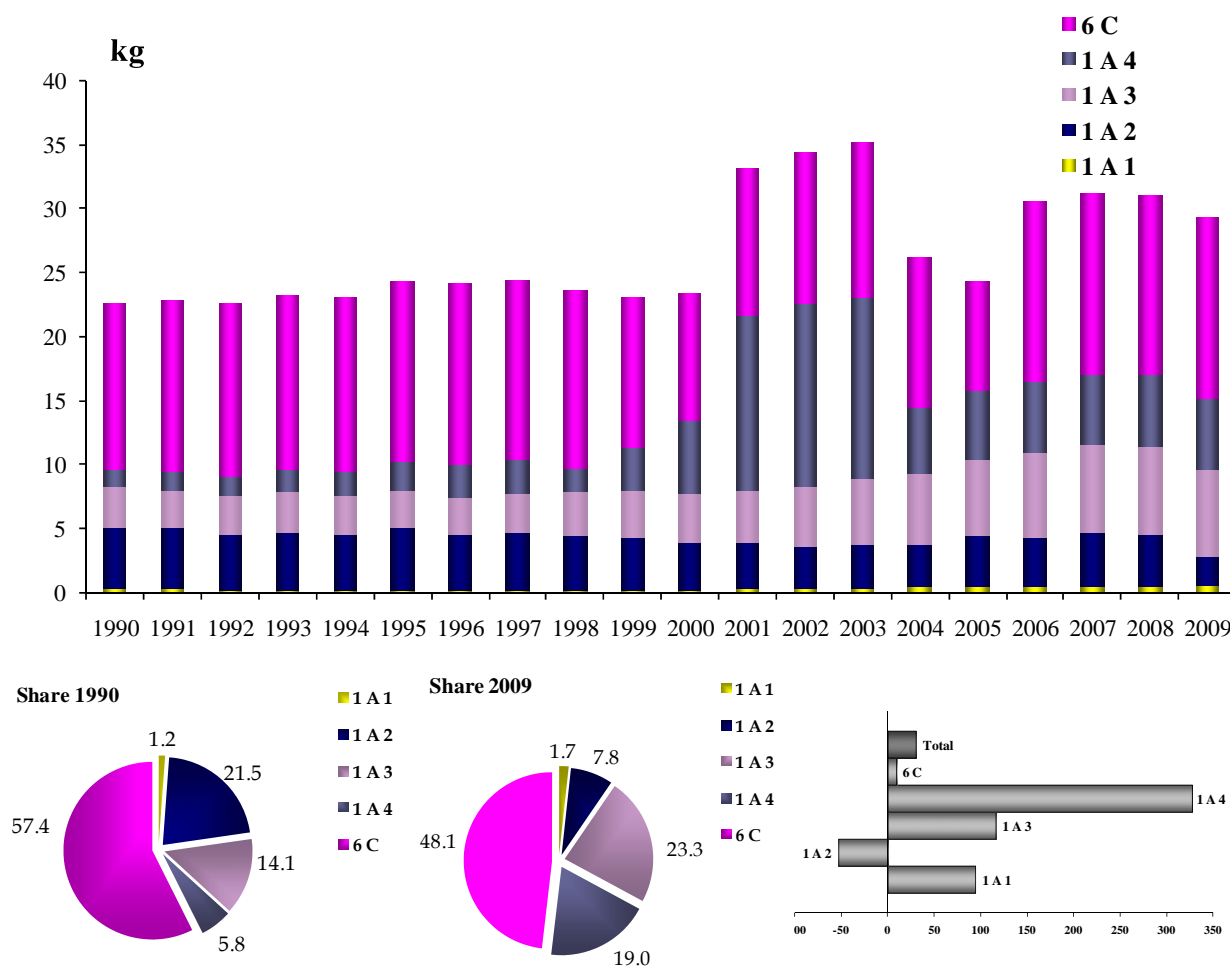


Figure 2.13 HCB emission trend, percentage share by sector and variation 1990-2009

	1990	1995	2000	2005	2006	2007	2008	2009
<i>Mg</i>								
Combustion in energy and transformation industries	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Non-industrial combustion plants	0.001	0.002	0.006	0.005	0.006	0.005	0.006	0.006
Combustion - industry	0.005	0.005	0.004	0.004	0.004	0.004	0.004	0.002
Road transport	0.003	0.003	0.004	0.006	0.007	0.007	0.007	0.007
Waste treatment and disposal	0.013	0.014	0.010	0.009	0.014	0.014	0.014	0.014
<b>Total</b>	<b>0.023</b>	<b>0.024</b>	<b>0.023</b>	<b>0.024</b>	<b>0.030</b>	<b>0.031</b>	<b>0.031</b>	<b>0.029</b>

**Table 2.13 HCB emission trend from 1990 to 2009 (Mg)**

The sector contributing most to the general trend is *waste treatment and disposal*, waste incineration (48% of the total), with 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 is accounted for in this sector) burnt in a specific incinerator. The other two relevant sectors are *road transport* and *non industrial combustion plants*, accounting for 23% and 19%, respectively; both sectors show a significant increase between 1990 and 2009.

#### 2.4.4 Polychlorinated biphenyl (PCB)

The national atmospheric emissions of polychlorinated biphenyl show a slight decreasing trend in the period 1990-2009, about 1.8%, from 279 kg to 188 kg.

Figure 2.14 and Table 2.14 illustrate the emission trend from 1990 to 2009. Figure 2.14 also illustrates the share of PCB emissions by category in 1990 and 2009 as well as the total and sectoral variation from 1990 to 2009.

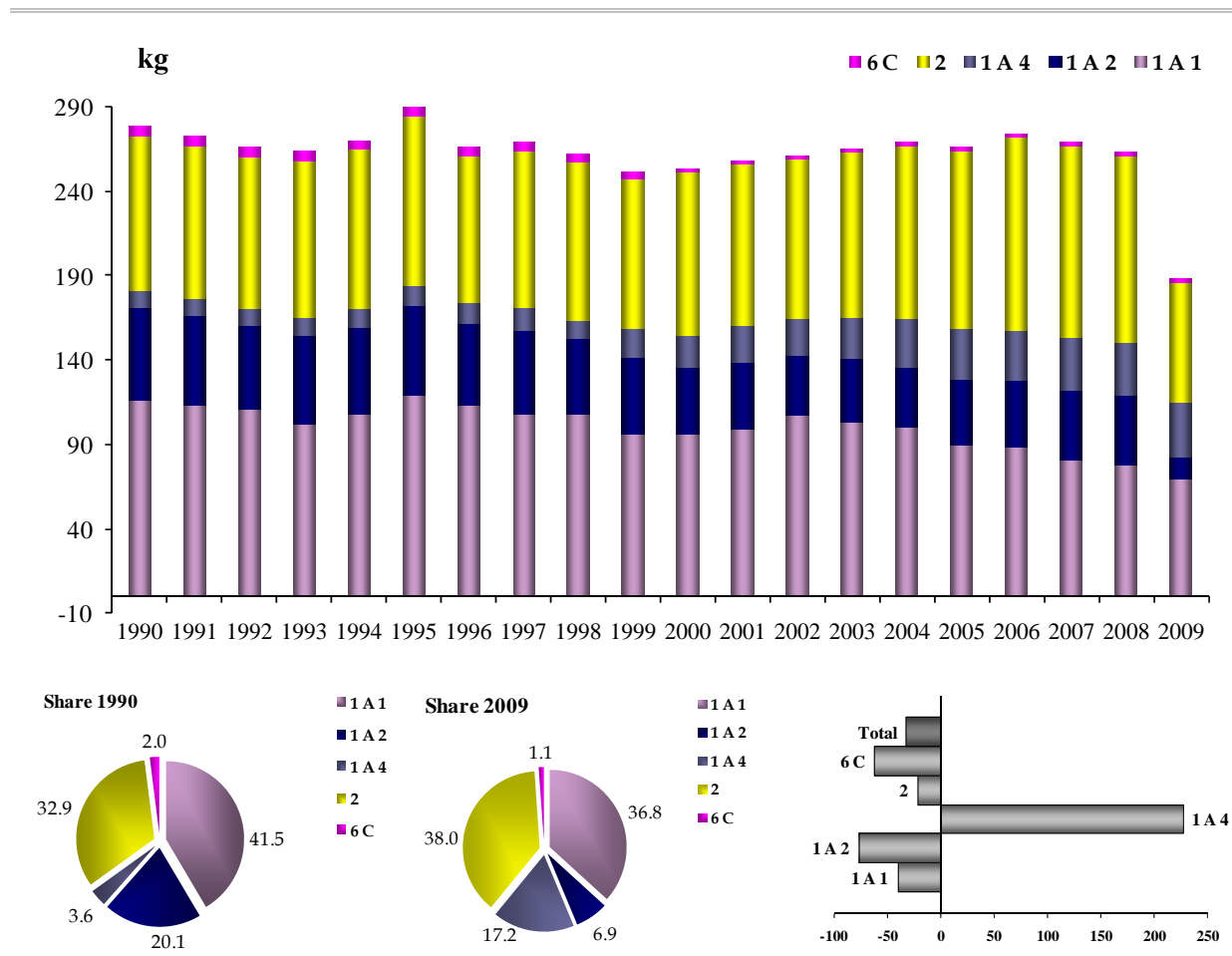


Figure 2.14 PCB emission trend, percentage share by sector and variation 1990-2009

	1990	1995	2000	2005	2006	2007	2008	2009
<i>Mg</i>								
Combustion in energy and transformation industries	0.115	0.119	0.096	0.089	0.089	0.081	0.078	0.069
Non-industrial combustion plants	0.010	0.012	0.019	0.029	0.030	0.031	0.032	0.032
Combustion - industry	0.056	0.053	0.039	0.040	0.039	0.041	0.041	0.013
Production processes	0.092	0.100	0.096	0.106	0.114	0.114	0.110	0.071
Waste treatment and disposal	0.006	0.005	0.002	0.002	0.002	0.002	0.002	0.002
<b>Total</b>	<b>0.279</b>	<b>0.289</b>	<b>0.253</b>	<b>0.266</b>	<b>0.273</b>	<b>0.269</b>	<b>0.263</b>	<b>0.188</b>

**Table 2.14 PCB emission trend from 1990 to 2009 (Mg)**

The subsectors contributing most to the general trend are the *production processes* sector and the *combustion in energy and transformation industries* sector, accounting for 38% and 37% of the total emissions, respectively, and showing a reduction by 22% and 40%. The other relevant subsectors are *non industrial combustion plants* accounting for 17% and relevantly increasing and *combustion in industry* which account for 7% and decrease between 1990 and 2009 of 77%.

### **3 Energy (NFR SECTOR 1)**

#### **3.1 Overview of the sector**

For the pollutants and sources discussed in this section, emissions result from the combustion of fuel. All the pollutants reported under the UNECE/CLRTAP are estimated. Stationary and mobile categories are covered as:

- Electricity (power plants and Industrial producers);
- Refineries (Combustion);
- Iron and steel industries (Combustion)
- Chemical and petrochemical industries (Combustion);
- Construction industries (roof tiles, bricks);
- Other industries (metal works factories, food, textiles, others);
- Road Transport;
- Coastal Shipping;
- Railways;
- Aircraft;
- Domestic;
- Commercial;
- Public Service;
- Fishing and Agriculture.

Fugitive emissions are also reported under the energy sector.

The national emission inventory is prepared using energy consumption information available from national statistics and an estimate of the actual use of the fuels. The latter information is available at sectoral level in a different number of publications and different information such as fuel consumption, distance travelled or some other statistical data related to emissions have been used to estimate it. For most of the combustion source categories, emissions are estimated from fuel consumption data reported in the National Energy Balance (BEN) as supplied by the Ministry for the Economic Development (MSE, several years), and from emission factors appropriate to the type of combustion and the pollutant.

The estimate from fuel consumption emission factors refers to stationary combustion in boilers and heaters. The other categories are estimated by more complex methods discussed in the relevant sections. The fuel consumption of Other Industry is estimated so that the total fuel consumption of these sources is consistent with the national energy balance.

Electricity generation by companies primarily for their own use is auto-generation, and the emissions produced should be reported under the industry concerned. However, national energy statistics report emissions from electricity generation as a separate category. The Italian inventory makes an overall calculation and then attempts to report as far as possible according to the methodology:

- auto-generators are reported in the relevant industrial sectors of section “1.A.2 Manufacturing Industries and Construction”, including sector “1.A.2.f Other”;
- refineries auto-generation is included in section 1.A.1.b;
- iron and steel auto-generation is included in section 1.A.1.c.

Those reports are based on estimates of fuel used for steam generation connected with electricity production supplied by the National Independent System Operator (Terna, several years).

Emissions from waste incineration facilities with energy recovery are reported under category 1.A.4.a (Combustion activity, commercial/institutional sector), whereas emissions from other types of waste incineration facilities are reported under category 6.C (Waste incineration). In fact, energy

recovered by these plants is mainly used for district heating of commercial buildings. In particular, for 2009, 95% of the total amount of waste incinerated is treated in plants with energy recovery system. Different emission factors for municipal, industrial and oils, hospital waste, and sewage sludge are applied, as reported in the waste chapter. Waste amount is then converted in energy content applying an emission factor equal to 9.2 GJ/t of waste.

Emissions from landfill gas recovered are used for heating and power in commercial facilities and reported under 1.A.4.a. Biogas recovered from the anaerobic digester of animal waste is used for utilities in the agriculture sector and relative emissions are reported under 1.A.4.c.

The energy sector account in 2009 for more than 50% of total emissions for all the pollutants estimated, except for ammonia where they account for 3.2%. In particular emissions from the energy sector are 98% of NO<sub>x</sub> total emissions, 91% of SO<sub>x</sub> and 85% of CO and PM<sub>2.5</sub> total national emissions.

In 2009 the following categories are key category for different pollutants: *public electricity and heat production* (1A1a), *petroleum refining* (1A1b), *stationary combustion in manufacturing industries* (1A2), *road transport categories* (1A3b), *national navigation* (1A3d ii), *stationary combustion plants in commercial/institutional* (1A4a i) and *residential* (1A4b i), *off-road vehicles in agriculture, forestry and fishing* (1A4c ii), *fugitive emissions from refining and storage* (1B2A iv) and from *natural gas distribution* (1B2b).

The same categories are key categories for 1990 while for the trend analysis all categories are key with exception of natural gas distribution (1B2b). In addition manufacture of solid fuels (1A1c) is trend key category for PAH emissions.

### 3.2 Methodological issues

Methodologies used for estimating emissions from this sector are based on and conform to the EMEP/CORINAIR guidebook (EMEP/CORINAIR, 2007; EMEP/EEA, 2009), the IPCC Guidelines (IPCC, 1997; IPCC, 2006) and the Good Practice Guidance (IPCC, 2000).

Specifically, for road transport, the most recent version of COPERT 4 programme, version 8.0, as for October 2010, has been used to calculate emissions (EEA, October 2010); the updated version of the model has been applied for the whole time series, resulting in slightly changes in emission levels. In the recalculation chapter, more detailed information is supplied on these figures.

A detailed description on the methods and national specific circumstances as well as reference material of the energy sector is documented in the national inventory report of the Italian greenhouse gas inventory (ISPRA, 2011[b]). At national level, trends of the CLRTAP pollutants are described in the environmental data yearbook published by ISPRA (ISPRA, 2010 [d]).

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.

Emission factors used are based as far as possible on national sources, or else on values specified in the EMEP/CORINAIR guidebook and/or IPCC guidelines which are appropriate for Italy.

The Institute, 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, now E-PRTR) and the Large Combustion Plants (LCP) Directives. All these data are managed and used to compile the inventory. Figures are cross checked to develop country-specific emission factors and input activity data levels; whenever data cannot be straight used for the inventory compilation, they are taken into account as verification. A unique database is under finalisation in order to improve the process for the analysis of this information and the efficiency in collecting data.

### 3.3 Time series and key categories

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

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 2008 the sector accounts for:

- 98% in national total NO<sub>x</sub> emissions;
- 91% in national total SO<sub>x</sub> emissions;
- 85% in national total CO emissions.

Moreover, the sector comprises 85% of total PM<sub>2.5</sub> emissions and is also an important source for heavy metals; specifically in 2009, energy sector is responsible for 83% of total Cd emissions and accounts for a high share of other heavy metals, i.e As (99%), Cu (97%), Ni (96%), Se (93%).

There are no particular differences as compared the sectoral share in 1990, except for lead whose contribution in 1990, accounting for 98% of total emissions, was about 26% higher than 2009.

The most important source of emissions in the sector, in 2009, is represented by *road transport* (1A3) at least for the main pollutants: NO<sub>x</sub> (52.2%), CO (46.7%), NMVOC (24.9%), particulate matter (PM<sub>10</sub> 19.9%, PM<sub>2.5</sub> 20.9%) and HCB (23.3%). There has been a strong reduction of lead emissions from 1990 to 2009 in road transport due to replacement of lead gasoline. An in depth analysis of the road transport category is reported in the paragraph 3.7.

*Manufacturing industries and construction* (1A2) is the main source for heavy metals, accounting for about 42% of lead total emissions, 32% for cadmium, 30% for mercury, and dioxin (27%). The source is also relevant for PM<sub>10</sub> and PM<sub>2.5</sub>, (respectively 7% and 8%) as well as SO<sub>x</sub> and NO<sub>x</sub>, about 19% and 10% of total emissions. The category is also key category for CO emissions (6%) and HCB (8%).

*Public electricity and heat production* (1A1a) is a main source of SO<sub>x</sub> emissions in 2009 with a share of 19.7%, together to *manufacturing industries and construction* (18.5%), *national navigation* (16.4%), *petroleum refining* (16.5%) and fugitive emissions from *processes in refinery* (13.2%); the source is also the main source of PCB emissions (36%) and is a key category for NO<sub>x</sub> emissions (5.1%).

*National navigation* (1A3d ii) is also key category for NO<sub>x</sub> (8.4%), NMVOC (7.9%), CO (6.7%), PM<sub>10</sub> (3.5%) and PM<sub>2.5</sub> (4.1%).

A sector which seems of increasing importance is the *non-industrial combustion* (1A4), as for NO<sub>x</sub>, NMVOC, CO, emissions, accounting for 15-25%, PM emissions, 39.1% and 46.6% of PM<sub>10</sub> and PM<sub>2.5</sub> respectively, dioxin (22.4%) and PAH (45.4%); these emissions are prevalently due to biomass combustion which occurs in the winter period becoming critical for air quality issues. This source is a key category for heavy metals, HCB and PCB due to the increase of combustion of waste with energy recovery reported under the sector.



	1A1a	1A1b	1A1c	1A2	1A2f ii	1A3a ii (i)	1A3a i (i)	1A3b i	1A3b ii	1A3b iii	1A3b iv	1A3b v	1A3b vi	1A3c	1A3d ii	1A3e	1A4a i	1A4b i	1A4b ii	1A4c	1A5b	1B1a	1B1b	1B2
SO <sub>x</sub>	19.7	16.5	2.0	18.5	0.0	0.1	0.1	0.1	0.0	0.0	0.0			0.0	16.4	0.0	1.8	2.4	0.0	0.1	0.0			13.2
NO <sub>x</sub>	5.1	1.8	0.5	10.4	2.4	0.2	0.2	20.7	7.9	22.6	1.0			0.2	8.4	0.1	4.1	3.6	0.0	6.7	1.0			0.7
NH <sub>3</sub>	0.0			0.4	0.0			2.5	0.1	0.0	0.0			0.0	0.0		0.0	0.1	0.0	0.0	0.0			
NM VOC	0.3	0.1	0.0	0.5	0.4	0.0	0.1	5.5	0.8	1.1	15.6	1.8		0.0	7.9	0.0	1.5	8.0	0.1	2.2	0.1	0.0	0.1	6.2
CO	1.0	0.1	0.1	5.9	0.6	0.1	0.1	23.1	2.6	2.0	19.0			0.0	6.7	0.0	0.8	18.0	0.1	4.1	0.7			0.0
PM10	1.0	0.5	0.2	6.9	1.0	0.0	0.0	5.7	3.9	3.2	1.6		5.5	0.2	3.5	0.0	0.7	32.5	0.0	5.9	0.7	0.4	0.1	0.3
PM2.5	1.1	0.6	0.3	7.9	1.2	0.0	0.0	6.8	4.7	3.8	1.9		3.6	0.2	4.1	0.0	0.8	38.7	0.0	7.1	0.9	0.4	0.1	0.3
Pb	1.3	0.2	0.0	42.5		0.2	0.3						5.8		0.1		19.8	1.7		0.0	0.0		0.3	
Cd	1.6	0.4	0.0	32.2	0.0	0.0	0.0	3.2	0.9	1.2	0.2		0.9	0.0	0.3		34.2	3.8	0.0	1.7	0.0		2.2	
Hg	9.1	1.9	0.3	30.0													23.3	2.3		1.3			1.1	
PAH	0.3	0.0	3.0	1.1	0.1	0.0	0.0	1.5	0.4	0.4	0.1			0.0	0.1		0.9	39.4	0.0	5.1	0.0			
Dioxin	2.1	2.0	0.0	27.4				2.3	0.1	0.2	0.5						3.0	17.4		2.0				
HCB	1.7			7.8				15.9	4.9	2.5	0.1						17.0	1.7		0.2				
PCB	36.0	0.5	0.2	6.9													14.2	2.7		0.3				

Note: blue shaded are key categories

**Table 3.1 Key categories in the energy sector in 2009**

Fugitive emissions from *fossil fuel distribution* (1B2) is key category for SO<sub>x</sub> emissions (13.2%) due to fugitive emissions in refinery (1B2a iv), and for NMVOC (2.5%) due to emissions from natural gas distribution (1B2b).

### 3.4 QA/QC and verification

A complete description of methodological and activity data improvements are documented every year in a QA/QC plan (ISPRA, 2011[c]).

The analysis of data collected from point sources allowed to distribute emissions at local level, for 2005 and previous years, as submitted under the CLTRAP. To illustrate an example, NO<sub>x</sub> emissions from point sources are reported in Figure 3.1, for the year 2005; point sources include public electricity and heat production plants, petroleum refineries, stationary combustion plants (*iron and steel, non-ferrous metals, chemicals, clinker*) and pipeline compressors.

The figure highlights that the most critical industrial areas are distributed in few regions.

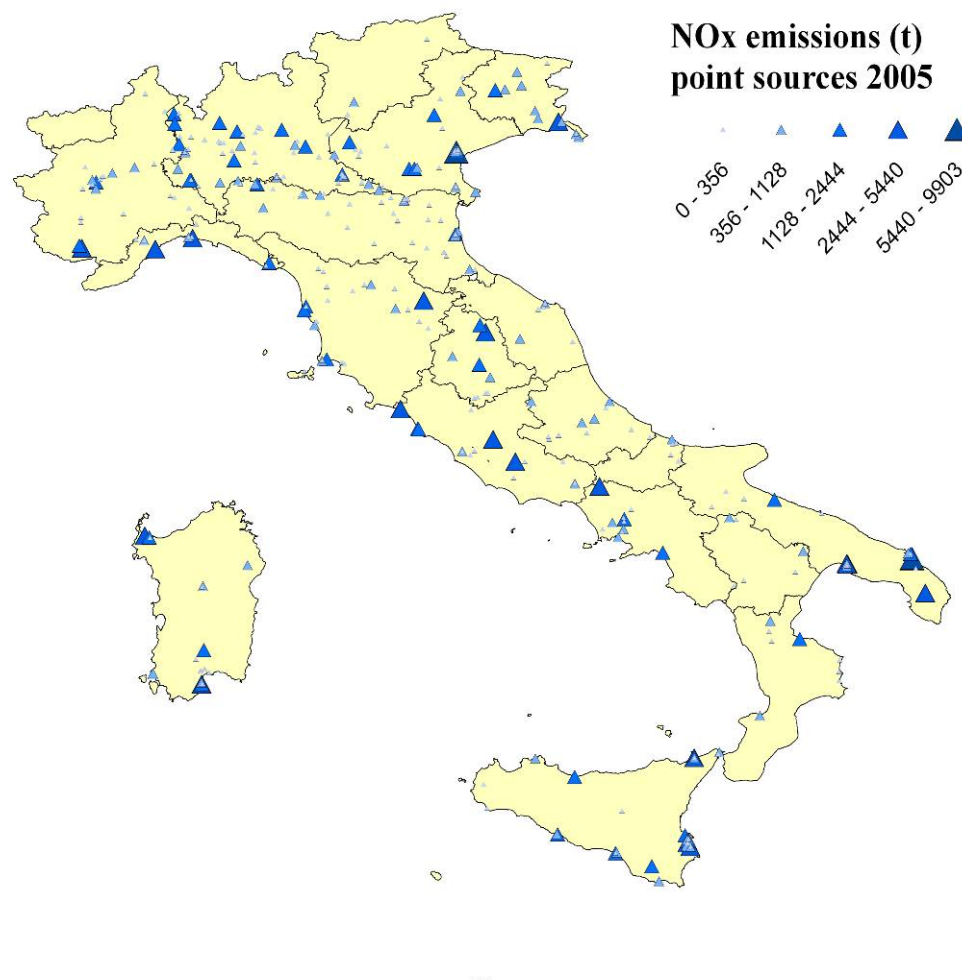
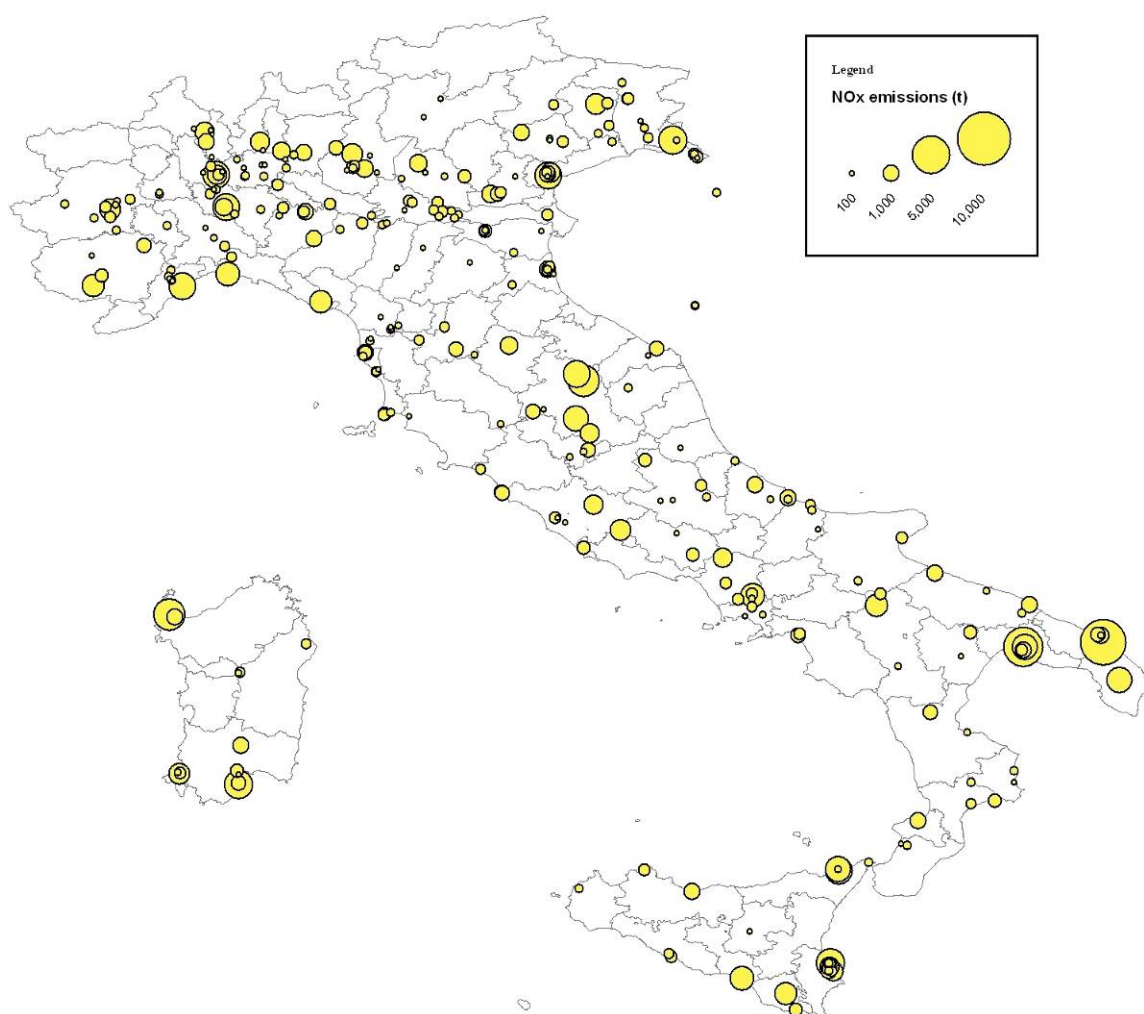


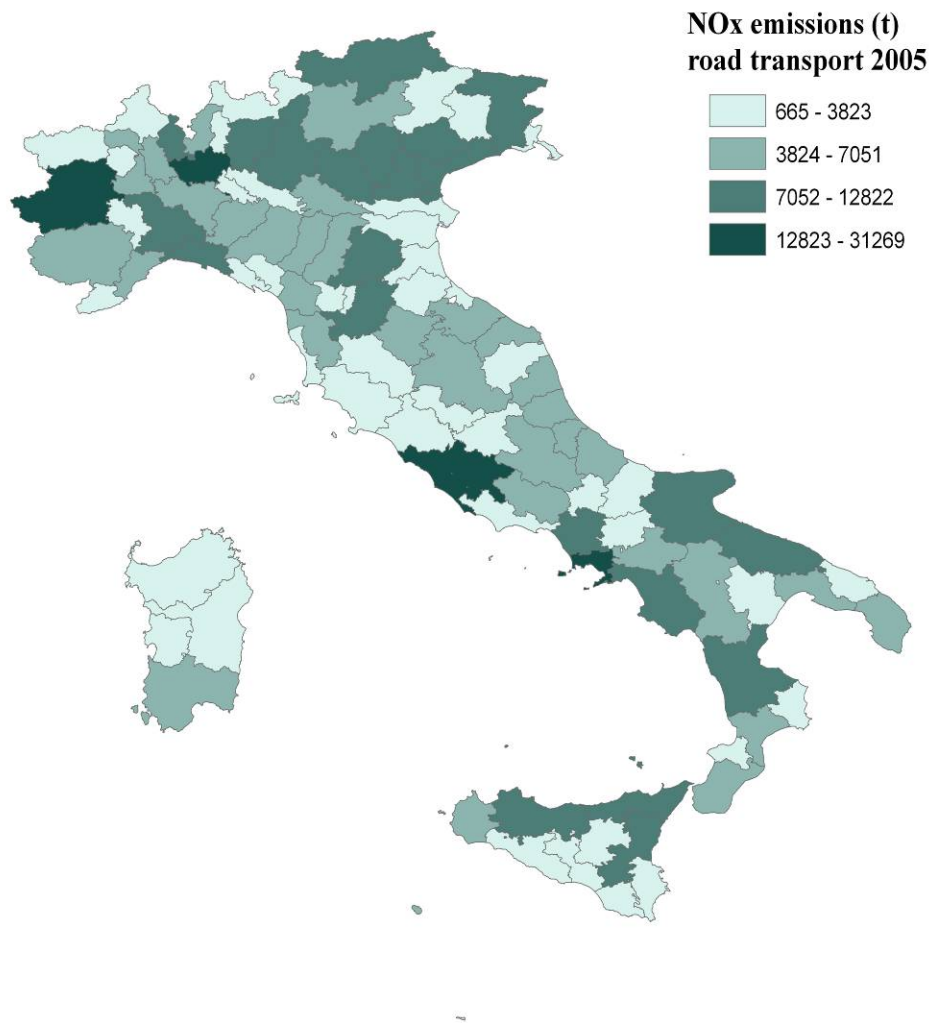
Figure 3.1 NO<sub>x</sub> emissions from point sources in 2005 (t)

In Figure 3.2, NO<sub>x</sub> emissions communicated from the plants, about 300, in the framework of the E-PRTR registry have been reported and geographically referenced. The territorial distribution shows similar results to those reported in the previous figure highlighting the industrial areas still in activity in 2009.



**Figure 3.2 NO<sub>x</sub> emissions from point sources in 2009 (t)**

Every five years emissions are disaggregated at regional and provincial level and figures are compared with results obtained by regional bottom up inventories. Emissions disaggregated at local level are also used as input for air quality modelling. NO<sub>x</sub> emissions from *road transport* have been disaggregated at NUTS3 level (ISPRA, 2009); disaggregation related to 2005 is reported in Figure 3.3.



**Figure 3.3** NO<sub>x</sub> emissions from *road transport* in 2005 (t)

### 3.5 Recalculations

In 2011 submission different recalculations have been performed in the energy sector.

For what concern the stationary fuel combustion categories the main update regarded the 1A4 category. *Non industrial stationary combustion* have been recalculated for the whole time series for the wood biomass fuel combustion taking in account of the distribution of the different installations and the penetration of the new innovative stoves during the period and on the basis of the emission factors published in the last version of the Guidebook (EMEP/EEA, 2009). Recalculations involved main pollutants, heavy metals and POP's and have a strong impact, resulting in a decrease of emission estimates, on Cd (from -2% in 1990 to -8% in 2008 with respect to the national total), Hg (from -2% in 1990 to -7% in 2008), PAH (from -4% in 1990 to -16% in 2008), while resulted in a strong increase of emissions of PM10 (from 5% in 1990 to 15% in 2008), PM2.5 (from 6% in 1990 to 18% in 2008) and a slight increase of NMVOC (less than 1% on the whole time series with respect to the national total).

Under the combustion in industry category (1A2), only for 2008, SO<sub>x</sub>, NO<sub>x</sub>, CO, NH<sub>3</sub> and PM10 emission factors for *cement production* have been updated on the basis of new data.

Zinc emissions from *copper manufactures* for the whole time series, 1990-2008, have been

estimated and included in the inventory on the basis of information collected in the framework of the E-PRTR registry.

Concerning mobile fuel combustion the upgraded version of COPERT 4, v.8.0, has been used resulting in a general revision of emission estimates. More detailed results are reported in the paragraph 3.7.

Moreover, SO<sub>x</sub> emission factors for 2008 for gasoil, 2007-2008 for diesel oil, and 2008 for residual oil (from 3% to 1.5% of S content in the fuel) and gasoil (from 0.2% to 0.1% of S) in harbour have been updated. In addition, maritime activity data have been updated for 2008 on the basis of the elaboration of the official national statistics available in the EUROSTAT database resulting, together with the SO<sub>x</sub> update for harbours, in a marked decrease of emissions for SO<sub>x</sub> (-4% on the national total in 2008).

Concerning fugitive emissions, in response to the review process, NMVOC emissions from *extraction and 1st treatment of solid fossil fuels* have been estimated for the whole time series resulting in about 200 tons in 2009.

### **3.6 Planned improvements**

Specific improvements are specified in the 2011 QA/QC plan (ISPRA, 2011[c]).

For the *energy* sector, a major progress will regard the finalisation of the database where information collected in the framework of different directives, Large Combustion Plant, E-PRTR and Emissions Trading, are gathered together thus highlighting the main discrepancies in information and detecting potential errors

## **3.7 Road transport (NFR SUBSECTOR 1.A.3.b)**

### **3.7.1 Overview**

The road transport sector provides a significant contribution to the national total pollution. The strong demand for mobility of people and goods by road makes relevant the problem of pollution from road transport, also in view of the impact on urban areas.

The growth of the fleet, its mileage and consumptions, have as a result a production of emissions that contributes substantially to total national emissions; that is balanced by the gradual replacement of older vehicles and the equipment of new models with the latest technologies to reduce emissions. The road transport sector gives a strong contribution to total national emissions in 2009: in particular nitrogen oxides emissions account for 52.2% of the total; emissions of carbon monoxide, non-methane volatile organic compounds, particulate matter with diameter less than 10 µm (PM<sub>10</sub>) and particulate matter with diameter less than 2.5 µm (PM<sub>2.5</sub>), are considerable too, respectively 46.7%, 24.9%, 19.9% and 20.9% of the total; the contribution of hexachlorobenzene (HCB) is also sensible: about 23.3% of the total.

The estimation refers to the following vehicle categories:

- 1.A.3.b.i Passenger cars
- 1.A.3.b.ii Light-duty trucks
- 1.A.3.b.iii Heavy-duty vehicles including buses
- 1.A.3.b.iv Mopeds and motorcycles
- 1.A.3.b.v Gasoline evaporation
- 1.A.3.b.vi Road vehicle tyre and brake wear

Emissions from road surface wear (code: 1.A.3.b.vii) are at present not included in the estimation.

In Table 3.2 the list of categories for road transport identified as keys by pollutant found for 2009, 1990 and the trend are reported.

	<i>Key categories in 2009</i>	<i>Key categories in 1990</i>	<i>Key categories in trend</i>
SO <sub>x</sub>		1 A 3 b i	1 A 3 b i
NO <sub>x</sub>	1 A 3 b i 1 A 3 b ii 1 A 3 b iii	1 A 3 b i 1 A 3 b iii	1 A 3 b i 1 A 3 b ii 1 A 3 b iii
NM VOC	1 A 3 b i 1 A 3 b iv 1 A 3 b v	1 A 3 b i 1 A 3 b iv 1 A 3 b v	1 A 3 b i 1 A 3 b iv 1 A 3 b v
NH <sub>3</sub>			1 A 3 b i
CO	1 A 3 b i 1 A 3 b iv	1 A 3 b i 1 A 3 b iv	1 A 3 b i 1 A 3 b iv
PM <sub>10</sub>	1 A 3 b i 1 A 3 b ii 1 A 3 b iii 1 A 3 b vi	1 A 3 b i 1 A 3 b ii 1 A 3 b iii 1 A 3 b vi	1 A 3 b i 1 A 3 b iii 1 A 3 b vi
PM <sub>2.5</sub>	1 A 3 b i 1 A 3 b ii 1 A 3 b iii 1 A 3 b vi	1 A 3 b i 1 A 3 b ii 1 A 3 b iii	1 A 3 b iii
Pb		1 A 3 b i	1 A 3 b i
HCB	1 A 3 b i	1 A 3 b i	1 A 3 b i

**Table3.2 List of key categories for pollutant in the road transport in 2009, in 1990 and in the trend**

### 3.7.2 Activity data

The road traffic data used are vehicle kilometre estimates for the different vehicle types and different road classifications in the national road network. These data have to be further broken down by composition of each vehicle fleet in terms of the fraction of diesel-fuelled and petrol-fuelled vehicles on the road and in terms of the fraction of vehicles on the road made to the different emission regulations which applied when the vehicle was first registered. These are related to the age profile of the vehicle fleet.

Additional data are required for the estimation of consumption of buses, because the available traffic data seldom distinguish beyond “heavy vehicles”. Moreover, traffic data on motorcycles are not exhaustive. In both cases, the energy consumption is estimated on the basis of the oil companies’ reports on sold fuels.

Basic data derive from different sources. Detailed data on the national fleet composition is found in the yearly report from ACI (ACI, several years). The National Association of Cycle-Motorcycle Accessories (ANCMA, several years) supplies useful information on mopeds fleet composition and mileages. The Ministry of Transport in the national transport yearbook (MINT, several years) reports passenger car mileages time series. The National Institute of Statistics carries out annually a survey on heavy goods vehicles, including annual mileages (ISTAT, several years [b]). The National Association of concessionaries of motorways and tunnels produces monthly statistics on highway mileages by light and heavy vehicles (AISCAT, several years). The National General Confederation of Transport and Logistics (CONFETRA, several years) and the national Central Committee of road transporters (Giordano, 2007) supplied useful information and statistics about heavy goods vehicles fleet composition and mileages.

In the following Tables 3.3, 3.4 and 3.5 detailed data on the relevant vehicle mileages in the circulating fleet are reported, subdivided according to the main emission regulations (ISPRA elaborations on ACI data).

	1990	1995	2000	2009
pre-1972, PRE ECE	0.05	0.03	0.01	0.005
1972 -1977, ECE 15.00/01	0.11	0.04	0.01	0.003
1978 -1986, ECE 15.02/03	0.32	0.15	0.03	0.01
1987 -1992, ECE 15.04	0.52	0.56	0.29	0.07
91/441/EC, from 1/1/93, euro I	0.001	0.22	0.27	0.08
94/12/ EC, from 1-1-97 , euro II	-	-	0.37	0.27
98/69/EC, from 1/1/2001, euro III	-	-	-	0.20
98/69/EC, from 1/1/2006, euro IV, V	-	-	-	0.37
Total	1.00	1.00	1.00	1.00

**Table 3.3 Gasoline cars technological evolution: circulating fleet calculated as stock data multiplied by effective mileage (%)**

	1990	1995	2000	2009
pre- 1993	1.00	0.91	0.34	0.02
91/441/EC, from 1/1/93, euro I	-	0.09	0.10	0.02
94/12/ EC, from 1-1-97 , euro II	-	-	0.56	0.10
98/69/EC, from 1/1/2001, euro III	-	-	-	0.33
98/69/EC, from 1/1/2006, euro IV, V	-	-	-	0.53
Total	1.00	1.00	1.00	1.00

**Table 3.4 Diesel cars technological evolution: circulating fleet calculated as stock data multiplied by effective mileage (%)**



	1990	1995	2000	2009
pre -1996	1.00	0.93	0.61	0.09
from 1/1/96, Dir. 91/542 EEC, euro I	-	0.07	0.21	0.08
from 1/1/97, Dir. 91/542 EEC, euro II	-	-	0.18	0.23
from 1/1/2001, Dir. 99/96, euro III	-	-	-	0.34
from 1/1/2006, Dir. 99/96, euro IV, V	-	-	-	0.25
Total	1.00	1.00	1.00	1.00

**Table 3.5 Trucks technological evolution: circulating fleet for light duty (%)**

Average emission factors are calculated for average speeds by three driving modes, urban, rural and motorway, combined with the vehicle kilometres travelled and vehicle categories.

ISPRA estimates total annual vehicle kilometres for the road network in Italy by vehicle type, see Table 3.6, based on data from various sources:

- Ministry of Transport (MINT, several years) for rural roads and on other motorway; the latter estimates are based on traffic counts from the rotating census and core census surveys of ANAS;
- highway industrial association for fee-motorway (AISCAT, several years);
- local authorities for built-up areas (urban).

	1990	1995	2000	2005	2006	2007	2008	2009
All passenger vehicles, total mileage (10 <sup>9</sup> veh-km/y)	304	362	391	418	425	425	409	395
Car fleet (10 <sup>6</sup> )	27	30	32	34	35	35	36	36
Moto, total mileage (10 <sup>9</sup> veh-km/y)	31	39	45	49	50	51	52	53
Moto fleet (10 <sup>6</sup> )	7	7	9	10	10	10	10	11
Goods transport, total mileage (10 <sup>9</sup> veh-km/y)	70	75	90	99	102	105	104	103
Truck fleet (10 <sup>6</sup> ), including LDV	2	3	3	4	4	5	5	5

**Table 3.6 Evolution of fleet consistency and mileage**

### 3.7.3 Methodological issues

A national methodology has been developed and applied to estimate emissions according to the IPCC Guidelines and Good Practice Guidance (IPCC, 1997; IPCC, 2000; IPCC, 2006) and the EMEP/EEA Guidebook (EMEP/EEA, 2009). In 2011 submission, the new version 8.0 of the model COPERT 4 (Computer Programme to calculate emissions from road transport, EEA, October 2010) has been applied to estimate emissions for the time series from 1990 to 2009, which, compared to the previous version, upgrades the methodology, the software and fixes some bugs in the model, determining a recalculation of emission estimates with respect to last submission. The annual update of the model is based on the availability of new measurements and studies regarding road transport emissions (for further information see: <http://www.emisia.com/copert/>).

The model, on the basis of the inputs inserted, gives in output results separately for vehicles category and urban, rural, highway areas, concerning emission estimates of CO, VOC, NMVOC, CH<sub>4</sub>, NO<sub>x</sub>, N<sub>2</sub>O, NH<sub>3</sub>, PM<sub>2.5</sub>, PM<sub>10</sub>, PM exhaust (the emission factors of particulate matter from combustion refer to particles smaller than 2.5 µm, that implicitly assumes that the fraction PM<sub>2.5</sub> to PM<sub>10</sub> is negligible), CO<sub>2</sub>, SO<sub>2</sub>, heavy metals, NO<sub>x</sub> speciation in NO and NO<sub>2</sub>, the speciation in elemental and organic carbon of PM, the speciation of NMVOC.

### 3.7.3.1 Exhaust emissions

Exhaust emissions from vehicles subsectors are split between cold and hot emissions; estimates are calculated either on the basis of a combination of total fuel consumption and fuel properties data or on the basis of a combination of drive related emission factors and road traffic data.

The calculation of emissions is based on emission factors calculated for the vehicle models most widely and systematically used, distinguishing between the type of vehicle, fuel, engine size or weight class, standard legislation. The legislative standards introduced become more stringent over the years, ensuring that new vehicles emit much less than the older ones as regards regulated pollutants.

With reference to four groups of pollutants, the method of calculation of exhaust emissions is different. The methodology implemented is derived from the EMEP/EEA Emission Inventory Guidebook 2009.

As regards the first two groups, methods are used leading to high standard detailed emissions data.

The first group includes CO, NO<sub>x</sub>, VOC, CH<sub>4</sub>, NMVOC, N<sub>2</sub>O, NH<sub>3</sub> and PM. For these pollutants, specific emission factors are applied relating to different engine conditions and urban, rural and highway driving shares.

The second group includes: CO<sub>2</sub>, SO<sub>2</sub>, Pb, Cd, Cr, Cu, Ni, Se, Zn. The emissions of these pollutants are estimated on the basis of fuel consumption.

For the third group of pollutants, including PAHs and POPs, PCDDs and PCDFs, detailed data are not available and then a simplified methodology is applied.

Finally the fourth group includes pollutants (alkanes, alkenes, alkynes, aldehydes, ketones, cycloalkanes and aromatic compounds) obtained as a fraction of the total emissions of NMVOC, assuming that the fraction of residual NMVOC are PAHs.

Because of the availability in Italy of an extensive and accurate database, a detailed methodology is implemented in the model COPERT 4 (EEA, October 2010).

Total emissions are calculated as the sum of hot emissions, deriving from the engine when it reaches a hot temperature, and cold emissions produced during the heating process. The different methodological approach is justified by the performance of vehicles in the two different phases.

The production of emissions is also closely linked to the driving mode, differentiating for activity data and emission factors, with reference to urban (where it is assumed that almost all cold emissions are produced), rural and highway shares.

Several factors contribute to the production of hot emissions such as the mileage, the speed, the type of road, the vehicle age, engine capacity and weight.

Cold emissions are mainly attributed to urban share, and are attributed only to passenger cars and light duty vehicles. Varying according to the weather conditions and driving behaviour, are related to the specific country.

Emissions are calculated from emission factors expressed in grams per kilometre and road traffic statistics estimated by ISPRA on account of data released from Ministry of Transport (MINT, several years). The emission factors are based on experimental measurements of emissions from in-service vehicles of different types driven under test cycles with different average speeds calculated from the emission functions and speed-coefficients provided by COPERT 4 (EEA, October 2010).

This source provides emission functions and coefficients relating emission factors (in g/km) to average speed for each vehicle type and Euro emission standard derived by fitting experimental measurements to polynomial functions. These functions were then used to calculate emission factor values for each vehicle type and Euro emission standard at each of the average speeds of the road

and area types.

According to a different logic the estimation of fuel dependent pollutants is performed.

Data of consumption of various fuels are derived from official statistics aggregated at national level and then estimated in the detail of vehicle categories, emission regulation and road type in Italy. The resulting error of approximation deriving from the comparison between the calculated value and the statistical value of the total fuel consumption, is corrected by applying a normalisation procedure to the breakdown of gasoline and diesel consumption by each vehicle type calculated on the basis of the fuel consumption factors added up, with reference to the BEN figures for total fuel consumption in Italy (adjusted for off-road consumption).

The 1990-2009 inventory used fuel consumption factors expressed as g of fuel per kilometre for each vehicle type and average speed calculated from the emission functions and speed-coefficients provided by the model COPERT 4 (EEA, October 2010). The updated version 8.0 of the model COPERT 4 has been used for the whole time series of the 2011 submission. As reported more in detail in the following, the updated version of the model revised emission and consumption factors of heavy duty trucks and buses, revised some functions of the software and fixed some bugs, compared to the previous version 7.1.

Emissions of sulphur dioxide and heavy metals from Italian road transport are calculated applying specific factors to consumption data of gasoline, diesel, liquefied petroleum gas (LPG) and natural gas, taken from the BEN (MSE, several years).

Emissions of SO<sub>2</sub> are based on the sulphur content of the fuel. Values for SO<sub>2</sub> vary annually as the sulphur-content of fuels change and are calculated every year for gasoline and gas oil and officially communicated to the European Commission in the framework of European Directives on fuel quality; these figures are also published by the refineries industrial association (UP, several years).

Emissions of heavy metals are estimated on the basis of data regarding the fuel and lubricant content and the engine wear (factors applied, deriving from studies performed by the Expert Panel on Heavy Metals and POPs of the UNECE Task Force on Emission Inventories are considered preliminary estimates in the EMEP/EEA Emission Inventory Guidebook 2009).

### **3.7.3.2 Evaporative emissions**

As regards NMVOC, the share of evaporative emissions is provided. These emissions are calculated only for gasoline vehicles: passenger cars, light duty vehicles, mopeds and motorcycles. Depending on temperature and vapour pressure of fuel, evaporative emissions have shown a growth over the years, nevertheless recently the contribution has been reduced by the introduction of control systems such as the canister.

The estimation procedure is differentiated according to the processes of diurnal emission, running losses and hot soak emissions (EMEP/EEA, 2009).

### **3.7.3.3 Emissions from tyre and brake wear**

Not exhaust PM from road vehicle tyre and brake wear is estimated (road wear is at present not included in the estimation model).

The focus is on the primary particles, deriving directly from tyre and brake wear.

The material that is produced by the effects of wear and attrition between surfaces is subject to evaporation at high temperatures developed by the contact.

Emissions are influenced by, as regards tyres, the composition and pressure of tyres, the structure and characteristics of vehicles, the peculiarities of the road and, as regards brakes, by the

composition of the materials of the components, the position, the configuration systems, and the mechanisms of actuation (EMEP/EEA, 2009).

### 3.7.4 Time series and key categories

The analysis of time series on transport data shows a trend that is the result of the general growth in mobility demand and consumptions, on the one side, and of the introduction of advanced technologies limiting emissions in modern vehicles, on the other side.

In 2009 key categories are identified for the pollutants: nitrogen oxides, non methane volatile organic compounds, carbon monoxide, particulate matter with diameter less than 10 µm and particulate matter with diameter less than 2.5 µm, hexachlorobenzene.

Nitrogen oxides emissions show a decrease from 1990 of about 45.5%. Emissions are mainly due to diesel vehicles. The decrease observed in emissions deriving from passenger cars, heavy-duty vehicles and buses is balanced by the growth of the emissions of light-duty trucks, mopeds and motorcycles.

In 2009, emissions of nitrogen oxides from passenger cars (Table 3.7), light-duty trucks and heavy-duty vehicles including buses are key categories. The same categories are identified as key in trend, while in 1990 passenger cars and heavy-duty vehicles including buses are key categories while light-duty trucks are not key category.

Source categories for NFR Subsector 1.A.3.b	1990	1995	2000	2005	2006	2007	2008	2009
	<i>Gg</i>							
1.A.3.b.i Passenger cars	530	585	367	251	245	237	217	203
1.A.3.b.ii Light-duty trucks	68	71	84	82	80	81	77	77
1.A.3.b.iii Heavy-duty vehicles including buses	338	329	298	269	251	256	249	222
1.A.3.b.iv Mopeds and motorcycles	5	6	7	9	9	10	10	10
<b>Total emissions</b>	<b>941</b>	<b>991</b>	<b>756</b>	<b>611</b>	<b>586</b>	<b>583</b>	<b>552</b>	<b>512</b>

**Table 3.7 Time series of nitrogen oxides emissions in road transport (Gg)**

As regards non methane volatile organic compounds, emissions from passenger cars, mopeds and motorcycles and gasoline evaporation are key categories in 2009, 1990 and in trend.

Despite the decline since 1990 of emissions of non methane volatile organic compounds from road transport (Table 3.8), it is the second source at national level, after the use of solvents; this trend is due to the combined effect of technological improvements that limit VOCs from tail pipe and evaporative emissions (for cars) and the expansion of two-wheelers fleet. In Italy there is in fact a remarkable fleet of motorbikes and mopeds (about 10.6 million vehicles in 2009) that use gasoline and are increasing but only a small part of this fleet complies with strict VOC emissions controls.

Source categories for NFR Subsector 1.A.3.b	1990	1995	2000	2005	2006	2007	2008	2009
	<i>Gg</i>							
1.A.3.b.i Passenger cars	661	682	364	140	117	100	86	76
1.A.3.b.ii Light-duty trucks	24	24	19	13	11	11	10	9
1.A.3.b.iii Heavy-duty vehicles including buses	30	26	21	17	17	15	14	12
1.A.3.b.iv Mopeds and motorcycles	250	334	312	227	214	201	188	178
1.A.3.b.v Gasoline evaporation	180	190	92	32	27	24	22	20
<b>Total emissions</b>	<b>964</b>	<b>1,066</b>	<b>716</b>	<b>397</b>	<b>360</b>	<b>328</b>	<b>298</b>	<b>275</b>

**Table 3.8 Time series of non methane volatile organic compounds emissions in road transport (Gg)**

Carbon monoxide emissions from passenger cars, mopeds and motorcycles are key categories in 2009, 1990 and in trend (Table 3.9).

A strong contribution to total emissions is given by gasoline vehicles; nevertheless from 1990 a general decrease is observed, of about 78.1%.

Source categories for NFNFR Subsector 1.A.3.b	1990	1995	2000	2005	2006	2007	2008	2009
	<i>Gg</i>							
1.A.3.b.i Passenger cars	4,798	4,520	2,468	1,108	923	797	682	605
1.A.3.b.ii Light-duty trucks	210	209	158	97	82	80	69	67
1.A.3.b.iii Heavy-duty vehicles including buses	84	79	67	64	59	61	59	53
1.A.3.b.iv Mopeds and motorcycles	497	616	663	559	554	535	512	498
<b>Total emissions</b>	<b>5,589</b>	<b>5,424</b>	<b>3,355</b>	<b>1,827</b>	<b>1,618</b>	<b>1,474</b>	<b>1,323</b>	<b>1,223</b>

**Table 3.9 Time series of carbon monoxide emissions in road transport (Gg)**

Emissions of PM10 deriving from passenger cars, light-duty trucks, heavy-duty vehicles including buses, road vehicle tyre and brake wear are key categories both in 2009 and in 1990; emissions from passenger cars, heavy-duty vehicles including buses, road vehicle tyre and brake wear are key categories in trend (Table 3.10).

As regards PM2.5, emissions from passenger cars, light-duty trucks, heavy-duty vehicles including buses, road vehicle tyre and brake wear are key categories in 2009 but emissions from road vehicle tyre and brake wear are not key categories in 1990; only emissions from heavy-duty vehicles including buses are key categories in trend (Table 3.11).

Source categories for NFR Subsector 1.A.3.b	1990	1995	2000	2005	2006	2007	2008	2009
	<i>Gg</i>							
1.A.3.b.i Passenger cars	24	20	18	17	17	17	16	15
1.A.3.b.ii Light-duty trucks	11	13	15	11	10	10	9	8
1.A.3.b.iii Heavy-duty vehicles including buses	16	15	12	10	9	9	8	7
1.A.3.b.iv Mopeds and motorcycles	4	5	5	4	4	4	3	3
<b>Total emissions</b>	<b>55</b>	<b>53</b>	<b>50</b>	<b>42</b>	<b>39</b>	<b>39</b>	<b>37</b>	<b>34</b>

**Table 3.10 Time series of particulate matter with diameter less than 10 µm emissions in road transport (Gg)**

Source categories for NFR Subsector 1.A.3.b	1990	1995	2000	2005	2006	2007	2008	2009
	<i>Gg</i>							
1.A.3.b.i Passenger cars	22	18	16	14	15	15	14	13
1.A.3.b.ii Light-duty trucks	11	12	14	10	9	9	8	8
1.A.3.b.iii Heavy-duty vehicles including buses	15	14	11	9	8	8	8	6
1.A.3.b.iv Mopeds and motorcycles	4	5	5	4	3	3	3	3
<b>Total emissions</b>	<b>51</b>	<b>49</b>	<b>46</b>	<b>37</b>	<b>35</b>	<b>35</b>	<b>32</b>	<b>30</b>

**Table 3.11 Time series of particulate matter with diameter less than 2.5 µm emissions in road transport (Gg)**

Emissions of particulate matter with diameter less than 10µm and less than 2.5µm show a decreasing trend from 1990 (respectively of about -37.3% and -41.4%); despite the decrease, diesel

vehicles, passenger cars, light duty vehicles and heavy duty trucks, are in 2009 mainly responsible for road transport emissions.

Emissions of hexachlorobenzene from passenger cars are key categories both for 1990, 2009 and the trend (Table 3.12).

HCB emissions estimates show a strong growth from 1990 (+115.8%), attenuated by a light decrease from 2007 onwards (-1.6%), and are almost entirely due to diesel vehicles.

It is worthwhile to point out that the HCB emission factor for diesel oil reported in the Guidebook has never been modified and that it is based on the assumption that HCB is present in diesel oil as an additive. Nevertheless, it is important to highlight that such an additive has never been used in Italy.

Source categories for NFR Subsector 1.A.3.b	1990	1995	2000	2005	2006	2007	2008	2009
	<i>kg</i>							
1.A.3.b.i Passenger cars	1.71	1.41	2.06	3.94	4.44	4.74	4.68	4.66
1.A.3.b.ii Light-duty trucks	0.59	0.70	1.10	1.28	1.35	1.41	1.39	1.43
1.A.3.b.iii Heavy-duty vehicles including buses	0.85	0.80	0.74	0.80	0.78	0.78	0.80	0.74
1.A.3.b.iv Mopeds and motorcycles	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02
<b>Total emissions</b>	<b>3.17</b>	<b>2.95</b>	<b>3.94</b>	<b>6.05</b>	<b>6.60</b>	<b>6.96</b>	<b>6.88</b>	<b>6.85</b>

**Table 3.12 Time series of hexachlorobenzene emissions in road transport (kg)**

Emissions of SO<sub>x</sub>, NH<sub>3</sub> and Pb are not key categories in 2009, despite emissions of SO<sub>x</sub> and Pb from passenger cars are key categories in 1990 and in trend, emissions of NH<sub>3</sub> from passenger cars are key categories in trend. Emissions of these pollutants are irrelevant in 2009, compared to other sectors. Emissions of SO<sub>2</sub> and Pb show strong decreases, due to limits on fuels properties imposed by legislation. SO<sub>x</sub> emissions decrease of -99.6% representing the 0.2% of the total in 2009. Emissions of Pb decrease of 99.7% and represent in 2009 the 5.8% of total national emissions. Emissions of NH<sub>3</sub>, despite the strong increase from 1990, in 2009 represent only the 2.6% of the total.

### 3.7.5 QA/QC and Uncertainty

Data used for estimating emissions from the road transport sector, derive from different sources, including official statistics providers and industrial associations.

A specific procedure undertaken for improving the inventory in the sector regards the establishment of a national expert panel in road transport which involves, on a voluntary basis, different institutions, local agencies and industrial associations cooperating for improving activity data and emission factors accuracy. In this group, emission estimates are presented annually, and new methodologies are shared and discussed. Reports and data of the meetings can be found at the following address: <http://www.sinanet.isprambiente.it/it/EPT/convegni/annunci-e-convegni>.

Besides, time series resulting from the recalculation due to the application of COPERT 4 have been discussed with national experts in the framework of an ad hoc working group on air emissions inventories. The group is chaired by ISPRA and includes participants from the local authorities responsible for the preparation of local inventories, sectoral experts, the Ministry of Environment, Land and Sea, and air quality model experts. Recalculations are comparable with those resulting from application of the new model at local level. Top-down and bottom-up approaches have been compared with the aim to identify the major problems and future possible improvements in the

methodology to be addressed.

A Montecarlo analysis has been carried out by EMISIA on behalf of the Joint Research Centre (Kouridis et al., 2010) in the framework of the study “Uncertainty estimates and guidance for road transport emission calculations” for 2005 emissions. The study shows an uncertainty assessment, at Italian level, for road transport emissions on the basis of 2005 input parameters of the COPERT 4 model (v. 7.0).

An application of Montecarlo analysis is being implemented, using the software tool COPERT 4 MC, considering 2009 emissions.

### **3.7.6 Recalculation**

The annual update of the emissions time series from road transport implies a periodic review process.

In 2011 and 2010 submissions, the new versions of COPERT 4 revised both the estimation methodology and the software, but not in such significant way as the transition to COPERT 4. In 2009 in fact, the transition from COPERT III to COPERT 4 was the occasion for a general review of input data, as activity data, model parameters and emission factors.

The most recent update of the software is COPERT 4, version 8.0 (EEA, October 2010). This is a user-friendly version that upgraded the methodology and the software and fixed some bugs, and it has been used to estimate emissions in the 2011 submission determining a recalculation of emission estimates, but did not produce significant changes with respect to the previous submission.

This updated version of the model revised hot emission factors of CO, VOC, NO<sub>x</sub>, PM exhaust and FC, for heavy duty trucks and buses (except CNG buses) on the basis of the latest Handbook of Emission Factors for Road Transport (HBEFA, 2010).

As regards Euro V vehicles, the new methodology distinguishes between the technologies EGR (exhaust gas recirculation) and SCR (selective catalytic reduction), but did not provide significant changes with respect to 2010 submission because of the still small number of Euro V vehicles in the Italian fleet.

As regards the software, some modifications relating to the worksheet of import/export and the installation were carried out; improvements concerning the exporting functions and the selection of load/slope effects were implemented and bugs relating to the calculation of mileage degradation factors, evaporation factors and the export process of fuel balance results were fixed. The updating of the minimum speed limit of hot emission factors parameters for hybrid passenger cars does not affect the Italian case.

### **3.7.7 Planned improvements**

Improvements for the next submission will derive mainly from the annual update of the software.

In particular a Montecarlo analysis will be completed, using the software tool COPERT 4 MC, considering 2009 emissions.

Improvements will be implemented, in the case of future availability of more detailed national data concerning fuels used, fleet data regarding in particular heavy duty trucks, buses and mopeds, other information about national factors and parameters useful for the calculation.

As regards HCB, improvements are planned concerning the study of Italian emission factors. Emissions are almost entirely due to diesel fuel and further investigation is requested regarding the use of additives in Italy, in order to obtain estimates reflecting better reality, it is expected in fact a downward revision.

## 4 INDUSTRIAL PROCESSES (NFR SECTOR 2)

### 4.1 Overview of the sector

By-products or fugitive emissions, which originate from industrial processes, are included in this category. Where emissions are released simultaneously from the production process and from combustion, as in the cement industry, these are estimated separately and included in category 1.A.2. This sector makes important contributions to emissions of heavy metals, PAH, dioxins and PCB.

Regarding emissions of the main pollutants, in 2009 industrial processes account for 9.1% of SO<sub>2</sub> emissions, 0.5% of NO<sub>x</sub>, 0.1% of NH<sub>3</sub>, 4% of NMVOC and 3.5% of CO. About particulate matter, in 2009 this sector account for 8.4% of PM<sub>10</sub> emissions and 4.0% of PM<sub>2.5</sub>. Industrial processes make a significant contribution to the total Italian emissions of heavy metals, despite significant reductions since 1990; particularly this sector account for 26.2% of Pb emissions, 14.7% of Cd and 28.8% of Hg. Regarding POPs emissions, 20.4% of PAH total emissions is emitted from industrial processes as well as 26.7% of dioxins and 38.0% of PCB.

In 2009, *iron and steel* sector (2C1) is a key category at level assessment for PM<sub>10</sub>, Pb, Cd, Hg, PAH, PCDD/PCDF and PCB; *cement production* (2A1) is key category only for PM<sub>10</sub> emissions and *food and drink* (2D2) is a key category source for NMVOC emissions. In 1990 similar figures were obtained, however 2A1 and 2D2 were not key categories while *other chemical industry* (2B5a) was a key source for Hg emissions. In 1990 *iron and steel production* was not key category for Pb emissions.

At trend assessment, *iron and steel* sector is key category for Pb, Hg, PAH, PCDD/PCDF and PCB, *cement production* is a key category source for SO<sub>2</sub> emissions and *other chemical industry* for Hg emissions.

### 4.2 Methodological issues

Methodologies used for estimating emissions from this sector are based on and conform to the *EMEP/CORINAIR guidebook* (EMEP/CORINAIR, 2007), the *IPCC Guidelines* (IPCC, 1997; IPCC, 2006) and the *Good Practice Guidance* (IPCC, 2000). Included in this sector are by-products or fugitive emissions, which originate from industrial processes.

There are different sources relevant to estimate emissions from this sector; activity data are provided by national statistics and industrial associations but a lot of information is supplied directly from industry. In fact, as for the *energy* sector, references derive from data collected in the framework of the EPER/E-PRTR registry, *Large Combustion Plant* directives 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.

#### ***Mineral products (2A)***

In this sector emissions from the following processes are estimated and reported: cement production, lime production, soda ash production. Asphalt roofing and road paving with asphalt activities are also included in this sector but they contribute only with NMVOC emissions.

*Cement production* (2A1), as already mentioned, is a key source for PM<sub>10</sub> emissions and accounts for 2.7% of the total national emissions in 2009.



During the last 15 years in Italy, changes in cement production sector have occurred which have led to a more stable structure. The oldest plants closed, wet processes were abandoned in favour of dry processes so as to improve the implementation of more modern and efficient technologies. There are 29 companies (88 plants of which: 58 full cycle and 30 grinding plants) currently operating in this sector: multinational companies and small and medium size enterprises (operating at national or only at local level) are present in the country. As for the localization of the operating plants: 45% is in northern Italy, 17% is in the central regions of the country and 38% is in the southern regions and in the islands. There are 80 active sintering rotary kilns which belong to the “dry” or of “semidry” types. In Italy different types of cement are produced; as for 2009 AITEC, the national cement association, has characterised the national production as follows: 73% is CEM II (Portland composite cement); 13.3% is CEM IV (pozzolanic cement); 7.9% is CEM I (ordinary Portland Cement) and 4.6% is CEM III (blastfurnace cement). Clinker production has been decreasing since 2007 (about 10% in 2008 compared to 2007; about 19% in 2009 compared to 2008).

To estimate emissions from cement production, activity data on clinker/cement production are used as provided by ISTAT (ISTAT, several years). Emission factor for PM10 emissions is equal to 130 g/Mg of cement for the whole time series and is calculated on the basis of plants emission data in the ninety's years.

Regarding SO<sub>2</sub> emissions, emission factors are derived from activity and emission data supplied directly by the plants in the context of the EPER/E-PRTR registry; these figures are available from 2003 and refer both to the combustion and process. In 2003, the total average emission factor derived from the communications by the production plants was equal to 650 g/t; this value has been split into 350 g/t for the combustion and 300 g/t for the process in accord with the default EF reported in the IPCC 96 guidelines. Both these values have been also used for previous years of the time series back to 1995. For the years from 1990 to 1994, the same EF has been used for the combustion process while for estimating emissions from the process an EF equal to 500 g/t, as suggested by the EMEP/CORINAIR Guidebook, has been used in consideration of the S content in the prevalent fuel used in the process (coal) at national scale. From 2004 onwards, the total SO<sub>2</sub> EF from cement production plants has been calculated on the basis of EPER/E-PRTR registry, setting the EF for process at 300 g/t and varying the combustion EF accordingly (EF Tot = EF Proc + EF comb).

The remaining categories of mineral products industry represent less than 1% for each pollutant except *road paving with asphalt* (2A6) that accounts for 1.3% of PM10 emissions.

### ***Chemical industry (2B)***

Emissions from categories of this sector are often negligible. Emission factors derive from data collected in the framework of the EPER/E-PRTR registry as well as from EMEP/EEA and EPA Guidebook.

As already mentioned, *other chemical industry* (2B5a) was key category for Hg emissions in 1990. Hg emissions refer to chlorine production with mercury cells process (EUROCHLOR, 1998). Total chlorine production in Italy amounted, in 1990, to 1,042,921 tonnes and reduced in 2009 to 303,728 tonnes. Activity production data are supplied by the National Institute of Statistics (ISTAT) and published in the official national statistics and from 2002 data are also collected at plant level in the EPER/E-PRTR registry framework. To estimate emissions from 1990 to 2001, the average emission factor supplied by EUROCHLOR for western Europe chlor-alkali production plants (EUROCHLOR, 2001) has been used, while from 2002 emission data have been supplied directly from the production plants in the framework of the EPER/E-PRTR. The average emission factor decreased from 1.11 g Hg/t in 2002 to 0.45 g Hg/t in 2009. The reduction observed in emissions for

the last years is mainly a consequence of the conversion of production plants from the mercury cells process to the membrane technology (Legambiente, 2007).

### ***Metal production (2C)***

The main activities in this sector are those regarding the *iron and steel* production.

The main processes involved in iron and steel production are those related to sinter and blast furnace plants, to basic oxygen and electric furnaces and to rolling mills. The sintering process is a pre-treatment step in the production of iron where fine particles of metal ores are agglomerated. Agglomeration of the fine particles is necessary to increase the passageway for the gases during the blast furnace process and to improve physical features of the blast furnace burden. Coke and a mixture of sinter, lump ore and fluxes are introduced into the blast furnace. In the furnace the iron ore is increasingly reduced and liquid iron and slag are collected at the bottom of the furnace, from where they are tapped. The combustion of coke provides both the carbon monoxide (CO) needed for the reduction of iron oxide into iron and the additional heat needed to melt the iron and impurities.

The resulting material, pig iron (and also scrap), is transformed into steel in subsequent furnaces which may be a basic oxygen furnace (BOF) or electric arc furnace (EAF).

Oxygen steelmaking allows the oxidation of undesirable impurities contained in the metallic feedstock by blowing pure oxygen. The main elements thus converted into oxides are carbon, silicon, manganese, phosphorus and sulphur.

In an electric arc furnace steel is produced from polluted scrap. The scrap is mainly produced by cars shredding and does not have a constant quality.

The iron and steel cycle is closed by rolling mills with production of long products, flat products and pipes.

In 1990, there were four integrated iron and steel plants in Italy. In 2009, there are only three of the above mentioned plants, one of which lacks sintering facilities, and oxygen steel production represents about 29% of the total production and the arc furnace steel the remaining 71% (FEDERACCAI, several years). Currently, long products represent about 50% of steel production in Italy, flat products about 40% and pipes the remaining 10%. Almost the whole flat production derives from one only integrated iron and steel plant while, in steel plants equipped with electric ovens, almost all located in the northern regions, long products are produced (e.g carbon steel, stainless steels) and seamless pipes (only one plant) (FEDERACCAI, 2008).

Basic information for Iron and steel production derives from different sources in the period 1990-2009.

Activity data are supplied by official statistics published in the national statistics yearbook (ISTAT, several years) and by the sectoral industrial association (FEDERACCAI, several years).

For the integrated plants, emission and production data have been communicated by the two largest plants for the years 1990-1995 in the framework of the CORINAIR emission inventory, distinguished by sinter, blast furnace and BOF, and by combustion and processes emissions. From 2000 production data have been supplied by all the plants in the framework of the ETS scheme, for the years 2000-2004 disaggregated for sinter, blast furnace and BOF plants, from 2005 specifying carbonates and fuels consumption. For 2002-2009 data have also been supplied by all the four integrated iron and steel plants in the framework of the European EPER/E-PRTR registry not distinguished for combustion and processes. Qualitative information and documentation available on the plants allowed reconstructing their history including closures or modifications of part of the plants; additional qualitative information regarding the plants collected and checked for other environmental issues or directly asked to the plant permitted to individuate the main driving of the

emission trends for pig iron and steel productions. Emissions from lime production in steel making industries are reported in 1A2 Manufacturing Industries and Construction category.

In 2009, *iron and steel sector* (2C1) is key category for PM10, Pb, Cd, Hg, PAH, PCDD/PCDF and PCB. In Table 4.1 relevant emission factors are reported.

		PM10 [g/Mg]	Cd [mg/Mg]	Hg [mg/Mg]	Pb [mg/Mg]	PCB [mg/Mg]	PAH [mg/Mg]	PCDD/PCD F [µg T- eq/Mg]
Blast furnace charging		60						
Pig iron tapping		41.4	0.3	0.3	15		3450	
Basic oxygen furnace	<i>Areal</i>	62	25	3	850	3.6		
	<i>Point</i>	122	25	3	850	3.6		
Electric arc furnace		124	50	150	3450	3.6	1.9	4.45
	<i>Areal</i>	59					125	
Rolling mills	<i>Point</i>	28.2					125	
Sinter plant (except combustion)		16						

**Table 4.1 Emission factors for iron and steel for the year 2009**

PM10 emission factors for integrated plants derive from personal communication of the largest Italian producer of pig iron and steel (ILVA, 1997) while PM10 emission factor for electric arc furnace derives from a sectoral study (APAT, 2003). The Emission factors manual PARCOM-ATMOS (TNO, 1992), the EMEP/Corinair Guidebook (EMEP/CORINAIR, 2006) and the IPPC Bref Report (IPPC, 2001) provide emission factors for heavy metals while a sectoral study (APAT, 2003) provides Cd emission factors for electric arc furnace.

Regarding POPs emissions, emission factors usually originate from EMEP/CORINAIR (EMEP/CORINAIR, 2007, EMEP/CORINAIR, 2006) except those relating to PAH and PCDD/PCDF from electric arc furnace that derive from direct measurements in some Italian production plants (ENEA-AIB-MATT, 2002).

As for other iron and steel activities, a series of technical meetings with the most important Italian manufacturers was held in the framework of E-PRTR in order to clarify methodologies for estimating POPs emissions. The analysis of data supplied by Industry is still ongoing and improvements in emission estimates are expected for the next year.

Emission factors used in 1990 estimates generally derive from Guidebook EMEP/CORINAIR.

The remaining categories of metal production industry represent less than 1% for each pollutant except Aluminium production (2C3) that accounts for 1.7% of SO<sub>2</sub> emissions.

### ***Other production (2D - 2G)***

In 2D sector, non-energy emissions from *pulp and paper* as well as *food and drink* production,

especially wine and bread, are reported. Lead emissions from *batteries manufacturing* can be found in 2G sector.

Emissions from these categories are usually negligible except NMVOC emissions from *food and drink* (2D2) that represent a key source for this pollutant. Emissions from this category refer to the processes in the production of bread, wine, beer and spirits. Activity data are derived from official statistics supplied by the National Institute of Statistics (ISTAT) and relevant industrial associations. Emission factors are those reported in the EMEP/CORINAIR guidebook and, in lack of national information, they are assumed constant for the whole time series (CORINAIR, 1994; EMEP/CORINAIR, 2006).

### 4.3 Time series and key categories

The following sections present an outline of the main key categories, and relevant trends, in the industrial process sector. Table 4.2 reports the key categories identified in the sector.

	2A1	2A2	2A4	2A5	2A6	2B1	2B2	2B3	2B5a	2C1	2C2	2C3	2D1	2D2	2G
	%														
<b>SO<sub>x</sub></b>	4.7					0.003			2.6	0.1	0.001	1.7	0.01		
<b>NO<sub>x</sub></b>						0.04	0.03	0.002	0.2	0.2	2.E-4	0.1	0.004		
<b>NH<sub>3</sub></b>			0.03			0.003	0.001		0.04						
<b>NMVOC</b>				0.002	0.7	0.01			0.3	0.3		0.01	0.1	2.6	
<b>CO</b>			0.4			0.002			0.4	1.8	0.003	0.9			
<b>PM10</b>	2.7	0.8		0.1	1.3				0.4	2.8	0.02	0.2		0.01	
<b>PM2.5</b>	0.5	0.1		0.01	0.2				0.2	2.73	0.01	0.1		0.001	
<b>Pb</b>										25.4					0.9
<b>Cd</b>									1.0	13.5		0.3			
<b>Hg</b>									1.8	27.0					
<b>PAH</b>										20.3		0.1			
<b>Dioxin</b>										26.7					
<b>HCB</b>															
<b>PCB</b>										38.0					

Note: blue shaded are key categories

**Table 4.2 Key categories in the industrial processes sector in 2009**

There is a general reduction of emissions in the period 1990 - 2009 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. In 2009, a further drop of the sectoral emissions is due to the decrease of production levels to the economic crisis.

#### *Mineral products (2A)*

As above mentioned, PM10 emission factor for cement production is constant from 1990 to 2009. Consequently, PM10 emissions trend follows that of the activity data.

In Table 4.3, activity data and PM10 emissions from Cement production are reported.

	1990	1995	2000	2005	2006	2007	2008	2009
Activity data [Gg]	29,786	28,778	29,816	33,122	33,210	33,742	31,119	25,259
PM10 emissions [Gg]	5.5	4.6	5.3	6.1	6.2	6.1	5.5	4.7

**Table 4.3 Activity data and PM10 emissions from Cement production, 1990 – 2009 (Gg)**

### **Chemical industry (2B)**

*Other chemical industry* (2B5a) was a key category for Hg emissions in 1990. Hg emissions refer to chlorine production with mercury cells process, in Table 4.4, activity data and Hg emissions from chlorine production are reported. As reported in paragraph 4.1, to estimate emissions from 1990 to 2001, the average emission factor supplied by EUROCHLOR for western Europe chlor-alkali production plants has been used, while from 2002 emission data have been supplied directly from the production plants in the framework of the EPER/E-PRTR. The average emission factor decreased from 1.11 g Hg/t in 2002 to 0.45 g Hg/t in 2009. The reduction observed in emissions for the last years is mainly a consequence of the conversion of production plants from the mercury cells process to the membrane technology.

	1990	1995	2000	2005	2006	2007	2008	2009
Activity data [Gg]	1043	869	786	535	566	474	368	304
Hg emissions [Mg]	2.8	1.7	0.9	0.5	0.5	0.3	0.2	0.1

**Table 4.4 Activity data and Hg emissions from chlorine production, 1990 – 2009**

### **Metal production (2C)**

Emission trend of HM, PCB and PCDD/PCDF is driven mainly by the electric arc furnaces iron and steel production which increased from 15.1 Mt in 1990 to 19.6 Mt in 2008; in 2009, because of the economic crisis, steel production from electric arc has decreased substantially.

In Table 4.5, activity data and HM, PCB and PCDD/PCDF emissions from electric arc furnace (EAF) and from the whole sector 2C1 are reported.

	1990	1995	2000	2005	2006	2007	2008	2009
Steel production <b>EAF</b> [Mt]	15,102	16,107	15,879	17,661	19,730	19,922	19,627	14,001
Cd emissions <b>EAF</b> [Mg]	1.1	1.1	0.8	0.9	1.0	1.0	1.0	0.7
Cd emissions <b>2C1</b> [Mg]	1.3	1.4	1.1	1.2	1.3	1.3	1.3	0.8
Hg emissions <b>EAF</b> [Mg]	2.3	2.4	2.4	2.6	3.0	3.0	2.9	2.1
Hg emissions <b>2C1</b> [Mg]	2.3	2.5	2.4	2.7	3.0	3.0	3.0	2.1
Pb emissions <b>EAF</b> [Mg]	52.1	55.6	54.8	60.9	68.1	68.7	67.7	48.3
Pb emissions <b>2C1</b> [Mg]	61.1	65.7	64.1	71.0	78.4	78.8	77.2	53.4
PCB emissions <b>EAF</b> [kg]	54.4	58.0	57.2	63.6	71.0	71.7	70.7	50.4
PCB emissions <b>2C1</b> [kg]	91.7	100.0	95.8	105.7	113.8	113.6	110.1	71.5
PCDD/PCDF emissions <b>EAF</b> [µg T-eq]	67.2	71.7	70.7	78.6	87.8	88.7	87.3	62.3
PCDD/PCDF emissions	67.2	71.7	70.7	78.6	87.8	88.7	87.3	62.3

	1990	1995	2000	2005	2006	2007	2008	2009
2C1 [µg T-eq]								

**Table 4.5 Activity data and HM, PCB and PCDD/PCDF emissions from electric arc furnace, 1990 – 2009**

For Pb and Hg, the same EFs have been used for the whole time series (derived by the EMEP/CORINAIR Guidebook), while for Cd a national emission factor, equal to 50 mg/t, was available thanks to a sectoral study (APAT, 2003) and refers to the years after 1997.

This study shows range < 1-54 mg/t and the value set to 50 mg/t was chosen for conservative reason being more consistent with the old one; this value should include technology progresses occurred in the iron and steel production activities in those years. In lack of information for the years backwards, the default CORINAIR EF was used.

For PCB and PCDD/PCDF, emission factors are constant from 1990 to 2009 and emission trends are ruled by activity data.

Emission trend of PAH is driven mainly by iron and steel production of integrated plants which increased from 1990 to 2008, while in 2009, because of the economic crisis, iron and steel production from integrated plants has decreased substantially.

In Table 4.6, activity data and PAH emissions from integrated plants and from the whole sector 2C1 are reported.

	1990	1995	2000	2005	2006	2007	2008	2009
Pig iron production [Mt]	11,852	11,678	11,209	11,424	11,497	11,111	10,441	5,692
Steel production BOF [Mt]	10,365	11,664	10,744	11,688	11,894	11,630	10,963	5,847
PAH emissions i. p.* [Mg]	44.3	43.9	42.3	43.7	44.4	43.0	40.5	24.1
PAH emissions 2C1 [Mg]	44.4	44.0	42.3	43.7	44.4	43.1	40.5	24.1

\*i. p.: integrated plants

**Table 4.6 Steel production data and PAH emissions from integrated plants, 1990 – 2009**

#### ***Other production (2D-2G)***

Emissions from this category refer to the processes in the production of bread, wine, beer and spirits. Emission factors are assumed constant for the whole time series. In Table 4.7, activity data and NMVOC emissions from sector 2D are reported.

	1990	1995	2000	2005	2006	2007	2008	2009
Activity data - Bread [Gg]	4,153	3,882	3,565	4,109	4,489	4,787	4,516	4,615
Activity data – Wine [10 <sup>6</sup> dm <sup>3</sup> ]	5,521	5,620	5,409	5,057	4,963	4,256	4,625	4,542
Activity data – Beer [10 <sup>6</sup> dm <sup>3</sup> ]	1,215	1,199	1,258	1,280	1,282	1,346	1,327	1,278
Activity data – Spirits [10 <sup>6</sup> dm <sup>3</sup> ]	268	232	206	161	180	118	80	127
NMVOC emissions [Gg]	31.7	29.2	26.8	27.5	29.8	28.6	26.2	28.3

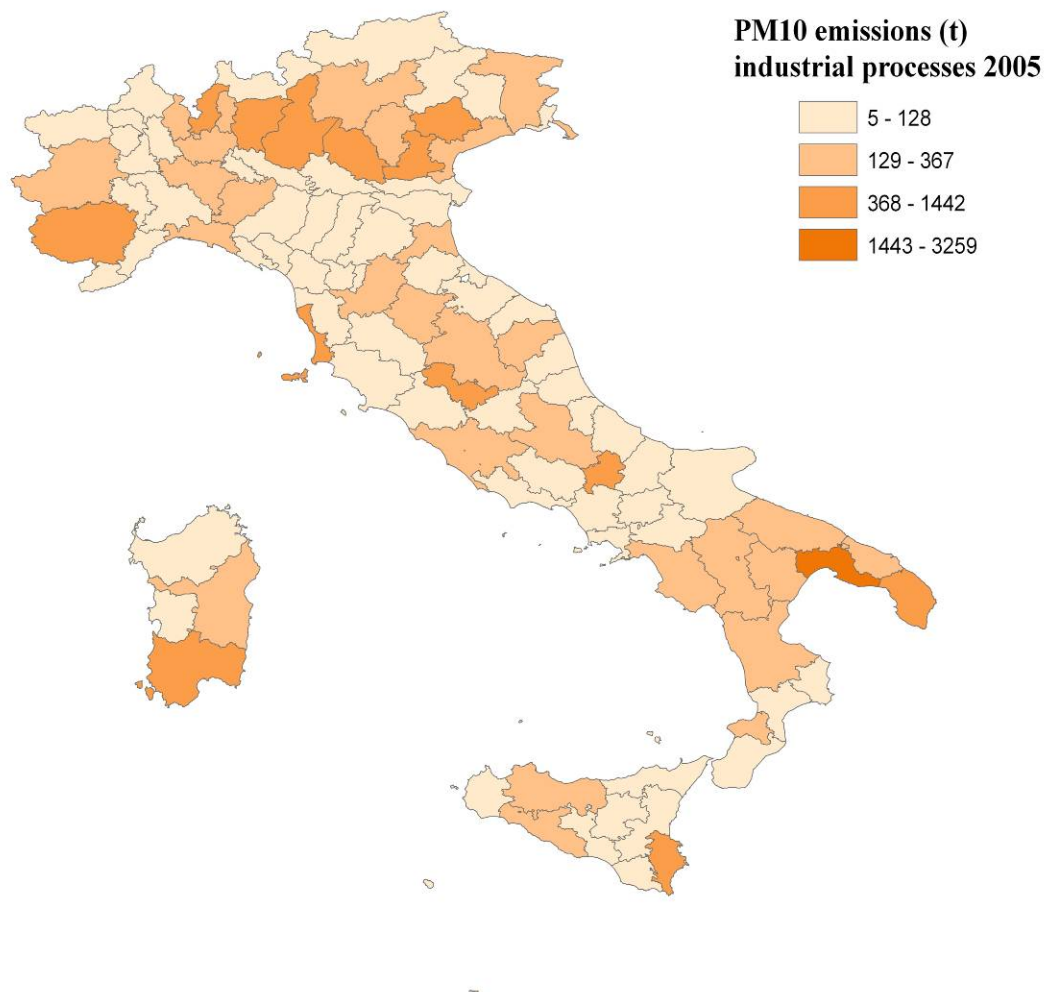
**Table 4.7 Activity data and NMVOC emissions from sector 2D**

#### **4.4 QA/QC and verification**

Activity data and emissions reported under EU-ETS and EPER/EPRTTR are compared to the information provided by the industrial associations. The general outcome of this verification step shows consistency among the information collected under different legislative framework and

information provided by the relevant industrial associations.

Every five years emissions are disaggregated at regional and provincial level and figures are compared with results obtained by regional bottom up inventories. PM10 emissions disaggregated at local level are also used as input for air quality modelling. The distribution of PM10 emissions from the *industrial processes* sector at NUTS3 level (ISPRA, 2009) for 2005 is reported in Figure 4.1.



**Figure 4.1** PM10 emissions from *industrial processes* in 2005 (t)

## **4.5 Recalculations**

### ***Mineral products (2A)***

In 2011, no recalculations have occurred.

### ***Chemical industry (2B)***

Recalculations occurred as, in the current submission, SO<sub>2</sub> emission factor regarding *sulphuric acid production* has been updated from 2002 to 2008 and because of activity data and Hg emission

factor regarding *chlorine production* have been updated on the basis of producers' communication.

#### ***Metal production (2C)***

Recalculations in the sector have been done because iron and steel activity data for 1991-1995, 2008, activity data from aluminium production since 2000 and ferroalloys activity data since 2002 have been updated.

Additional data supplied by the integrated iron and steel plants allowed to improve 2008 estimates and activity data relative to early nineties have been compared and checked with old database CORINAIR recovering useful data.

Activity data from primary aluminium and ferroalloys production have been updated since 2000 and 2002 on the basis of new information derived from ETS and personal communication while Hg emission factor for ferroalloys has been updated from 1990 to 2006 on the basis of producer communication in the framework of E-PRTR registry.

#### ***Other production (2D-2G)***

In 2011, no meaningful recalculations have occurred.

### **4.6 Planned improvements**

As above mentioned, a series of technical meetings with the most important Italian manufacturers was held in the framework of E-PRTR in order to clarify methodologies for estimating POPs emissions. The analysis of data supplied by industry is still ongoing and improvements in emission estimates are expected for the next year.



## 5 Solvent and other product use (NFR SECTOR 3)

### 5.1 Overview of the sector

In the sector all non combustion emissions from other industrial sectors than manufacturing and energy industry are reported.

Emissions are related to the use of solvent in paint application, degreasing and dry cleaning, chemical products, manufacture and processing and other solvent use.

NMVOC emissions are estimated from all the categories of the sector as well as PM for polyester and polyvinylchloride processing, in the chemical product category, and PAH emissions from the preservation of wood in the other solvent use.

The categories included in the sector are specified in the following.

3A1 *Decorative coating* includes emissions from paint application for construction and buildings, domestic use and wood products.

3A2 *Industrial coating* includes emissions from paint application for manufacture of automobiles, car repairing, coil coating, boat building and other industrial paint application.

3B1 *Degreasing* includes emissions from the use of solvents for metal degreasing and cleaning.

3B2 *Dry cleaning* includes emissions from the use of solvent in cleaning machines.

3C *Chemical products, manufacture and processing* covers the emissions from the use of chemical products such as polyurethane and polystyrene foam processing, manufacture of paints, inks and glues, textile finishing and leather tanning.

3D1 *Printing* includes emissions from the use of solvent in the printing industry

3D2 *Domestic solvent use* includes emissions from the use of solvent in household cleaning and car care products as well as cosmetics.

3D3 *Other product use* addresses emissions from glass wool enduction, fat, edible and non-edible oil extraction, preservation of wood, application of glues and adhesives, vehicles dewaxing.

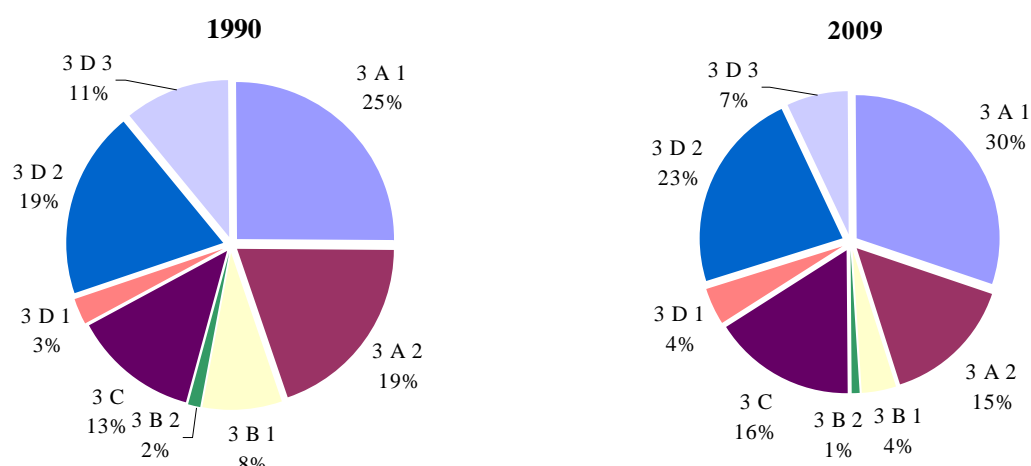
No other emissions from the sector occur.

NMVOC emissions from 3A1, 3A2, 3C, 3D2 and 3D3 are key categories in 2009; the same categories were also key categories in 1990. Concerning the trend 1990-2009, 3A1, 3D2 and 3C result as key categories.

The sector accounts, in 2009, for 41% of total national NMVOC emissions, whereas in 1990 the weight out of the total was equal to 30%. Total NMVOC emissions of the sector decreased by 24.6% between 1990 and 2009.

PM and PAH are also estimated but they account for less than 0.1%.

In Figure 5.1 the share of NMVOC emissions of the sector is reported for the years 1990 and 2009.



**Figure 5.1 Share of NMVOC emissions for the solvent use sector in 1990 and 2009**

## 5.2 Methodological issues

The sector is characterized by a multitude of activities which implies 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 has been collected even though improvements are still needed especially in some areas.

Emissions of NMVOC from solvent use have been estimated according to the methodology reported in the EMEP/CORINAIR guidebook, applying both national and international emission factors (Vetrella, 1994; EMEP/CORINAIR, 2007). Country specific emission factors provided by several accredited sources have been used extensively, together with data from the national EPER Registry; in particular, for paint application (Offredi, several years; FIAT, several years), solvent use in dry cleaning (ENEA/USLRMA, 1995), solvent use in textile finishing and in the tanning industries (Techne, 1998; Regione Toscana, 2001; Regione Campania, 2005; GIADA 2006). Basic information from industry on percentage reduction of solvent content in paints and other products has been applied to EMEP/CORINAIR emission factors in order to evaluate the reduction in emissions during the considered period.

In the following, a more detailed description is reported for the key categories of NMVOC emissions.

### *Decorative coating (3A1)*

The category includes NMVOC emissions from the application of paint for construction and buildings, domestic use and wood products.

Activity data on the consumption of paint for construction and buildings and related domestic use are provided by the Ministry of Productive Activities for 1990 and 1991 (MICA, 1999) and updated on the basis of production figures provided annually by the National Institute of Statistics (ISTAT, several years).

As for the emission factors, those for construction and buildings are taken from the EMEP/EEA guidebook and considered constant for the all period, whereas the default values for domestic use vary in consideration of the different share between solvent and water content in paint throughout the years.

On the other hand, information on activity data and emission factors for emissions from wood products are provided by the national association of wood finishing (Offredi, several years).

### ***Industrial coating (3A2)***

The category includes emissions from paint application for manufacture of automobiles, car repairing, coil coating, boat building and other industrial paint application.

Activity data on the consumption of paint for manufacture of automobiles are provided by the National Automobile Association (ACI, several years) in the Annual Statistical Report and the emission factors are those reported by the main automobile producers on the relevant activity in their environmental reports and communicated from 2003 in the framework of E-PRTR.

For the paint used in car repairing, activity data are provided by the Ministry of Productive Activities for 1990 and 1991 (MICA, 1999) and updated on the basis of production figures provided annually by the National Institute of Statistics (ISTAT, several years). Emission factors are those provided by the EMEP guidebook considering different shares between solvent and water based paint throughout the years.

Concerning coil coating, boat building and other industrial paint application, activity data are provided by the Ministry of Productive Activities for 1990 and 1991 (MICA, 1999) and updated annually by the National Institute of Statistics (ISTAT, several years). Emission factors are taken from the EMEP guidebook considering the national legislation where relevant.

### ***Chemical products, manufacture and processing (3C)***

The category comprises emissions from the use of chemical products such as polystyrene, polyurethane, polyvinylchloride and polystyrene foam processing, manufacture of paints, inks and glues, textile finishing and leather tanning.

Activity data for polystyrene and polyurethane are derived from the relevant industrial associations, and ISTAT (ISTAT, several years), whereas emission factors are from the EMEP/CORINAIR guidebook. As for polyvinylchloride, activity data and emission factors are supplied in the framework of EPRTR. For the other categories, activity data are provided by the relevant industrial associations and by ISTAT, while emission factors are taken from the EMEP/CORINAIR guidebook considering national information on the solvent content in products supplied by the specific industrial associations.

### ***Domestic solvent use (3D2)***

The category comprises a lot of subcategories which emissions, specifically NMVOC, originate from use of solvent in household cleaning and car care products as well as cosmetics.

Emissions from this category have been calculated using a detailed methodology, based on VOC content per type of consumer product.

As regards household and car care products, information on VOC content and activity data has been supplied by the Sectoral Association of the Italian Federation of the Chemical Industry (Assocasa, several years) and by the Italian Association of Aerosol Producers (AIA, several years [a] and [b]). As regards cosmetics and toiletries, basic data have been supplied by the Italian Association of Aerosol Producers too (AIA, several years [a] and [b]) and by the national Institute of Statistics and industrial associations (ISTAT, several years [a], [b], [c] and [d]; UNIPRO, several years); emission factors time series have been reconstructed on the basis of the information provided by the European Commission (EC, 2002).

### ***Other product use (3D3)***

The category includes NMVOC emissions from the application of glues and adhesives, which account for about 90% of the emission from the category, emissions from fat, edible and non edible oil extraction and minor emissions from glass wool induction.

Activity data and emission factors for the application of glues and adhesives are provided by the relevant industrial association up to 2004. After that period, the update of activity data is on the basis of information by ISTAT (ISTAT, several years) whereas the emission factor is considered constant in absence of further information.

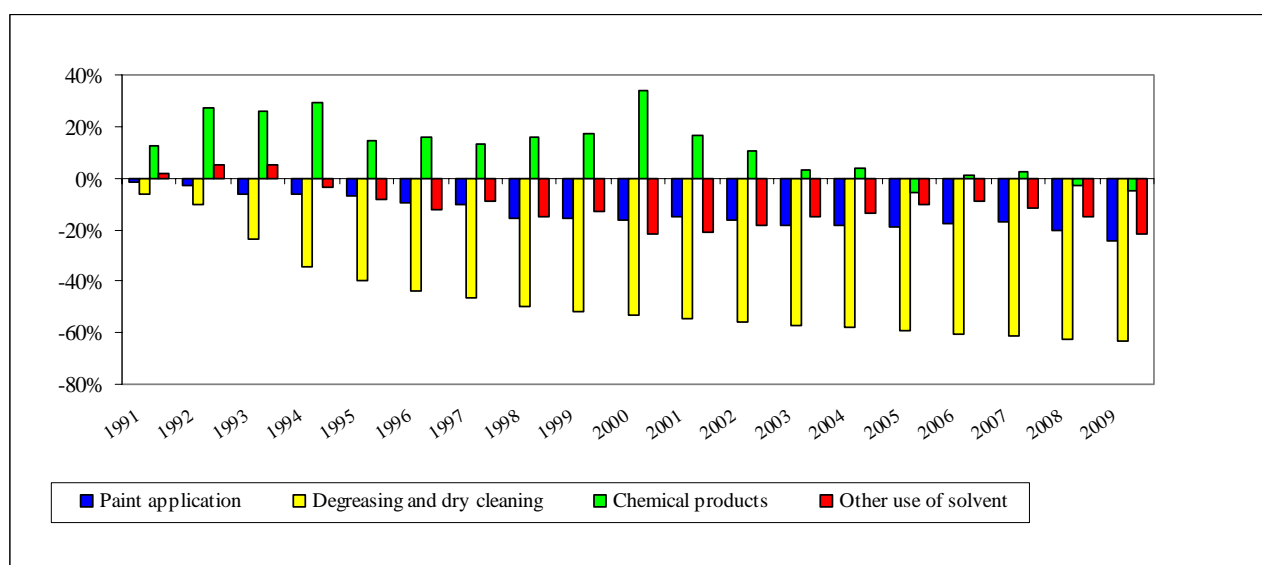
For fat, edible and non edible oil extraction activity data derive from the FAOSTAT database (<http://faostat.fao.org>) whereas default emission factors do not change over the period.

### 5.3 Time series and key categories

The sector accounts, in 2009, for 41% of total national NMVOC emissions, whereas in 1990 the weight out of the total was equal to 30%. PM and PAH are also estimated in this sector but they account for less than 0.1%.

NMVOC emissions from the sector decreased from 1990 to 2009 of about 25%, from 604 Gg in 1990 to 456 Gg in 2009, mainly due to the reduction of emissions in industrial coating applications, in degreasing and dry cleaning and in other product use. The general reduction observed in the emission trend of the sector is due to the implementation of the European Directive 1999/13/EC (EC, 1999) on the limitation of emissions of volatile organic compounds due to the use of organic solvents, entered into force in Italy in January 2004, and the European Directive 2004/42/EC (EC, 2004), entered in force in Italy in March 2006, which establishes a reduction of the solvent content in products.

Figure 5.2 shows emission trends from 1991 to 2009 with respect to 1990 by sub-sector.



**Figure 5.2** Trend of NMVOC emissions from 1991 to 2009 as compared to 1990

Table 5.1 represents the pollutants estimated in the sector and the key categories identified.

The main source of emissions is *paint application* where NMVOC emissions derive mainly from construction and building and wood application. The second source of emissions is *domestic solvent use*, mostly for the consumption of cosmetics, followed by *chemical products and other product use*, especially for emissions from polyurethane processing, paints manufacturing and leather tanning.

	3A1	3A2	3B1	3B2	3C	3D1	3D2	3D3
	%							
SO <sub>x</sub>								
NO <sub>x</sub>								
NH <sub>3</sub>								
NMVOC	12.42	6.12	1.60	0.30	6.65	1.76	9.52	2.82
CO								
PM <sub>10</sub>					0.01			
PM <sub>2.5</sub>					0.01			
Pb								
Cd								
Hg								
PAH							0.01	
Dioxin								
HCB								
PCB								

Note: blue shaded are key categories

**Table 5.1 Key categories in the solvent and other product use sector in 2009**

In Table 5.2 and 5.3 respectively activity data and emission factors used to estimate emissions from the sector are reported at SNAP code level.

A strong decrease in the content of solvents in the products in the ninety years is observed.

			1990	1995	2000	2005	2006	2007	2008	2009
<b>06 01</b>	<b>Paint application</b>									
06 01 01	Paint application : manufacture of automobiles	<i>vehicles</i>	2,850,993	2,511,971	2,754,968	1,744,755	1,926,234	1,988,207	1,676,036	1,330,501
06 01 02	Paint application : car repairing	<i>Mg paint</i>	22,250	17,850	24,276	23,475	24,422	25,417	23,184	19,320
06 01 03	Paint application : construction and buildings (except item 06.01.07)	<i>Mg paint</i>	111,644	120,736	125,928	163,455	173,907	174,033	160,558	163,455
06 01 04	Paint application : domestic use (except 06.01.07)	<i>Mg paint</i>	420,000	420,000	420,000	420,000	420,000	420,000	420,000	420,000
06 01 05	Paint application : coil coating	<i>Mg paint</i>	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500
06 01 06	Paint application : boat building	<i>Mg paint</i>	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
06 01 07	Paint application : wood	<i>Mg paint</i>	150,000	150,000	140,000	140,000	145,000	145,000	145,000	123,250
	Other industrial paint application	<i>Mg paint</i>	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000
<b>06 02</b>	<b>Degreasing, dry cleaning and electronics</b>									
06 02 01	Metal degreasing	<i>Mg solvents</i>	52,758	32,775	25,895	22,237	21,569	20,922	20,295	19,686
06 02 02	Dry cleaning	<i>machines</i>	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
<b>06 03</b>	<b>Chemical products manufacturing or processing</b>									
06 03 01	Polyester processing	<i>Mg product</i>	179,852	197,882	168,704	112,188	118,767	122,985	116,068	78,279
06 03 02	Polyvinylchloride processing	<i>Mg product</i>	617,600	575,600	405,285	348,497	316,296	318,225	296,993	77,559
06 03 03	Polyurethane processing	<i>Mg product</i>	145,700	230,633	350,187	175,278	201,400	210,148	196,585	196,585
06 03 04	Polystyrene foam processing (c)	<i>Mg product</i>	85,004	80,400	90,200	35,200	36,900	35,300	32,800	28,100
06 03 05	Rubber processing	<i>Mg product</i>	671,706	700,859	810,124	831,187	827,947	858,731	789,871	637,105
06 03 06	Pharmaceutical products manufacturing	<i>Mg product</i>	80,068	88,094	104,468	106,861	111,666	104,041	104,250	109,760
06 03 07	Paints manufacturing	<i>Mg product</i>	697,129	747,417	900,683	964,631	1,008,765	1,028,580	969,135	885,049
06 03 08	Inks manufacturing	<i>Mg product</i>	87,527	110,667	132,256	132,521	129,611	140,060	136,224	123,388
06 03 09	Glues manufacturing	<i>Mg product</i>	111,683	266,169	302,087	315,016	315,016	315,016	315,016	315,016
06 03 12	Textile finishing	<i>1000 m2</i>	1,332,679	1,301,105	1,173,047	987,705	1,024,070	1,044,012	899,727	730,244
06 03 13	Leather tanning	<i>1000 m2</i>	173,700	183,839	200,115	157,891	169,897	168,697	159,892	172,995
<b>06 04</b>	<b>Other use of solvents and related activities</b>									
06 04 01	Glass wool enduction	<i>Mg product</i>	105,029	119,120	139,421	129,958	153,254	158,264	136,768	68,228
06 04 03	Printing industry	<i>Mg ink</i>	73,754	91,667	100,690	111,550	111,550	111,550	111,550	111,550
06 04 04	Fat, edible and non edible oil extraction	<i>Mg product</i>	5,327,560	7,348,480	6,965,380	9,466,060	7,493,497	7,324,272	7,347,039	7,683,754
06 04 05	Application of glues and adhesives	<i>Mg product</i>	98,500	234,751	266,996	278,495	278,495	278,495	278,495	278,495
06 04 08	Domestic solvent use (other than paint application)(k)	<i>Mg product</i>	1,938,779	2,282,020	2,410,338	2,767,759	2,790,264	2,717,561	2,723,252	2,592,907
06 04 09	Vehicles dewaxing	<i>vehicles</i>	2,540,597	1,740,212	2,361,075	2,238,344	2,353,249	2,514,905	2,193,570	2,177,601

**Table 5.2 Activity data in the solvent and other product use sector**

			1990	1995	2000	2005	2006	2007	2008	2009
<b>06 01</b>	<b>Paint application</b>									
06 01 01	Paint application : manufacture of automobiles	<i>g/vehicles</i>	8,766	6,361	4,884	4,117	4,003	3,903	3,299	2,911
06 01 02	Paint application : car repairing	<i>g/Mg paint</i>	700,000	700,000	605,500	605,500	605,500	605,500	605,500	605,500
06 01 03	Paint application : construction and buildings (except item 06.01.07)	<i>g/Mg paint</i>	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
06 01 04	Paint application : domestic use (except 06.01.07)	<i>g/Mg paint</i>	126,450	113,100	99,750	99,750	99,750	99,750	99,750	99,750
06 01 05	Paint application : coil coating	<i>g/Mg paint</i>	200,000	200,000	10,000	10,000	10,000	10,000	10,000	10,000
06 01 06	Paint application : boat building	<i>g/Mg paint</i>	750,000	750,000	622,500	502,500	502,500	502,500	502,500	502,500
06 01 07	Paint application : wood	<i>g/Mg paint</i>	446,500	425,000	406,300	390,750	377,250	377,250	377,250	377,250
	Other industrial paint application	<i>g/Mg paint</i>	530,000	530,000	439,900	376,300	376,300	376,300	376,300	376,300
<b>06 02</b>	<b>Degreasing, dry cleaning and electronics</b>									
06 02 01	Metal degreasing	<i>g/Mg solvents</i>	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000
06 02 02	Dry cleaning	<i>g/machines</i>	306,000	154,000	103,000	103,000	103,000	103,000	103,000	103,000
<b>06 03</b>	<b>Chemical products manufacturing or processing</b>									
06 03 01	Polyester processing	<i>g/Mg product</i>	325	325	325	325	325	325	325	325
06 03 02	Polyvinylchloride processing	<i>g/Mg product</i>	0	0	0	0	0	0	0	0
06 03 03	Polyurethane processing	<i>g/Mg product</i>	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000
06 03 04	Polystyrene foam processing (c)	<i>g/Mg product</i>	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000
06 03 05	Rubber processing	<i>g/Mg product</i>	12,500	10,000	8,000	8,000	8,000	8,000	8,000	8,000
06 03 06	Pharmaceutical products manufacturing	<i>g/Mg product</i>	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000
06 03 07	Paints manufacturing	<i>g/Mg product</i>	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000
06 03 08	Inks manufacturing	<i>g/Mg product</i>	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
06 03 09	Glues manufacturing	<i>g/Mg product</i>	20,000	5,041	3,603	2,806	2,806	2,806	2,806	2,806
06 03 12	Textile finishing	<i>g/1000 m2</i>	296	296	296	296	296	296	296	296
06 03 13	Leather tanning	<i>g/1000 m2</i>	150,000	150,000	125,000	110,000	110,000	110,000	110,000	110,000
<b>06 04</b>	<b>Other use of solvents and related activities</b>									
06 04 01	Glass wool enduction	<i>g/Mg product</i>	800	800	800	800	800	800	800	800
06 04 03	Printing industry	<i>g/Mg ink</i>	234,649	228,190	184,332	174,227	174,227	174,227	174,227	174,227
06 04 04	Fat, edible and non edible oil extraction	<i>g/Mg product</i>	752	713	703	719	724	721	720	754
06 04 05	Application of glues and adhesives	<i>g/Mg product</i>	600,000	151,230	108,086	84,190	84,190	84,190	84,190	84,190
06 04 08	Domestic solvent use (other than paint application)(k)	<i>g/Mg product</i>	60,117	52,262	42,356	46,117	46,859	46,141	46,048	43,246
06 04 09	Vehicles dewaxing	<i>g/vehicles</i>	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000

**Table 5.3 Emission factors in the solvent and other product use sector**

#### 5.4 QA/QC and verification

Data production and consumption time series for some activities (paint application in constructions and buildings, polyester processing, polyurethane processing, pharmaceutical products, paints manufacturing, glues manufacturing, textile finishing, leather tanning, fat edible and non edible oil extraction, application of glues and adhesives) are checked with data acquired by the National Statistics Institute (ISTAT, several years [a], [b] and [c]), the Sectoral Association of the Italian Federation of the Chemical Industry (AVISA, several years) and the Food and Agriculture Organization of the United Nations (FAO, several years). For specific categories, emission factors and emissions are also shared with the relevant industrial associations; this is particularly the case of paint application for wood, some chemical processes and anaesthesia and aerosol cans.

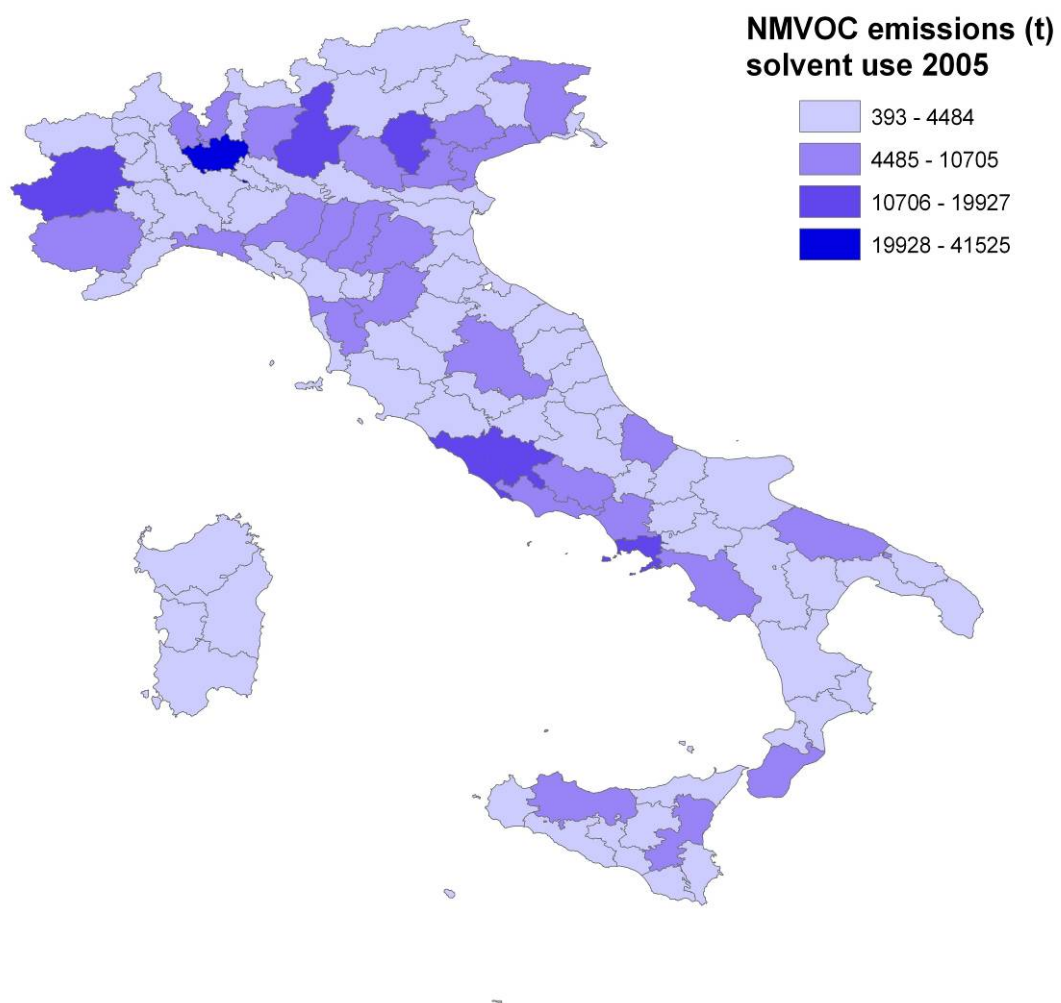
In the framework of the MeditAIRaneo project, ISPRA commissioned to Techne Consulting S.r.l. a survey to collect national information on emission factors in the solvent sector. The results, published in the report “*Rassegna dei fattori di emissione nazionali ed internazionali relativamente al settore solventi*” (TECHNE, 2004), have been used to verify and validate emission estimates. At the end of 2008, ISPRA commissioned to Techne Consulting S.r.l. another survey to compare emission factors with the last update published in the EMEP/CORINAIR guidebook (EMEP/EEA, 2009). The results are reported in “*Fattori di emissione per l'utilizzo di solventi*” (TECHNE, 2008) and have been used to update emission factors for polyurethane and polystyrene foam processing activities.

In addition, for paint application, data communicated from the industries in the framework of the EU Directive 2004/42, implemented by the Italian Legislative Decree 161/2006, on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products have been used as a verification of emission estimates. These data refer to the composition of the total amount of paints and varnishes (water and solvent contents) in different subcategories for interior and exterior use and the total amount of products used for vehicle refinishing and they are available from the year 2007.

Furthermore, every five years ISPRA carries out emission estimates at NUTS level which is the occasion of an additional check with local environmental agencies.

The distribution of NMVOC emissions from the *solvent and other product use* sector at NUTS3 level (ISPRA, 2009) for 2005 is reported in Figure 5.3.





**Figure 5.3** NMVOC emissions from *solvent and other product use* in 2005 (t)

## 5.5 Recalculations

In Table 5.4 the comparison of NMVOC emissions between the actual and previous submission is reported only for those years where recalculations actually occurred.

The main modifications involved category 3D for emissions from both domestic solvent use and fat edible and non edible oil extraction. Specifically, the time series from 1994 to 1998 and from 2005 to 2008 has been revised considering an updating of the apparent consumption of cosmetics and from 2006 also modifications of fat edible and non edible oil activity data. For emissions from category 3C, the only change regarded an update of polystyrene foam processing for 2008 on account of new information provided by the relevant industry.

NMVOC		
	3C. Chemical products	3D. Other
<b>1994</b>		-0.12%
<b>1995</b>		-0.71%
<b>1996</b>		-2.80%
<b>1997</b>		-1.07%
<b>1998</b>		-0.91%
<b>2005</b>		0.04%
<b>2006</b>		0.01%
<b>2007</b>		0.01%
<b>2008</b>	0.02%	-0.26%

**Table 5.4 Recalculations of NMVOC emissions between 2010 and 2009 submissions**

## 5.6 Planned improvements

Specific improvements will regard the improvement of emission factors for some relevant categories

## 6 Agriculture (NFR SECTOR 4)

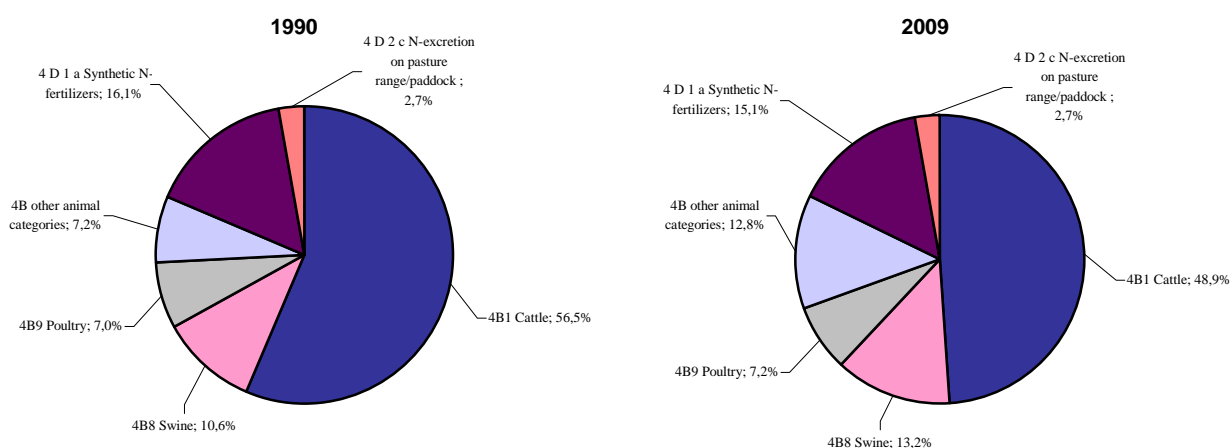
### 6.1 Overview of the sector

The agriculture sector is responsible for the largest part of NH<sub>3</sub> emissions, and contributes also to PM<sub>10</sub>, PM<sub>2.5</sub>, TSP, NMVOC, and CO emissions. Italy estimates agricultural emissions for manure management (4B), agricultural soils (4D), and field burning of agricultural wastes (4F) sources.

Last update of estimations for the agricultural emission inventory was performed on March 2011.

In 2009, key categories level were identified for NH<sub>3</sub> (4B1a, 4B1b, 4B2, 4B8, 4B9b, 4D1a) and for PM<sub>10</sub> (4B9b) emissions. In 1990 similar figures were obtained, however, for NH<sub>3</sub> emissions, 4B2 and 4B9b were not key categories. For the trend analysis, key categories were only related to NH<sub>3</sub> emissions (4B1a, 4B1b, 4B2, 4B8, 4B9d, 4D1a).

In 2009, NH<sub>3</sub> emissions from the agriculture sector were 370 Gg (95% of national emissions) where 4B and 4D categories represent 82% and 18% of total agricultural emissions. The trend of NH<sub>3</sub> from 1990 to 2009 shows a decrease of 19% due to reduction in the number of animals, cultivated surface/crop production, and use of synthetic N-fertilisers. A representation of the contribution by source of agriculture NH<sub>3</sub> emissions for 1990 and 2009 is shown in Figure 6.1.



**Figure 6.1 Share of NH<sub>3</sub> emissions in the agriculture sector for 1990 and 2009**

Agricultural official statistics are mainly collected from the National Institute of Statistics, ISTAT<sup>1</sup>. Most important activity data (number of animals, N-fertilizers, agricultural surface and production, milk production) are available on-line: <http://agri.istat.it/jsp/Introduzione.jsp>. ISTAT has a major role in the comprehensive collection of data through structural (such as the Farm Structure Survey, FSS) and conjunctural surveys, and the general agricultural census. For consistency reasons the same agricultural official statistics are used for UNFCCC and UNECE/CLRTAP emission inventory.

ISPRA participates to the Agriculture, Forestry, and Fishing Quality Panel, which has been established to monitor and improve national statistics. This is the opportunity to get in touch with experts from the Agriculture Service from ISTAT in charge for main agricultural surveys. In this way, data used for the inventory is continuously updated according to latest information available.

<sup>1</sup> Istituto Nazionale di Statistica, ISTAT

Agricultural statistics reported by ISTAT are also published in European statistics database<sup>2</sup> (EUROSTAT). The verification of statistics is done as part of the QA/QC procedures; therefore, as soon as outliers are identified ISTAT and category associations are contacted. In Table 6.1 the time series of main animals' categories is shown.

Year	Dairy	Non-dairy	Buffalo	Sheep	Goats	Horses	Mules and asses	Swine	Rabbits	Poultry
heads										
1990	2,641,755	5,110,397	94,500	8,739,253	1,258,962	287,847	83,853	6,949,091	14,893,771	173,341,562
1991	2,339,520	5,581,998	83,300	8,397,070	1,260,980	314,125	66,255	7,029,000	15,877,391	173,060,622
1992	2,146,398	5,425,617	103,200	8,460,557	1,355,485	315,848	56,946	6,779,700	16,398,563	172,683,589
1993	2,118,981	5,322,148	100,900	8,669,560	1,408,767	323,305	49,383	6,834,100	16,530,691	173,261,404
1994	2,011,919	5,156,841	108,300	9,964,108	1,658,051	323,986	43,063	6,619,600	16,905,054	178,659,192
1995	2,079,783	5,189,304	148,404	10,667,971	1,372,937	314,778	37,844	6,625,890	17,110,587	184,202,416
1996	2,080,369	5,093,563	171,558	10,943,457	1,419,225	312,080	34,120	6,670,676	17,433,566	183,044,930
1997	2,078,388	5,094,846	161,491	10,893,711	1,351,003	313,000	30,000	6,795,447	17,609,737	186,815,499
1998	2,116,176	5,013,332	186,276	10,894,264	1,331,077	290,000	33,500	6,802,442	17,705,163	198,799,819
1999	2,125,571	5,036,190	200,481	11,016,784	1,397,329	288,000	33,000	6,881,822	18,020,802	196,573,062
2000	2,065,000	4,988,000	192,000	11,089,000	1,375,000	280,000	33,000	6,828,000	17,873,993	176,722,211
2001	2,077,618	4,661,270	193,774	8,311,383	1,024,769	285,000	33,000	7,170,771	18,494,839	209,187,654
2002	1,910,948	4,599,149	185,438	8,138,309	987,844	277,819	28,913	7,399,237	18,852,530	205,566,136
2003	1,913,424	4,591,279	222,268	7,950,981	960,994	282,936	28,507	7,478,114	18,866,643	196,511,409
2004	1,838,330	4,466,271	210,195	8,106,043	977,984	277,767	28,932	7,301,612	19,654,694	191,315,963
2005	1,842,004	4,409,921	205,093	7,954,167	945,895	278,471	30,254	7,484,162	20,504,282	188,595,022
2006	1,821,370	4,295,765	230,633	8,227,185	955,316	287,123	31,013	7,541,642	20,238,089	177,274,561
2007	1,838,783	4,444,051	293,947	8,236,668	920,085	315,725	34,557	7,545,050	20,964,928	188,871,886
2008	1,830,711	4,348,375	307,149	8,175,196	957,248	332,496	36,239	7,561,567	19,515,455	197,298,265
2009	1,878,421	4,224,396	344,007	8,012,651	960,950	343,519	40,608	7,473,207	19,957,348	199,924,644

**Table 6.1 Time series of the number of animals**

In Table 6.2 the nitrogen content of synthetic N-fertilisers by type applied to soils is shown together with the differentiated EFs. Detailed figures for “other nitrogenous fertilizers” are reported from 1998 because disaggregated official statistics from ISTAT were available only from that year (ENEA, 2006).

<sup>2</sup> <http://epp.eurostat.ec.europa.eu/portal/page/portal/agriculture/data/database>

Type of fertilizers	Emission factor	Nitrogen content (t N yr <sup>-1</sup> )									
		1990	1995	2000	2003	2004	2005	2006	2007	2008	2009
Ammonium sulphate	10%	50,762	61,059	36,698	26,550	30,211	27,855	30,170	35,039	28,431	23,803
Calcium cyanamide	2%	3,310	507	3,003	2,751	2,437	2,357	2,455	2,847	3,595	3,864
Nitrate (*)	2%	157,221	189,907	164,134	173,187	169,195	167,872	156,957	153,526	135,710	78,859
Urea	15%	291,581	321,196	329,496	354,208	361,048	317,814	338,027	336,686	312,427	232,815
Other nitric nitrogen	2%	-	-	3,204	6,112	5,326	5,219	4,882	3,749	3,952	3,671
Other ammoniacal nitrogen	2%	-	-	6,278	13,127	15,900	18,069	17,497	17,063	15,620	13,018
Other amidic nitrogenous	15%	-	-	6,988	10,487	14,546	17,420	17,038	19,470	20,634	16,101
Phosphate nitrogen	5%	112,237	99,468	77,916	85,079	77,949	69,758	70,719	55,674	29,702	47,397
Potassium nitrogen	2%	3,937	2,876	5,291	10,105	12,201	12,289	13,336	18,047	16,887	17,369
NPK nitrogen	2%	138,018	101,528	113,897	108,358	116,361	106,384	99,965	83,694	63,712	56,191
Organic mineral	2%	444	20,960	38,688	34,684	36,191	34,809	34,218	39,695	29,254	25,691
<b>TOTAL</b>		<b>757,509</b>	<b>797,500</b>	<b>785,593</b>	<b>824,649</b>	<b>841,363</b>	<b>779,846</b>	<b>785,265</b>	<b>765,490</b>	<b>659,922</b>	<b>518,778</b>

(\*) nitrate includes ammonium and calcium nitrate

**Table 6.2 Time series of N content by fertilisers and relevant emission factors**

## 6.2 Methodological issues

Methodologies used for estimating national emissions from this sector are based on and conform to the *EMEP/CORINAIR guidebook* (EMEP/CORINAIR, 2007), the *IPCC Guidelines* (IPCC, 1997; IPCC, 2006) and the *IPCC Good Practice Guidance* (IPCC, 2000). Italy is also evaluating to estimate emissions from those sources which have not been calculated according to the EMEP/EEA 2009 air pollutant emission inventory guidebook. Consistency among methodologies for the preparation of the agricultural emission inventory under the UNFCCC and UNECE/CLRTAP is guaranteed through an operational synergy for activity data collection, inventory preparation and reporting to international conventions and European Directives (Córdoba and De Lauretis, 2007). Information reported in the *National Inventory Report/Common Reporting Format (NIR/CRF)* for the GHG inventory is consistent to that in the *Informative Inventory Report/Nomenclature for Reporting (IIR/NFR)*.

### *Manure management (4B)*

For 4B category, Italy has estimated emission sources recommended in the EMEP/EEA 2009 Guidebook (NH<sub>3</sub>, NMVOC, PM<sub>10</sub>, and PM<sub>2.5</sub>). NO emissions from 4B were not estimated. A very high uncertainty affects EFs for estimating these emissions so further studies are necessary to carry out the estimates. Italy is assessing the possibility to implement estimations of this pollutant. A detailed and updated description of the methodologies for the estimation of NH<sub>3</sub> emissions, as well as of national specific circumstances and reference material, is provided in sectoral reports (Córdoba *et al.*, 2008; APAT, 2005), and in the NIR (ISPRA, 2011[b]). The national NH<sub>3</sub> emission inventory has been prepared by ISPRA with the support of *Research Centre on Animal Production, CRPA*<sup>3</sup>.

<sup>3</sup> CRPA, Centro Ricerche Produzioni Animali

Detailed information on activity data sources, methods and EFs by pollutant for 4B category is shown in Table 6.3.

NFR code	Animal category	Method	Activity data	Emission Factor
4B1a, 4B1b	Cattle	T2 (NH <sub>3</sub> ), T1 (NMVOC, PM10, PM2.5)	NS	CS (NH <sub>3</sub> ), D (NMVOC, PM10, PM2.5)
4B3,4,5,6,7	Buffalo, Sheep, Goats, Horses, Mules and Asses	T1 (NH <sub>3</sub> , NMVOC, PM10, PM2.5)	NS, IS	CS (NH <sub>3</sub> ), D (NMVOC, PM10, PM2.5)
4B8	Swine	T2 (NH <sub>3</sub> ), T1 (NMVOC, PM10, PM2.5)	NS	CS (NH <sub>3</sub> ), D (NMVOC, PM10, PM2.5)
4B9a,b,c,d	Poultry	T2 (NH <sub>3</sub> ), T1 (NMVOC, PM10, PM2.5)	AS	CS (NH <sub>3</sub> ), D (NMVOC, PM10, PM2.5)
4B13	Other	T1 (NH <sub>3</sub> , NMVOC, PM10, PM2.5)	NS	CS (NH <sub>3</sub> ), D (NMVOC)

NS=national statistics; IS= International statistics (FAO); AS= category association statistics (UNA<sup>4</sup>); CS=country-specific; D=Default (from guidebook)

**Table 6.3 Activity data sources, methods and emission factors by pollutant for manure management**

The estimation procedure for 4B NH<sub>3</sub> emissions consists in successive subtractions from the quantification of nitrogen excreted annually for each livestock category. This quantity can be divided in two different fluxes, depending on whether animals are inside (housing, storage and manure application) or outside the stable (grazing). The animal grazing source is reported in 4D2c *N-excretion on pasture range and paddock*. The excretion rates (CRPA, 2006[a]; GU, 2006; Xiccato *et al.*, 2005), slurry/solid manure production, and average weights (CRPA, 2006[a]; GU, 2006; Regione Emilia Romagna, 2004) were updated with country specific information. Other improvements of country specific EFs were obtained with research studies (CRPA, 2006 [a], [b], CRPA, 2010[b]). Average weight and N excretion rate for NH<sub>3</sub> estimations are reported in Table 6.4.

Category	Weight (kg)	Housing	Grazing	TOTAL
			kg head <sup>-1</sup> yr <sup>-1</sup>	
Non-dairy cattle	386	47.77	0.95	<b>48.72</b>
Dairy cattle	603	110.20	5.80	<b>116.00</b>
Buffalo	516	90.34	2.70	<b>93.04</b>
Other swine (*)	85	12.92	0.00	<b>12.92</b>
Sow (*)	172	28.13	0.00	<b>28.13</b>
Sheep	47	1.62	14.58	<b>16.20</b>
Goats	47	1.62	14.58	<b>16.20</b>
Horses	524	20.00	30.00	<b>50.00</b>
Mules and asses	300	20.00	30.00	<b>50.00</b>
Poultry	1.8	0.53	0.00	<b>0.53</b>
Rabbit	1.6	1.02	0.00	<b>1.02</b>

(\*) other swine and sow are sources that represent the 'swine' category

**Table 6.4 Average weight and nitrogen excretion rates from livestock categories in 2009**

<sup>4</sup> UNA, Unione Nazionale dell'Avicoltura

Average emission factors used for estimating NH<sub>3</sub> emissions are reported in Table 6.5.

Category	Housing	Storage	Land spreading	TOTAL
kg NH <sub>3</sub> head <sup>-1</sup> yr <sup>-1</sup>				
Non-dairy cattle	6.70	9.01	5.50	<b>21.21</b>
Dairy cattle	15.46	20.36	12.65	<b>48.47</b>
Buffalo	12.67	16.69	12.21	<b>41.57</b>
Other swine (*)	2.41	2.08	1.39	<b>5.88</b>
Sow (*)	4.87	4.43	3.08	<b>12.38</b>
Sheep	0.22	-	0.46	<b>0.68</b>
Goats	0.22	-	0.46	<b>0.68</b>
Horses	3.24	-	2.75	<b>5.99</b>
Mules and asses	3.24	-	2.75	<b>5.99</b>
Hens	0.09	0.06	0.04	<b>0.19</b>
Chicken	0.08	0.05	0.03	<b>0.15</b>
Other poultry	0.18	0.11	0.06	<b>0.35</b>
Rabbit	0.34	0.13	0.07	<b>0.54</b>
Fur animal	1.37	-	0.34	<b>1.70</b>

**Table 6.5 NH<sub>3</sub> emission factors for manure management for the year 2009**

For 4B NMVOC emissions a tier 1 method was used for calculations. EFs used are constant for the whole time series for the different livestock categories. NMVOC EFs are those included in the US EPA AP 42 Compilation of Air Pollutant Emission Factors Guidebook<sup>5</sup>.

For 4B particulate matter emissions a tier 1 method was used for calculations. EFs for PM<sub>10</sub> and PM<sub>2.5</sub> are those derived from the EMEP/CORINAIR guidebook, which have been corrected based on the Italian animal breeding characteristics and weight parameters (see Córdor *et al.*, 2008; page 70). Specifically, for the category 4B9b (broilers), the annual PM<sub>10</sub> emission factor is equal to 0.083 kg per head.

#### ***Agricultural soils (4D)***

For *agricultural soils* (4D), estimations of NH<sub>3</sub> emissions account for the direct application of synthetic N-fertilizers (4D1a), animal grazing (4D2c) and N fixed by leguminous cultivation<sup>6</sup>. For 4D1a no estimations were performed for NMVOC, NO<sub>x</sub>, PM<sub>10</sub>, and PM<sub>2.5</sub> and for 4D2c there are no estimations for NO. Italy is assessing the possibility for implementing estimations for these pollutants.

Emissions from synthetic N-fertilizer are based on the guidebook methodology, which provides different EFs by type of fertilizers taking into account climatic conditions (EFs in Table 6.2). A tier1/tier 2 method has been implemented for 4D1a source. NH<sub>3</sub> emissions from synthetic N-fertilizers are obtained with the amount of the N content by type of fertilizer multiplied by the

<sup>5</sup> <http://www.epa.gov/ttn/chief/ap42/index.html>

<sup>6</sup> included in 4D2c since there is no specification in the EMEP/EEA 2009 guidebook where to report legume emissions in the NFR, '4G Other' category is not appropriate since other sources should be reported.

specific EFs.

A validation of EFs and estimations was carried out considering the results of a research study that estimated, at NUTS 2 level, emissions for the use of synthetic N-fertilizers considering type of cultivation, altitude, and climatic conditions (CRPA, 2010[b]).

For 4D2c the time series of the quantity of N from animal grazing is the same as that reported in the NIR 2011 and in the relevant CRF Table 4.Ds1. The method for estimating 4D2c emissions is described in 4B (tier 2). Detailed information on activity data sources, methods and EFs by pollutant is shown in Table 6.6.

Nitrogen input from N-fixing crops has been estimated starting from data on surface and production for N-fixing crops and forage legumes; more details on cultivated surface and N fixed by cultivar are reported in Table 6.26 of the NIR 2011.

NFR code	Category	Method	Activity data	Emission Factor
4D1a	Synthetic N-fertilizers	T1/T2 (NH <sub>3</sub> )	NS	D (NH <sub>3</sub> )
4D1a	Farm-level agricultural operations including storage, handling and transport of agricultural products	-	-	-
4D2b	Off-farm storage, handling and transport of bulk agricultural products	-	-	-
4D2c	N-excretion on pasture range and paddock	T2 (NH <sub>3</sub> )	NS	CS (NH <sub>3</sub> )

**Table 6.6 Activity data sources, methods and emission factors by pollutant for agriculture soils**

#### ***Field burning of agricultural wastes (4F)***

For 4F calculations were performed for NMVOC, CO, NO<sub>x</sub>, PM10, and PM2.5 emissions. A tier 1 approach was applied. EFs for NO<sub>x</sub>, CO, NMVOC are those from the IPCC (IPCC, 1997), while EFs for PM10 and PM2.5 are from the EMEP/CORINAIR guidebook. No estimations were performed for NH<sub>3</sub> and SO<sub>x</sub> emissions.

### **6.3 Time series and key categories**

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

The agriculture sector is the main source of NH<sub>3</sub> emissions in Italy; for the main pollutants, in 2009 the sector accounts for:

- 95% in national total NH<sub>3</sub> emissions;
- 11% in national total PM10 emissions; and
- 4% in national total PM2.5 emissions.

Moreover, the sector comprises 0.5% of total CO emissions, 0.1% of NMVOC, and 0.05% of NO<sub>x</sub>. There are no particular differences as compared to the sectoral share in 1990 when the agriculture sector accounted for 98% of NH<sub>3</sub> emissions, 7% of PM10 and 3% of PM2.5.

Table 6.7 reports the key categories identified in the agriculture sector while the time series of NH<sub>3</sub> emissions by sources is shown in Table 6.8.

Concerning NH<sub>3</sub> emissions, the category *manure management (4B)* represents, in 2009, 78% of ammonia emissions (79% in 1990). In particular, NH<sub>3</sub> emissions from *cattle (4B1)* stand for 60% of 4B emissions, while emissions from *swine (4B8)* and *poultry (4B9)* represent 16% and 9%, respectively. *Direct soil emissions (4D)*, specifically for the use of synthetic N-fertilisers (4D1a) represent 14% in 2009 of NH<sub>3</sub> emissions (16% in 1990).

Regarding PM10 emissions, the category *manure management (4B)* accounts for 9.5% in 2009



(6.4% in 1990). *Poultry* (4B9) and *swine* (4B8) represent the major contributors to the total PM10 emissions from category 4B with 62% and 22%, respectively).

	4B1a	4B1b	4B2	4B3	4B4	4B6	4B7	4B8	4B9a	4B9b	4B9d	4B13	4D1a	4D2c	4F
	%														
SO <sub>x</sub>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO <sub>x</sub>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05
NH <sub>3</sub>	23.28	22.91	3.66	1.38	0.17	0.53	0.06	12.47	2.59	4.25	3.45	2.88	14.30	2.58	-
NM VOC	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.01	-	-	-	-	-	-	0.05
CO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.47
PM10	0.65	0.76	0.08	-	-	0.05	0.01	2.09	0.61	5.22	-	-	-	-	1.24
PM2.5	0.50	0.60	0.06	-	-	0.04	0.00	0.41	0.09	0.82	-	-	-	-	1.49
Pb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PAH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dioxin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HCB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PCB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: blue shaded are key categories

**Table 6.7 Key categories in the agriculture sector in 2009**

NFR SECTOR 4	1990	1995	2000	2004	2005	2006	2007	2008	2009
4 B 1 a Cattle Dairy	139	106	102	89	89	88	89	89	91
4 B 1 b Cattle Non-Dairy	120	118	110	97	95	90	96	94	90
4 B 2 Buffalo	4	6	8	9	9	10	12	12	14
4 B 3 Sheep	6	7	7	5	5	6	6	6	5
4 B 4 Goats	1	1	1	1	1	1	1	1	1
4 B 6 Horses	2	2	2	2	2	2	2	2	2
4 B 7 Mules and Asses	1	0	0	0	0	0	0	0	0
4 B 8 Swine	49	46	46	47	49	49	49	49	49
4 B 9 a Laying Hens	17	15	12	12	10	10	10	10	10
4 B 9 b Broilers	15	16	15	15	15	14	15	16	17
4 B 9 c Turkeys	0	0	0	0	0	0	0	0	0
4 B 9 d Other Poultry	11	14	13	14	13	13	13	14	13
4 B 13 Other (*)	9	10	10	11	12	11	12	11	11
4 D 1 a Synthetic N-fertilizers	73	80	79	85	77	81	80	72	56
4 D 2 c N-excretion on pasture range/paddock	12	13	13	10	10	10	10	10	10
<b>TOTAL</b>	<b>457</b>	<b>433</b>	<b>417</b>	<b>398</b>	<b>387</b>	<b>384</b>	<b>395</b>	<b>386</b>	<b>370</b>

Note: (\*) 4B13 includes rabbits and fur animals

**Table 6.8 Time series of ammonia emissions in agriculture (Gg)**

For PM2.5 emissions; the category *manure management* (4B) contributes for 2.5% in 2009 (1.8% in 1990). *Cattle* (4B1) accounts for 44%, while *poultry* (4B9) stands for 36% to the total PM2.5

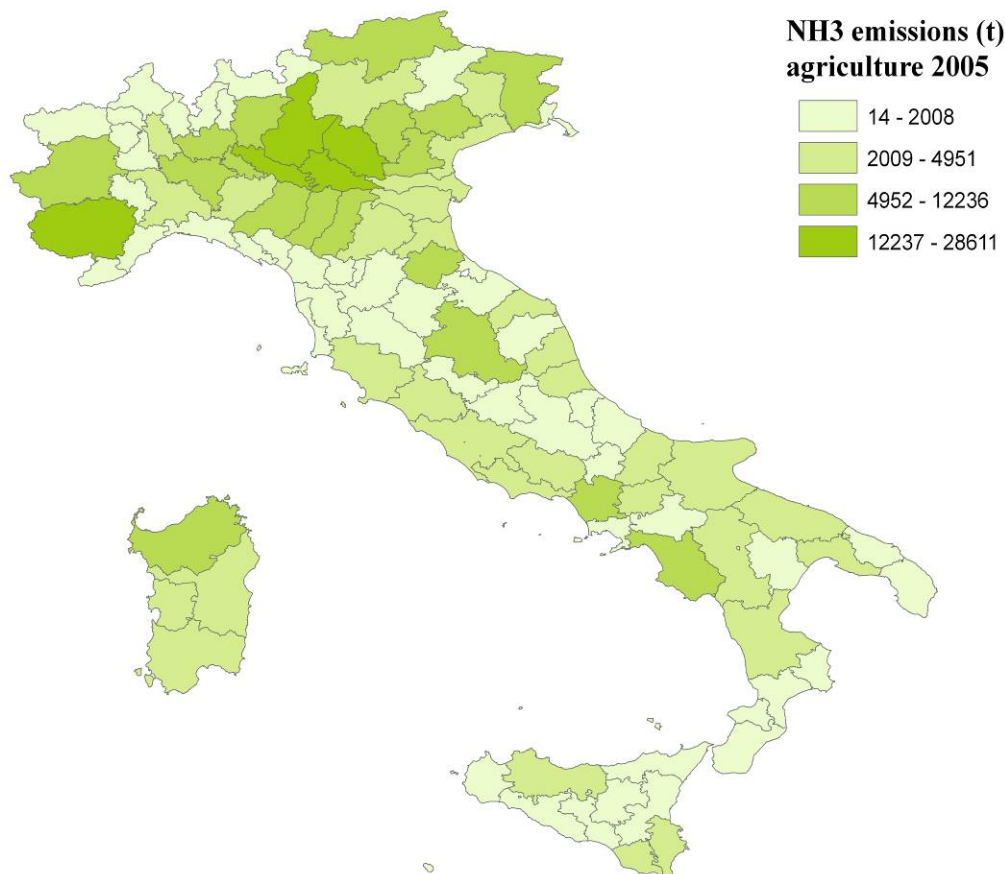
emissions from category 4B.

The largest and most intensive agricultural area in Italy is the Po River catchment with the following characteristics: high crop yields due to climatic factors, double cropping system adopted by livestock farms, flooded rice fields, high livestock density and animal production that keep animals in stables all the year (Bassanino et al 2011, Bechini and Castoldi 2009). 64%, 77% and 83% of cattle, poultry and swine production are located in Piedmont, Lombardy, Emilia-Romagna, and Veneto Regions (Northern Italy/Po River Basin). At regional level, the presence of large cattle, poultry and swine farms in the Po basin assume a particular relevance for air quality issues, especially, for the specific meteorological conditions of this area.

The reduction of 4B NH<sub>3</sub> emissions is mainly related to the reduction in the number of animals. Between 1990 and 2009 total 4B NH<sub>3</sub> emissions have reduced by 19.2%. Cattle livestock decreased by 21.3% (from 7,752,152 to 6,102,817 heads). Dairy cattle and non-dairy cattle have decreased by 28.9% and 17.3%, respectively. The main driving force has been the quota milk of the I Pillar from the Common Agricultural Policy as verified also at European level (EEA, 2010[b]). However, the number of animals for swine and poultry has increased between 1990 and 2009 by 7.5% and 15.3%, respectively (see Table 6.1). Abatement technologies are considered in the EFs used for NH<sub>3</sub> estimations. Research studies funded by ISPRA, such as the MeditAiraneo project, or by the Ministry of Environment have allowed us to collect information on the inclusion of abatement technologies in Italy, especially those related to the swine and poultry recovery and treatment of manure and to land spreading (CRPA, 2006[b]; Córdor et al., 2008; CRPA, 2010[b]).

NH<sub>3</sub> emissions of 4D1a category are driven by the use of N-fertilizers. Between 1990-2009 emissions have reduced by 23.8% while the use of N-fertilizers by 37%. Between 2007/2008 and 2008/2009 N fertiliser distribution has decreased by 17% and 25%, respectively (see Table 6.2). According to the Italian Fertilizer Association (AIF, *Associazione Italiana Fertilizzanti*) the use of fertilisers is determined by their cost and particularly by the price of agricultural products. In the last years, price has decreased and, as a result, farmers need to save costs, consequently, less fertilisers is being used (Perelli, 2007).

Every 5 years the national agriculture UNFCCC/CLRTAP emission inventory is disaggregated at NUTS3 level as requested by CLRTAP (Córdor *et al.*, 2008). A database with the time series for all sectors and pollutants has been published (ISPRA, 2008[a]; ISPRA, 2008[b]; ISPRA, 2009; ISPRA, 2011[d]). The disaggregation (NUTS3) of the NH<sub>3</sub> agricultural emissions is shown in Figure 6.2. In 2005, four regions from Italy contributed with 63% of agricultural NH<sub>3</sub> emissions: Lombardia (25%), Veneto (15%), Emilia Romagna (13%) and Piemonte (10%).



**Figure 6.2 NH<sub>3</sub> emissions from Agriculture in 2005 (t)**

#### **6.4 QA/QC and verification**

QA/QC procedures for the agriculture sector are in line with the IPCC Good Practice Guidance and consistent with the EEA/EMEP Guidebook. Italy has drawn up a QA/QC procedure manual and elaborates annually a QA/QC plan both for the UNFCCC and UNECE/CLTRPA inventories. In the QA/QC Agriculture section GHG and NH<sub>3</sub> emissions improvements are specified (see ISPRA, 2011[c]). Furthermore, feedbacks for the agricultural emission inventory derive also from communication of data to different institutions (ISTAT, UNA, CPRA etc.) and/or at local level (regional environmental institutions). In addition, ISPRA participates in a technical working group on agriculture within the National Statistical System, composed by producers and users of agricultural statistics.

NECD data are submitted some months before the LRTAP submission and for the last reported year they are draft estimates. Therefore, differences are due to the preparation of the final UNFCCC/CLRTAP agricultural emission inventory which is finished and communicated by 15 March of each year. In addition, under the NECD, data are submitted only for the last two years and the rest of the time series is not updated while this is done under the LRTAP submission.

## 6.5 Recalculations

In 2011, no recalculations were implemented for the agricultural emission inventory.

## 6.6 Planned improvements

Since the 2006 submission, results from a specific project on Mediterranean area, the *MeditAIRaneo Agriculture* project, have been included in the preparation of the UNFCCC/UNECE-CRLTAP agricultural emission inventory (CRPA, 2006[a]). Moreover, outcomes from the convention signed between APAT (now ISPRA) and the Ministry for the Environment, Land and Sea on NH<sub>3</sub> emission scenarios have been incorporated to the agricultural emissions inventory (CRPA, 2006 [a], [b]; ENEA, 2006, CRPA, 2010[b]).

Currently, uncertainty analysis, for the agricultural emission sector, is carried out only for the GHG emission inventory. We plan to estimate uncertainties also for the other pollutants, including NH<sub>3</sub> and PM. Monte Carlo analysis has also been performed for one key category of the GHG agricultural emission inventory; initial results are shown in the NIR (ISPRA, 2011[b]).

We expect to implement estimations for the 4G ‘other’ category, HCH (lindane) emissions from the use of pesticides. Currently, ISPRA is controlling the availability of activity data and EFs.

No emissions are estimated for 4D2a *Farm-level agricultural operations including storage, handling and transport of agricultural products* and 4D2b *off-farm storage, handling and transport of bulk agricultural products*. However, Italy will assess the availability of AD and EFs for these sources.

In the near future the *ad hoc* “Survey on Agricultural Production Methods” (SAPM) regulated by the EU will be crucial for improving the preparation of the agricultural emission inventory. In Italy, this survey will be carried out during the 2010 General Agricultural Census; data will be available at the end of 2012. Information such as animal grazing period, animal housing, storage systems characteristics, and the use of manure/slurry for land application will be collected. Some information at NUTS3 level (Italian provinces) has been already collected with the incorporation of specific queries in the Farm Structure Survey (FSS) from 2005 and 2007. Information on housing and storage systems, respectively, was analysed, and will be validated with information that will be obtained from the 2010 Agricultural Census (CRPA, 2010[a]). In the coming years specific surveys or the inclusion of specific queries on already existing surveys such as Farm Structure Survey (FSS) or Farm Accounting Data Network (FADN) will provide valuable information on animal and agronomic production methods. Right now is under discussion among EU member which will be the best way to face agri-environmental information collection which can be obtained from surveys.

## 7 Waste (NFR SECTOR 6)

### 7.1 Overview of the sector

Italy estimates the categories of the waste sector, as reported in the following box. Under category 6B, no emissions are reported as only CH<sub>4</sub> and N<sub>2</sub>O occurred. Notwithstanding, emissions from the exceeding biogas which is flared are not estimated at the moment because emission factors are under investigation.

NFR		SNAP	
6A	Solid waste disposal on land	09 04 01 09 04 02	Managed waste disposal on land Unmanaged waste disposal on land
6Ca	Clinical waste incineration	09 02 07	Incineration of hospital wastes
6Cb	Industrial waste incineration	09 02 02 09 02 05 09 02 08	Incineration of industrial wastes Incineration of sludge from wastewater treatment Incineration of waste oil
6Cc	Municipal waste incineration	09 02 01	Incineration of municipal wastes
6Ce	Small scale waste burning	09 07 00	Open burning of agricultural wastes
6Cd	Cremation	09 09 01	Cremation of corpses
6D	Other waste	09 10 03 09 10 05	Sludge spreading Compost production from waste

As regards air pollutants, emissions estimated for each sector are reported in Table 7.1.

Main pollutants	6A	6Ca	6Cb	6Cc	6Ce	6Cd	6D
NO <sub>x</sub>		X	X	X	X	X	X
CO		X	X	X	X	X	
NMVOG	X	X	X	X	X	X	X
SO <sub>x</sub>		X	X	X		X	
NH <sub>3</sub>	X						X
<b>Particulate matter</b>							
TSP		X	X	X	X	X	
PM10		X	X	X	X	X	
PM2.5		X	X	X	X	X	
<b>Priority heavy metals</b>							
Pb		X	X	X		X	
Cd		X	X	X		X	
Hg		X	X	X		X	
<b>POPs Annex II</b>							
PCB		X	X	X			
<b>POPs Annex III</b>							
Dioxins		X	X	X	X	X	
PAH		X	X	X	X	X	
HCB		X	X	X			
<b>Other heavy metals</b>							
As		X	X	X		X	
Cr		X	X	X		X	
Cu		X	X	X		X	
Ni		X	X	X		X	
Se		X	X	X			
Zn		X	X	X			

Table 7.1 Air pollutant emissions estimated for each sector

In 2009, *small scale open burning* (6Ce) is a key category for what concern CO, PM10, PM2.5, PAH and dioxins; *industrial waste incineration* (6Cb), due to waste water sludge incineration, is key category for HCB emissions.

In 1990, *small scale open burning* (6Ce) is a key category for the same pollutants except for CO, whereas *industrial waste incineration* (6Cb) is key category for dioxins and HCB emissions; *clinical waste incineration* (6Ca) is key category for HCB while *municipal waste incineration* (6Cc) is key category for dioxins.

As regard the trend, *small scale open burning* (6Ce) is a key category for what concern CO, PM10, PM2.5, PAH and dioxins; *industrial waste incineration* (6Cb) and *municipal waste incineration* (6Cc) are key categories for dioxins, whereas *clinical waste incineration* (6Ca) is a key category for what concern HCBs.

The waste sector, and in particular Waste incineration (6C), is a relevant source of different pollutants; for the main pollutants, in 2009, the sector accounts for:

- 48.1% in national total HCB emissions;
- 27.4% in national total PAH emissions.
- 16.3% in national total Dioxin emissions;

Moreover, the sector comprises 7.2% and 7.4% of total PM10 and PM2.5 emissions, respectively, 10.8% of CO, 2.1% of NMVOC, 1.6% of NO<sub>x</sub>, and for what concern priority heavy metals 2.5% of Cd, nearly 2% of Hg and 1.7% of Pb.

## 7.2 Methodological issues

### ***Solid waste disposal on land (6A)***

Solid waste disposal on land is a major source concerning greenhouse gas emissions but not concerning air pollutants. Notwithstanding, NMVOC and NH<sub>3</sub> emissions are estimated, as a percentage of methane emitted, calculated using the IPCC Tier 2 methodology (IPCC, 1997; IPCC, 2000), through the application of the First Order Decay Model (FOD). A detail description of the model and its application to Italian landfills is reported in the National Inventory Report on the Italian greenhouse gas inventory (ISPRA, 2011 [b]).

Emissions from the landfill gas combustion in landfills flaring are not estimated at the moment: activity data are available but emission factors are under investigation.

It has been assumed that non-methane volatile organic compounds are 1.3 weight per cent of methane (Gaudioso et al., 1993): this assumption refers to US EPA data (US EPA, 1990). As regard ammonia, emission factor has been assumed equal to 1 volume per cent of methane too (Tchobanoglous G. et al., 1993).

Methane, and consequently NMVOC and NH<sub>3</sub> air pollutants, is emitted from the degradation of waste occur in municipal landfills, both managed and unmanaged (due to national legislation, from 2000 municipal solid wastes are disposed only into managed landfills). The main parameters that influence the estimation of emissions from landfills are, apart from the amount of waste disposed into managed landfill, the waste composition, which vary trough the years in the model, the fraction of methane in the landfill gas, which has been assumed 50%, and the amount of landfill gas collected and treated. These parameters are strictly dependent on the waste management policies throughout the waste streams which start from its generation, flow through collection and transportation, separation for resource recovery, treatment for volume reduction, stabilisation,

recycling and energy recovery and terminate at landfill sites.

Basic data on waste production and landfills system are those provided by the national Waste Cadastre, basically built with data reported through the Uniform Statement Format (MUD). The Waste Cadastre is formed by a national branch, hosted by ISPRA, and by regional and provincial branches.

These figures are elaborated and published by ISPRA yearly since 1999: the yearbooks report waste production data, as well as data concerning landfilling, incineration, composting and generally waste life-cycle data (ANPA-ONR, several years; ISPRA, several years).

For inventory purposes, a database of waste production, waste disposal in managed and unmanaged landfills and sludge disposal in landfills was created and it has been assumed that waste landfilling started in 1950.

For the year 2009, the non hazardous landfills in Italy dispose 16,158 Gg of MSW and 3,216 Gg of industrial wastes, as well as 364 Gg of sludge from urban wastewater treatment plants.

In Table 7.2, the time series of AMSW and domestic sludge disposed into non hazardous landfills from 1990 is reported.

ACTIVITY DATA (Gg)	1990	1995	2000	2005	2006	2007	2008	2009
MSW production	22,231	25,780	28,959	31,664	32,511	32,542	32,472	34,144
MSW disposed in landfills for non hazardous waste	17,432	22,459	21,917	17,226	17,526	16,912	15,981	16,158
Assimilated MSW disposed in landfills for non hazardous waste	2,828	2,978	2,825	2,914	2,481	2,777	3,703	3,216
Sludge disposed in managed landfills for non hazardous waste	2,454	1,531	1,326	544	525	407	364	364
Total Waste to managed landfills for non hazardous waste	16,363	21,897	26,069	20,684	20,532	20,095	20,049	19,739
Total Waste to unmanaged landfills for non hazardous waste	6,351	5,071	0	0	0	0	0	0
<b>Total Waste to landfills for non hazardous waste</b>	<b>22,714</b>	<b>26,968</b>	<b>26,069</b>	<b>20,684</b>	<b>20,532</b>	<b>20,095</b>	<b>20,049</b>	<b>19,739</b>

**Table 7.2 Trend of MSW production and MSW, AMSW and domestic sludge disposed in landfills (Gg)**

### ***Waste Incineration (6Ca - 6Cb - 6Cc)***

Regarding waste incineration, methodology used for estimating emissions is based on and conform to the EMEP/CORINAIR Guidebook (EMEP/CORINAIR, 2007).

In this sector only emissions from facilities without energy recovery are reported, whereas emissions from waste incineration facilities with energy recovery are reported in the Energy Sector 1A4a. In 2009, about 95% of the total amount of waste incinerated is treated in plants with energy recovery system.

Existing incinerators in Italy are used for the disposal of municipal waste, together with some industrial waste, sanitary waste and sewage sludge for which the incineration plant has been authorized from the competent authority. Other incineration plants are used exclusively for industrial and sanitary waste, both hazardous and not, and for the combustion of waste oils, whereas there are few plants that treat residual waste from waste treatments, as well as sewage sludge.

A complete database of the incineration plants is now available, updated with the information reported in the yearly report on waste production and management published by ISPRA (APAT-

ONR, several years; ISPRA, several years). For each plant a lot of information is reported, among which 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.). A specific emission factor is therefore used for each pollutant combined with plant specific waste activity data.

In Table 7.3, emission factors for each pollutant and waste typology are reported. Emission factors have been estimated on the basis of a study conducted by ENEA (De Stefanis, 1999), based on emission data from a large sample of Italian incinerators (FEDERAMBIENTE, 1998; AMA-Comune di Roma, 1996), legal thresholds (Ministerial Decree 19 November 1997, n. 503 of the Ministry of Environment; Ministerial Decree 12 July 1990) and expert judgements.

For PCB and HCB emission factors published on the Guidebook EMEP/EEA (EMEP/CORINAIR, 2007) in the relevant chapters are used.

Air Pollutant	u.m	Municipal	Industrial	Clinical	Sludge	Oil
NO <sub>x</sub>	kg/t	1.15	2	0.603624	3	2
CO	kg/t	0.07	0.56	0.07542	0.6	0.07542
NMVOC	kg/t	0.46046	7.4	7.4	0.25116	7.4
SO <sub>2</sub>	kg/t	0.39	1.28	0.02594	1.8	1.28
PM <sub>10</sub>	g/t	46	240	25.676	180	240
PM <sub>2.5</sub>	g/t	46	240	25.676	180	240
As	g/t	0.05	0.12	0.0042	0.5	0.12
Cu	g/t	1	1.2	0.564	10	1.2
Se	g/t	0.013	0.006	0.03736	-	0.006
Zn	g/t	0.017	12.6	-	10	12.6
Cd	g/t	0.25	0.8	0.001128	1.2	0.8
Cr	g/t	0.45	1.6	0.01168	3	1.6
Hg	g/t	0.15	0.8	0.03684	1.2	0.8
Ni	g/t	16.35	0.8	0.02504	3	0.8
Pb	g/t	1.35	24	0.0246	3	24
PAH	g/t	0.05	0.48	0.00014126	0.6	0.48
PCB	g/t	0.005	0.005	0.02	0.005	-
HCB	g/t	0.001	0.0001	0.019	0.500	-

**Table 7.3 Emission factors for waste incineration**

As regard dioxin emissions, clinical and industrial emission factors are also derived from data collected from a large sample of Italian incinerators and legal thresholds, as well as expert judgement; in particular for municipal solid waste, emission factors vary within the years and the facility on the basis of plant technology (i.e. typology of combustion chamber and gas treatment section) and the year of the upgrade. This site specific evaluation has been possible thanks to a study conducted in the past for a sample of municipal waste incinerators located in Regione Lombardia in order to produce an assessment of field-based values applicable to other facilities with the same characteristics (Pastorelli et al., 2001). Moreover, for the incineration plants reported in the EPER register, verification on emissions has been carried out. In Table 7.4 dioxin emission factors for waste incineration are reported for 1990 and 2009.



Waste Typology	u.m	1990	2009
Municipal	µg/t	115 - 1.6	0.5
Clinical	µg/t	200	0.8
Industrial	µg/t	80 - 135	0.8
Sludge	µg/t	77	0.6
Oil	µg/t	200	0.8

**Table 7.4 Dioxin emission factors for 1990 and 2009**

In Table 7.5 activity data are reported by type of waste.

Waste incinerated	1990	1995	2000	2005	2006	2007	2008	2009
			(Gg)					
<b>Total waste</b>	1,716.3	2,209.3	3,061.7	4,966.2	5,066.4	5,145.3	5,287.3	5,199.2
with energy recovery	946.6	1,593.7	2,751.9	4,707.4	4,800.2	4,897.7	5,034.4	4,946.3
without energy recovery	769.8	615.6	309.8	258.7	266.1	247.6	252.9	252.9
<b>Clinical waste (6Ca)</b>	138.2	154.5	110.3	126.2	145.3	131.9	135.0	136.2
with energy recovery	25.3	41.1	76.7	89.8	95.1	76.3	79.4	80.6
without energy recovery	112.9	113.4	33.6	36.4	50.3	55.6	55.6	55.6
<b>Industrial waste (6Cb)</b>	552.6	618.2	626.5	1,620.1	1,651.7	1,714.0	1,797.8	1,711.4
with energy recovery	294.9	367.1	513.9	1,449.7	1,458.7	1,550.5	1,625.1	1,538.6
without energy recovery	257.7	251.0	112.6	170.4	193.0	163.6	172.8	172.8
<b>Municipal waste (6Cc)</b>	1,025.6	1,436.6	2,324.9	3,219.9	3,269.3	3,299.4	3,354.5	3,351.6
with energy recovery	626.4	1,185.5	2,161.4	3,167.9	3,246.5	3,270.9	3,330.0	3,327.0
without energy recovery	399.2	251.1	163.5	51.9	22.9	28.5	24.6	24.6

**Table 7.5 Amount of waste incinerated by type (Gg)**

### ***Cremation of corpses (6Cd)***

Emissions from incineration of human bodies in crematoria have been carried out this year for the entire time series. The methodology used for estimating emissions is based on and conform to the EMEP/EEA Air Pollutant Emission Inventory Guidebook (EMEP/EEA, 2009).

Activity data have been supplied by a specific branch of Federutility, which is the federation of energy and water companies (SEFIT, 2010), whereas emission factors are those reported in the Guidebook.

Since some years ago, cremation was not so popular in Italy, also because the Catholic Church encouraged burial. Partly because cemeteries are becoming overcrowded, the number of cremations in Italy has risen from 5,809 in 1990 to 71,898 in 2009. In Table 7.6 time series of number of cremations as well as annual deaths and crematoria in Italy are reported.

Cremation of corpses	1990	1995	2000	2005	2006	2007	2008	2009
Cremations	5,809	15,436	30,167	48,196	53,013	58,554	63,611	71,898
Deaths	543,700	555,203	560,241	567,304	557,892	570,801	585,126	591,663
% of cremation	1.07	2.78	5.38	8.50	9.50	10.26	10.87	12.15
Crematoria	NA	31	35	43	44	45	46	51

**Table 7.6 Cremation time series (activity data)**

The major emissions from crematoria are nitrogen oxides, carbon monoxide, sulphur dioxide, particulate matter, mercury, hydrogen fluoride (HF), hydrogen chloride (HCl), NMVOCs, other heavy metals, and some POPs. In Table 7.7 emission factors for cremation are reported.

Air pollutant	u.m.	Cremation
NO <sub>x</sub>	kg/body	0.309
CO	kg/body	0.141
NMVOC	kg/body	0.013
SO <sub>x</sub>	kg/body	0.544
PM10	g/body	14.6
PM2.5	g/body	14.6
Pb	mg/body	0.0186
Cd	mg/body	0.00311
Hg	mg/body	0.934
As	mg/body	0.011
Cr	mg/body	0.00844
Cu	mg/body	0.00771
Ni	mg/body	0.0107
PAH	µg/body	0.0103
Dioxins	µg/body	0.0168

**Table 7.7 Emission factors for cremation of corpses**

### ***Small scale waste burning (6Ce)***

Emissions from burning of agriculture residues burnt off-site are key categories as regards the following pollutants: CO, PM10, PM2.5, PAH and Dioxins (see Table 7.11). Moreover, PTS, NMVOC and NO<sub>x</sub> emissions have been estimated. No estimations were performed for NH<sub>3</sub> and SO<sub>x</sub> emissions.

A country-specific methodology has been used. Parameters taken into consideration are the following:

1. Amount of removable burnable residues (t), estimated with annual crop production (ISTAT, several years [a], [b]; ISTAT, 2011 [a], [b]) and removable residues/product ratio (IPCC, 1997; CESTAAT, 1988; Borgioli, 1981).
2. Amount of dry residues in removable residue (t dry matter), calculated with amount of removable burnable residues and fraction of dry matter (IPCC, 1997; CESTAAT, 1988; Borgioli, 1981).
3. Amount of removable dry residues oxidized (t dry matter), assessed with amount of dry residues in the removable residues, burnt fraction of removable residues (CESTAAT, 1988) and fraction of residues oxidized during burning (IPCC, 1997).

4. Amount of carbon from removable residues burning release in air (t C), calculated with the amount of removable dry residue oxidized and the fraction of carbon from the dry matter of residues (IPCC, 1997; CESTAAT, 1988).
5. C-CH<sub>4</sub> from removable residues burning (t C-CH<sub>4</sub>), calculated with the amount of carbon from removable residues burning release in air and default emissions rate for C-CH<sub>4</sub>, equal to 0.005 (IPCC, 1997).
6. C-CO from removable residues burning (t C-CO), calculated with the amount of carbon from removable residues burning release in air and default emissions rate for C-CO, equal to 0.06 (IPCC, 1997).
7. Amount of nitrogen from removable residues burning release in air (t N), calculated with the amount of removable dry residue oxidized and the fraction of nitrogen from the dry matter of residues. The fraction of nitrogen has been calculated considering raw protein content from residues (dry matter fraction) divided by 6.25.
8. N-NO<sub>x</sub> from removable residues burning (t N-NO<sub>x</sub>), calculated with the amount of nitrogen from removable residues burning release in air and the default emissions rate for N- NO<sub>x</sub>, equal to 0.121 (IPCC, 1997).

NMVOC emissions have been considered equal to CH<sub>4</sub> emissions. As regards the other pollutants, the following emission factors have been used to estimate PAH, dusts and dioxins (Table 7.8).

Air pollutant	u.m.	Removable residues	References
PAH	g/t	8.58	TNO, 1995
PM10	g/t	3.3	TNO, 2001
PM2.5	g/t	2.8	TNO, 2001
Dioxins	µg/t	10	EMEP/CORINAIR, 2007

**Table 7.8 Emission factors for burning of agriculture residues**

Removable residues from agriculture production are estimated for each crop type such as cereal, green crop, permanent cultivation, from national statistics (ISTAT, several years [a], [b]; ISTAT, 2011 [a], [b]); most of these wastes refer especially to the prunes of olives and wine, because of the typical national cultivation. Activity data (agricultural production) used for estimating burning of agriculture residues are reported in Table 7.9.

Under the waste sector, the burning of removable agriculture residues that are collected and could be managed in different ways (disposed in landfills, used to produce compost or used to produce energy) is reported. Different percentages of the removable agriculture residue burnt for different residues are assumed, varying from 10% to 90%, according to national and international literature. Moreover, these removable wastes are assumed to be all burned in open air (e.g. on field) or in fireplaces without abatement technology control, taking in consideration the higher available CO, NMVOC, PM, PAH and dioxins emission factors as reported in the table above.

<b>Agricultural production</b>	<b>1990</b>	<b>1995</b>	<b>2000</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
	(kt)							
<b>Cereals</b>								
Wheat	8,108.5	7,946.1	7,427.7	7,717.1	7,181.7	7,170.2	8,859.4	6,534.7
Rye	20.8	19.8	10.3	7.9	8.6	9.0	10.8	12.2
Barley	1,702.5	1,387.1	1,261.6	1,214.1	1,297.4	1,225.3	1,236.7	1,049.2
Oats	298.4	301.3	317.9	429.2	394.9	361.1	356.1	314.4
Rice	1,290.7	1,320.9	1,245.6	1,444.8	1,450.0	1,540.1	1,333.0	1,644.1
Maize	5,863.9	8,454.2	10,139.6	10,427.9	9,626.4	9,809.3	9,722.9	8,143.0
Sorghum	114.2	214.8	215.2	184.9	221.4	193.2	224.6	243.4
<b>Woody crops</b>								
Grapes	8,438.0	8,447.7	8,869.5	8,553.6	8,326.7	7,392.4	7,813.0	7,578.4
Olives	912.5	3,323.5	2,810.3	3,774.8	3,415.7	3,249.8	3,473.9	3,600.5
Citrus Orchards	2,868.8	2,607.7	3,100.2	3,518.1	3,653.7	3,892.6	3,484.3	3,825.9
Orchards	5,793.5	5,406.6	5,948.6	6,036.0	5,998.0	5,955.6	5,855.9	6,144.9
Carobs	29.2	44.4	38.1	31.7	26.1	32.8	31.2	30.0
<b>Total</b>	<b>35,441.0</b>	<b>39,474.0</b>	<b>41,384.5</b>	<b>43,340.0</b>	<b>41,600.5</b>	<b>40,831.3</b>	<b>42,401.7</b>	<b>39,120.8</b>

**Table 7.9 Time series of crop productions (kt)**

#### ***Other waste (6D)***

Under this category, NMVOC emissions from compost production and NO<sub>x</sub> and ammonia emissions from the sludge spreading are reported.

The amount of waste treated in composting plants has shown a great increase from 1990 to 2009 (from 363,319 tons to 7,166,890 tons).

Information on input waste to composting plants is published yearly by ISPRA since 1996, including data for 1993 and 1994 (ANPA, 1998; APAT-ONR, several years; ISPRA, several years), while for 1987 and 1995 only data on compost production are available (MATTM, several years; AUSITRA-Assoambiente, 1995); on the basis of this information the whole time series has been reconstructed.

The composting plants are classified in two different kinds: the plants that treat a selected waste (food, market, garden waste, sewage sludge and other organic waste, mainly from the agro-food industry); and the mechanical-biological treatment plants, that treat the unselected waste to produce compost, refuse derived fuel (RDF), and a waste with selected characteristics for landfilling or incinerating system.

It is assumed that 100% of the input waste to the composting plants from selected waste is treated as compost, while in mechanical-biological treatment plants 30% of the input waste is treated as compost on the basis of national studies and references (Favoino and Cortellini, 2001; Favoino and Girò, 2001).

NMVOC emission factor (51 g NMVOC kg<sup>-1</sup> treated waste) is from international scientific literature too (Finn and Spencer, 1997).

As regard the sludge spreading, the total production of sludge from urban wastewater plants, as well as the total amount of sludge used in agriculture and some parameters such as N content, is communicated from 1995 by the Ministry for the Environment, Land and Sea from 1995 (MATTM,

2005; MATTM 2010) in the framework of the reporting commitments fixed by the European Sewage Sludge Directive (EC, 1986) transposed into the national Legislative Decree 27 January 1992, n. 99. From 1990 to 1994 activity data and parameters were reconstructed, as reported in detail in the Chapter 8 of the National Inventory Report on the Italian greenhouse gas inventory (ISPRA, 2011 [b]).

The amount of sewage N applied was calculated using the amount of sewage sludge (expressed in t dry matter) and the N content of sludge. It is assumed that the dry matter contained in sludge at national level is 25% of total sludge. In Table 7.10, the total amount of sewage sludge production as well as sludge used in agriculture and nitrogen content in sludge is reported.

The volatilization factor for N-NH<sub>3</sub>+NO<sub>x</sub> emissions is 20% (IPCC, 1997), whereas 16% is emitted as N-NH<sub>3</sub> and 4% as N-NO<sub>x</sub>.

Year	Sewage sludge production (t)	Sewage sludge used in agriculture (t)	Sewage sludge used in agriculture (t of dry matter)	N concentration in sludge (% dry matter)	Total N in sludge (t)
1990	3,272,148	392,658	98,164	5.0	4,875
1991	3,428,000	411,360	102,840	5.0	5,107
1992	3,155,825	378,699	94,675	5.0	4,702
1993	2,883,649	360,155	90,039	5.0	4,472
1994	2,660,337	510,022	127,505	5.0	6,332
1995	2,437,024	630,046	157,512	5.0	7,823
1996	2,563,404	698,019	174,505	5.0	8,667
1997	2,843,644	870,987	217,747	5.0	10,814
1998	3,532,924	777,256	194,314	5.3	10,292
1999	3,598,156	860,095	215,024	4.0	8,706
2000	3,402,016	869,696	217,424	5.0	10,954
2001	3,539,858	1,173,011	293,253	5.5	16,076
2002	3,771,044	1,208,448	302,112	5.1	15,339
2003	3,621,346	1,191,443	297,861	4.9	14,648
2004	3,880,940	780,643	195,161	4.1	8,055
2005	4,298,576	862,970	215,742	4.1	8,874
2006	4,280,324	758,220	189,555	4.1	7,778
2007	3,509,775	808,391	202,098	4.1	8,305
2008	3,040,723	778,663	194,666	4.5	8,841
2009	3,736,230	1,158,480	289,620	3.9	11,365

**Table 7.10 Sludge spreading activity data and parameters, 1990 – 2009**

### 7.3 Time series and key categories

The following Table 7.11 presents an outline of the weight of the different categories for each pollutant in the waste sector for the year 2009. Key categories are those shaded.

	6A	6Ca	6Cb	6Cc	6Cd	6Ce	6D
			%				
SO <sub>x</sub>		0.0006	0.10	0.004	0.02		
NO <sub>x</sub>		0.003	0.04	0.003	0.002	1.38	0.15
NH <sub>3</sub>	1.66						0.61
NM VOC	0.72	0.04	0.10	0.001	0.0001	1.23	0.03
CO		0.0002	0.004	0.0001	0.0004	10.85	
PM <sub>10</sub>		0.001	0.02	0.001	0.001	7.18	
PM <sub>2.5</sub>		0.001	0.03	0.001	0.001	7.38	
Pb		0.0007	1.71	0.02	0.000001		
Cd		0.001	2.36	0.10	0.000004		
Hg		0.03	1.89	0.05	0.001		
PAH		0.00001	0.07	0.001	0.000000001	27.35	
Dioxins		0.02	0.06	0.006	0.000001	16.24	
HCB		3.60	44.45	0.08			
PCB		0.59	0.46	0.07			

Note: blue shaded are key categories

**Table 7.11 Key categories in the waste sector in 2009**

The following pie charts show, for the main pollutants, the contribution of each sub-category to the total emissions from the waste sector, both for 1990 and 2009 (Figure 7.1, Figure 7.2, Figure 7.3 and Figure 7.4).

In particular, as regard dioxin emissions, waste sector accounts for 16.3% on the national total: from 1990 emissions have decrease nearly 70% as a consequence of the introduction of more stringent limits of these emissions for incineration plants (Figure 7.2 and Figure 7.5).

As for HCB emissions, it is important to point out that the waste incineration sector is the major source of HCB emissions, in particular the waste water sludge incineration, 13.0 Kg in 2009, which shows an increase with respect to the reference year, 10.4 Kg in 1990 (Figure 7.2).

Finally, in Table 7.12, time series emissions for each pollutant of the waste sector are reported.

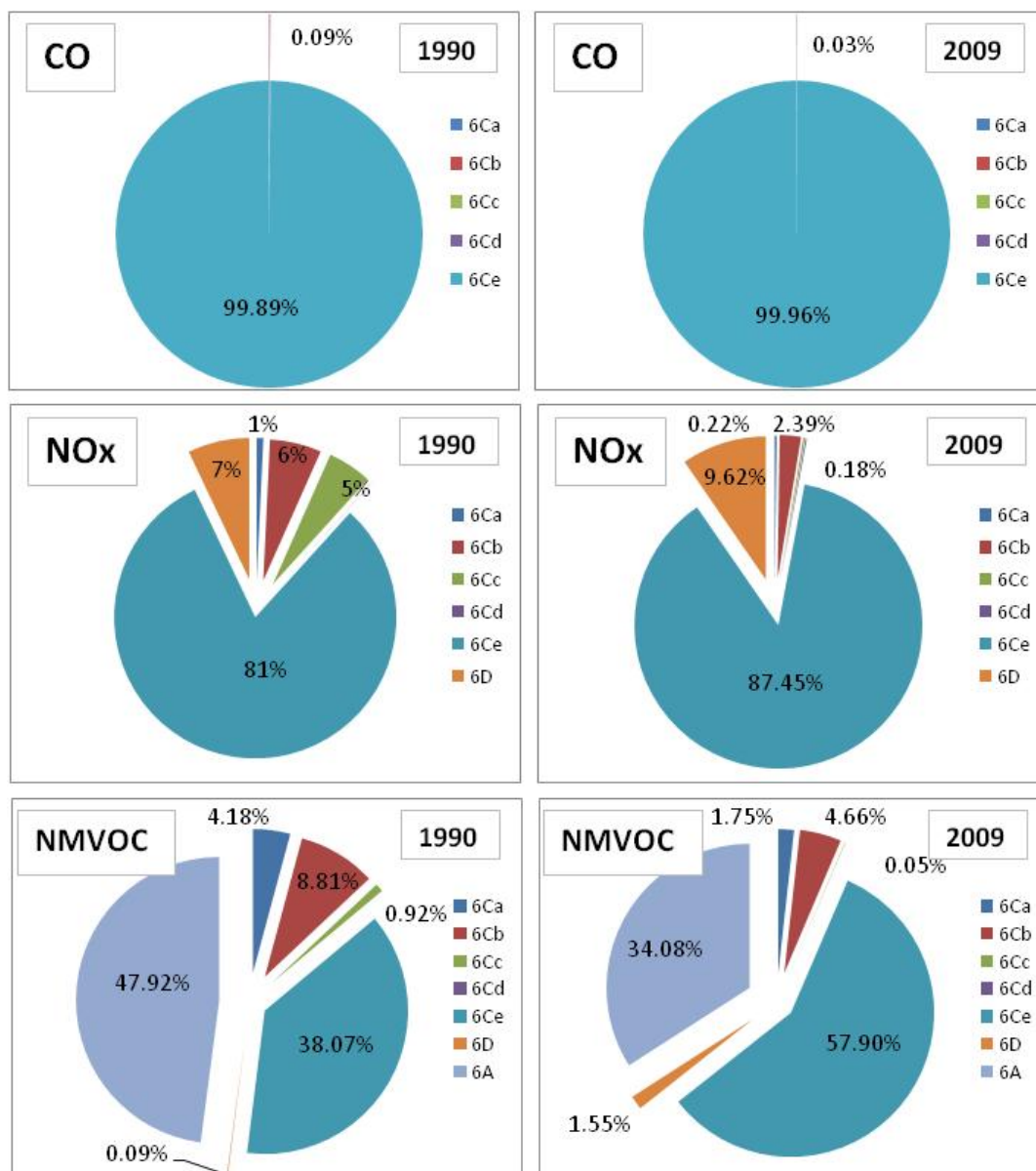


Figure 7.1 Contribution of CO, NO<sub>x</sub> and NMVOC sub-category emissions to waste sector total emissions

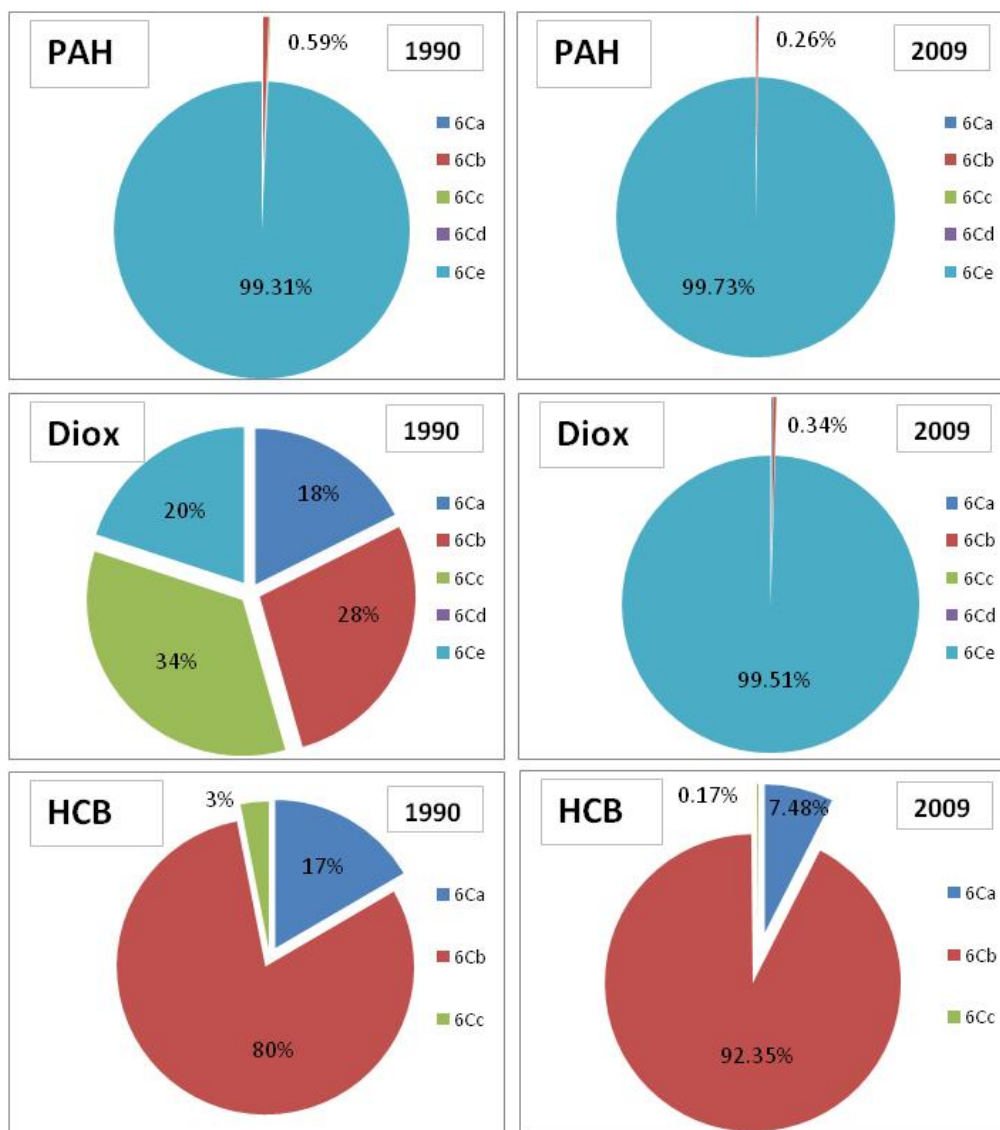
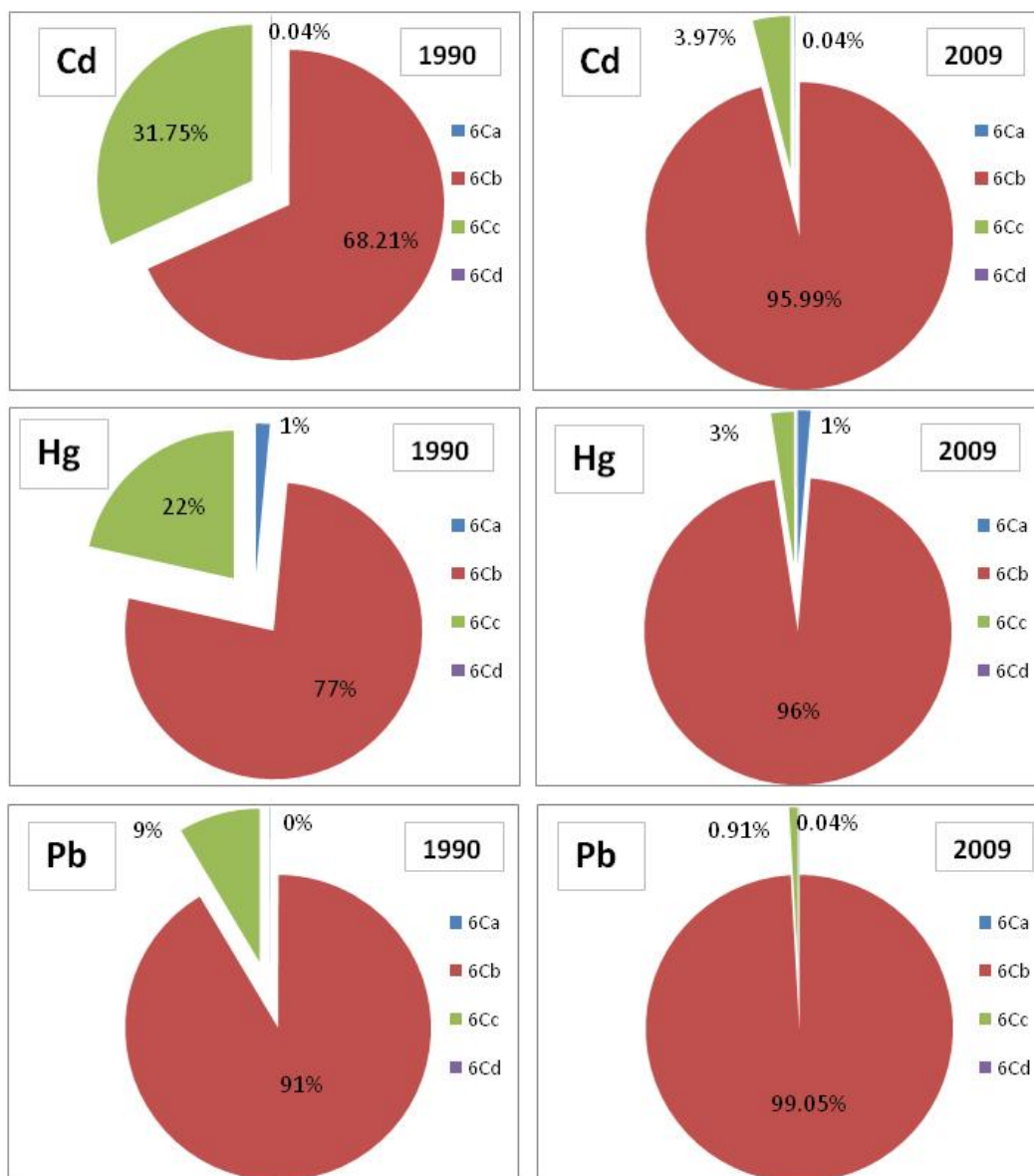


Figure 7.2 Contribution of POPs Annex III sub-category emissions to waste sector total emissions





**Figure 7.3 Contribution of priority heavy metals sub-category emissions to waste sector total emissions**

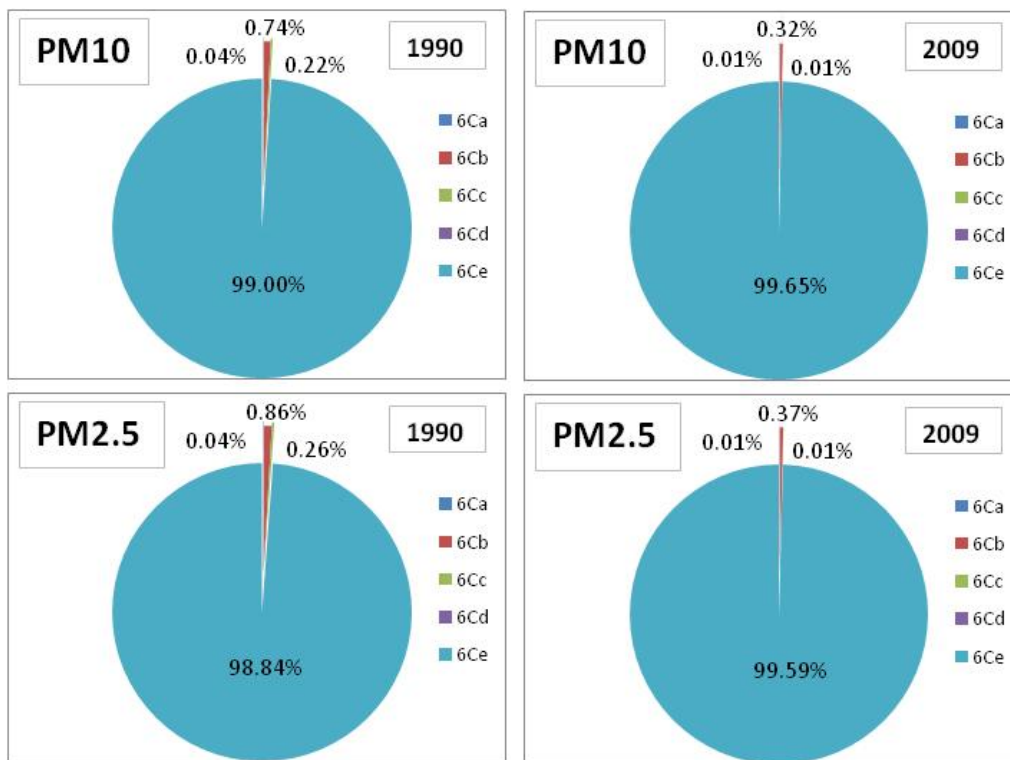


Figure 7.4 Contribution of PM10 and PM2.5 sub-category emissions to waste sector total emissions

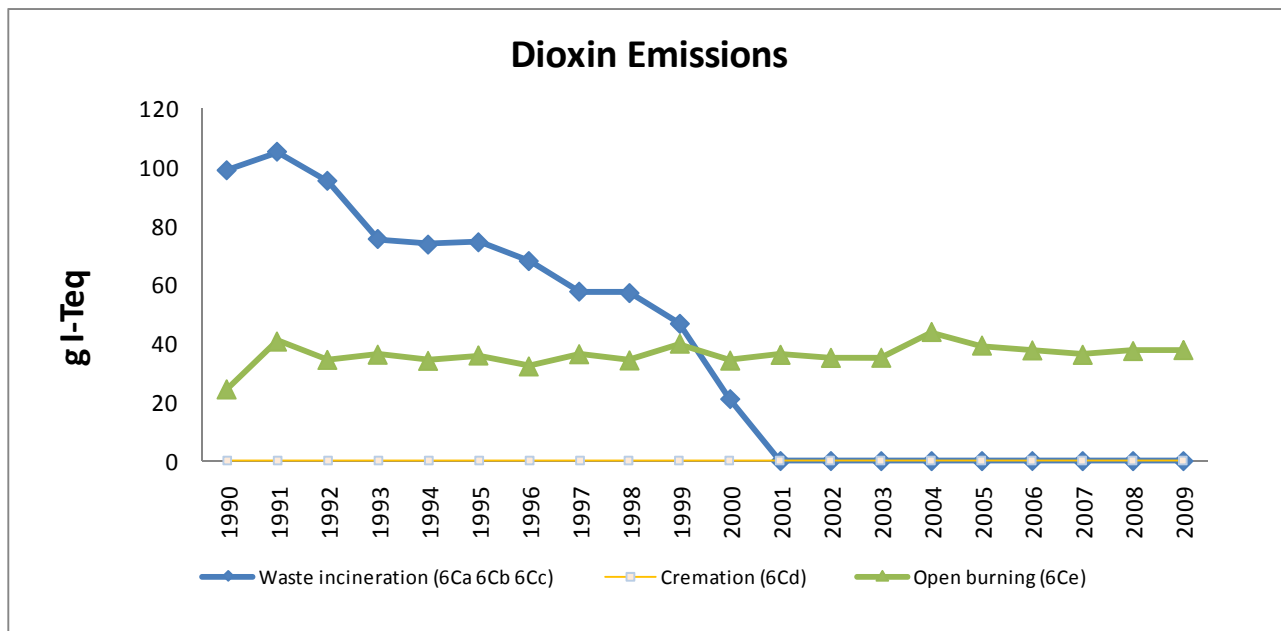


Figure 7.5 Time series of dioxin emissions of the waste sector by category (g I-Teq)

WASTE SECTOR	1990	1995	2000	2005	2006	2007	2008	2009
<b>Solid waste disposal (6A)</b>								
NMVOC (Gg)	9.567	9.978	11.514	9.731	9.315	8.902	8.382	7.991
NH <sub>3</sub> (Gg)	7.757	8.090	9.335	7.889	7.552	7.218	6.796	6.479
<b>Waste incineration (6C)</b>								
CO (Gg)	159.19	269.30	249.23	295.74	281.39	269.38	280.62	283.95
NO <sub>x</sub> (Gg)	8.44	13.70	12.26	14.53	13.89	13.27	13.76	14.04
NMVOC (Gg)	10.38	15.52	12.95	15.57	15.08	14.32	14.93	15.09
SO <sub>x</sub> (Gg)	0.50	0.44	0.23	0.27	0.30	0.27	0.28	0.28
PM10 (Gg)	8.21	11.98	11.37	13.05	12.51	12.02	12.44	12.44
PM2.5 (Gg)	7.05	10.28	9.75	11.19	10.73	10.31	10.67	10.67
PAH (t)	21.28	31.10	29.54	33.90	32.51	31.22	32.31	32.62
Dioxins (g I-Teq)	123.51	110.54	55.58	39.59	37.98	36.47	37.74	38.11
HCB (kg)	12.93	14.02	9.86	8.56	13.98	14.13	14.12	14.12
PCB (kg)	5.54	4.78	2.05	1.84	2.08	2.07	2.10	2.10
As (t)	0.06	0.05	0.03	0.03	0.03	0.03	0.03	0.03
Cd (t)	0.31	0.27	0.14	0.16	0.17	0.15	0.15	0.15
Cr (t)	0.62	0.55	0.28	0.32	0.36	0.31	0.32	0.32
Cu (t)	0.95	0.82	0.48	0.41	0.51	0.49	0.49	0.49
Hg (t)	0.28	0.25	0.12	0.15	0.17	0.15	0.15	0.15
Ni (t)	6.78	4.36	2.80	1.02	0.59	0.65	0.60	0.60
Pb (t)	6.29	5.88	2.54	3.83	4.12	3.42	3.63	3.63
Se (t)	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Zn (t)	3.20	3.11	1.37	2.11	2.36	1.99	2.11	2.11
<b>Compost production (6D)</b>								
NMVOC (Gg)	0.018	0.040	0.168	0.346	0.369	0.380	0.364	0.364
<b>Sludge spreading (6D)</b>								
NO <sub>x</sub>	0.641	1.028	1.440	1.166	1.022	1.092	1.162	1.494
NH <sub>3</sub>	0.956	1.539	2.207	1.888	1.685	1.793	1.890	2.380

**Table 7.12 Time series emissions in the waste sector by category and pollutant**

## 7.4 Recalculations

Recalculations in the sector involved NMVOC and NH<sub>3</sub> emissions from *solid waste disposal on land*, which account for an increase by 12% in average for the whole time series. In particular, the quantity of sludge disposed of in landfills has been updated since 1990, assimilated municipal solid wastes have been added, as well as waste compositions have been revised and updated.

Moreover, emissions from cremation of corpses and NO<sub>x</sub> emissions from sludge spreading have been estimated in this submission for the first time.

## 7.5 Planned improvements

Emissions from the landfill gas combustion in landfills flaring are under investigation and will be included in further submissions.

As for landfills, also emissions from the exceeding biogas which is flared in wastewater treatment plants are under investigation for what concern the emission factors and will be included in further submissions.

Concerning waste incineration, in order to improve QA/QC activity, a rearrangement of incinerators database is planned. Moreover, further investigation on cremation is planned.

## 8 Recalculations and Improvements

### 8.1 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 2009 have been submitted.

The percentage difference between the time series reported in the 2010 submission and the series reported this year (2011 submission) are shown in Table 8.1 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 2008 show a decrease for PAH, CO, SO<sub>x</sub>, Hg, Cd, and dioxins, whereas an increase is observed for PM<sub>10</sub>, PM<sub>2.5</sub>, Pb, NMVOC, NH<sub>3</sub> and NO<sub>x</sub>.

Relevant changes in the whole time series regarded, in particular, a revision of estimates for the wood biomass burnt in the *non industrial stationary combustion* sector (1A4) where emission estimates have been revised taking in account the emission factors published in the last version of the EMEP/EEA guidebook (EMEP/EEA, 2009) and the distribution of the different installations, including the innovative stoves, for the whole time series. The recalculation involved all the pollutants and resulted in high different figures for Cd and PAH, with lower emission estimates, and PM<sub>10</sub> and PM<sub>2.5</sub>, with higher values.

In the *energy* sector a further revision of the emission estimates regarded the road transport sector. Specifically, the upgraded version of COPERT model, version 8.0 (EEA, October 2010), has been applied to calculate emissions of all pollutants for the whole period 1990-2008. The new version of the model upgraded the methodology, the software and fixed some bugs, with respect to the previous submission, but did not produce significant changes with respect to the previous submission.

In response to the review process (UNECE, 2010) NMVOC emissions from *extraction and first treatment of solid fossil* fuels have been estimated and included in the inventory for the whole time series.

Update of SO<sub>x</sub> emission factors for diesel, gasoil and residual oil jointly with a revision of maritime activity data for 2008 resulted in a strong reduction of SO<sub>x</sub> emission in the same year.

In the *industrial processes* sector recalculations regarded the update of SO<sub>x</sub> emission factor for the *sulphuric acid* production for the years 2002-2008, Hg emissions from *chlorine* production, from 2003, and *ferroalloys* production activity data since 2002 and Hg emission factor from 1990 to 2006, on the basis of new information collected in the framework of the E-PRTR registry.

For the *solvent* sector the main modifications involved category 3D for emissions from both domestic solvent use and fat edible and non edible oil extraction. Specifically, the time series from 1994 to 1998 and from 2005 to 2008 has been revised considering an updating of the apparent consumption of cosmetics and from 2006 also modifications of fat edible and non edible oil activity data.

In the agriculture sector no recalculations have occurred while for the waste sector, recalculations affected NMVOC and NH<sub>3</sub> emissions from solid waste disposal on land, accounting in average for an increase by 12% in the whole time series. In response to the review process (UNECE, 2010)

emissions from the cremation of corps have also been estimated for the whole period.

	SO <sub>x</sub>	NO <sub>x</sub>	NH <sub>3</sub>	NMVOC	CO	PM10	PM2.5	Pb	Hg	Cd	DIOX	PAH
	%											
1980	0.4	0.5	0.4	0.0	-1.5							
1981	0.4	0.5	0.4	0.0	-1.5							
1982	0.4	0.5	0.4	0.0	-1.5							
1983	0.5	0.5	0.4	0.0	-1.5							
1984	0.6	0.5	0.4	0.0	-1.5							
1985	0.6	0.4	0.4	0.0	-1.5							
1986	0.0	-1.0	0.4	1.0	0.0							
1987	0.0	-1.0	0.4	1.0	0.0							
1988	0.0	-1.0	0.4	0.9	-0.1							
1989	0.0	-1.1	0.4	0.8	-0.1							
1990	0.0	-1.0	0.4	0.8	-0.6	5.2	6.1	0.0	-2.2	-2.1	0.0	-4.3
1991	0.0	-1.0	0.4	0.9	-0.7	6.0	7.0	0.0	-2.6	-2.3	0.0	-4.6
1992	0.0	-0.9	0.4	0.9	-0.7	6.3	7.4	0.1	-3.0	-2.7	0.0	-5.7
1993	0.0	-0.9	0.3	0.8	-0.7	5.8	6.8	0.1	-2.9	-2.7	-0.1	-5.4
1994	0.0	-0.9	0.4	1.0	-0.9	6.9	8.1	0.1	-3.6	-3.3	-0.1	-6.7
1995	0.0	-0.9	0.4	0.9	-1.0	6.6	7.8	0.1	-3.5	-3.3	-0.1	-6.8
1996	0.0	-1.2	0.5	0.7	-1.0	6.7	7.9	0.1	-3.6	-3.3	-0.1	-7.5
1997	0.0	-1.0	0.6	0.9	-1.3	7.5	8.9	0.1	-4.0	-3.8	-0.2	-8.0
1998	0.1	-0.9	0.6	1.0	-1.4	7.6	9.1	0.1	-4.3	-4.1	-0.2	-8.9
1999	0.1	-0.9	0.5	1.3	-1.8	8.5	10.2	0.1	-5.3	-4.8	-0.3	-9.9
2000	0.1	-1.2	0.6	1.5	-2.2	8.5	10.3	0.2	-4.9	-4.5	-0.4	-11.0
2001	0.1	-1.0	0.9	1.7	-2.4	8.7	10.6	0.2	-4.9	-4.7	-0.5	-11.5
2002	0.2	-1.1	0.9	1.5	-2.3	7.9	9.8	0.6	-4.2	-4.9	-0.5	-10.9
2003	0.2	-0.9	0.8	1.7	-2.7	8.6	10.6	0.6	-4.6	-5.2	-0.5	-11.6
2004	0.3	-0.9	0.6	2.0	-3.4	9.9	12.2	0.7	-5.2	-5.8	-0.7	-12.4
2005	0.3	-0.5	0.7	2.0	-3.5	10.1	12.6	0.6	-4.8	-5.2	-0.7	-12.1
2006	0.3	-0.3	0.7	2.3	-4.1	11.2	14.0	0.7	-5.2	-5.7	-0.7	-13.3
2007	0.4	0.0	0.7	3.0	-5.3	14.3	17.6	0.9	-6.7	-7.3	-0.9	-16.0
2008	-4.0	0.0	0.7	3.0	-5.8	14.3	17.6	0.9	-6.7	-7.3	-0.9	-16.0

**Table 8.1 Recalculation between 2010 and 2011 submissions**

## 8.2 Planned improvements

Specific improvements are specified in the 2011 QA/QC plan (ISPRA, 2011[c]); they can be summarized as follows.

For the *energy* and *industrial processes* sectors, a major progress will regard the finalisation of the database where information collected in the framework of different directives, Large Combustion Plant, E-PRTR 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.

A general revision will concern PAH, dioxin and heavy metals estimates in order to improve the accuracy and reduce the uncertainty.

The new chapters of the EMEP/EEA Guidebook 2009 (EMEP/EEA, 2009) will be considered and latest methodologies and update emission factors will be applied in the next year submission of the inventory.

The comparison between local inventories and national inventory and the meetings and exchange of information with local environmental agencies will continue.

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

## 9 Projections

The national projections reported within the UNECE Convention are calculated by the model GAINS Italy, the Italian version of the GAINS Europe model (Amman et al., 1999; IIASA, 2008). The estimations of SO<sub>2</sub>, NO<sub>x</sub>, NMVOC and NH<sub>3</sub> 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 and 2020. 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<sub>2</sub>, NO<sub>x</sub> e SO<sub>x</sub>. Markal Italy (Gracceva and Contaldi, 2004) is also used to develop the energy mitigation scenario also for the Fifth National Communication under the UN Convention on Climate Change (MATTM, 2009) and the EU GHG Monitoring Mechanism requirements.
- 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 Vialeto 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 9.1.

Moreover in Table 9.2, the national emission ceilings for Italy established by the D.Lgs. 171/2004 according to Annex I of the NEC directive are reported.

The latest projections show that the 2010 emissions ceilings will be reached for all the pollutants.

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://www.minambiente.it/>.



NFR codes	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	NMVOC
	<i>kt</i>			
1A1a: Public electricity and heat	82.85	43.24	1.50	21.62
1A1b,c: Other energy industries	25.50	47.13	0.09	0.80
1A2: Manufacturing industries & construction	117.51	42.88	0.40	32.06
1A3a: Civil aviation (LTO)	6.27	0.70		0.88
1A3b: Road transportation	447.60	0.70	11.00	191.84
1A3c: Railways	4.94			0.75
1A3d: Navigation	97.42	41.89	0.04	8.76
1A4a,b,c i: Commercial/Residential/Agriculture stationary	87.70	12.46	1.7	74.94
1A4b ii: Household and gardening (mobile)	0.01			1.91
1A4c ii: Off-road vehicles and other machinery	62.39	0.05	0.03	16.24
1A5b: Other, mobile (including military)	18.05	0.01	0.03	7.90
1B1b: Solid fuel transformation		2.03		
1B2a: Oil	8.86	29.89		39.65
1B2b: Natural gas				29.40
1B2c: Flaring in oil and gas extraction	0.32	8.88		
2B: Chemical industry	0.55	1.45	0.15	3.24
2C: Metal industry		7.74		20.41
2D: Other production		0.27		27.82
3A: Paint application				178.45
3B: Degreasing and dry cleaning				12.16
3C: Chemical products, manufacturing and processing				53.88
3D: Other				178.50
4B1: Cattle			192.07	
4B3-7 & 13: Other			26.86	
4B8: Swine			48.11	
4B9: Poultry			41.66	
4D1: Direct soil emissions			77.90	
4F: Field burning of agricultural waste	1.68	0.74		4.18
6A: Solid waste disposal on land				11.12
6C: Waste incineration	0.59	0.26		
7: Other	7.60	28.79	1.17	
<b>Total</b>	<b>969.84</b>	<b>269.11</b>	<b>408.65</b>	<b>916.51</b>

**Table 9.1 Emission projections for the year 2010**

NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	NMVOC
<i>kt</i>			
990	475	419	1159

**Table 9.2 National emission ceilings for Italy**

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## Annex A1 NFR codes

<b>1 A 1 a</b>	Public Electricity and Heat Production	<b>2 B 4</b>	Carbide Production
<b>1 A 1 b</b>	Petroleum refining	<b>2 B 5</b>	Other chemical industry
<b>1 A 1 c</b>	Manufacture of Solid Fuels and Other Energy Industries	<b>2 C 1</b>	Iron and steel Production
<b>1 A 2 a</b>	Manufacturing industries and construction (stationary combustion): Iron and Steel	<b>2 C 2</b>	Ferroalloys Production
<b>1 A 2 b</b>	Manufacturing industries and construction (stationary combustion): Non-ferrous Metals	<b>2 C 3</b>	Aluminium Production
<b>1 A 2 c</b>	Manufacturing industries and construction (stationary combustion): Chemicals	<b>2 C 5 a</b>	Copper Production
<b>1 A 2 d</b>	Manufacturing industries and construction (stationary combustion): Pulp, Paper and Print	<b>2 C 5 b</b>	Lead Production
<b>1 A 2 e</b>	Manufacturing industries and construction (stationary combustion): Food Processing, Beverages and Tobacco	<b>2 C 5 c</b>	Nickel Production
<b>1 A 2 f i</b>	Manufacturing industries and construction (stationary combustion): Other industries	<b>2 C 5 d</b>	Zinc Production
<b>1 A 2 f ii</b>	Mobile Combustion in Manufacturing Industries and Construction	<b>2 C 5 e</b>	Other metal production
<b>1 A 3 a ii (i)</b>	Civil Aviation (Domestic, LTO)	<b>2 C 5 f</b>	Storage, handling and transport of metal products
<b>1 A 3 a i (i)</b>	Civil Aviation (International, LTO)	<b>2 D 1</b>	Pulp and Paper
<b>1 A 3 b i</b>	Road Transport, Passenger cars	<b>2 D 2</b>	Food and Drink
<b>1 A 3 b ii</b>	Road Transport, Light duty vehicles	<b>2 D 3</b>	Wood processing
<b>1 A 3 b iii</b>	Road Transport, Heavy duty vehicles	<b>2 E</b>	Production of POPs
<b>1 A 3 b iv</b>	Road Transport, Mopeds & Motorcycles	<b>2 F</b>	Consumption of POPs and Heavy Metals (e.g. electrical and scientific equipment)
<b>1 A 3 b v</b>	Road Transport, Gasoline evaporation	<b>2 G</b>	Other production, consumption, storage, transportation or handling of bulk products
<b>1 A 3 b vi</b>	Road Transport, Automobile tyre and brake wear	<b>3 A 1</b>	Decorative coating application
<b>1 A 3 b vii</b>	Road Transport, Automobile road abrasion	<b>3 A 2</b>	Industrial coating application
<b>1 A 3 c</b>	Railways	<b>3 A 3</b>	Other coating application
<b>1 A 3 d i (ii)</b>	International inland waterways	<b>3 B 1</b>	Degreasing
<b>1 A 3 d ii</b>	National Navigation	<b>3 B 2</b>	Dry cleaning
<b>1 A 3 e</b>	Pipeline compressors	<b>3 C</b>	Chemical products
<b>1 A 4 a i</b>	Commercial / Institutional: Stationary	<b>3 D 1</b>	Printing
<b>1 A 4 a ii</b>	Commercial / Institutional: Mobile	<b>3 D 2</b>	Domestic solvent use including fungicides
<b>1 A 4 b i</b>	Residential: Stationary plants	<b>3 D 3</b>	Other product use
<b>1 A 4 b ii</b>	Residential: Household and gardening (mobile)	<b>4 B 1 a</b>	Cattle Dairy
<b>1 A 4 c i</b>	Agriculture/ Forestry / Fishing: Stationary	<b>4 B 1 b</b>	Cattle Non-Dairy
<b>1 A 4 c ii</b>	Agriculture/ Forestry / Fishing: Off-road Vehicles and Other Machinery	<b>4 B 2</b>	Buffalo
<b>1 A 4 c iii</b>	Agriculture/ Forestry / Fishing: National Fishing	<b>4 B 3</b>	Sheep
<b>1 A 5 a</b>	Other, Stationary (including Military)	<b>4 B 4</b>	Goats
<b>1 A 5 b</b>	Other, Mobile (Including military)	<b>4 B 6</b>	Horses
<b>1 B 1 a</b>	Fugitive emission from Solid Fuels: Coal Mining and Handling	<b>4 B 7</b>	Mules and Asses
<b>1 B 1 b</b>	Fugitive emission from Solid Fuels: Solid fuel transformation	<b>4 B 8</b>	Swine
<b>1 B 1 c</b>	Other fugitive emission from Solid Fuels	<b>4 B 9 a</b>	Laying Hens
<b>1 B 2 a i</b>	Exploration Production, Transport	<b>4 B 9 b</b>	Broilers
<b>1 B 2 a iv</b>	Refining / Storage	<b>4 B 9 c</b>	Turkeys
<b>1 B 2 a v</b>	Distribution of oil products	<b>4 B 9 d</b>	Other Poultry
<b>1 B 2 a vi</b>	Geothermal energy extraction	<b>4 B 13</b>	Other (rabbits and animal furs)
<b>1 B 2 b</b>	Natural gas	<b>4 D 1</b>	Synthetic N-fertilizers
<b>1 B 2 c</b>	Venting and flaring	<b>4 D 2 a</b>	Farm-level agricultural operations including storage, handling and transport of agricultural products
<b>2 A 1</b>	Cement Production	<b>4 D 2 b</b>	Off-farm storage, handling and transport of bulk agricultural products
<b>2 A 2</b>	Lime Production	<b>4 D 2 c</b>	N-excretion on pasture range and paddock
<b>2 A 3</b>	Limestone and Dolomite Use	<b>4 F</b>	Field burning of agricultural wastes
<b>2 A 4</b>	Soda Ash Production and use	<b>4 G</b>	Agriculture Other
<b>2 A 5</b>	Asphalt Roofing	<b>6 A</b>	Solid waste disposal on land
<b>2 A 6</b>	Road Paving with Asphalt	<b>6 B</b>	Waste-water handling
<b>2 A 7 a</b>	Quarrying and mining of minerals other than coal	<b>6 C a</b>	Clinical Waste Incineration
<b>2 A 7 b</b>	Construction and demolition	<b>6 C b</b>	Industrial Waste Incineration
<b>2 A 7 c</b>	Storage, handling and transport of mineral products	<b>6 C c</b>	Municipal Waste Incineration

<b>2 A 7 d</b>	Other Mineral products	<b>6 C d</b>	Cremation
<b>2 B 1</b>	Ammonia Production	<b>6 C e</b>	Small Scale Waste Burning
<b>2 B 2</b>	Nitric Acid Production	<b>6 D</b>	Other waste
<b>2 B 3</b>	Adipic Acid Production		

## A2 NFR and SNAP codes

SNAP Sector		NFR09 Code	NFR09 Longname		GNFR Sector
SNAP 1	←	1 A 1 a	Public electricity and heat production	→	A_PublicPower
SNAP 1	←	1 A 1 b	Petroleum refining	→	B_IndustrialComb
SNAP 1	←	1 A 1 c	Manufacture of solid fuels and other energy industries	→	B_IndustrialComb
SNAP 3	←	1 A 2 a	Stationary combustion in manufacturing industries and construction: Iron and steel	→	B_IndustrialComb
SNAP 3	←	1 A 2 b	Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	→	B_IndustrialComb
SNAP 3	←	1 A 2 c	Stationary combustion in manufacturing industries and construction: Chemicals	→	B_IndustrialComb
SNAP 3	←	1 A 2 d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	→	B_IndustrialComb
SNAP 3	←	1 A 2 e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	→	B_IndustrialComb
SNAP 3	←	1 A 2 f i	Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	→	B_IndustrialComb
SNAP 8	←	1 A 2 f ii	Mobile Combustion in manufacturing industries and construction: (Please specify in your IIR)	→	I_OffRoadMob
SNAP 8	←	1 A 3 a ii (i)	Civil aviation (Domestic, LTO)	→	J_AviLTO
SNAP 8	←	1 A 3 a i (i)	International aviation (LTO)	→	J_AviLTO
SNAP 7	←	1 A 3 b i	Road transport: Passenger cars	→	G_RoadRail
SNAP 7	←	1 A 3 b ii	Road transport: Light duty vehicles	→	G_RoadRail
SNAP 7	←	1 A 3 b iii	Road transport: Heavy duty vehicles	→	G_RoadRail
SNAP 7	←	1 A 3 b iv	Road transport: Mopeds & motorcycles	→	G_RoadRail
SNAP 7	←	1 A 3 b v	Road transport: Gasoline evaporation	→	G_RoadRail
SNAP 7	←	1 A 3 b vi	Road transport: Automobile tyre and brake wear	→	G_RoadRail
SNAP 7	←	1 A 3 b vii	Road transport: Automobile road abrasion	→	G_RoadRail
SNAP 8	←	1 A 3 c	Railways	→	G_RoadRail
SNAP 8	←	1 A 3 d i (ii)	International inland waterways	→	H_Shipping
SNAP 8	←	1 A 3 d ii	National navigation (Shipping)	→	H_Shipping
SNAP 1	←	1 A 3 e	Pipeline compressors	→	B_IndustrialComb
SNAP 2	←	1 A 4 a i	Commercial / institutional: Stationary	→	C_SmallComb
SNAP 8	←	1 A 4 a ii	Commercial / institutional: Mobile	→	I_OffRoadMob
SNAP 2	←	1 A 4 b i	Residential: Stationary plants	→	C_SmallComb
SNAP 8	←	1 A 4 b ii	Residential: Household and gardening (mobile)	→	I_OffRoadMob
SNAP 2	←	1 A 4 c i	Agriculture/Forestry/Fishing: Stationary	→	C_SmallComb
SNAP 8	←	1 A 4 c ii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	→	I_OffRoadMob
SNAP 8	←	1 A 4 c iii	Agriculture/Forestry/Fishing: National fishing	→	H_Shipping
SNAP 2	←	1 A 5 a	Other stationary (including military)	→	C_SmallComb
SNAP 8	←	1 A 5 b	Other, Mobile (including military, land based and recreational boats)	→	I_OffRoadMob
SNAP 5	←	1 B 1 a	Fugitive emission from solid fuels: Coal mining and handling	→	E_Fugitive
SNAP 4	←	1 B 1 b	Fugitive emission from solid fuels: Solid fuel transformation	→	E_Fugitive
SNAP 5	←	1 B 1 c	Other fugitive emissions from solid fuels	→	E_Fugitive
SNAP 5	←	1 B 2 a i	Exploration, production, transport	→	E_Fugitive
SNAP 4	←	1 B 2 a iv	Refining / storage	→	E_Fugitive
SNAP 5	←	1 B 2 a v	Distribution of oil products	→	E_Fugitive
SNAP 5	←	1 B 2 b	Natural gas	→	E_Fugitive
SNAP 9	←	1 B 2 c	Venting and flaring	→	E_Fugitive
SNAP 5	←	1 B 3	Other fugitive emissions from geothermal energy production , peat and other energy extraction not included in 1 B 2	→	E_Fugitive
SNAP 4	←	2 A 1	Cement production	→	D_IndProcess
SNAP 4	←	2 A 2	Lime production	→	D_IndProcess
SNAP 4	←	2 A 3	Limestone and dolomite use	→	D_IndProcess
SNAP 4	←	2 A 4	Soda ash production and use	→	D_IndProcess
SNAP 4	←	2 A 5	Asphalt roofing	→	D_IndProcess
SNAP 4	←	2 A 6	Road paving with asphalt	→	D_IndProcess
SNAP 5	←	2 A 7 a	Quarrying and mining of minerals other than coal	→	D_IndProcess
SNAP 4	←	2 A 7 b	Construction and demolition	→	D_IndProcess
SNAP 4	←	2 A 7 c	Storage, handling and transport of mineral products	→	D_IndProcess
SNAP 4	←	2 A 7 d	Other Mineral products	→	D_IndProcess
SNAP 4	←	2 B 1	Ammonia production	→	D_IndProcess
SNAP 4	←	2 B 2	Nitric acid production	→	D_IndProcess
SNAP 4	←	2 B 3	Adipic acid production	→	D_IndProcess
SNAP 4	←	2 B 4	Carbide production	→	D_IndProcess
SNAP 4	←	2 B 5 a	Other chemical industry	→	D_IndProcess
SNAP 4	←	2 B 5 b	Storage, handling and transport of chemical products	→	D_IndProcess
SNAP 4	←	2 C 1	Iron and steel production	→	D_IndProcess
SNAP 4	←	2 C 2	Ferroalloys production	→	D_IndProcess
SNAP 4	←	2 C 3	Aluminum production	→	D_IndProcess
SNAP 4	←	2 C 5 a	Copper production	→	D_IndProcess
SNAP 4	←	2 C 5 b	Lead production	→	D_IndProcess
SNAP 4	←	2 C 5 c	Nickel production	→	D_IndProcess
SNAP 4	←	2 C 5 d	Zinc production	→	D_IndProcess
SNAP 4	←	2 C 5 e	Other metal production	→	D_IndProcess
SNAP 4	←	2 C 5 f	Storage, handling and transport of metal products	→	D_IndProcess
SNAP 4	←	2 D 1	Pulp and paper	→	D_IndProcess
SNAP 4	←	2 D 2	Food and drink	→	D_IndProcess
SNAP 4	←	2 D 3	Wood processing	→	D_IndProcess
SNAP 4	←	2 E	Production of POPs	→	D_IndProcess
SNAP 4	←	2 F	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	→	D_IndProcess
SNAP 6	←	2 G	Other production, consumption, storage, transportation or handling of bulk products	→	D_IndProcess
SNAP 6	←	3 A 1	Decorative coating application	→	F_Solvents
SNAP 6	←	3 A 2	Industrial coating application	→	F_Solvents
SNAP 6	←	3 A 3	Other coating application	→	F_Solvents
SNAP 6	←	3 B 1	Degreasing	→	F_Solvents
SNAP 6	←	3 B 2	Dry cleaning	→	F_Solvents
SNAP 6	←	3 C	Chemical products	→	F_Solvents
SNAP 6	←	3 D 1	Printing	→	F_Solvents
SNAP 6	←	3 D 2	Domestic solvent use including fungicides	→	F_Solvents
SNAP 6	←	3 D 3	Other product use	→	F_Solvents



SNAP Sector		NFR09 Code	NFR09 Longname		GNFR Sector
SNAP 10	←	4 B 1 a	Cattle dairy	→	O_AgriLivestock
SNAP 10	←	4 B 1 b	Cattle non-dairy	→	O_AgriLivestock
SNAP 10	←	4 B 2	Buffalo	→	O_AgriLivestock
SNAP 10	←	4 B 3	Sheep	→	O_AgriLivestock
SNAP 10	←	4 B 4	Goats	→	O_AgriLivestock
SNAP 10	←	4 B 6	Horses	→	O_AgriLivestock
SNAP 10	←	4 B 7	Mules and asses	→	O_AgriLivestock
SNAP 10	←	4 B 8	Swine	→	O_AgriLivestock
SNAP 10	←	4 B 9 a	Laying hens	→	O_AgriLivestock
SNAP 10	←	4 B 9 b	Broilers	→	O_AgriLivestock
SNAP 10	←	4 B 9 c	Turkeys	→	O_AgriLivestock
SNAP 10	←	4 B 9 d	Other poultry	→	O_AgriLivestock
SNAP 10	←	4 B 13	Other	→	O_AgriLivestock
SNAP 10	←	4 D 1 a	Synthetic N-fertilizers	→	P_AgriOther
SNAP 10	←	4 D 2 a	Farm-level agricultural operations including storage, handling and transport of agricultural products	→	P_AgriOther
SNAP 10	←	4 D 2 b	Off-farm storage, handling and transport of bulk agricultural products	→	P_AgriOther
SNAP 10	←	4 D 2 c	N-excretion on pasture range and paddock unspecified	→	P_AgriOther
SNAP 10	←	4 F	Field burning of agricultural wastes	→	O_AgriWastes
SNAP 10	←	4 G	Agriculture other(c)	→	P_AgriOther
SNAP 9	←	6 A	Solid waste disposal on land	→	L_OtherWasteDisp
SNAP 9	←	6 B	Waste-water handling	→	M_WasteWater
SNAP 9	←	6 C a	Clinical waste incineration (d)	→	N_WasteIncinc
SNAP 9	←	6 C b	Industrial waste incineration (d)	→	N_WasteIncinc
SNAP 9	←	6 C c	Municipal waste incineration (d)	→	N_WasteIncinc
SNAP 9	←	6 C d	Cremation	→	N_WasteIncinc
SNAP 9	←	6 C e	Small scale waste burning	→	N_WasteIncinc
SNAP 9	←	6 D	Other waste(e)	→	L_OtherWasteDisp
SNAP 5	←	7 A	Other (included in national total for entire territory)	→	R_Other
SNAP 11	←	1 A 3 a ii (ii)	Civil aviation (Domestic, Cruise)	→	K_CivilAviCruise
SNAP 11	←	1 A 3 a i (ii)	International aviation (Cruise)	→	T_IntAviCruise
SNAP 11	←	1 A 3 d i (i)	International maritime navigation	→	z_Memo
SNAP 11	←	1 A 3	Transport (fuel used)	→	z_Memo
SNAP 11	←	7 B	Other not included in national total of the entire territory	→	z_Memo
SNAP 11	←	11 A	Volcanoes	→	S_Natural
SNAP 11	←	11 B	Forest fires	→	S_Natural
SNAP 11	←	11 C	Other natural emissions	→	S_Natural