ISPRA
Istituto Superiore per la Protezione
e la Ricerca Ambientale

Italian Emission Inventory 1990 - 2010

Informative Inventory Report 2012

161 / 2012

RAPPORTI

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Rapporti 161/2012

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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 2010, 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 mean for comparing the relative contribution of different emission sources and supporting 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 the work related to inventory compilation.

In particular, in compliance with the LRTAP Convention, Italy has to submit annually data on national emissions of SO_X, NO_X, NMVOC, CO and NH_3, and various heavy metals and POPs. The submission consists of the national emission inventory, communicated through compilation of the Nomenclature Reporting Format (NRF), and the informative inventory report (IIR) to ensure the properties of transparency, consistency, comparability, completeness and accuracy.

In the period 1990-2010, emissions from most pollutants described in this report show a downward trend. Reductions are especially relevant for the main pollutants (SO_X -88%; NO_X -52%; CO -62%; NMVOC -46%) and lead (-94%) whereas a significant raise is observed for polycyclic aromatic hydrocarbons (+54%).

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_X 90%; NO_X 98%; CO 86%; PM2.5 88%; Cd 84%). 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_X 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_3 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%, 20% and 13%, respectively).

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

1 INTRODUCTION

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

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

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

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

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

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

Table 1.1 *Dates of signature and ratification of the UNECE Convention and Protocols*

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

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

Main Pollutants

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

Particulate matter

- TSP, total suspended particulate;
- PM10, particulate matter less than 10 microns in diameter;
- PM2.5, particulate matter less than 2.5 microns in diameter.

Heavy Metals

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

Persistent organic pollutants (POPs)

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

1.2 National Inventory

As a Party to the *United Nations Economic Commission for Europe* (UNECE) *Convention on Long Range Transboundary Air Pollution* (CLRTAP), Italy has to submit annually data on emissions of air pollutants in order to fulfil obligations, in compliance with the implementation of Protocols under the Convention. Parties are required to report on annual national emissions of SO_X, NO_X, NMVOC, CO and NH_3, and various heavy metals and POPs according to the *Guidelines for 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 2010, including descriptions of methods, data sources, QA/QC activities carried out and a trend analysis. The inventory accounts for anthropogenic emissions of the following substances: sulphur oxides (SO_X), nitrogen oxides (NO_X), ammonia (NH_3), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), total suspended particulate (TSP), particulate matter, particles of size <10 µm, (PM10), particulate matter, particles of size < 2.5µm, (PM2.5), lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As), chromium

(Cr), copper (Cu), nickel (Ni), selenium (Se), zinc (Zn), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAH), dioxins (Diox), hexachlorobenzene (HCB). Other pollutants are reported either as not estimated or not occurring, further investigation is planned to verify these emissions.

Detailed information on emission figures of primary pollutants, particulate matter, heavy metals and persistent organic pollutants as well as estimation procedures are provided in order to improve the transparency, consistency, comparability, accuracy and completeness of the inventory provided.

The national inventory is updated annually in order to reflect revisions and improvements in the methodology and the availability of new information. Changes are applied retrospectively to earlier years, which accounts for any difference in previously published data.

Total emissions by pollutant from 1990 to 2010 are reported in Table 1.2.

Table 1.2 *Emission time series by pollutant*

		1990	1995	2000	2005	2006	2007	2008	2009	2010
SO_X	*Gg*	1,794	1,320	749	403	381	338	283	232	210
NO_X	*Gg*	2,014	1,893	1,421	1,212	1,158	1,127	1,057	973	964
NMVOC	*Gg*	2,015	2,085	1,607	1,317	1,286	1,261	1,194	1,131	1,080
NH_3	*Gg*	468	449	449	416	411	420	409	393	379
CO	*Gg*	7,093	7,043	4,802	3,446	3,234	3,098	2,964	2,725	2,711
As	*Mg*	37	27	45	40	41	41	42	42	45
Cd	*Mg*	10	9	9	8	8	9	9	7	8
Cr	*Mg*	93	75	52	60	61	63	61	50	55
Cu	*Mg*	183	199	198	208	209	212	206	189	193
Hg	*Mg*	11	10	9	10	10	11	10	9	10
Ni	*Mg*	123	114	105	111	109	106	103	104	111
Pb	*Mg*	4,414	2,028	944	280	288	312	301	232	270
Se	*Mg*	10	10	11	12	12	12	12	10	11
Zn	*Mg*	927	908	870	945	1,015	1,022	1,001	729	875
TSP	*Gg*	291	292	254	244	243	257	253	244	250
PM10	*Gg*	244	243	209	197	197	207	204	198	202
PM2.5	*Gg*	211	210	178	166	165	176	173	169	173
PAH	*Mg*	99	113	115	136	140	152	153	139	153
Dioxin	*g IT_q*	466	455	374	307	316	332	323	251	262
HCB	*kg*	43	38	24	21	27	26	26	23	23
PCB	*kg*	278	289	253	267	275	275	269	197	219

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

1.3 Institutional arrangements

The 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 21st May 2004. Every five years, starting from 2012 with reference to 2010 emissions, ISPRA shall provide the disaggregation of the national emission inventory at provincial level as established by the Legislative Decree n. 155 of 13th August 2010. 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 7th March 2008. The Ministry for the Environment, Land and Sea is responsible for the endorsement of the inventory and for the communication to the Secretariat of the different conventions.

The *Italian National System*, currently in place, is fully described in the document '*National Greenhouse Gas Inventory System in Italy*' (ISPRA, 2012[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/EEA guidebook, 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 MIT (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 information about 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 estimates are affected by a high uncertainty, sectoral studies 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 (MIT), and data supplied directly by the relevant professional associations.

Emission factors and methodologies used in the estimation process are consistent with the EMEP/EEA 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 Release and Transfer Register (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 relevant 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.

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.

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

SECTOR	ACTIVITY DATA	SOURCE
1 Energy 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
2 Industrial Processes	Production data	National Statistical Yearbooks- National Institute of Statistics International Statistical Yearbooks-UN European Emissions Trading Scheme European Pollutant Release and Transfer Register Sectoral Industrial Associations
3 Solvent and Other Product Use	Amount of solvent use	National Environmental Publications - Sectoral Industrial Associations International Statistical Yearbooks - UN
4 Agriculture	Agricultural surfaces Production data Number of animals Fertilizer consumption	Agriculture Statistical Yearbooks - National Institute of Statistics Sectoral Agriculture Associations
5 Land Use, Land Use Change and Forestry	Forest and soil surfaces Amount of biomass Biomass burnt Biomass growth	Statistical Yearbooks - National Institute of Statistics State Forestry Corps National and Regional Forestry Inventory Universities and Research Institutes
6 Waste	Amount of waste	National Waste Cadastre - Institute for Environmental Protection and Research , National Waste Observatory

Methodologies are consistent with the *EMEP/EEA 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, 2012 [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, these figures do not always 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 7th 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 Release and Transfer Register (Italian PRTR) are also used in the development of emission estimates or taken into account as a verification of emission estimates for some specific categories. Italian PRTR data are reported by operators to national and local competent authorities for quality assessment and validation. ISPRA collects facilities' reports and supports the validation activities at national and at local level. ISPRA communicates to the Ministry for the Environment, Land and Sea and to the European Commission within 31st March 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, the national 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 from 2007 and to the 1990. Results are reported in the following tables for the year 1990 (Table 1.4) and 2010 (Table 1.5) by pollutant.

The trend analysis has also been applied considering 1990 and 2010. The results are reported in Table 1.6.

Table 1.4 *Key categories for the Italian Emission Inventory in 1990*

	Key categories in 1990												**Total** (%)
SO_x	1A1a (42.9%)	1A2 (16.6%)	1A1b (10.7%)	1A3d ii (4.3%)	1B2a iv (3.8%)	1A3b i (3.4%)							81.7
NO_x	1A3b i (26.2%)	1A1a (20.3%)	1A3b iii (16.8%)	1A2 (12.2%)	1A4c ii (5.1%)								80.6
NH_3	4B1a (29.6%)	4B1b (25.5%)	4D1a (15.7%)	4B8 (10.4%)									81.2
NMVOC	1A3b i (24.2%)	1A3b iv (12.2%)	1A3b v (8.9%)	3A1 (7.6%)	3A2 (5.8%)	3D2 (5.8%)	1A3d ii (4.8%)	3C (3.8%)	1A4c ii (3.3%)	3D3 (3.3%)	1B2a v (3.0%)		82.6
CO	1A3b i (67.1%)	1A3b iv (7.0%)	1A2 (4.3%)	1A4c ii (3.8%)									82.2
PM10	1A1a (15.5%)	1A2 (14.6%)	1A4b i (10.9%)	1A3b i (7.9%)	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
PM2.5	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%)	2C1 (2.8%)			82.8
Pb	1A3b i (77.5%)	1A2 (6.0%)											83.4
Cd	1A2 (55.8%)	2C1 (13.1%)	1A4a i (7.7%)	1A4b i (7.0%)									83.6
Hg	1A2 (36.5%)	2B5a (24.5%)	2C1 (20.0%)										81.0
PAH	2C1 (44.9%)	6Ce (21.4%)	1A4b i (18.7%)										85.0
Dioxin	1A2 (25.2%)	1A4a i (22.6%)	2C1 (14.4%)	6Cc (9.1%)	6Cb (7.0%)	6Ce (5.3%)							83.6
HCB	4G (54.9)	6Cb (24.3%)	1A2 (11.3%)										90.6
PCB	1A1a (40.7%)	2C1 (32.9%)	1A2 (20.1%)										93.8

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 2010*

	Key categories in 2010												**Total** (%)
SO_x	1A2 (22.5%)	1A1b (19.5%)	1A1a (14.8%)	1B2a iv (11.8%)	1A3d ii (10.5%)	2A1 (4.9%)							84.0
NO_x	1A3b iii (23.2%)	1A3b i (19.0%)	1A2 (11.3%)	1A3d ii (9.5%)	1A3b ii (8.0%)	1A4c ii (5.3%)	1A4a i (4.6%)						80.8
NH_3	4B1b (23.2%)	4B1a (22.3%)	4D1a (13.8%)	4B8 (12.9%)	4B9b (4.4%)	4B2 (4.1%)							80.9
NMVOC	1A3b iv (17.7%)	1A4b i (12.7%)	3D2 (10.2%)	3A1 (9.6%)	3C (7.1%)	1A3d ii (5.4%)	1A3b i (4.4%)	3A2 (4.3%)	3D3 (2.8%)	1B2b (2.7%)	2D2 (2.6%)	1A4a i (2.5%)	82.1
CO	1A4b i (26.9%)	1A3b i (17.9%)	1A3b iv (16.0%)	6Ce (9.6%)	1A2 (8.6%)	1A3d ii (5.6%)							84.6
PM10	1A4b i (43.2%)	1A2 (6.2%)	6C e (5.8%)	1A3b vi (4.6%)	1A3b i (4.5%)	4B9b (4.5%)	1A3b ii (3.3%)	1A3d ii (3.2%)	2C1 (2.8%)	1A3b iii (2.7%)			80.8
PM2.5	1A4b i (50.0%)	1A2 (6.8%)	6Ce (5.8%)	1A3b i (5.2%)	1A3b ii (3.9%)	1A3d ii (3.7%)	1A3b iii (3.1%	1A4c ii (3.0%))					81.6
Pb	1A2 (38.6%)	1A4a i (26.4%)	2C1 (24.6%)										89.6
Cd	1A4a i (40.5%)	1A2 (30.4%)	2C1 (13.1%)										84.0
Hg	1A4a i (30.7%)	2C1 (27.3%)	1A2 (26.0%)										83.9
PAH	1A4b i (48.0%)	2C1 (21.8%)	6Ce (19.8%)										89.6
Dioxin	2C1 (29.1%)	1A2 (23.8%)	1A4b i (23.3%)	6Ce (13.4%)									89.6
HCB	6Cb (45.4%)	1A4a i (29.6%)	1A2 (14.5%)										89.5
PCB	2C1 (42.4%)	1A1a (27.9%)	1A4a i (17.3%)										87.6

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 1990-2010*

	Key categories in trend												Total (%)
SO_X	1A1a (35.3%)	1B2 a iv (14.8%)	1A1b (11.0%)	1A3 d ii (7.7%)	1A2 (7.4%)	2A1 (4.7%)							80.8
NO_X	1A1a (31.9%)	1A3b i (14.4%)	1A3b iii (12.6%)	1A3d ii (9.4%)	1A3b ii (9.2%)	1A4a i (7.6%)							85.1
NH_3	4B1a (29.2%)	4B2 (12.9%)	4B8 (10.3%)	4B1b (9.1%)	1A3b i (8.5%)	4D1 a (7.4%)	4B9 b (4.5%)						81.9
NMVOC	1A3b i (27.8%)	1A4b i (15.1%)	1A3b v (10.4%)	1A3b iv (7.9%)	3D2 (6.2%)	3C (4.7%)	1A4a i (3.2%)	1A4c ii (3.1%)	3A1 (2.8%)				81.2
CO	1A3b i (46.4%)	1A4b i (22.7%)	1A3b iv (8.5%)	6Ce (6.9%)									84.4
PM10	1A4b i (40.5%)	1A1a (18.3%)	1A2 (10.6%)	1A4c ii (5.0%)	1A3b i (4.3%)	1A3b iii (3.8%)							82.4
PM2.5	1A4b i (43.1%)	1A1 a (18.2%)	1A2 (10.4%)	1A4c ii (5.2%)	1A3b i (4.4%)								81.3
Pb	1A3 b i (42.2%)	1A2 (17.8%)	1A4a i (14.3%)	2C1 (12.6%)									86.9
Cd	1A4a i (47.6%)	1A2 (36.9%)											84.4
Hg	1A4a i (37.3%)	2B5 (31.8%)	1A2 (14.5%)										83.6
PAH	1A4b i (45.2%)	2C1 (35.6%)											80.8
Dioxin	1A4 a i (21.3%)	1A4b i (20.8%)	2C1 (16.5%)	6Cc (10.3%)	6Ce (9.2%)	6Cb (7.9%)							86.0
HCB	4G (47.2%)	1A4a i (24.1%)	6Cb (18.9%)										90.3
PCB	1A4a i (27.6%)	1A1a (23.7%)	1A2 (23.5%)	2C1 (17.4%)									92.2

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

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 in the current inventory compilation are figured out in the annual QA/QC plans (ISPRA, 2012 [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.

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.

Technical reviews of emission data submitted under the CLRTAP convention are undertaken periodically for each Party. Specifically, an in depth review of the Italian inventory was carried out in 2010. A summary of the main findings can be found in the relevant technical report at the address

http://www.ceip.at/fileadmin/inhalte/emep/pdf/2010/IT_Stage3_Review_Report_2010.pdf.

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 Gains Italy project implemented by ENEA and supported by ISPRA and the regional authorities. In 2012, ISPRA will finalise the provincial inventory for the year 2010 and update the previous inventory years.

In addition to these expert panels, ISPRA participates in technical working groups within the National Statistical System. These groups, named *Circoli di qualità* ("Quality Panels"), 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 practices in the last year regarded the progress on management of information collected in the framework of different European obligations, Large Combustion Plant, E-PRTR and Emissions Trading, which are gathered together in an informative system thus highlighting the main discrepancies among data, detecting potential errors and improving the time series consistency. ISPRA collects these data from the industrial facilities and the inventory team manages all this information and makes use of it in the preparation of the national inventory. The informative system is based on identification codes to trace back individual point sources in different databases. The database is in continuous improvement 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* 2012 (ISPRA, 2012 [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 mean 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_X emissions from manure management, from cattle, buffalo, swine and other livestock categories, and NO_X emissions from direct soil emission, from the use of fertilizers in soils, 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 (SOX)

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 2010. Figure 2.1 also illustrates the share of SO_X emissions by category in 1990 and 2010 as well as the total and sectoral variation from 1990 to 2010.

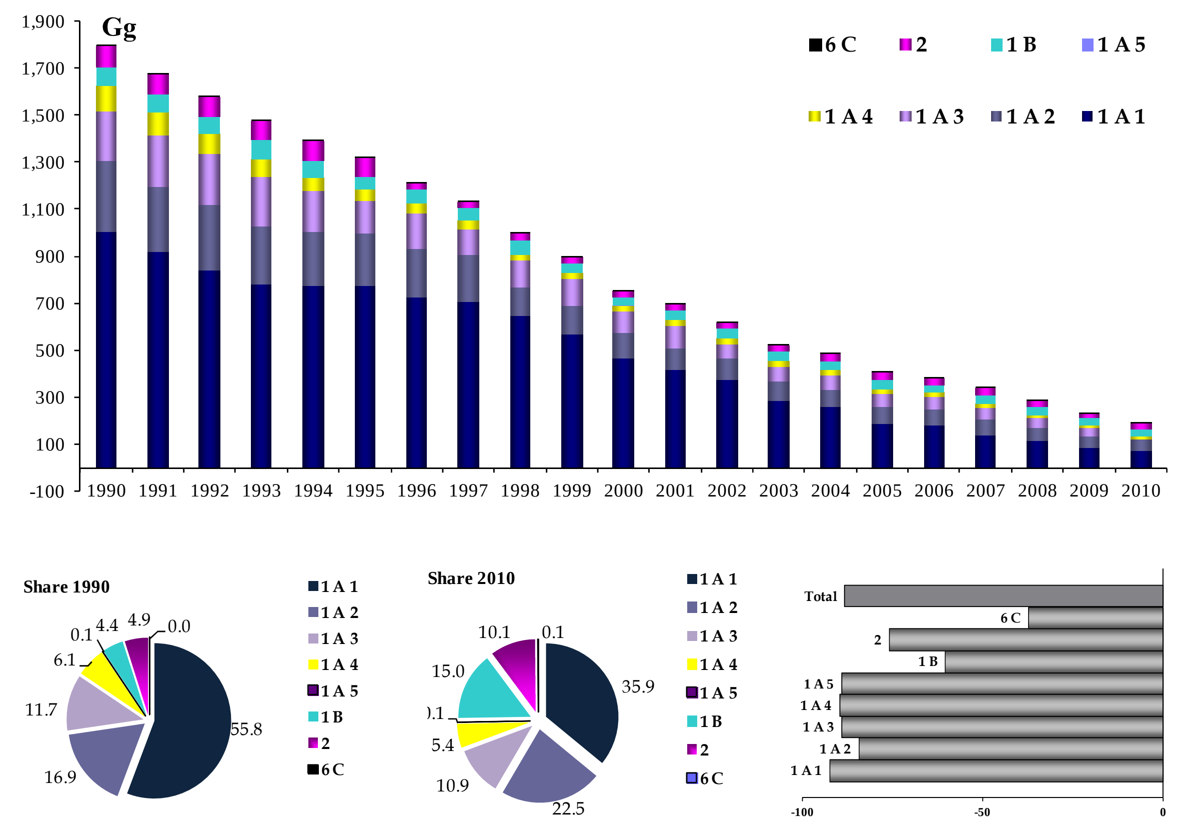


Figure 2.1 *SO_X emissions trend, percentage share by sector and variation 1990-2010*

Table 2.1 *SO_X emission trend from 1990 to 2010 (Gg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
				Gg					
Combustion in energy and transformation industries	1,001	776	467	187	184	139	113	88	76
Non industrial combustion plants	96	35	23	20	18	17	12	12	11
Combustion - Industry	299	215	104	73	66	67	59	43	47
Production processes	156	125	50	59	53	59	51	45	46
Road transport	130	72	12	2	2	2	2	0	0
Other mobile sources and machinery	100	86	84	51	48	46	39	38	23
Waste treatment and disposal	13	11	10	11	9	9	8	6	7
Total	***1,794***	***1,320***	***749***	***403***	***381***	***338***	***283***	***232***	***210***

Figures show a general decline of SO_X emissions during the period, from 1,794 Gg in 1990 to 210 Gg in 2010. The national target of SO_X 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* (-92%) and in *industry* (-84%), representing in 2010 about 36%, and 23% of the total, respectively. Emissions deriving from *non industrial combustion plants* (-88%) and *road transport* (-100%) show a strong decrease too, but these emissions represent only about 5% and 0.2% of the total in 2010, respectively. *production processes* and *other mobile sources and machiner*y also present a significant decreasing trend, showing an influence on the total of 22% and 11% and dropping by about -70% and -77%, respectively.

Since SO_X emissions are included in the NEC directive, an explanation of the sectoral decreasing trend, starting from the early eighties, is outlined more in details in the following.

Combustion in energy and transformation industries

The trend of emissions of this sector shows a reduction in the early eighties mainly due to the use of natural gas in place of coal in the energy production 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_X 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 of 24th May 1988), laying down rules concerning the authorisation of plants, and the Ministerial Decree of 12th 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 Ministerial Decree of 8th May 1989, gave a contribution to the reduction of emissions in the sector.

Finally, in recent years, a further shift to natural gas in place of fuel oil has contributed to a decrease in emissions.

Non industrial combustion plants

The declining of the emissions occurred mainly as a result of the increase in natural gas and LPG as alternative fuel 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 as the category previously analyzed, as both in the scope of the same rules.

Production processes

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

Road transport

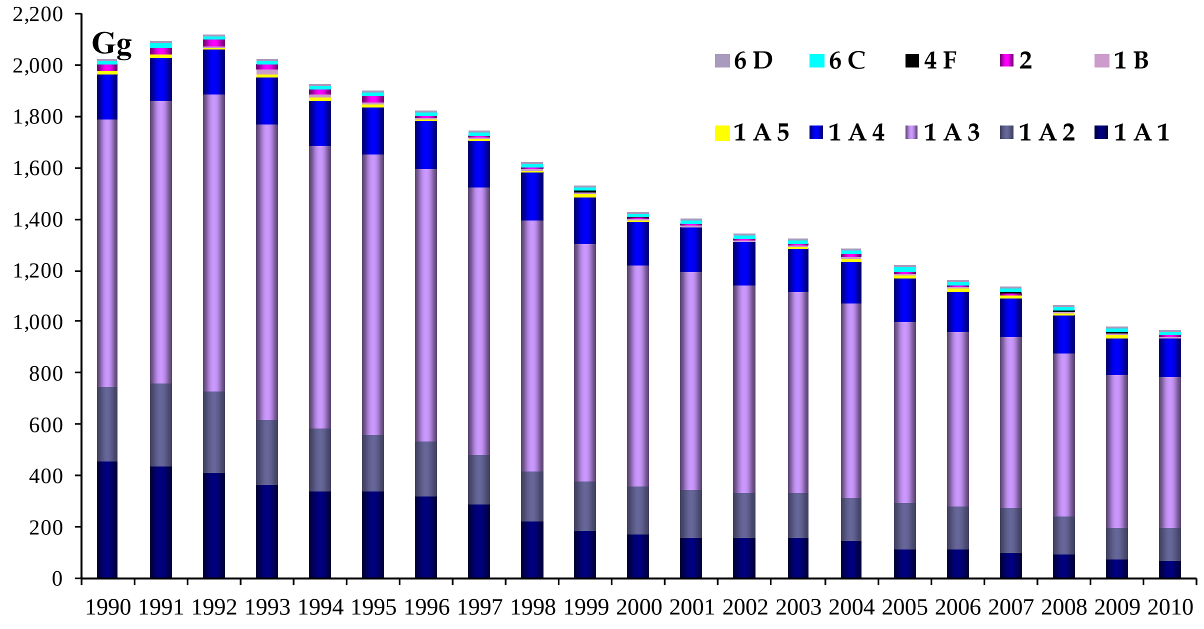
The reduction of emissions is mainly due to the introduction of Directives regulating the sulphur content in liquid fuels.

Other mobile sources and machinery

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

2.1.2 Nitrogen oxides (NOX)

The national atmospheric emissions of nitrogen oxides show a decreasing trend in the period 1990-2010, from 2,014 Gg to 964 Gg. Figure 2.2 and Table 2.2 show emission figures from 1990 to 2010. Figure 2.2 also illustrates the share of NO_X emissions by category in 1990 and 2010 as well as the total and sectoral variation from 1990 to 2010.



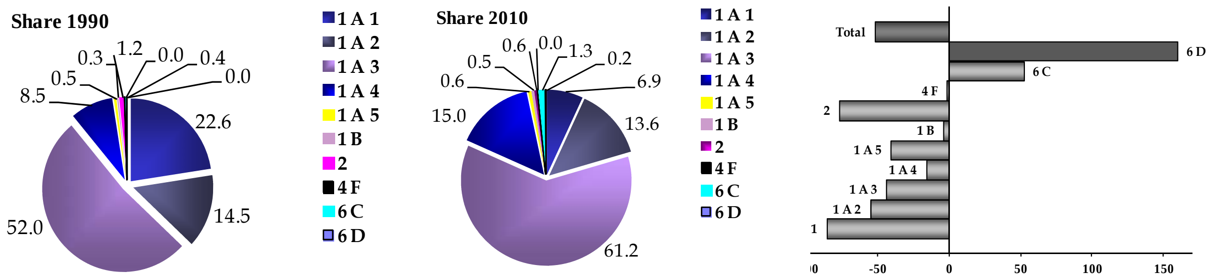


Figure 2.2 *NO_X emission trend, percentage share by sector and variation 1990-2010*

Table 2.2 *NO_X emission trend from 1990 to 2010 (Gg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
				Gg					
Combustion in energy and transformation industries	457	344	173	117	114	102	92	74	68
Non industrial combustion plants	61	61	64	76	74	75	79	81	86
Combustion - Industry	246	177	148	148	146	147	128	102	109
Production processes	30	31	9	16	13	11	9	12	10
Road transport	939	989	745	607	579	575	543	502	491
Other mobile sources and machinery	270	275	268	232	217	201	190	187	185
Waste treatment and disposal	9	15	14	16	15	15	15	16	15
Agriculture	0	1	0	0	0	0	0	0	0
Total	***2,014***	***1,893***	***1,421***	***1,212***	***1,158***	***1,127***	***1,057***	***973***	***964***

Total emissions show a reduction of about 52% from 1990 to 2010, 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 51% in 2010), which shows a reduction of 48% between 1990 and 2010; *other mobile sources and machinery* in 2010 contributes to the total emissions for 19% and have reduced by 32% from 1990. Combustion in energy and in industry shows a decrease of about 85% and 56%, respectively, having a share on the total of about 7% and 11%, 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 58% and 41%, respectively, but accounting only for 2% and 9% of the total, respectively.

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

Combustion in energy and transformation industries

Emissions from this sector show an upward trend until 1988 due to an increase in energy consumption, not prevented by reduction measures. From 1988 onwards, emissions present a gradual reduction due, mainly, to the introduction of the two regulatory instruments already mentioned for sulphur dioxide: the DPR 203/88 (Decree of President of the Republic of 24th May 1988), laying down rules for the authorization of facilities and the Ministerial Decree of 12th July 1990, which introduces plant emission limits. The adoption of these regulations, as the Ministerial Decree of 8th May 1989 on large combustion plants, has led to a shift in energy consumption from oil with high sulphur content to oil with lower sulphur content and to natural gas.

In recent years, the conversion to the use of natural gas to replace fuel oil has intensified, thanks to incentives granted for the improvement of energy efficiency. These measures, together with those of promoting renewable energy and energy saving, have led to a further reduction of emissions in the sector.

Non industrial combustion plants

The increase in emissions is explained by the growing trend of energy consumption during the period considered. This is due to the fact that in the last twenty years all the new buildings are equipped with heating system and old buildings have been 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 one hand, the growth of both the fleet and the mileage, on the other hand 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 2010 at 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_X limits from 1st January 1999, with a following decreasing trend particularly in recent years. Regarding aviation, in the absence of specific legislation up to now, emissions have increased in relation to the growth in air traffic.

2.1.3 *Ammonia (NH3)*

The national atmospheric emissions of ammonia show a slight decline in the period 1990-2010, from 468 Gg to 379 Gg. Figure 2.3 and Table 2.3 report the emission figures from 1990 to 2010. Figure 2.3 also illustrates the share of NH_3 emissions by category in 1990 and 2010 as well as the total and sectoral variation from 1990 to 2010.

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

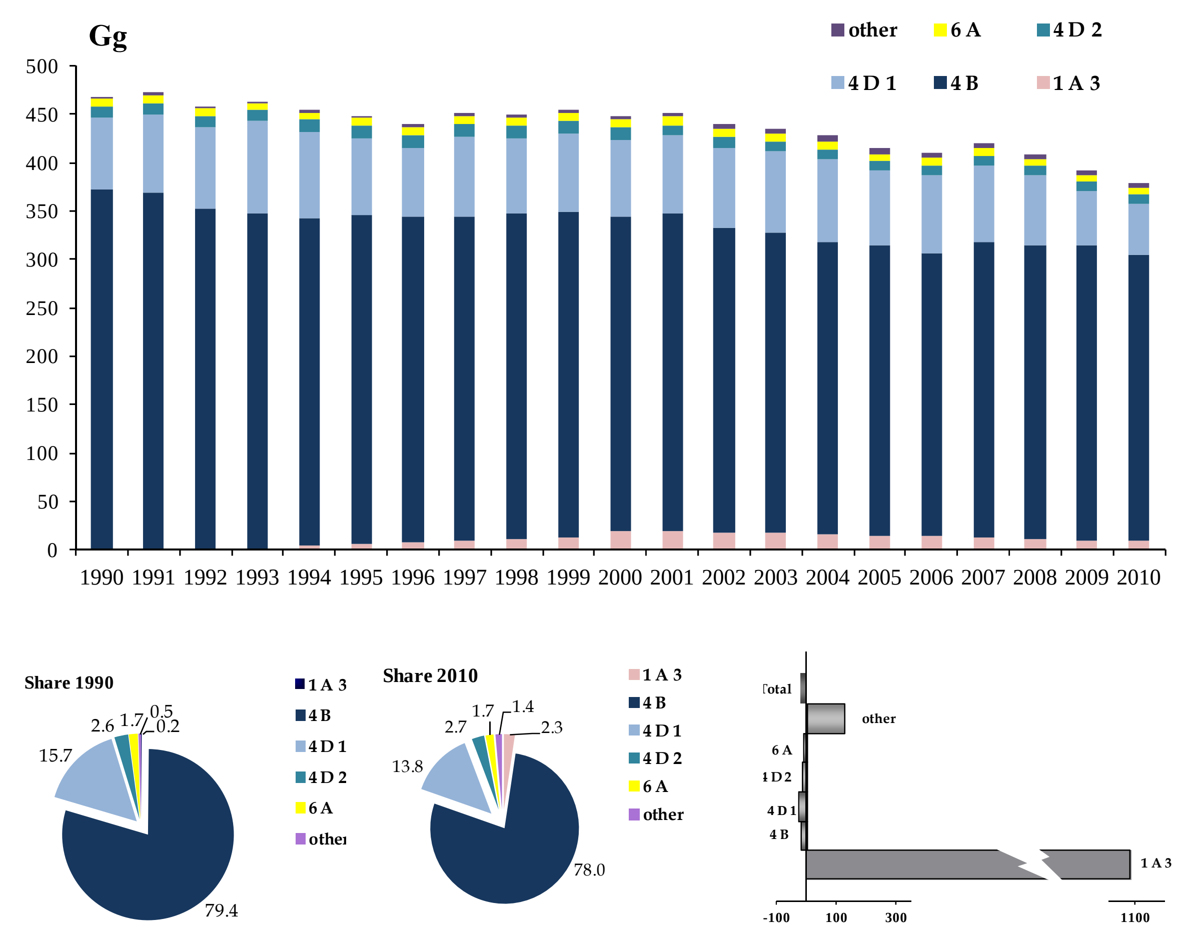


Figure 2.3 *NH_3 emission trend, percentage share by sector and variation 1990-2010*

Table 2.3 *NH_3 emission trend from 1990 to 2010 (Gg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Gg				
Combustion in energy and transformation industries	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
Non industrial combustion plants	0.2	0.3	0.3	0.5	0.5	0.7	0.7	0.8	0.8
Combustion - Industry	0.1	0.1	0.1	3.4	2.3	1.6	1.8	1.5	1.2
Production processes	0.8	0.4	0.3	0.5	0.6	0.4	0.4	0.4	0.4
Road transport	0.7	5.6	19.5	14.8	13.9	12.5	11.1	10.1	8.9
Other mobile sources and machinery	0.0	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	9.1	9.2
Agriculture	457.3	432.4	416.7	386.7	383.9	395.1	385.9	370.7	358.3
Total	***468***	***449***	***449***	***416***	***411***	***420***	***409***	***393***	***379***

In 2010 *agriculture* is the main source of emissions, with a 95% contribution out of the total NH_3 emissions; from 1990 to 2010 emissions from this sector show a decrease of about 22%. Emissions from *road transport* show a strong increase, but the share on the total is only about 2%. Emissions from *waste treatment and disposa*l, accounting also only for 2% of the total, show an increase of about 6%. Emissions from *combustion in energy and transformation industries* show an increase of about 23%, but in 2010 the contribution to total emissions is almost zero. Emissions from *non industrial combustion plants* decrease considerably, 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 48%, 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 1990-2010. Figure 2.4 and Table 2.4 illustrate the emissions values from 1990 to 2010. Figure 2.4 also illustrates the share of NMVOC emissions by category in 1990 and 2010 as well as the total and sectoral variation from 1990 to 2010.

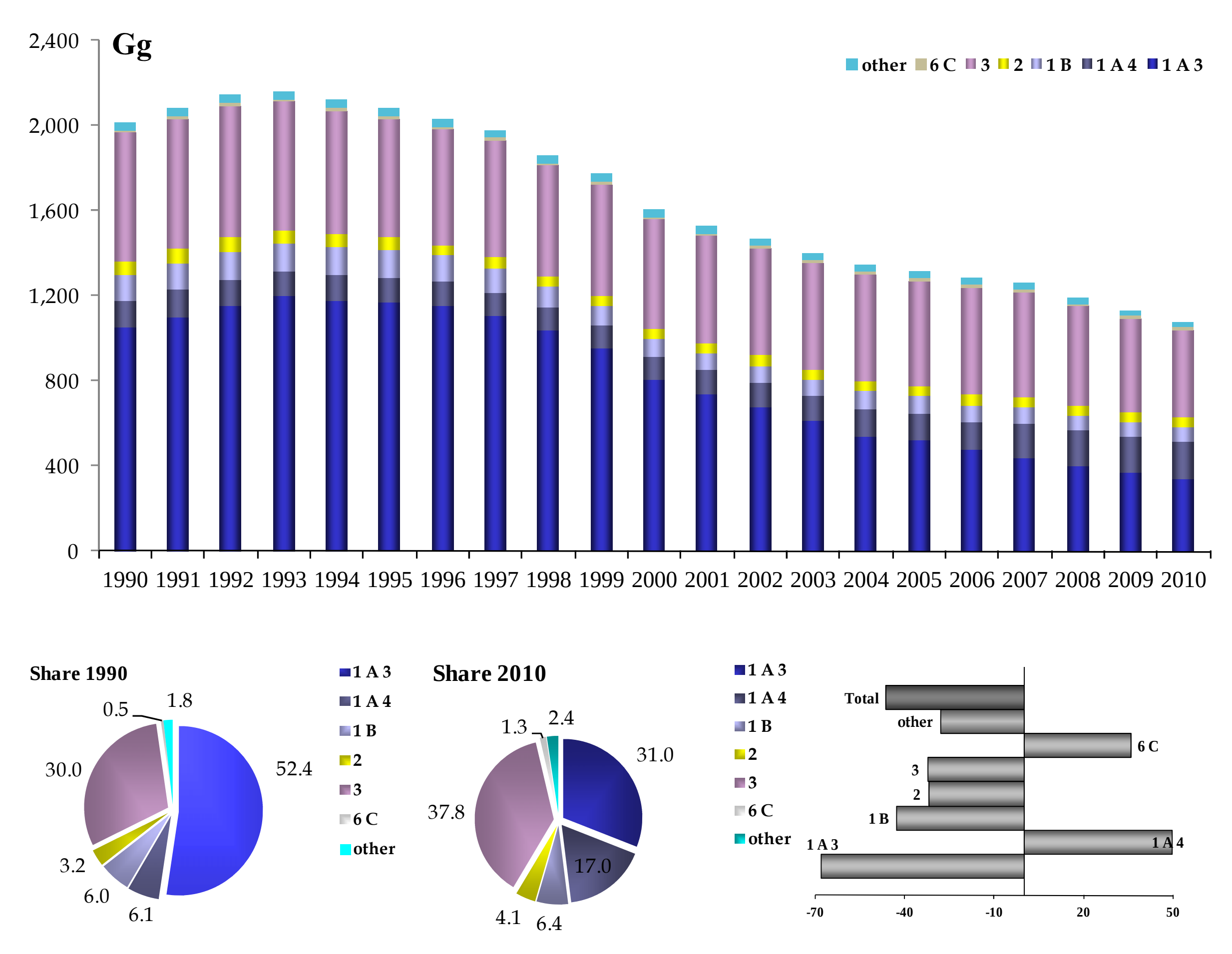


Figure 2.4 *NMVOC emission trend, percentage share by sector and variation 1990-2010*

The global emission trend shows a reduction of about 46% between 1990 and 2010, from 2,015 Gg to 1,080 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 38% and showing a decrease of about 32%. The main reductions relate to the *road transport* sector (-71%), accounting for 25% of the total and to the sector of *extraction and distribution of fossil fuels/geothermal energy* (-46%), accounting only for 5%. Emissions from *other mobile sources and machinery*, accounting for 7% of the total, decrease of about 57%. Emissions from *non industrial combustion plants* show the largest increase (294%), accounting for 16%. Emissions from *waste treatment and disposal*, accounting only for 2%, show an increase of about 13%, while emissions from *combustion in industry* show a decrease of about 12%, accounting for less than 1%. Emissions from *agriculture* decrease of about 9%, accounting for less than 1%.

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

Table 2.4 *NMVOC emission trend from 1990 to 2010 (Gg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Gg				
Combustion in energy and transformation industries	8	7	6	6	6	6	5	5	5
Non industrial combustion plants	43	55	69	103	111	144	149	161	170
Combustion - Industry	7	8	8	8	8	8	7	6	6
Production processes	95	86	71	76	78	78	70	65	64
Extraction and distrib. of fossil fuels / geothermal energy	91	104	57	54	51	48	48	47	49
Solvent and other product use	604	558	513	491	500	489	466	436	408
Road transport	958	1,057	703	430	390	353	321	293	274
Other mobile sources and machinery	187	184	155	122	116	110	102	94	80
Waste treatment and disposal	20	26	25	26	25	24	24	24	23
Agriculture	1	1	1	1	1	1	1	1	1
Total	***2,015***	***2,085***	***1,607***	***1,317***	***1,286***	***1,261***	***1,194***	***1,131***	***1,080***

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 of 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, in many cases, local authorities have imposed abatement equipments in the industrial painting sector and forced the replacement of open loop with closed loop laundry machines even before the EU Directive 99/13/EC (EC, 1999) came into force.

Road transport

The trend of emissions in this sector is characterized by a first stage of reduction in the early eighties, which occurred despite the increase of consumption and mileage because of the gradual adjustment of the national fleet to the European legislation, ECE Regulation 15 and subsequent amendments, introducing 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 legislation, which provide the use of catalytic device to reduce exhaust and evaporative emissions from cars, NMVOC emissions gradually reduced.

A different explanation of the emission trend pertains to the nineties. In fact, in this period an increase of the fleet and 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 16th 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 21st 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 1990-2010, from 7,093 Gg to 2,711 Gg. The emission figures from 1990 to 2010 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 2010, as well as the total and sectoral variation from 1990 to 2010.

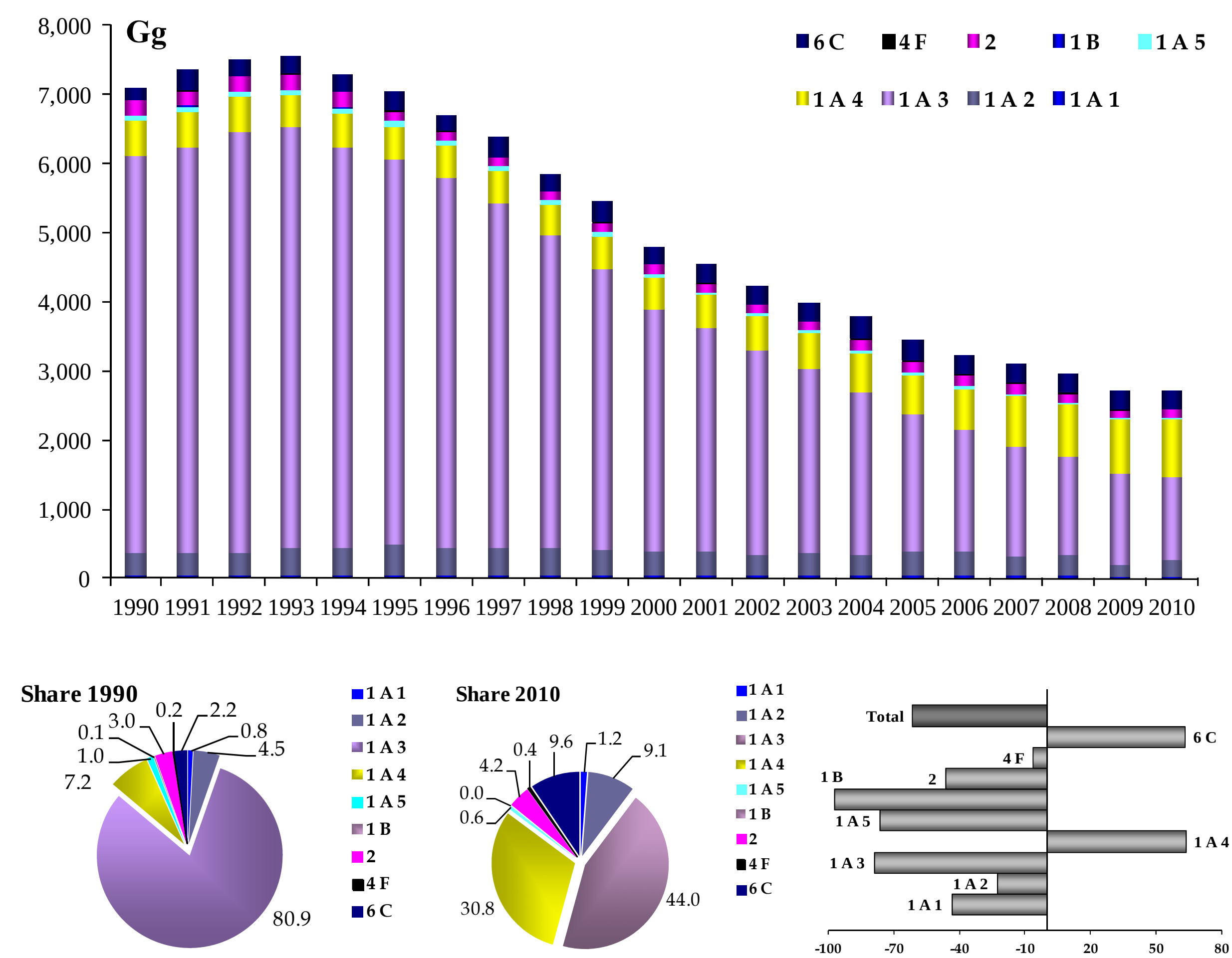


Figure 2.5 *CO emission trend, percentage share by sector and variation 1990-2010*

Table 2.5 *CO emission trend from 1990 to 2010 (Gg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Gg				
Combustion in energy and transformation industries	59	54	56	54	54	40	38	32	33
Non industrial combustion plants	215	282	347	481	523	661	691	750	784
Combustion - Industry	306	411	312	326	323	267	283	155	233
Production processes	224	140	129	144	149	139	134	101	115
Road transport	5,551	5,372	3,301	1,785	1,562	1,391	1,236	1,119	1,032
Other mobile sources and machinery	567	503	396	348	330	319	288	272	243
Waste treatment and disposal	159	269	249	296	281	269	281	284	260
Agriculture	13	13	12	13	12	13	13	12	12
Total	***7,093***	***7,043***	***4,802***	***3,446***	***3,234***	***3,098***	***2,964***	***2,725***	***2,711***

The decrease in emissions (-62%) is mostly due to the trend observed for the transport sector (including road, railways, air and maritime transport) which shows a total reduction from 1990 to 2010 of about 79%. Specifically by sector, emissions from *road transport* and *other mobile sources and machinery*, accounting in 2010 respectively for 38% and 9% of the total, show a decrease from 1990 to 2010 of about 81% and 57% respectively. On the other hand, emissions from *non industrial combustion plants*, representing about 29% of the total, show a strong increase between 1990 and 2010, equal to 264% due to the increase of wood combustion for heating; figures show a strong increase in emissions from *waste treatment and disposal* too (63%), whose share is 10% 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 1990-2010, from 244 Gg to 202 Gg. Figure 2.6 and Table 2.6 illustrate the emission trend from 1990 to 2010. Figure 2.6 also illustrates the share of PM10 emissions by category in 1990 and 2010 as well as the total and sectoral variation from 1990 to 2010.

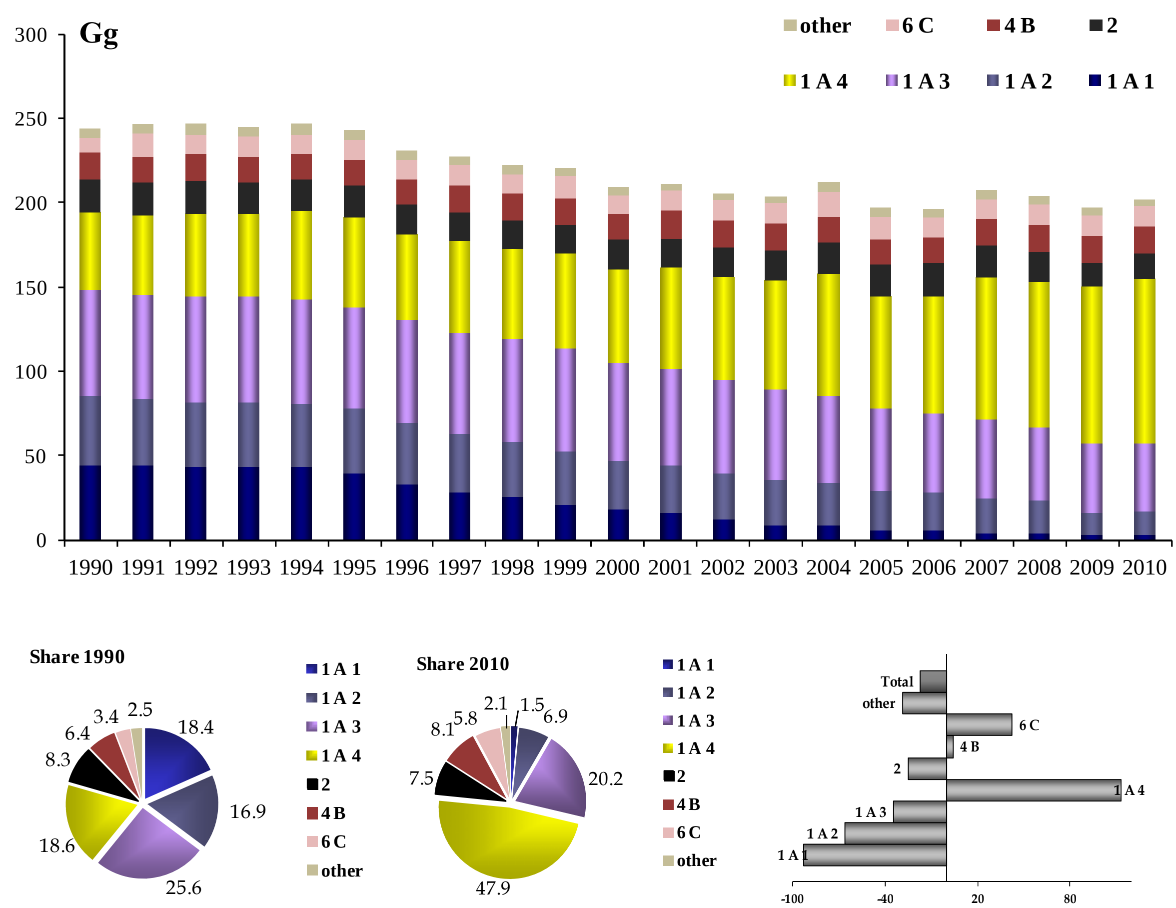


Figure 2.6 *PM10 emission trend, percentage share by sector and variation 1990-2010*

Table 2.6 *PM10 emission trend from 1990 to 2010 (Gg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
			Gg						
Combustion in energy and transformation industries	45	40	18	6	6	4	4	3	3
Non industrial combustion plants	29	34	39	54	59	75	78	85	91
Combustion - Industry	36	33	24	20	20	18	18	12	12
Production processes	22	20	19	20	21	20	19	15	16
Extraction and distribution of fossil fuels / geothermal energy	1	1	1	1	1	1	1	1	1
Solvent and other product use	0	0	0	0	0	0	0	0	0
Road transport	55	53	50	42	40	40	37	35	34
Other mobile sources and machinery	32	33	30	24	21	19	17	16	15
Waste treatment and disposal	8	12	11	13	13	12	12	13	12
Agriculture	18	18	17	18	17	18	18	18	18
Total	***244***	***243***	***209***	***197***	***197***	***207***	***204***	***198***	***202***

A considerable amount of emissions is mostly to be attributed to *road transport* (17% in 2010); from 1990 to 2010 the trend shows a reduction of about 38%. In 2010 *other mobile sources and machinery*, accounting for 8% of the total, shows a reduction of about 52%. Emissions from *non industrial combustion plants* and from *combustion in industry* account for about 45% and 6% of the total respectively, but while the former shows an increase of about 217%, the latter decreases of by about 65%. Emissions from *production processes* accounting for 8% of the total in 2010 decrease of about 29% between 1990 and 2010. The largest decrease (-93%) is observed in emissions deriving from *combustion in energy and transformation industries*, whose 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 2010, with a variation from 211 Gg to 173 Gg. Figure 2.7 and Table 2.7 illustrate the emission trend from 1990 to 2010. Figure 2.7 also illustrates the share of PM2.5 emissions by category in 1990 and 2010 as well as the total and sectoral variation from 1990 to 2010.

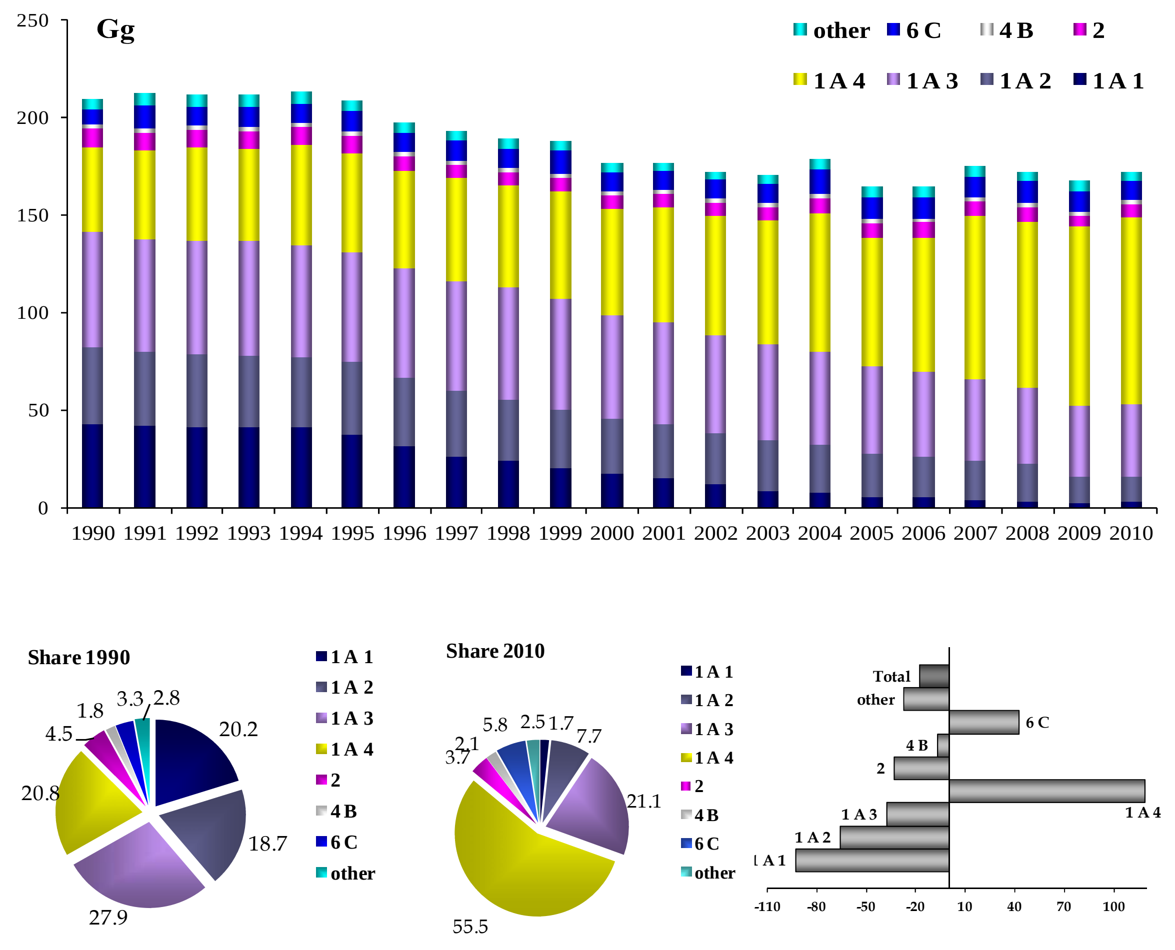


Figure 2.7 *PM2.5 emission trend, percentage share by sector and variation 1990-2010*

Table 2.7 *PM2.5 emission trend from 1990 to 2010 (Gg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Gg				
Combustion in energy and transformation industries	43	38	18	6	5	4	3	3	3
Non industrial combustion plants	27	33	38	54	58	75	78	85	90
Combustion - Industry	34	32	23	19	19	18	17	11	12
Production processes	11	10	8	8	9	9	8	6	7
Extraction and distribution of fossil fuels / geothermal energy	1	1	1	1	1	1	1	1	1
Solvent and other product use	0	0	0	0	0	0	0	0	0
Road transport	51	49	46	37	36	35	33	31	30
Other mobile sources and machinery	32	33	30	24	21	19	17	16	15
Waste treatment and disposal	7	10	10	11	11	10	11	11	10
Agriculture	6	6	6	6	6	6	6	6	6
Total	***211***	***210***	***178***	***166***	***165***	***176***	***173***	***169***	***173***

Total emissions show a global reduction from 1990 to 2010 of about 18%. Specifically, emissions from *road transport*, accounting for 17% of total emissions, decrease of about 42%. Emissions from *other mobile sources and machinery* show a reduction of 52%, accounting in 2010 for 9% of total emissions. Emissions from *non industrial combustion plants* and from *combustion in industry* account for 52% and 7% of the total respectively, but while the former shows an increase of about 233%, the latter decreases by about 65%. Emissions from *waste treatment and disposal*, accounting for 6% of the total in 2010, show an increase of about 42%. The largest decrease is observed for *combustion in energy* and *transformation industries* (-93%), being the influence on the total in 2010 equal to 2%.

2.3 Heavy metals (Pb, Cd, Hg)

This section provides an illustration of the most significant developments between 1990 and 2010 of lead, cadmium and mercury emissions.

2.3.1 Lead (Pb)

The national atmospheric emissions of lead show a strong decreasing trend (-94%) between 1990 and 2010, varying from 4,412 Mg to 270 Mg. Figure 2.8 and Table 2.8 illustrate the emission trend from 1990 to 2010. Figure 2.8 also illustrates the share of Pb emissions by category in 1990 and 2010 as well as the total and sectoral variation from 1990 to 2010.

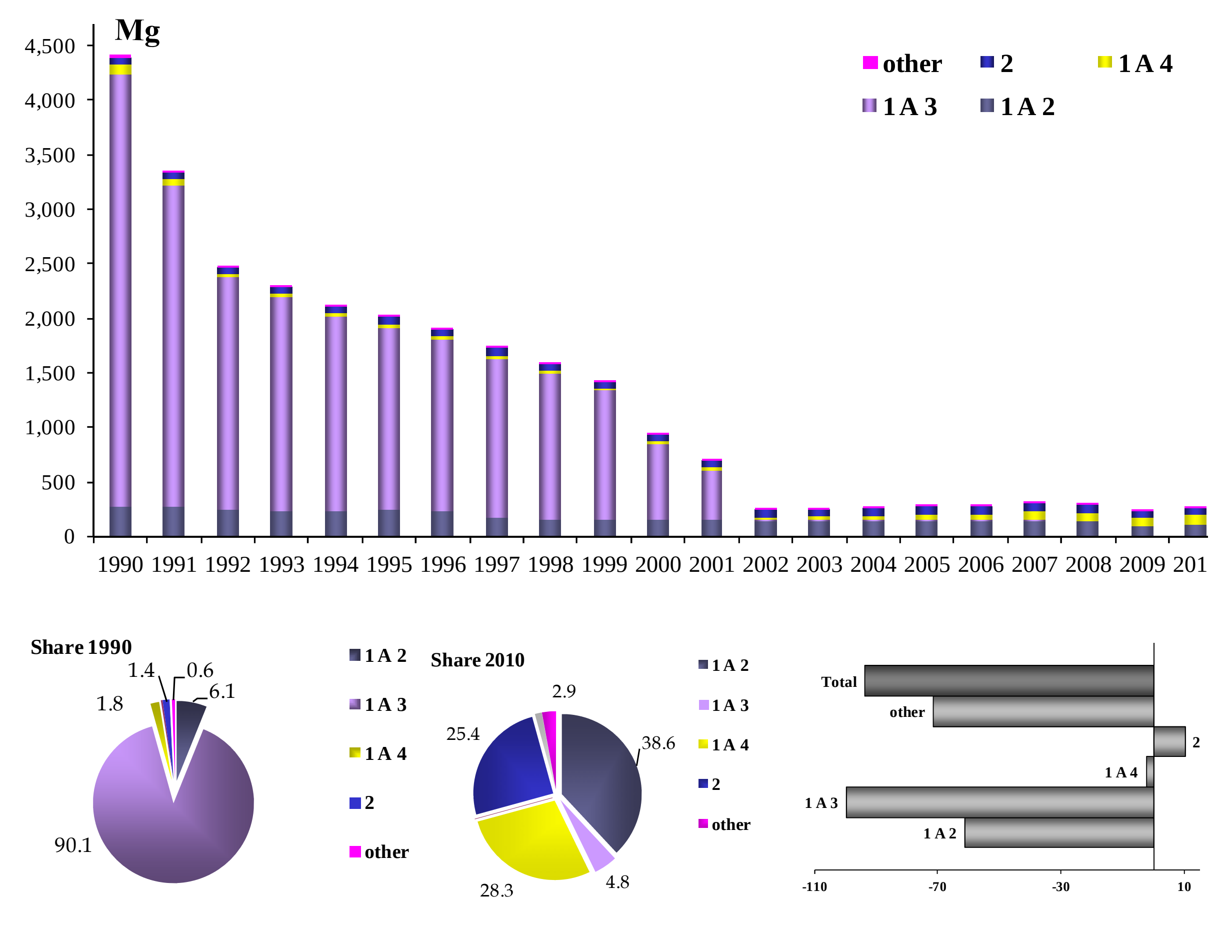


Figure 2.8 *Pb emission trend, percentage share by sector and variation 1990-2010*

Table 2.8 *Pb emission trend from 1990 to 2010 (Mg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
			Mg						
Combustion in energy and transformation industries	4	4	4	4	4	4	4	3	3
Non-industrial combustion plants	11	13	18	43	43	67	67	68	77
Combustion - industry	263	235	153	142	142	142	134	89	104
Production processes	64	68	67	74	82	82	80	56	70
Road transport	3,922	1,645	685	12	12	13	12	12	12
Other mobile sources and machinery	144	46	13	1	1	1	1	1	1
Waste treatment and disposal	6	5	3	4	4	3	3	3	4
Total	***4,414***	***2,028***	***944***	***280***	***288***	***312***	***301***	***232***	***270***

In 2010 emissions from *combustion in industry - processes with contact* have the most significant impact on the total (38%) and show a reduction of about 54%. Emissions from *production processes* and, in particular, from processes in iron and steel industries and collieries increased by about 8%, and represent 25% of the total. Emissions from *non industrial combustion plants* show a strong increase and represent, in 2010, 28% of the total. As to 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 2010 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 2010. Figure 2.9 also illustrates the share of Cd emissions by category in 1990 and 2010 as well as the total and sectoral variation from 1990 to 2010.

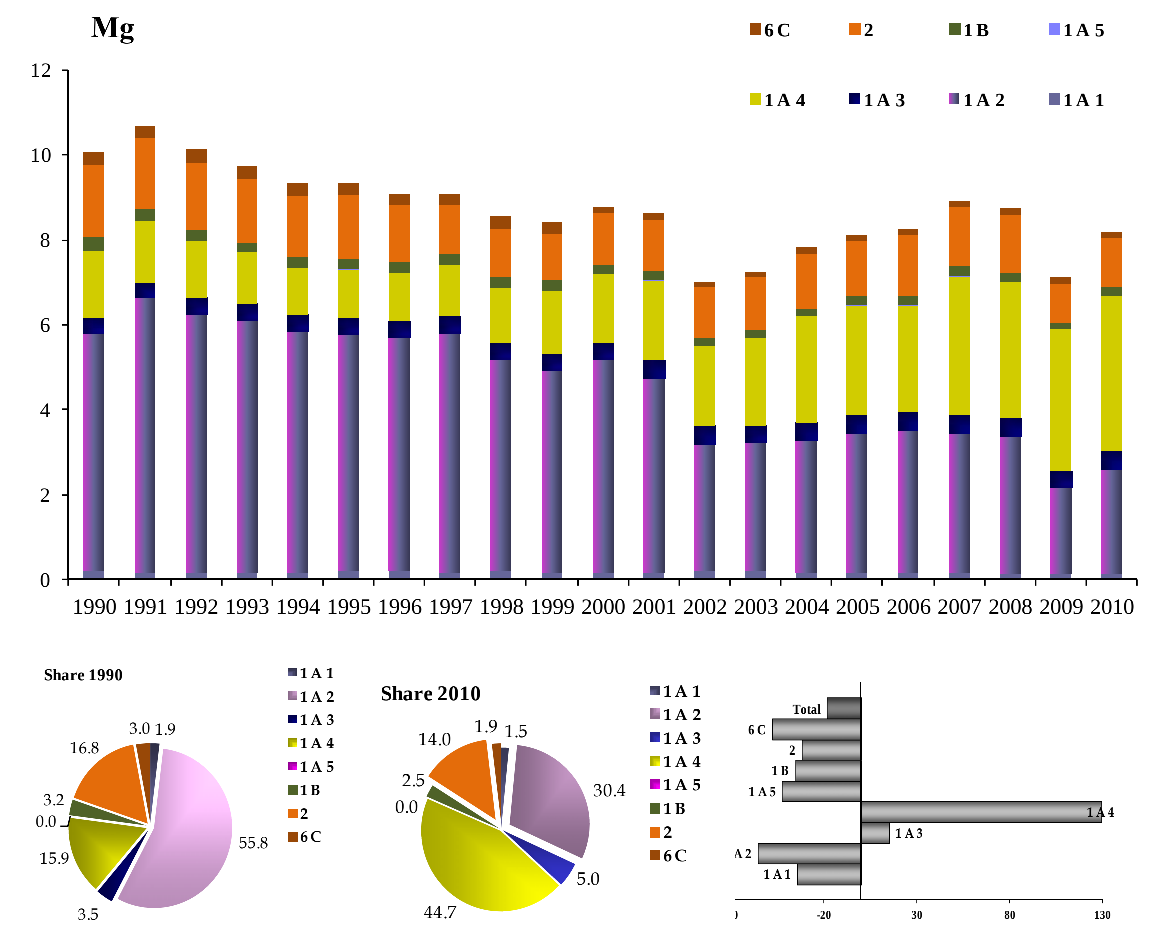


Figure 2.9 *Cd emission trend, percentage share by sector and variation 1990-2010*

Table 2.9 *Cd emission trend from 1990 to 2010 (Mg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Mg				
Combustion in energy and transformation industries	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1
Non-industrial combustion plants	1.6	1.1	1.6	2.6	2.5	3.2	3.2	3.3	3.7
Combustion - industry	5.6	5.6	5.0	3.3	3.4	3.3	3.2	2.0	2.5
Production processes	2.0	1.8	1.4	1.5	1.6	1.6	1.6	1.1	1.4
Road transport	0.3	0.4	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	0.0
Waste treatment and disposal	0.3	0.3	0.1	0.2	0.2	0.1	0.1	0.1	0.2
Total	***10.1***	***9.3***	***8.8***	***8.1***	***8.3***	***8.9***	***8.7***	***7.1***	***8.2***

Emissions show a global reduction of 19% between 1990 and 2010, from 10.1 Mg to 8.2 Mg. Among the most significant variations, emissions from *combustion in industry* and from *non industrial combustion plants* represent 30% and 45% of the total respectively, showing the former a decrease (-56%) and the latter a strong increase (130%). Emissions from *production processes* decrease by about 32% and represent 17% of the total. Emissions from *waste treatment and disposal* (i.e. waste incineration), accounting for 2% of the total, register a reduction of about 48%. 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 1990-2010. Figure 2.10 and Table 2.10 illustrate the emission trend from 1990 to 2010. Figure 2.10 also illustrates the share of Hg emissions by category in 1990 and 2010 as well as the total and sectoral variation from 1990 to 2010.

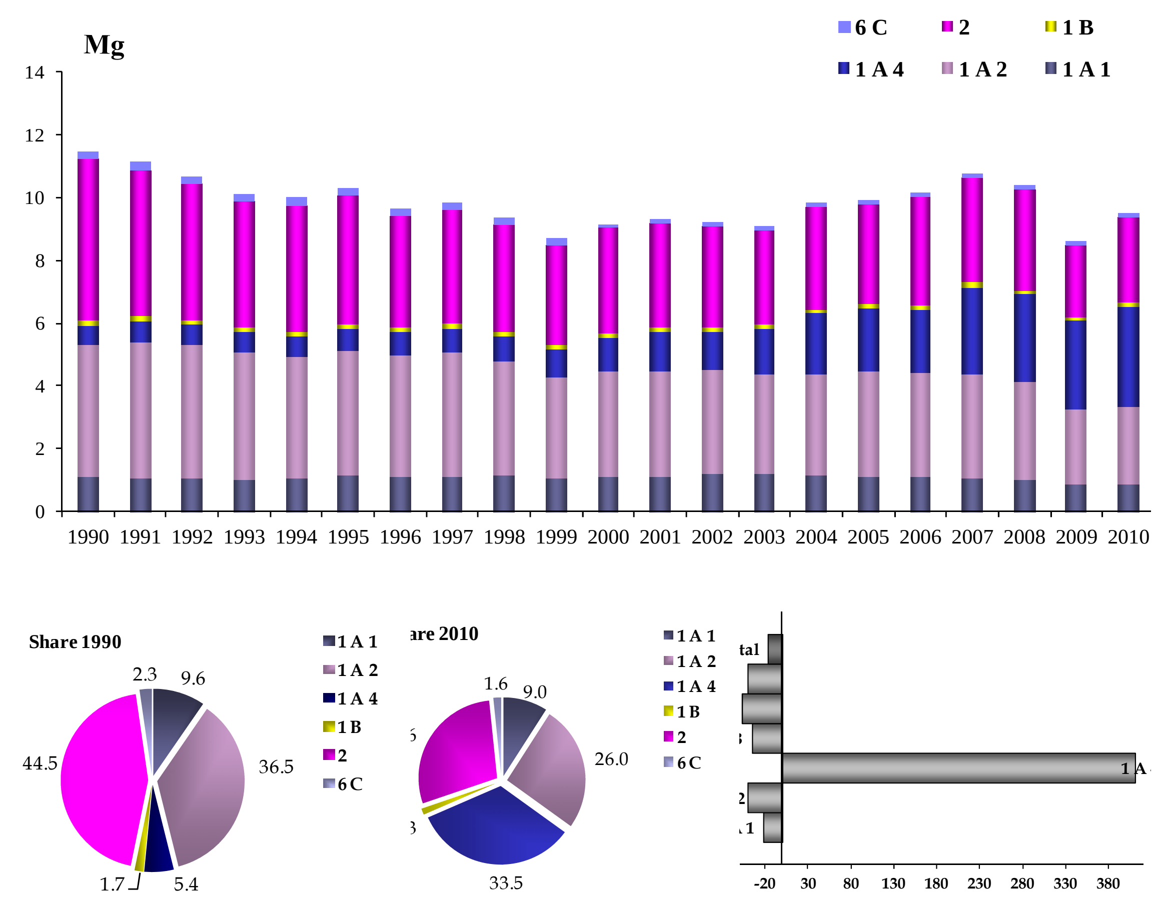


Figure 2.10 *Hg emission trend, percentage share by sector and variation 1990-2010*

Table 2.10 *Hg emission trend from 1990 to 2010 (Mg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
				Mg					
Combustion in energy and transformation industries	1.1	1.1	1.1	1.1	1.1	1.1	1.0	0.9	0.9
Non-industrial combustion plants	0.6	0.7	1.1	2.0	2.0	2.8	2.8	2.9	3.2
Combustion - industry	4.2	4.0	3.4	3.4	3.3	3.3	3.1	2.4	2.5
Production processes	5.3	4.3	3.5	3.3	3.6	3.5	3.3	2.3	2.9
Waste treatment and disposal	0.3	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.2
Total	***11.5***	***10.3***	***9.1***	***9.9***	***10.2***	***10.8***	***10.4***	***8.6***	***9.5***

Emission trend shows a global reduction of about 17% from 1990 to 2010, varying from 11.5 Mg to 9.5 Mg. The main variations concern: emissions from *production process - processes in iron and steel industries and collieries*, representing 29% of the total and decreasing by 9%; emissions from *combustion in industry - processes with contact*, accounting for 22% and decreasing by 41%; emissions from *non industrial combustion plants* which represent 33% of the total and showing the strongest increase (411%). Emissions deriving from *combustion in energy and transformation industries*, accounting for 9%, show a 22% reduction. Emissions from *production process - processes in inorganic chemical industries*, contributing to the total only for 1%, 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 41%.

2.4 Persistent organic pollutants (POPs)

In this section, the most significant peculiarities of polycyclic aromatic hydrocarbons and dioxins, occurred between 1990 and 2010, 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 2010, from 99 Mg to 153 Mg. Figure 2.11 and Table 2.11 illustrate the emission trend from 1990 to 2010. Figure 2.11 also illustrates the share of PAH emissions by category in 1990 and 2010 as well as the total and sectoral variation from 1990 to 2010.

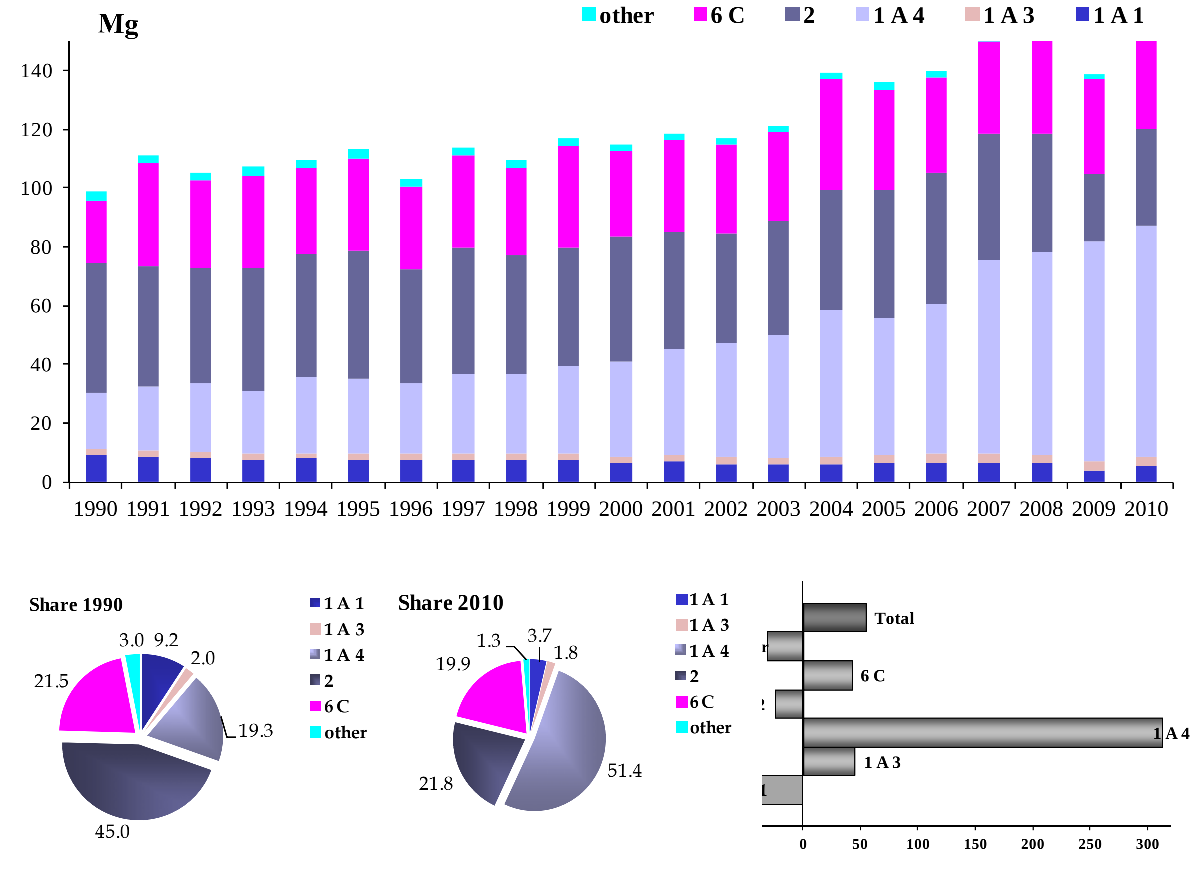


Figure 2.11 *PAH emission trend, percentage share by sector and variation 1990-2010*

Table 2.11 *PAH emission trend from 1990 to 2010 (Mg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Mg				
Combustion in energy and transformation industries	9	8	7	6	7	7	6	4	6
Non-industrial combustion plants	19	25	32	47	51	66	69	75	78
Combustion - industry	3	3	2	2	2	2	2	1	2
Production processes	44	44	42	44	45	43	41	23	33
Road transport	2	2	2	3	3	3	3	3	3
Other mobile sources and machinery	0	0	0	0	0	0	0	0	0
Waste treatment and disposal	21	31	30	34	33	31	32	33	30
Total	***99***	***113***	***115***	***136***	***140***	***152***	***153***	***139***	***153***

Between 1990 and 2010, total emissions show a growth of about 54%. Among the most significant changes, emissions from *non industrial combustion plants - residential plants* account for 48% of the total and show a strong increase (about 297%) due to the increase in wood consumption for heating; emissions from *production processes - processes in iron* and *steel industries* and *collieries* account for 22% of the total and show a decrease of 25%; emissions from *waste treatment and disposal - open burning of agricultural wastes*, except stubble burning, accounting for 20% of the total, show an increase of 43%. Emissions from combustion in iron and steel integrated plants account for 4% of the total and show a decrease of 35%. Emissions from *plants in agriculture, forestry and aquaculture*, accounting for 2% in 2010, show a large growth from 2000 onwards, due to the use of biomass in plants. 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 2010, with values varying from 466 g I Teq to 262 g I Teq. Figure 2.12 and Table 2.12 illustrate the emission trend from 1990 to 2010. Figure 2.12 also illustrates the share of dioxin emissions by category in 1990 and 2010 as well as the total and sectoral variation from 1990 to 2010.

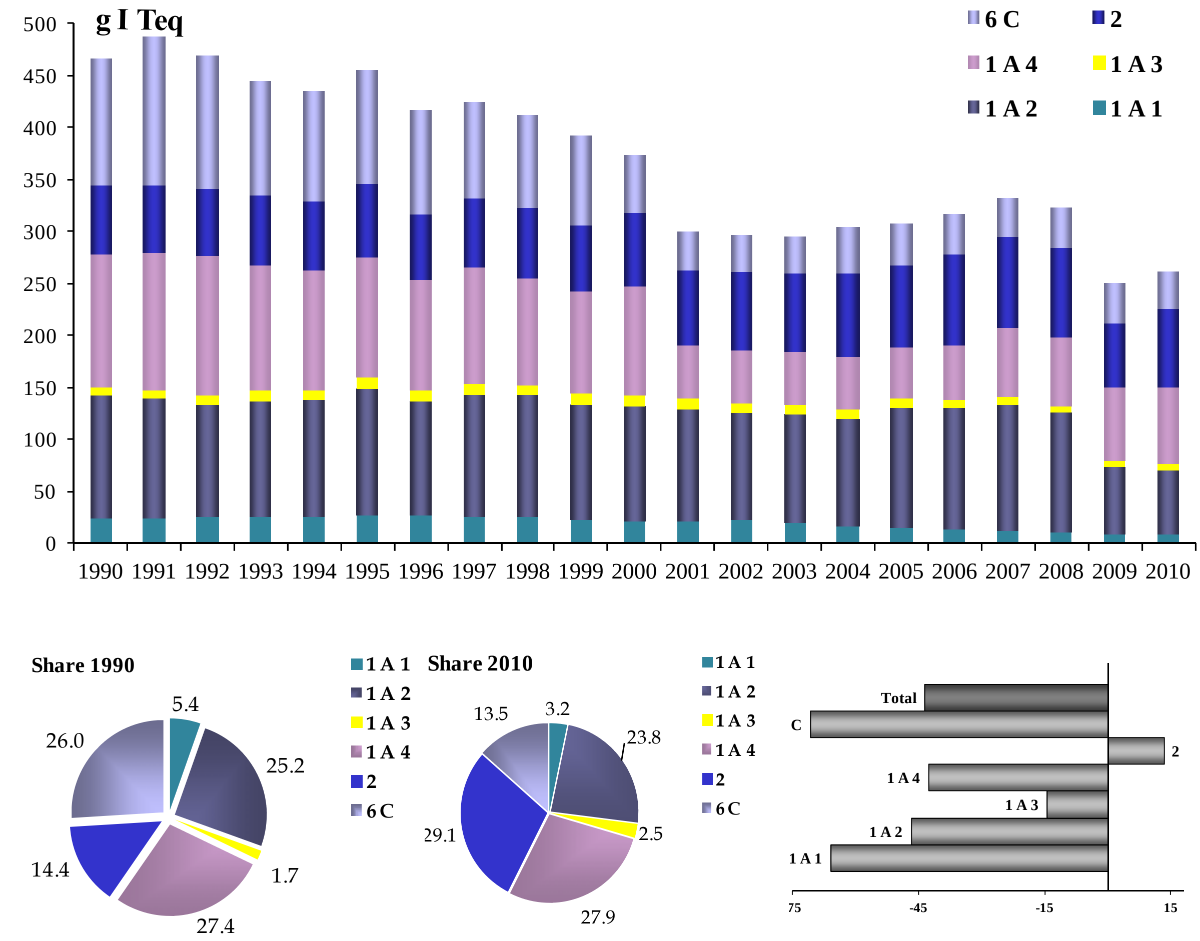


Figure 2.12 *Dioxin emission trend, percentage share by sector and variation 1990-2010*

Table 2.12 *Dioxin emission trend from 1990 to 2010 (g I Teq)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
					g I Teq				
Combustion in energy and transformation industries	25	28	22	15	14	12	11	10	8
Non-industrial combustion plants	128	115	105	50	53	66	65	70	73
Combustion - industry	117	121	111	116	116	122	115	64	62
Production processes	67	72	71	79	88	89	87	62	76
Road transport	8	10	10	8	8	8	7	7	7
Waste treatment and disposal	121	108	56	40	38	36	38	38	35
Total	***466***	***455***	***374***	***307***	***316***	***332***	***323***	***251***	***262***

The general trend shows a decrease from 1990 to 2010 equal to 44%, with a noticeable decline between 1995 and 2001. The most considerable reductions, between 1990 and 2010, are observed in *combustion in industry*, *non-industrial combustion plants* and *waste treatment disposal* (-47%,-43% and -71%, 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 2010, the subsectors which have contributed most to total emissions are *production processes*, *non-industrial combustion plants* and *combustion in industry* accounting for 29%, 28% and 24% of the total respectively. In particular emissions from production processes show an increase of 13% in the period 1990-2010.

2.4.3 Hexachlorobenzene (HCB)

The national atmospheric emissions of hexachlorobenzene show a decreasing trend in the period 1990-2010, varying from 43 kg to 23 kg due to the decrease of the use of pesticide in agriculture. Figure 2.13 and Table 2.13 illustrate the emission trend from 1990 to 2010. Figure 2.13 also illustrates the share of HCB emissions by category in 1990 and 2010 as well as the total and sectoral variation from 1990 to 2010.

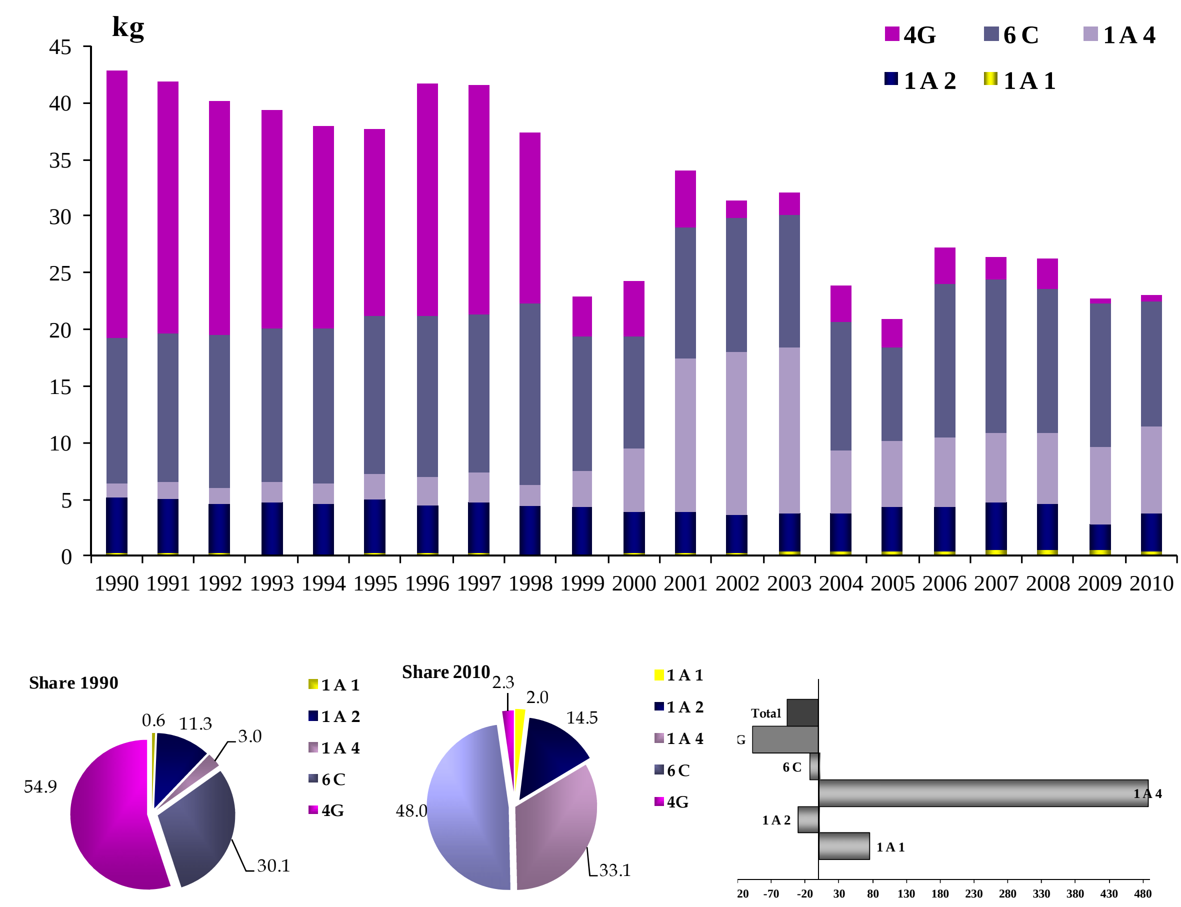


Figure 2.13 *HCB emission trend, percentage share by sector and variation 1990-2010*

Table 2.13 *HCB emission trend from 1990 to 2010 (Mg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Mg				
Combustion in energy and transformation industries	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000
Non-industrial combustion plants	0.001	0.002	0.006	0.006	0.006	0.006	0.006	0.007	0.008
Combustion - industry	0.005	0.005	0.004	0.004	0.004	0.004	0.004	0.002	0.003
Agriculture	0.023	0.016	0.005	0.002	0.003	0.002	0.003	0.001	0.001
Waste treatment and disposal	0.013	0.014	0.010	0.008	0.014	0.014	0.013	0.013	0.011
Total	***0.043***	***0.038***	***0.024***	***0.021***	***0.027***	***0.026***	***0.026***	***0.023***	***0.023***

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 (i.e. sludge incineration with energy recovery) in these years. In particular, the considerable increase of the amount sludge burnt at a specific incinerator is the reason of the peaks observed. The other two relevant sectors are *non industrial combustion plants* and *combustion in industry*, accounting for 33% and 15%, respectively; emissions from *non industrial combustion plants* show a significant increase between 1990 and 2010 (487%) while a decrease of 31% has to be noted for emissions from *combustion in industry*. The use of pesticide in *agriculture* category is the main driver for the decreasing trend of the HCB national emissions.

2.4.4 *Polychlorinated biphenyl (PCB)*

The national atmospheric emissions of polychlorinated biphenyl show a decreasing trend in the period 1990-2010, about -21%, from 278 kg to 219 kg.

Figure 2.14 and Table 2.14 illustrate the emission trend from 1990 to 2010. Figure 2.14 also illustrates the share of PCB emissions by category in 1990 and 2010 as well as the total and sectoral variation from 1990 to 2010.

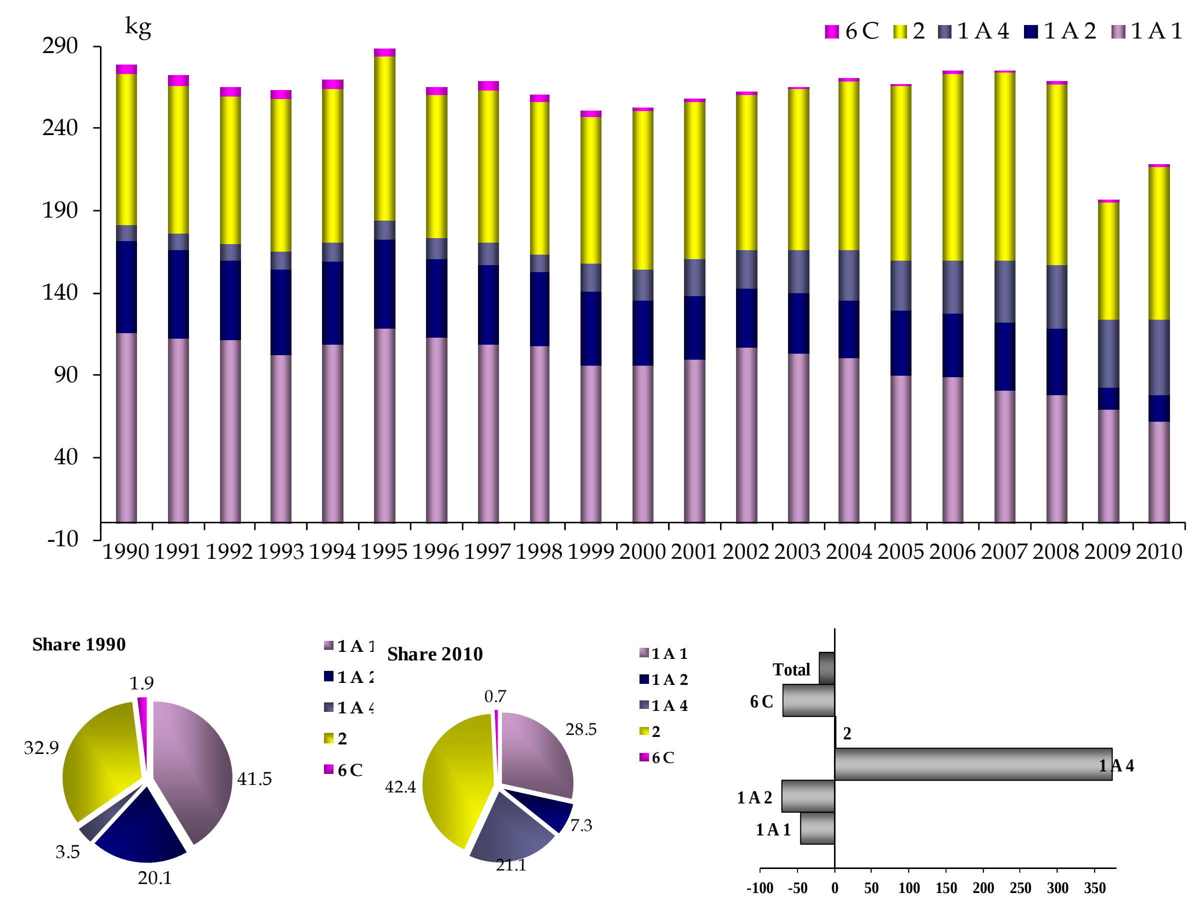


Figure 2.14 *PCB emission trend, percentage share by sector and variation 1990-2010*

Table 2.14 *PCB emission trend from 1990 to 2010 (Mg)*

	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
				Mg					
Combustion in energy and transformation industries	0.115	0.119	0.096	0.089	0.089	0.081	0.078	0.069	0.062
Non-industrial combustion plants	0.010	0.012	0.019	0.031	0.032	0.038	0.038	0.041	0.046
Combustion - industry	0.056	0.053	0.039	0.040	0.039	0.041	0.041	0.013	0.016
Production processes	0.092	0.100	0.096	0.106	0.114	0.114	0.110	0.071	0.093
Waste treatment and disposal	0.005	0.005	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Total	***0.278***	***0.289***	***0.253***	***0.267***	***0.275***	***0.275***	***0.269***	***0.197***	***0.219***

The subsectors contributing most to the general trend are the *production processes* sector and the *combustion in energy and transformation industries* sector, accounting for 42% and 28% of the total emissions respectively, the former showing an increase of 1%, the latter a reduction of 46%. The other relevant subsectors are *non industrial combustion plants* accounting for 21% and relevantly increasing and *combustion in industry* which account for 7% and decrease between 1990 and 2010 of 71%.

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 details, such as fuel consumption, distance travelled or some other statistical data related to emissions. 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 industries” 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 relevant emissions 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 2010, 97% 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 2010 for more than 49% of total emissions for all the pollutants estimated, except for ammonia where they account for 2.8%. In particular emissions from the energy sector are 98% of NO_X, 90% of SO_X, 87% of PM2.5 and 86% of CO total national emissions.

In 2010 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).

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 9.0, has been used to calculate emissions (EMISIA SA, 2011): the updated version of the model has been applied for the whole time series, resulting in slightly changes in emission levels. In paragraph 3.7 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, 2012[b]). At national level, trends of the CLRTAP pollutants are described in the environmental data yearbook published by ISPRA (ISPRA, 2012 [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 level. 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/EEA 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 Release and Transfer Register (Italian 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.

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 2010 the sector accounts for:

- 98% in national total NO_X emissions;
- 90% in national total SO_X emissions;
- 87% in national total PM2.5 emissions.

Moreover, the sector comprises 86% of total CO emissions and is also an important source for heavy metals; specifically in 2010, energy sector is responsible for 84% of total Cd emissions and accounts for a high share of other heavy metals, i.e As (99%), Cu (96%), Ni (96%), Se (92%).

There are no particular differences as compared to the sectoral share in 1990, except for lead whose contribution in 1990, accounting for 98% of total emissions, was about 25% higher than 2010.

The most important source of emissions in the sector, in 2010, is represented by *road transport* (1A3) at least for the main pollutants: NO_X (50.9%), CO (38.1%), NMVOC (25.4%), and particulate matter (PM10 12.2%, PM2.5 14.2%). There has been a strong reduction in lead emissions from 1990 to 2010 from *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 a main source of heavy metals, accounting for about 39% of lead total emissions, 30% for cadmium, 26% for mercury, and dioxin (24%). The source is also significant for PM10 and PM2.5, (respectively 6% and 7%) as well as SO_X and NO_X, about 23% and 11% of total emissions. The category is also key category for CO emissions (9%) and HCB (15%).

Public electricity and heat production (1A1a) is a main source of SO_X emissions in 2010 with a share of 14.8%, together with *manufacturing industries and construction* (22.5%), *petroleum refining* (19.5%), fugitive emissions from *processes in refinery* (11.8%), national *navigation* (10.5%) and cement production (4.9%). The same category is also a significant source of PCB emissions (28%).

National *navigation* (1A3d ii) is also key category for NO_X (9.5%), NMVOC (5.4%), CO (5.6%), PM10 (3.2%) and PM2.5 (3.7%).

A sector which seems of increasing importance in terms of emissions is the *non-industrial combustion* (1A4): NO_X, NMVOC, CO emissions of this category range between 15-30% of national total; PM10 and PM2.5 emissions account for 47.9% and 55.5% respectively; dioxin is 27.9% and PAH is 51.4% of national total. These emissions are prevalently due to biomass combustion in winter and they are also becoming critical for air quality issues. *Non-industrial combustion* is also a key category for heavy metals, HCB and PCB due to the increase of combustion of waste with energy recovery reported under the sector. An in depth analysis of this category is reported in the paragraph 3.8.

Fugitive emissions from *fossil fuel distribution* (1B2) is key category for SO_X emissions (11.8%) due to fugitive emissions in refinery (1B2a iv), and for NMVOC (2.7%) due to emissions from natural gas distribution (1B2b).

Table 3.1 *Key categories in the energy sector in 2010*

	1A1 a	1A1 b	1A1c	1A2	1A2f ii	1A3 a ii (i)	1A3 a i (i)	1A3 b i	1A3 b ii	1A3 b iii	1A3 b iv	1A3 b v	1A3 b vi	1A3c	1A3 d ii	1A3e	1A4 a i	1A4 bi	1A4 bii	1A4c	1A5 b	1B1a	1B1 b	1B2
SO_X	14.8	19.5	1.7	22.5	0.0	0.1	0.1	0.1	0.0	0.0	0.0			0.0	10.5	0.0	2.7	2.6	0.0	0.0	0.1			15.0
NO_X	4.2	2.0	0.6	11.3	2.3	0.2	0.2	19.0	8.0	23.2	0.8			0.3	9.5	0.2	4.6	4.1	0.0	6.3	0.6			0.5
NH_3	0.0			0.3	0.0			2.2	0.1	0.0	0.0			0.0	0.0	-	0.0	0.2	0.0	0.0	0.0			
NMVOC	0.3	0.1	0.1	0.6	0.4	0.1	0.1	4.4	0.8	1.0	17.7	1.5		0.0	5.4	0.0	2.5	12.7	0.1	1.8	0.1	0.0	0.2	6.2
CO	0.9	0.2	0.2	8.6	0.5	0.1	0.1	17.9	2.2	1.9	16.0			0.0	5.6	0.0	0.9	26.9	0.1	3.0	0.6			0.0
PM10	0.8	0.4	0.3	6.2	0.7	0.0	0.0	4.5	3.3	2.7	1.7		4.6	0.1	3.2	0.0	0.8	43.2	0.0	3.9	0.4	0.3	0.1	0.2
PM2.5	0.9	0.5	0.3	6.8	0.9	0.0	0.0	5.2	3.9	3.1	2.0		3.0	0.2	3.7	0.0	0.9	50.0	0.0	4.5	0.5	0.4	0.1	0.3
Pb	0.9	0.2	0.0	38.6		0.1	0.2						4.4	-	0.1		26.4	1.9		0.0			0.3	
Cd	1.1	0.4	0.0	30.4	0.0	0.0	0.0	2.3	0.7	0.9	0.2		0.7	0.0	0.2		40.5	3.4	0.0	0.7	0.0		2.5	
Hg	6.9	1.8	0.3	26.0													30.7	2.2		0.6			1.3	
PAH	0.1	0.0	3.5	1.3	0.0	0.0	0.0	1.1	0.3	0.3	0.0			0.0	0.0		1.2	48.0	0.0	2.2	0.0			
Dioxin	1.2	2.0	0.0	23.8				1.9	0.1	0.1	0.4						3.6	23.3		1.0				
HCB	2.0			14.5													29.6	3.4		0.2				
PCB	27.9	0.6	0.0	7.3													17.3	3.6		0.2				

Note: key categories are shaded in blue

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, 2012[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_X 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.

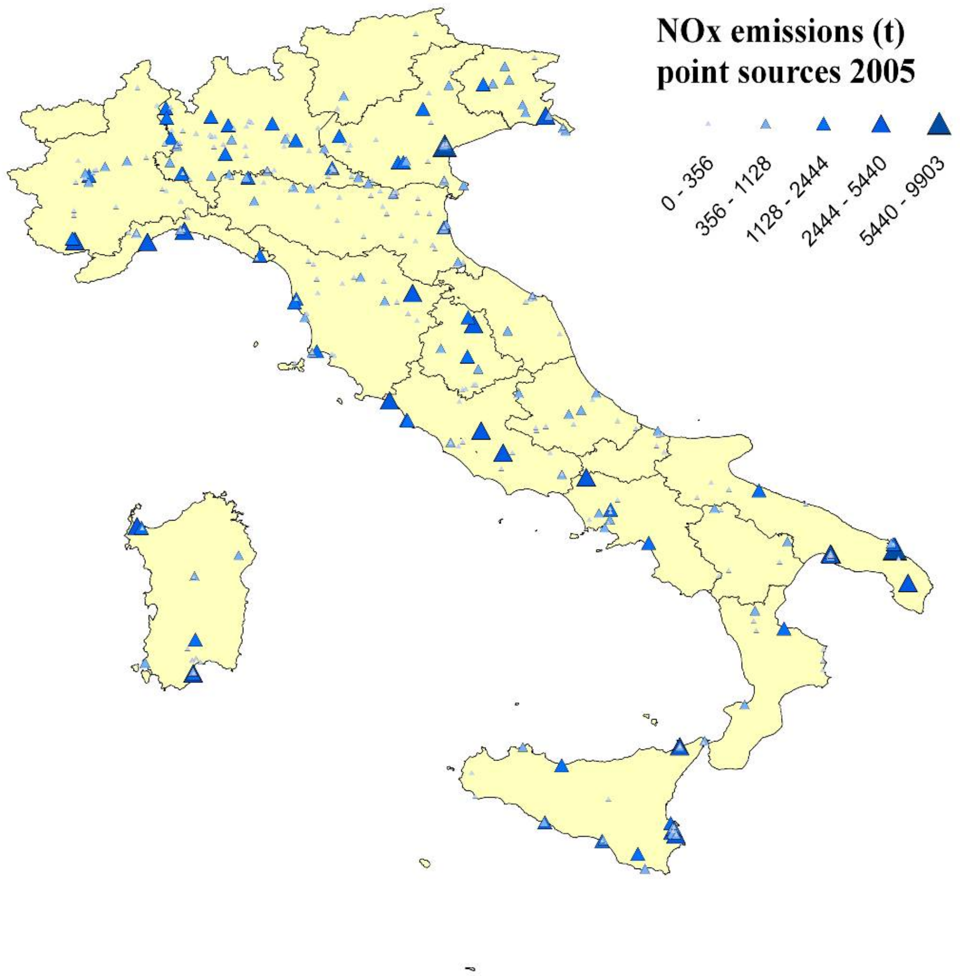


Figure 3.1 *NO_X emissions from point sources in 2005 (t)*

In Figure 3.2, NO_X emissions communicated by 229 facilities (power plants, refineries, cement plants and iron and steel integrated plants), in the framework of the national EPER/EPRTR register and LCP Directive, have been processed and geographically located. The territorial distribution shows similar results to those reported in the previous figure highlighting the industrial areas still in activity in 2010.

Figure 3.2 *NO_X emissions from point sources in 2010 (t)*

Every five years emissions are disaggregated at regional and provincial level and figures are compared with results obtained by regional bottom up inventories. This year 2010 emissions will be disaggregated at provincial level. Emissions disaggregated at local level are also used as input for air quality modelling. NO_X

emissions from *road transport* have been disaggregated at NUTS3 level (ISPRA, 2009); disaggregation related to 2005 is reported in Figure 3.3.

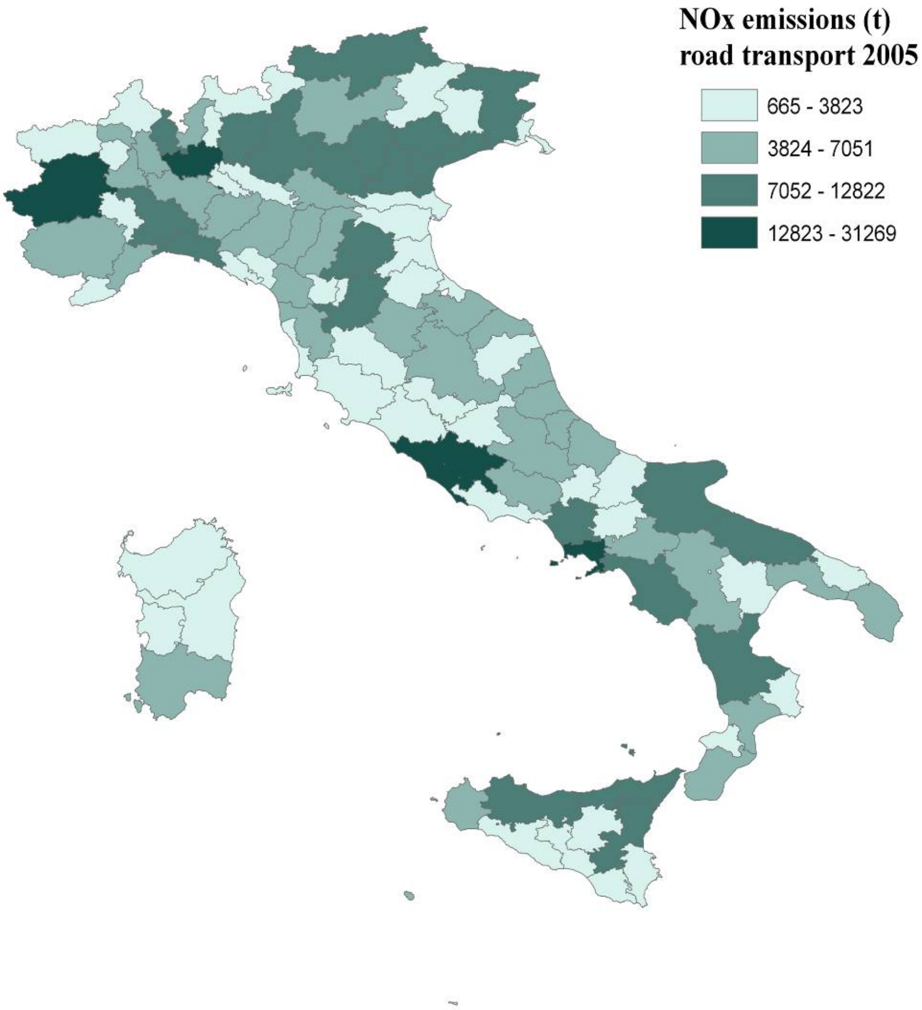


Figure 3.3 *NO_X emissions from road transport in 2005 (t)*

3.5 Recalculations

In 2012 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 from 2001 for the wood biomass fuel combustion taking into account the update of activity data time series. Recalculations affected main pollutants, heavy metals and POPs and had a strong impact resulting in an increase of previously submitted emission estimates of PM emissions, and PAH: e.g. PM10 (from 1% in 2001 to 12% in 2009), PM2.5 (from 1% in 2001 to 15% in 2009), PAH (from 2% in 2001 to 14% in 2009). In addition energy recovery from waste reported in the commercial heating has been updated for the whole time series as a consequence of the reorganization of the waste incinerators database resulting in slight differences for all the pollutants. More detailed information is reported in paragraph 3.8.

Concerning mobile fuel combustion (1A3) the upgraded version of COPERT 4, v.9.0, has been used for road transport sector resulting in a general revision of emission estimates. Additional information regarding the distribution of two strokes and four strokes engines for motorcycles have been introduced from 2005 resulting in the increase of about 3% of total national NMVOC emissions. HCB emissions from road transport have been deleted according to the EMEP/EEA Guidebook and to the information collected from the fuel producers. More detailed results are reported in paragraph 3.7.

The composition of the fleet of gasoline fuelled recreational craft has been updated from 2001 revising the two strokes and four strokes engine distribution considering a change from two strokes to four strokes engines of the national fleet due to the introduction in the market of new models. In 2000, the composition of the fleet was 90% two stroke engine equipped and 10% four stroke while in 2010 the last one is about 30% of the fleet. This change resulted in a recalculation of NO_X, CO, NMVOC, NH3 and Benzene emission factors for this category.

Under the combustion in industry category (1A2), for 2009, NO_X emission factor for *cement production* and activity data for glass, iron and steel, secondary copper and lime production have been updated resulting in minor recalculation of emissions.

SO_X and NMVOC emission factors for *coke production* (1A1c) have been updated for 2008 and 2009 on the basis of new information from the E-PRTR register.

3.6 Planned improvements

Specific improvements are specified in the 2012 QA/QC plan (ISPRA, 2012[c]).

For the *energy* sector, a major progress will regard the improvement of the information system where data collected in the framework of different obligations, Large Combustion Plant, E-PRTR and Emissions Trading, are gathered together thus highlighting the main discrepancies in information and detecting potential errors. Further progress will regard the aviation and maritime sectors improving the annual estimations on the basis of detailed databases on flights and ships movements.

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, the growth of the fleet, its mileage and consumptions, make relevant the problem of pollution from road transport, also in view of the impact on urban areas. On the other hand, the growth of emissions has slowed down by the gradual replacement of older vehicles and the equipment of new models with the latest technologies to reduce emissions.

The road transport sector contributes to total national emissions in 2010 as follows: nitrogen oxides emissions for 50.9% of the total; emissions of carbon monoxide, non-methane volatile organic compounds, particulate matter with diameter less than 10 µm (PM10) and particulate matter with diameter less than 2.5 µm (PM2.5), for 38.1%, 25.4%, 16.8% and 17.2% respectively 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 estimated.

In Table 3.2 the list of key categories by pollutant identified for road transport in 2010, 1990 and at trend assessment is reported.

Table 3.2 *List of key categories for pollutant in the road transport in 2010, in 1990 and in the trend*

	Key categories in 2010				*Key categories in 1990*				*Key categories in trend*		
SOx					1 A 3 bi				1 A 3 bi		
NOx	1 A 3 bi	1 A 3 bii	1 A 3 biii		1 A 3 bi	1 A 3 biii			1 A 3 bi	1 A 3 bii	1 A 3 biii
NMVOC	1 A 3 bi	1 A 3 biv			1 A 3 bi	1 A 3 biv	1 A 3 bv		1 A 3 bi	1 A 3 biv	1 A 3 bv
NH_3									1 A 3 bi		
CO	1 A 3 bi	1 A 3 biv			1 A 3 bi	1 A 3 biv			1 A 3 b i	1 A 3 biv	
PM10	1 A 3 bi	1 A 3 bii	1 A 3 biii	1 A 3 bvi	1 A 3 bi	1 A 3 bii	1 A 3 biii	1 A 3 bvi	1 A 3 bi	1 A 3 biii	
PM2.5	1 A 3 bi	1 A 3 bii	1 A 3 biii		1 A 3 bi	1 A 3 bii	1 A 3 biii		1 A 3 bi		
Pb					1 A 3 bi				1 A 3 bi		

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 set by 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 (MIT, 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).

Table 3.3 *Passenger Cars and Light Duty Vehicles technological evolution: circulating fleet calculated as stock data multiplied by actual mileage (%)*

	1990	1995	2000	2005	2010
PRE ECE, pre-1972	0.05	0.03	0.01	0.01	0.00
ECE 15/00-01, 1972-1977	0.11	0.04	0.01	0.00	0.00
ECE 15/02-03, 1978-1986	0.32	0.15	0.03	0.01	0.01
ECE 15/04, 1987-1992	0.52	0.57	0.28	0.10	0.05
PC Euro 1 - 91/441/EEC, from 1/1/93	0.001	0.23	0.28	0.17	0.06
PC Euro 2 - 94/12/EEC, from 1/1/97	-	-	0.38	0.35	0.23
PC Euro 3 - 98/69/EC Stage2000, from 1/1/2001	-	-	-	0.26	0.21
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006	-	-	-	0.09	0.41
PC Euro 5 - EC 715/2007, from 1/1/2011	-	-	-	-	0.03

a. Gasoline cars technological evolution

	1990	1995	2000	2005	2010
Conventional, pre-1993	1.00	0.92	0.34	0.05	0.01
PC Euro 1 - 91/441/EEC, from 1/1/93	-	0.08	0.10	0.03	0.01
PC Euro 2 - 94/12/EEC, from 1/1/97	-	-	0.56	0.25	0.09
PC Euro 3 - 98/69/EC Stage2000, from 1/1/2001	-	-	-	0.53	0.26
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006	-	-	-	0.13	0.58
PC Euro 5 - EC 715/2007, from 1/1/2011	-	-	-	-	0.05

b. Diesel cars technological evolution

	1990	1995	2000	2005	2010
Conventional, pre-1993	1.00	0.90	0.72	0.47	0.03
PC Euro 1 - 91/441/EEC, from 1/1/93	-	0.10	0.19	0.26	0.03
PC Euro 2 - 94/12/EEC, from 1/1/97	-	-	0.09	0.20	0.10
PC Euro 3 - 98/69/EC Stage2000, from 1/1/2001	-	-	-	0.06	0.09
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006	-	-	-	0.01	0.73
PC Euro 5 - EC 715/2007, from 1/1/2011	-	-	-	-	0.02

c. LPG cars technological evolution

	1990	1995	2000	2005	2010
Conventional, pre 10/1/94	1.00	0.93	0.60	0.38	0.15
LD Euro 1 - 93/59/EEC, from 10/1/94	-	0.07	0.24	0.19	0.12
LD Euro 2 - 96/69/EEC, from 10/1/98	-	-	0.16	0.15	0.26
LD Euro 3 - 98/69/EC Stage2000, from 1/1/2002	-	-	-	0.28	0.24
LD Euro 4 - 98/69/EC Stage2005, from 1/1/2007	-	-	-	0.01	0.23
LD Euro 5 - 2008 Standards 715/2007/EC, from 1/1/2012	-	-	-	-	0.001

d. Gasoline Light Duty Vehicles technological evolution

	1990	1995	2000	2005	2010
Conventional, pre 10/1/94	1.00	0.93	0.60	0.26	0.09
LD Euro 1 - 93/59/EEC, from 10/1/94	-	0.07	0.22	0.12	0.07
LD Euro 2 - 96/69/EEC, from 10/1/98	-	-	0.19	0.19	0.21
LD Euro 3 - 98/69/EC Stage2000, from 1/1/2002	-	-	-	0.41	0.33
LD Euro 4 - 98/69/EC Stage2005, from 1/1/2007	-	-	-	0.01	0.29
LD Euro 5 - 2008 Standards 715/2007/EC, from 1/1/2012	-	-	-	-	0.01

e. Diesel Light Duty Vehicles technological evolution

Table 3.4 *Heavy Duty Trucks and Buses* ***technological evolution: circulating fleet calculated as stock data multiplied by actual mileage (%)***

	1990	**1995**	**2000**	**2005**	**2010**
Conventional, pre 10/1/1993	1.00	0.90	0.67	0.39	0.20
HD Euro I - 91/542/EEC Stage I, from 10/1/93	-	0.10	0.10	0.06	0.05
HD Euro II - 91/542/EEC Stage II, from 10/1/96	-	-	0.22	0.27	0.21
HD Euro III - 2000 Standards, 99/96/EC, from 10/1/2001	-	-	-	0.28	0.31
HD Euro IV - 2005 Standards, 99/96/EC, from 10/1/2006	-	-	-	-	0.19
HD Euro V - 2008 Standards, 99/96/EC, from 10/1/2009	-	-	-	-	0.03

a. Heavy Duty Trucks technological evolution

	1990	**1995**	**2000**	**2005**	**2010**
Conventional, pre 10/1/1993	1.00	0.93	0.65	0.34	0.20
HD Euro I - 91/542/EEC Stage I, from 10/1/93	-	0.07	0.07	0.08	0.07
HD Euro II - 91/542/EEC Stage II, from 10/1/96	-	-	0.28	0.32	0.25
HD Euro III - 2000 Standards, 99/96/EC, from 10/1/2001	-	-	-	0.26	0.45
HD Euro IV - 2005 Standards, 99/96/EC, from 10/1/2006	-	-	-	-	0.01
HD Euro V - 2008 Standards, 99/96/EC, from 10/1/2009	-	-	-	-	0.03

b. Buses technological evolution

Table 3.5 *Mopeds and motorcycles* **technological evolution:** *circulating fleet calculated as stock data multiplied by actual mileage* ***(%)***

	1990	**1995**	**2000**	**2005**	**2010**
Conventional, pre 6/17/1999	1.00	1.00	0.86	0.53	0.37
Euro I - 97/24 from 6/17/1999	-	-	0.14	0.27	0.23
Euro II, 2002/51/EC, 2003/77/EC, from 7/1/2004 (for mopeds: 97/24/EC, from 6/17/2002)	-	-	-	0.17	0.23
Euro III, 2002/51/EC, 2003/77/EC, from 1/1/2007 (for mopeds not defined yet)	-	-	-	0.03	0.17

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 (MIT, 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 (management authority for national road and motorway network);
- highway industrial association for fee-motorway (AISCAT, several years);
- local authorities for built-up areas (urban).

Table 3.6 *Evolution of fleet consistency and mileage*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
All passenger vehicles, total mileage (10^9 veh-km/y)	303	361	389	411	418	419	404	397	389
Car fleet (10^6)	27	30	32	34	35	35	36	36	36
Moto, total mileage (10^9 veh-km/y)	31	39	45	48	48	49	47	48	50
Moto fleet (10^6)	7	7	9	10	10	10	10	10	11
Goods transport, total mileage (10^9 veh-km/y)	70	75	89	99	102	105	104	103	105
Truck fleet (10^6), including LDV	2	3	3	4	4	5	5	5	5

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). The updated version 9.0 of the model COPERT 4 (EMISIA SA, 2011) has been used for the whole time series of the 2012 submission. The updated version of the model considers the increase in fuel consumption due to air conditioning use, revises some functions of the software and fixes some bugs, 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 output results separately for vehicles category and urban, rural, highway areas, concerning emission estimates of CO, VOC, NMVOC, CH_4, NO_X, N_2O, NH_3, PM2.5, PM10, PM exhaust (the emission factors of particulate matter from combustion refer to particles smaller than 2.5 m, that implicitly assumes that the fraction PM2.5 to PM10 is negligible), CO_2, SO_2, heavy metals, NO_X speciation in NO e NO_2, 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 the 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_X, VOC, CH_4, NMVOC, N_2O, NH_3 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_2, SO_2, 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 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. 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 of NMVOC, NO_X, CO and PM are calculated on the basis of emission factors expressed in grams per kilometre and road traffic statistics estimated by ISPRA on account of data released from Ministry of Transport (MIT, 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 (EMISIA SA, 2011). 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.

Emissions of fuel dependent pollutants have been estimated applying a different approach.

Data on 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 1990-2010 inventory used fuel consumption factors expressed as grams 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, version 9.0. Emissions of sulphur dioxide and heavy metals from Italian road transport are calculated applying specific factors to consumption of gasoline, diesel, liquefied petroleum gas (LPG) and natural gas, taken from the BEN (MSE, several years).

Emissions of SO_2 are based on the sulphur content of the fuel. Values for SO_2 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 the 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 emissions from road vehicle tyre and brake wear are 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 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 one side, and of the introduction of advanced technologies limiting emissions in modern vehicles, on the other side.

In 2010 key categories are identified for the following 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.

Nitrogen oxides emissions show a decrease from 1990 of about 47.8%. 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 2010, 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.

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

Source categories for NFR Subsector 1.A.3.b	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Gg				
1.A.3.b.i Passenger cars	528	583	360	249	240	231	210	195	183
1.A.3.b.ii Light-duty vehicles	68	71	81	81	80	81	77	77	77
1.A.3.b.iii Heavy-duty vehicles including buses	338	330	296	270	251	257	250	223	223
1.A.3.b.iv Mopeds and motorcycles	5	6	7	7	7	7	7	7	7
Total emissions	**939**	**989**	**745**	**607**	**579**	**575**	**543**	**502**	**491**

As regards non methane volatile organic compounds, emissions from passenger cars, mopeds and motorcycles are key categories in 2010, 1990 and in trend, while NMVOC emissions from gasoline evaporation is a key category in 1990 and trend assessment.

Despite the decline since 1990 of emissions of non methane volatile organic compounds from this category, *road transport* (Table 3.8) is the second source at national level after the *use of solvents*; this trend is due to the combined effects 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 2010) that uses gasoline and is increasing, but only a small part of this fleet complies with strict VOC emissions controls.

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

Source categories for NFR Subsector 1.A.3.b	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Gg				
1.A.3.b.i Passenger cars	487	498	274	114	95	79	67	56	47
1.A.3.b.ii Light-duty vehicles	18	18	15	11	10	10	9	9	8
1.A.3.b.iii Heavy-duty vehicles including buses	29	25	20	16	16	15	14	12	11
1.A.3.b.iv Mopeds and motorcycles	245	328	305	256	243	227	211	199	192
1.A.3.b.v Gasoline evaporation	179	189	89	32	26	22	20	18	16
Total emissions	**958**	**1,057**	**703**	**430**	**390**	**353**	**321**	**293**	**274**

Carbon monoxide emissions from passenger cars, mopeds and motorcycles are key categories in 2010, 1990 and in trend; the time series of CO emissions is reported in Table 3.9. A strong contribution to total emissions is given by gasoline vehicles; nevertheless from 1990 to 2010 a general decrease, of about 60%, is observed.

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

Source categories for NFR Subsector 1.A.3.b	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Gg				
1.A.3.b.i Passenger cars	4,759	4,473	2,426	1,094	905	764	656	566	485
1.A.3.b.ii Light-duty trucks	210	204	145	96	82	78	69	68	61
1.A.3.b.iii Heavy-duty vehicles including buses	84	79	67	64	59	62	59	53	53
1.A.3.b.iv Mopeds and motorcycles	497	616	663	530	516	487	452	432	434
Total emissions	**7,541**	**7,367**	**5,301**	**3,790**	**3,568**	**3,398**	**3,244**	**3,128**	**3,042**

Emissions of PM10 deriving from passenger cars, light-duty vehicles, heavy-duty vehicles including buses, road vehicle tyre and brake wear are key categories both in 2010 and in 1990; emissions from passenger cars and heavy-duty vehicles including buses are key categories in trend (Table 3.10).

As regards PM2.5, emissions from passenger cars, light-duty vehicles, heavy-duty vehicles including buses are key categories in 2010; only emissions from heavy-duty vehicles including buses is a key category in trend (Table 3.11).

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	2010
					Gg				
1.A.3.b.i Passenger cars	19	15	13	11	11	11	10	10	9
1.A.3.b.ii Light-duty vehicles	10	12	13	9	8	8	7	7	7
1.A.3.b.iii Heavy-duty vehicles including buses	14	13	10	8	7	7	7	6	5
1.A.3.b.iv Mopeds and motorcycles	3	5	4	4	4	4	4	4	3
1 A 3 b vi Road Transport:, Automobile tyre and brake wear	8	9	9	10	10	10	10	9	9
Total emissions	**55**	**53**	**50**	**42**	**40**	**40**	**37**	**35**	**34**

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

Source categories for NFR Subsector 1.A.3.b	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Gg				
1.A.3.b.i Passenger cars	19	15	13	11	11	11	10	10	9
1.A.3.b.ii Light-duty vehicles	10	12	13	9	8	8	7	7	7
1.A.3.b.iii Heavy-duty vehicles including buses	14	13	10	8	7	7	7	6	5
1.A.3.b.iv Mopeds and motorcycles	3	5	4	4	4	4	4	4	3
1 A 3 b vi Road Transport:, Automobile tyre and brake wear	4	5	5	5	5	5	5	5	5

Source categories for NFR Subsector 1.A.3.b	1990	1995	2000	2005	2006	2007	2008	2009	2010
					Gg				
Total emissions	**51**	**49**	**46**	**37**	**36**	**35**	**33**	**31**	**30**

Emissions of particulate matter with diameter less than 10µm and less than 2.5µm show a decreasing trend from 1990 (respectively of about -37.8% and -41.7%); despite the decrease, diesel vehicles, passenger cars, light duty vehicles and heavy duty trucks, are in 2010 mainly responsible for road transport emissions.

Emissions of SO_X, NH_3 and Pb are not key categories in 2010, despite emissions of SO_X and Pb from passenger cars are key categories in 1990 and in trend, emissions of NH_3 from passenger cars is key category in trend. Emissions of these pollutants are irrelevant in 2010, compared to other sectors. Emissions of SO_X and Pb show strong decreases, due to limits on fuels properties imposed by legislation. SO_X emissions decrease by 99.7%, representing 0.2% of the total in 2010. Emissions of Pb decrease of 99.7% and represent, in 2010, 4.4% of total national emissions. Emissions of NH_3, despite the strong increase from 1990, in 2010 represent only 2.3% 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 at identifying 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).

3.7.6 Recalculation

The annual update of the emissions time series from road transport implies a periodic review process. In the last submission, the new versions of COPERT 4 revised the estimation methodology, fixing some bugs. The most recent update of the software is COPERT 4, version 9.0 (EMISIA SA, 2011). The updating to version COPERT 4 v 9.0 introduces important elements such as the increase in fuel consumption due to air conditioning use. Another significant element is the introduction of the production of CO_2 due to the consumption of urea in vehicles provided with selective catalytic reduction after treatment systems, depending on the carbon included in the urea molecule. In addition version 9.0 updates NO_2/NO_X mass ratios, includes ethanol as a fuel, updates biodiesel O:C and H:C ratios, updates the heavy metals emission factors (Gkatzoflias D., Kouridis C., Ntziachristos L., Description of new elements in COPERT 4 v 9.0, November 2011). For the calculation of NH_3 emission factors a maximum value of cumulative mileage has been fixed, and the calculation algorithm, for NH_3 hot/cold emissions, has been revised in particular as regards the calculation of cold urban, hot urban, rural and highway emissions (Gkatzoflias D., Ntziachristos L., COPERT 4 v 8.1, September 2011).

As previously mentioned, another cause explaining differences respect to submission 2011 can be individuated in the updated distribution among weight classes for articulated heavy duty trucks fleet and the additional information about fleet of 2-stroke motorcycles.

Moreover HCB emissions from road transport have been deleted according to the EMEP/EEA Guidebook and to the information collected from the fuel producers. It is worthwhile to point out that the HCB emission factor for diesel oil reported in the Guidebook is based on the assumption that HCB is present in diesel oil as an additive and it is important to highlight that such an additive has never been used in Italy.

3.7.7 Planned improvements

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

3.8 Civil sector: small combustion and off-road vehicles (NFR SUBSECTOR 1.A.4 - 1.A.5)

3.8.1 Overview

Emissions from energy use in the civil sector cover combustion in a small-scale combustion units, with thermal capacity 50 MW_{th}, and off road vehicles in the commercial, residential and agriculture sectors.

The emissions refer to the following categories:

- 1 A 4 a i Commercial / Institutional: Stationary
- 1 A 4 a ii Commercial / Institutional: Mobile
- 1 A 4 b i Residential: Stationary plants
- 1 A 4 b ii Residential: Household and gardening (mobile)
- 1 A 4 c i Agriculture/Forestry/Fishing: Stationary
- 1 A 4 c ii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery
- 1A 4 c iii Agriculture/Forestry/Fishing: National Fishing
- 1 A 5 a Other, Stationary (including Military)
- 1 A 5 b Other, Mobile (Including military, land based and recreational boats)

In Table 3.12 the list of categories for small combustion and off road vehicles identified as key categories by pollutant for 2010, 1990 and in the trend is reported.

Table 3.12 *List of key categories by pollutant in the civil sector in 2010, 1990 and trend*

	Key categories in 2010		*Key categories in 1990*		*Key categories in trend*	
NOx	1 A 4 a i	1 A 4 c ii	1 A 4 c ii		1 A 4 a i	
NMVOC	1 A 4 b i	1 A 4 a i	1 A 4 c ii		1 A 4 a i	1 A 4 c ii
CO	1 A 4 b i		1 A 4 c ii		1 A 4 b i	
PM_{10}	1 A 4 b i		1 A 4 b i	1 A 4 c ii	1 A 4 b i	1 A 4 c ii
$PM_{2.5}$	1 A 4 b i	1 A 4 c ii	1 A 4 b i	1 A 4 c ii	1 A 4 b i	1 A 4 c ii
Pb	1 A 4 a i				1 A 4 a i	
Cd	1 A 4 a i		1 A 4 a i	1 A 4 b i	1 A 4 a i	
Hg	1 A 4 a i				1 A 4 a i	
PAH	1 A 4 b i		1 A 4 b i		1 A 4 b i	
DIOX	1 A 4 b i		1 A 4 a i		1 A 4 a i	1 A 4 b i
HCB	1 A 4 a i				1 A 4 a i	
PCB	1 A 4 a i				1 A 4 a i	

3.8.2 Activity data

The Commercial / Institutional emissions arise from the energy used in the institutional, service and commercial buildings, mainly for heating. Additionally, this category includes all emissions due to wastes used in electricity generation. In the residential sector the emissions arise from the energy used in residential buildings, mainly for heating and the sector includes emission from household and gardening machinery. The Agriculture/ Forestry/ Fishing sector includes all emissions due to the fuel use in agriculture, mainly to produce mechanical energy, the fuel use in fishing and for machinery used in the forestry sector. Emissions from military aircraft and naval vessels are reported under 1A.5.b Mobile.

The estimation procedure follows that of the basic combustion data sheet. Emissions are estimated from the energy consumption data that are reported in the national energy balance (MSE, several years). The national energy balance does separate energy consumption between civil and agriculture-fishing, but it does not distinguish between Commercial – Institutional and Residential.

The total consumption of each fuel is therefore subdivided between commercial and residential on the basis of the percentage figures estimated by ENEA and reported in its annual energy report (ENEA, several years).

Emissions from 1.A.4.b Residential and 1.A.4.c Agriculture/Forestry/Fishing are disaggregated into those arising from stationary combustion and those from off-road vehicles and other machinery.

The time series of fuel consumption for the civil sector are reported in Table 3.13.

Table 3.13 *Time series of fuel consumption for the civil sector*

	1990	**1995**	**2000**	**2005**	**2010**
			TJ		
1 A 4 a i Commercial / Institutional: Stationary	267,685	295,363	357,066	460,177	539,215
1 A 4 b i Residential: Stationary plants	861,399	867,918	888,568	1,053,467	1,022,057
1 A 4 b ii Residential: Household and gardening (mobile)	466	571	373	154	66
1 A 4 c i Agriculture/Forestry/Fishing: Stationary	9,612	9,604	13,821	16,947	16,162
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	96,638	101,801	94,542	95,805	84,404
1A 4 c iii Agriculture/Forestry/Fishing: National Fishing	8,714	9,733	8,666	10,457	7,726
1 A 5 b Other, Mobile (Including military, land based and recreational boats)	14,830	20,800	11,587	16,935	8,995

The emission factors used derive from the EMEP/EEA Emission Inventory Guidebook 2009 (EMEP/EEA, 2009).

3.8.3 *Methodological issues*

A national methodology has been developed and applied to estimate NO_X emissions from gas powered plants and all emission factors for wood combustion.

3.8.3.1 *NO_X emissions from gas powered plants in the civil sector*

A national methodology has been developed and applied to estimate NO_X emissions from gas powered plants in the civil sector, according to the EMEP/EEA Guidebook (EMEP/EEA, 2009).

On the basis of the information and data reported in available national studies for the year 2003, a distribution of heating plants in the domestic sector by technology and typology has been assessed for that year together with their specific emissions factors. Data related to heating plant, both commercial and residential, have been supplied for 2003 by a national energy research institute (CESI, 2005). In this study, for the residential sector, the sharing of single and multifamily houses plants by technology and a quantitative estimation of the relevant gas powered ones are reported, including their related NO_X emission factors. Domestic final consumption by type of plant, single or multifamily plants, has been estimated on the basis of data supplied by ENEA on their distribution (ENEA, several year).

Data reported by ASSOTERMICA (ASSOTERMICA, several years) related to numbers of heating plants sold, has been used for the years after 2003 to update the information related to the technologies. A linear regression, for the period 1995-2003, has been applied, while for the period 1990-1994, the technology with the highest emission factor has been assumed to be operating.

In Table 3.14 the time series of resulting NO_X average emissions factors for the relevant categories is reported.

Table 3.14 *Time series of NO_X emissions factor for the civil sector*

EF NOx	1990	1995	2000	2005	2010
			g/Gj		
1 A 4 a i Commercial / Institutional: Stationary	50	48.5	40.2	35.2	34.8
1 A 4 b i Residential: Stationary plants	50	48.2	38.6	32.4	32.3

3.8.3.2 *Emissions from wood combustion in the civil sector*

A national methodology has been developed and applied to estimate emissions from wood combustion in the civil sector, according to the TIER 2 methodology reported in the EMEP/EEA Guidebook (EMEP/EEA, 2009). In the past years several surveys have been carried out to estimate national wood consumption in the domestic heating and the related technologies used. In the estimation process, two surveys have been taken into account: the first survey (Gerardi and Perrella, 2001) has evaluated the technologies for wood combustion used in Italy for the year 1999, while the second survey (ARPA, 2007) was related to the year 2006. The technologies assessed by the abovementioned surveys and their distribution are reported in Table 3.15.

Table 3.15 *Distribution of wood combustion technologies*

Distribution of wood combustion technologies		
	1999	2006
	%	
Fireplaces	55.2	44.7
Stoves	22.5	27.6
Advanced fireplaces	11.8	20.2
Pellet stoves	0	3.1
Advanced stoves	5.2	4.4
Other	5.3	0

Average emission factors for 1999 and 2006 have been estimated at national level taking into account the technology distributions; for 1990 only old technologies (fireplaces and stoves) have been considered and linear regressions have been applied to reconstruct the time series from 1990 to 2006. For the last years the 2006 emission factors have been used in absence of further available information.

In Table 3.16 emission factors are reported.

Table 3.16 *Emission factors for wood combustion*

	1990	**1995**	**2000**	**2005**
		g/Gj		
NO_x	50	55	59	61
CO	6000	5791	5591	5427
NMVOC	1270	1170	1079	1026
SO_2	10	11	12	13
NH_3	9	7	6	6
PM10	845	771	705	669
PM2.5	838	765	700	665
PAH	0.67	0.62	0.59	0.56
PCB	0.00	0.00	0.00	0.00
HCB	0.00	0.00	0.00	0.00
As	0.00	0.00	0.00	0.00
Cd	0.00	0.00	0.00	0.00
Cr	0.00	0.00	0.00	0.00
Cu	0.01	0.01	0.01	0.01
Hg	0.00	0.00	0.00	0.00
Ni	0.00	0.00	0.00	0.00
Pb	0.04	0.04	0.04	0.04
Se	0.00	0.00	0.00	0.00
Zn	0.10	0.10	0.10	0.09
B(a)P	0.20	0.19	0.18	0.17
B(b)F	0.20	0.19	0.17	0.17
B(k)F	0.12	0.11	0.10	0.10
IND	0.15	0.14	0.13	0.13

3.8.4 Time series and key categories

The time series of emissions for civil sector and for off road vehicles shows an increasing trend for all pollutants except for SO_X and NO_X, due to a gradually shift of diesel fuel to gas, concerning SO_X, and to a replacement of classic boilers with those with low emission for NO_X. All the other pollutants have a growing trend, as a consequence of the increase of wood combustion.

Time series of emissions is reported in Table 3.17.

Table 3.17 *Time series of emissions in civil sector: small combustion and off-road vehicles*

		1990	1995	2000	2005	2006	2007	2008	2009	2010
SO_x (Gg)	1 A 4	110.27	45.36	24.07	20.18	18.16	16.84	11.74	11.55	11.26
	1 A 5	1.19	0.81	0.21	0.17	0.14	0.12	0.10	0.11	0.13
NO_x (Gg)	1 A 4	171.94	182.77	171.01	164.35	156.11	147.52	143.87	145.64	144.55
	1 A 5	10.27	11.26	6.76	12.87	10.57	9.90	8.57	10.17	6.11
CO (Mg)	1 A 4	510.37	475.32	461.27	548.44	585.54	717.98	746.88	803.89	835.28
	1 A 5	74.10	86.31	50.26	60.79	46.98	41.48	21.28	17.02	17.35
PM10 (Mg)	1 A 4	45.48	52.71	55.08	65.95	69.22	83.85	85.73	92.22	96.80
	1 A 5	1.27	1.54	0.90	1.60	1.32	1.23	1.07	1.27	0.81
PM2.5 (Mg)	1 A 4	43.95	51.22	54.08	65.41	68.70	83.25	85.15	91.60	96.14
	1 A 5	1.27	1.54	0.90	1.60	1.32	1.23	1.07	1.27	0.81
Pb (Mg)	1 A 4	78.48	30.32	20.69	43.03	43.48	67.07	66.93	67.82	76.53
	1 A 5	16.34	4.22	1.16	0.00	0.00	0.00	0.03	0.00	0.00
Cd (Mg)	1 A 4	1.60	1.14	1.63	2.56	2.49	3.25	3.23	3.35	3.66
	1 A 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hg (Mg)	1 A 4	0.62	0.69	1.06	2.01	2.01	2.78	2.79	2.88	3.19
	1 A 5	-	-	-	-	-	-	-	-	-
PAH (Mg)	1 A 4	19.04	25.25	32.12	46.73	51.19	66.07	69.01	75.12	78.52
	1 A 5	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01
HCB (Kg)	1 A 4	1.30	2.23	5.69	5.81	6.19	6.19	6.33	6.78	7.63
	1 A 5	-	-	-	-	-	-	-	-	-
PCB (Kg)	1 A 4	9.72	12.01	19.34	30.99	31.89	37.94	38.46	41.29	46.01
	1 A 5	-	-	-	-	-	-	-	-	-

3.8.5 QA/QC and Uncertainty

Basic data used in the estimation process are reported by Ministry of Economic Development in the National Energy Balance (BEN) and by TERNA (National Independent System Operator), concerning the waste used to generate electricity.

The energy data used to estimate emissions have different levels of accuracy:

- the overall sum of residential and institutional/service/commercial energy consumption is quite reliable and their uncertainty is comparable with data reported in the BEN; the amount of fuels used is periodically reported by main suppliers.
- the energy consumption for agriculture and fisheries is reported in energy statistics; data are quite reliable as they have special taxation regimes and they are accounted for separately.
- the energy use for military and off roads is reported in official statistics, but models are applied to estimate the energy use at a more disaggregated level.

3.8.6 Recalculation

NO_X emission factors have been updated for the whole time series for natural gas. Biomass fuel consumption in residential activity data has been revised from 2001 according to the relevant data supplied in the national energy balance for 2010. Energy recovery from waste reported in the commercial heating has been updated for the whole time series as a consequence of the revision of the waste incinerators database; further details are reported in the waste chapter.

3.8.7 Planned improvements

A survey on wood consumption and combustion technologies is going to be carried out and is going to provide data related to 2011. In addition the updating of emissions factors, for the period 2007-2011, is planned for the next submission.

4 INDUSTRIAL PROCESSES (NFR SECTOR 2)

4.1 Overview of the sector

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

Regarding emissions of the main pollutants, in 2010, industrial processes account for 10.1% of SO_2 emissions, 0.6% of NO_X, 0.1% of NH_3, 4.1% of NMVOC and 4.2% of CO. About particulate matter, in 2010 this sector account for 7.5% of PM10 emissions and 3.7% of PM2.5. Industrial processes make a significant contribution to the total Italian emissions of heavy metals, despite significant reductions since 1990; particularly this sector account for 25.4% of Pb emissions, 14% of Cd and 28.6% of Hg. Regarding POPs emissions, 21.8% of PAH total emissions is emitted from industrial processes as well as 29.1% of dioxins and 42.4% of PCB.

In 2010, *iron and steel* sector (2C1) is a key category at level assessment for PM10, Pb, Cd, Hg, PAH, PCDD/PCDF and PCB; *cement production* (2A1) is key category only for SO_2 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 while was key category for PM2.5.

At trend assessment, *iron and steel* sector is key category for Pb, PAH, PCDD/PCDF and PCB, *cement production* is a key category source for SO_2 emissions and *other chemical industry* for Hg emissions.

4.2 Methodological issues

Methodologies used for estimating emissions from this sector are based on and comply with the *EMEP/CORINAIR guidebook* (EMEP/CORINAIR, 2007), the *IPCC Guidelines* (IPCC, 1997; IPCC, 2006) and the *Good Practice Guidance* (IPCC, 2000). Included also 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 national PRTR reporting obligation, *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 the exchange of information. 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 category for SO_2 emissions and accounts for 4.9% of the total national emissions in 2010.

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 28 companies (87 plants of which: 58 full cycle and 29 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 2010 AITEC, the national cement association, has characterised the national production as follows: 72% is CEM II (Portland composite cement); 13.6% is CEM IV (pozzolanic cement); 9.9% is CEM I (ordinary Portland Cement) and 3.5% is CEM III (blastfurnace cement). Clinker and cement production has been decreasing since 2007 (about 25% in 2010 compared to 2007).

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 nineties. PM10 emissions from this category account for 2.2% of total national emissions.

Regarding SO_2 emissions, emission factors are derived from activity and emission data supplied directly by the plants in the context of the national PRTR reporting obligation; these figures are available from 2002 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 of cement produced; 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_2 EF from cement production plants has been calculated on the basis of the data reported to the national EPER/E-PRTR register, 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 r*oad paving with asphalt* (2A6) that accounts for 1.1% 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 national EPER/E-PRTR register 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 are released from chlorine production facility with mercury cells process (EUROCHLOR, 1998). Total chlorine production in Italy amounted, in 1990, to 1,042,921 tonnes and reduced in 2010 to 268,328 tonnes. Activity production data are supplied by the National Institute of Statistics (ISTAT) and published in the official national statistics and since 2002 data have also been collected at facility level in the national EPER/E-PRTR register. 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 since 2002 emission data have been supplied directly by the production facilities in the framework of the national EPER/E-PRTR. The average emission factor decreased from 1.11 g Hg/t in 2002 to 0.49 g Hg/t in 2010. The reduction observed in emissions for the last years is a consequence of both the conversion of production plants from the mercury cells process to the membrane technology and also the suspension of production at the existing facilities. In 2007 eight facilities carried out the chlor-alkali production, 1 facility had the membrane process in place, 1 facility was replacing mercury cells with membrane process while in the other 6 facilities the production was still based on the mercury cell process (Legambiente, 2007). In 2010 out of the previously mentioned eight facilities 4 have the membrane process in place, 3 facilities have stopped the production for different reasons and 1 facility still operated the mercury cell process.

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 2010, there are only three of the above mentioned plants, one of which lacks sintering facilities; oxygen steel production represents about 33% of the total production and the arc furnace steel the remaining 67% (FEDERACCIAI, several years). Currently, long products represent about 44% of steel production in Italy, flat products about 45%, and pipe the remaining 11%. Almost the whole flat production derives from only one 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) (FEDERACCIAI, several years).

Basic information for *Iron and steel production* derives from different sources in the period 1990-2010. Activity data are supplied by official statistics published in the national statistics yearbook (ISTAT, several years) and by the sectoral industrial association (FEDERACCIAI, 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 process 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 2002-2010 data have also been supplied by all the four integrated iron and steel plants in the framework of the EPER/E-PRTR registry but not distinguished between combustion and process. 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 2010, *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.

Table 4.1 *Emission factors for iron and steel for the year 2010*

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

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 the national 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 1.4% of SO_2 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.

Table 4.2 *Key categories in the industrial processes sector in 2010*

	2A1	2A2	2A4	2A5	2A6	2B1	2B2	2B3 %	2B5a	2C1	2C2	2C3	2D1	2D2	2G
SO_x	4.9					0.005			3.7	0.2	0.001	1.4			
NO_x						0.06	0.02	0.002	0.2	0.2	3E-4	0.05			
NH_3			0.1			0.003	0.001		0.05						
NMVOC				0.002	0.7	0.01			0.3	0.3		0.01	0.1	2.6	
CO			0.8			0.003			0.4	2.4	0.003	0.6			
PM10	2.2	0.7		0.05	1.1				0.4	2.8	0.02	0.2		0.01	
PM2.5	0.4	0.1		0.01	0.2				0.2	2.6	0.01	0.1		0.001	
Pb									-	24.6					0.8
Cd									0.8	13.1		0.2			
Hg									1.4	27.3					
PAH										21.8		0.04			
Dioxin										29.1					
HCB															
PCB										42.4					

Note: key categories are shaded in blue

There is a general reduction of emissions in the period 1990 - 2010 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.

Mineral products (2A)

As above mentioned, PM10 emission factor for cement production is constant from 1990 to 2010 while SO_2 emission factor reduced from 1990 to 1995 and remains constant in the subsequent years. Consequently, SO_2 and PM10 emissions trends follow that of the activity data.

In Table 4.3, activity data, SO_2 and PM10 emissions from Cement production are reported.

Table 4.3 *Activity data, SO_2 and PM10 emissions from Cement production, 1990 – 2010 (Gg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Activity data [Gg]	42,414	35,432	41,119	47,291	47,985	47,231	42,538	36,167	34,283
SO_2 emissions (Gg)	21.2	10.6	12.3	14.2	14.4	14.2	12.8	10.9	10.3
PM10 emissions [Gg]	5.5	4.6	5.3	6.1	6.2	6.1	5.5	4.7	4.5

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 national EPER/E-PRTR reporting obligation. The average emission factor decreased from 1.11 g Hg/t in 2002 to 0.49 g Hg/t in 2010. The reduction observed in Hg emissions for the last years is a consequence of the conversion of production plants from the mercury cells process to the membrane technology but it depends also on suspensions of production processes at some facilities.

Table 4.4 *Activity data and Hg emissions from chlorine production, 1990 – 2010*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Activity data [Gg]	1043	869	786	535	508	409	340	256	268
Hg emissions [Mg]	2.8	1.7	0.9	0.5	0.5	0.3	0.2	0.1	0.1

Metal production (2C)

Emission trend of HMs, 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 and 2010, 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.

Table 4.5 *Activity data and HMs, PCB and PCDD/PCDF emissions from electric arc furnace, 1990 – 2010*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Steel production **EAF** [kt]	15,102	16,107	15,879	17,661	19,730	19,922	19,627	14,001	17,115
Cd emissions **EAF** [Mg]	1.1	1.1	0.8	0.9	1.0	1.0	1.0	0.7	0.9
Cd emissions **2C1** [Mg]	1.3	1.4	1.1	1.2	1.3	1.3	1.3	0.8	1.1
Hg emissions **EAF** [Mg]	2.3	2.4	2.4	2.6	3.0	3.0	2.9	2.1	2.6
Hg emissions **2C1** [Mg]	2.3	2.5	2.4	2.7	3.0	3.0	3.0	2.1	2.6
Pb emissions **EAF** [Mg]	52.1	55.6	54.8	60.9	68.1	68.7	67.7	48.3	59.0
Pb emissions **2C1** [Mg]	61.1	65.7	64.1	71.0	78.4	78.8	77.2	53.4	66.5
PCB emissions **EAF** [kg]	54.4	58.0	57.2	63.6	71.0	71.7	70.7	50.4	61.6
PCB emissions **2C1** [kg]	91.7	100.0	95.8	105.7	113.8	113.6	110.1	71.5	92.7
PCDD/PCDF emissions **EAF** [g T-eq]	67.2	71.7	70.7	78.6	87.8	88.7	87.3	62.3	76.2
PCDD/PCDF emissions **2C1** [g T-eq]	67.2	71.7	70.7	78.6	87.8	88.7	87.3	62.3	76.2

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 2010 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 and 2010, 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.

Table 4.6 *Steel production data and PAH emissions from integrated plants, 1990 – 2010*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Pig iron production [Gg]	11,852	11,678	11,209	11,424	11,497	11,111	10,441	5,687	8,555
Steel production BOF [Gg]	10,365	11,664	10,744	11,688	11,894	11,630	10,963	5,847	8,635
PAH emissions i.p.* [Mg]	44.3	43.9	42.3	43.7	44.4	43.0	40.5	22.6	33.2
PAH emissions 2C1 [Mg]	44.4	44.0	42.3	43.7	44.4	43.1	40.5	22.7	33.3

*i.p.: integrated plants

Other production (2D-2G)

Emissions from these categories are usually negligible except for NMVOC emissions from *food and drink* (2D2) that represent a key category for this pollutant. 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 2D2 are reported.

Table 4.7 *Activity data and NMVOC emissions from sector 2D2***,** *1990 – 2010*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Activity data - Bread [Gg]	4,153	3,882	3,565	4,109	4,489	4,787	4,516	4,214	4,603
Activity data – Wine [10^6 dm^3]	5,521	5,620	5,409	5,057	4,963	4,256	4,625	4,542	4,673
Activity data – Beer [10^6 dm^3]	1,215	1,199	1,258	1,280	1,282	1,346	1,327	1,278	1,281
Activity data – Spirits [10^6 dm^3]	268	232	206	161	180	118	80	127	115
NMVOC emissions [Gg]	31.7	29.2	26.8	27.5	29.8	28.6	26.2	26.5	27.9

4.4 QA/QC and verification

Activity data and emissions reported under EU-ETS and the national EPER/EPRTR register 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, next update of distribution of emissions at local level is scheduled for the present year the resulting map (related to year 2010) will be available in the next submission.

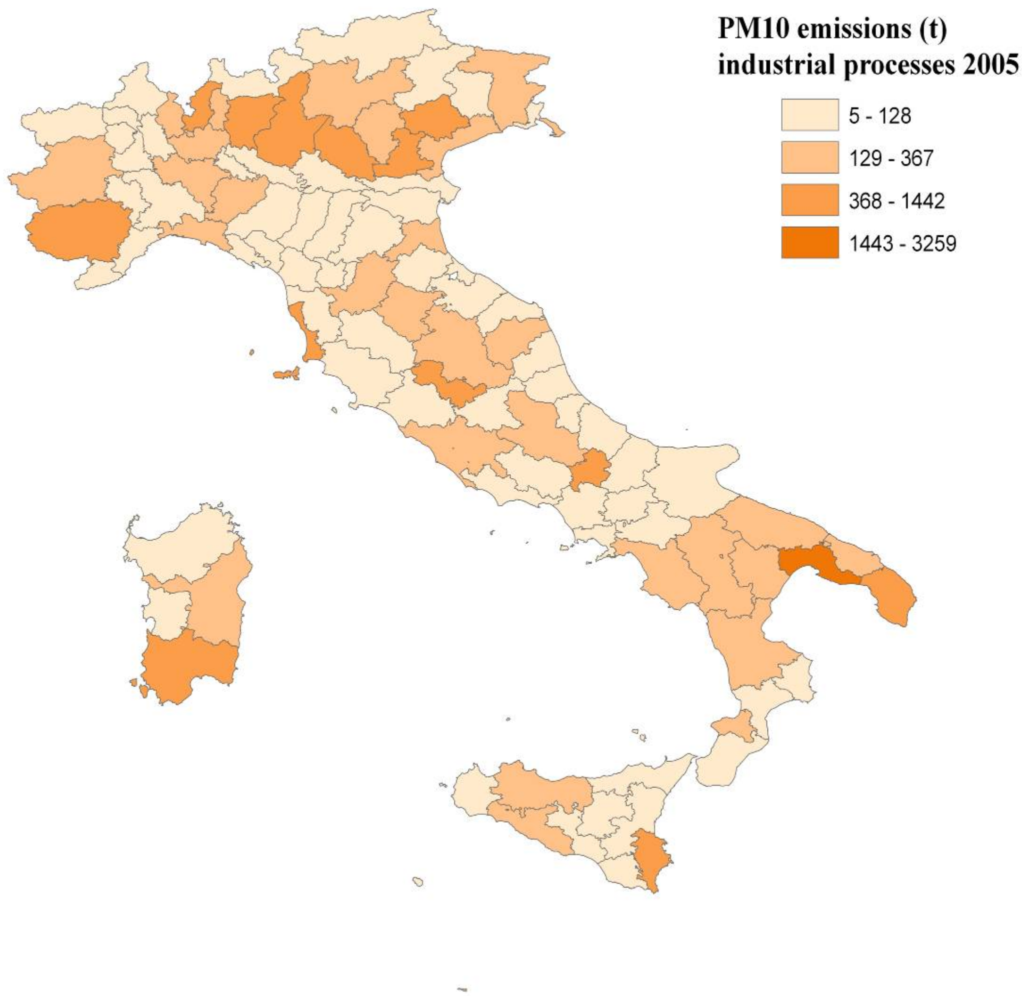


Figure 4.1 *PM10 emissions from industrial processes in 2005 (t)*

4.5 4.5 Recalculations

Mineral products (2A)

CO and NH3 emissions from soda ash production have been revised from 2007 to 2009 due to an update of the activity data.

Recalculation also occurred for NMVOC emissions from road paving, from 2006, because update activity data were supplied by the sectoral association. Consequently, for NMVOC emissions, recalculations for the mineral industry result in about +10% increase in 2006, +12% increase in 2007, +13% increase in 2008 and 2009.

Chemical industry (2B)

Recalculations occurred for 2009, as activity data for *Ethylene*, *Polypropylene* and *Acrylonitrile Butadiene Styrene* productions and NMVOC emission factor for *Polypropylene* have been updated by the relevant operators.

Moreover, from 2006, Hg emission factor and activity data regarding *chlorine production* have been updated on the basis of producers’ communication.

Metal production (2C)

Recalculations in the sector of NMVOC, PAH and PM emissions have been done because iron and steel activity data for 2009 has been updated.

Other production (2D-2G)

In the current submission 2009 activity data for bread production have been updated resulting in a minor change in NMVOC emissions.

4.6 Planned improvements

As above mentioned, a series of technical meetings with the most important Italian manufacturers was held in the framework of the national 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 this 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 form 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 2010; the same categories were also key categories in 1990. Concerning the trend 1990-2010, 3A1, 3C and 3D2 result as key categories.

The sector accounts, in 2010, for 38% 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 32.4% between 1990 and 2010.

PM and PAH are also estimated but they account for less than 0.01%.

In Figure 5.1 the share of NMVOC emissions of the sector is reported for the years 1990 and 2010.

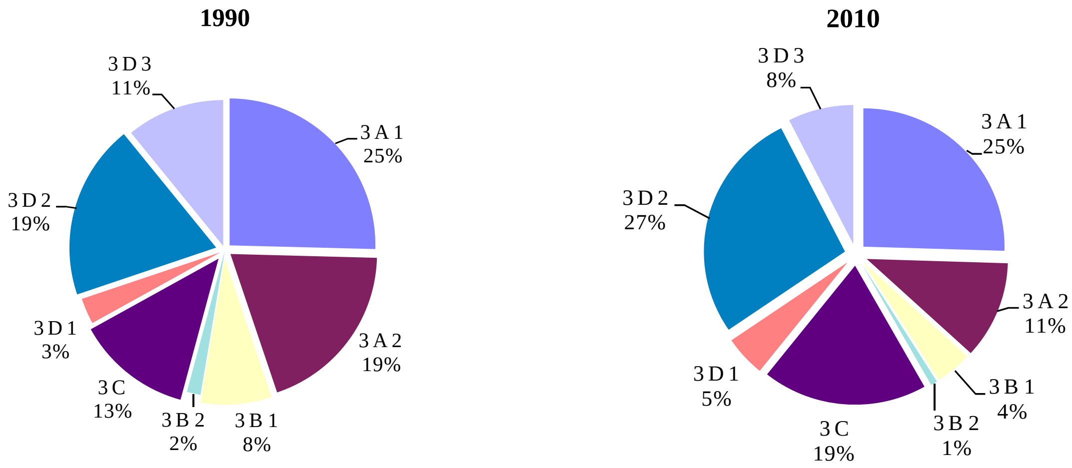


Figure 5.1 *Share of NMVOC emissions for the solvent use sector in 1990 and 2010*

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/PRTR 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).

From 2007 onwards, data are also provided by SSOG (Stazione Sperimentale per le industrie degli Oli e dei Grassi, *Experimental Station for Oils and Fats Industries*), which collects information and data regarding national production and imports for paint categories set out in directive 2004/42/EC 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.

As for emission factors, those for construction and buildings are taken from the EMEP/EEA guidebook and considered constant till 2009, whereas the default values for domestic use vary in consideration of the different share between solvent and water content in paint throughout the years. For 2010 emission factors have been calculated taking into account maximum VOC content limit values for paint and varnishes set out in Annex II A of Directive 2004/42/EC and data collected by SSOG.

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).

In this category, the paint application in construction and building category is one of the biggest contributors to national NMVOC emissions and its share has grown consistently in recent years. NMVOC emissions due to the use of paint and other products except from industrial coating could not be controlled properly in the past since the EU Directive 2004/42/EC entered into force. This directive, transposed in Italian legislation in 2004, sets out maximum VOC content for many paint, varnishes and vehicle refinishing products that had to be achieved in two steps. The early limit values, that had to be respected from 2007 till 2009, did not lead to a significant reduction of NMVOC emission, while the latest values, that had to be respected from 2010 onwards, brought to a significant decrease.

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. From 2007 onwards emission factors have been calculated taking into account maximum VOC content limit values for paint and varnishes set out in Annex II B of Directive 2004/42/EC and data collected by SSOG.

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.

The NMVOC emissions from category 3A2 are decreasing constantly from the nineties, when all industrial installations have been subjected to permits from local authorities. Since then, most of the installations have to comply with emission limit values and technological requirements imposed at regional level, taking in account the EU directives on industrial emissions (i.e. Directive 99/13/EC on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations) and often going beyond the European legislation.

With regard to car repairing the emission cut from 2007 onwards is mainly due to the maximum contents of VOC set by EU Directive 2004/42/EC.

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 the national PRTR. 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 whose emissions, specifically NMVOC, originate from the 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 enduction.

Activity data and emission factors for the application of glues and adhesives had been provided by the relevant industrial association up to 2004. After that period, activity data have been updated 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 2010, for about 38% 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 2010 of about 32 %, from 604 Gg in 1990 to 408 Gg in 2010, mainly due to the reduction of emissions in paint application, 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. In 2010, specifically, the reduction of emissions from paint application for domestic use, which dropped by 67% as compared the previous year, is due to the implementation of the Italian Legislative Decree 161/2006.

Figure 5.2 shows emission trends from 1991 to 2010 with respect to 1990 by sub-sector.

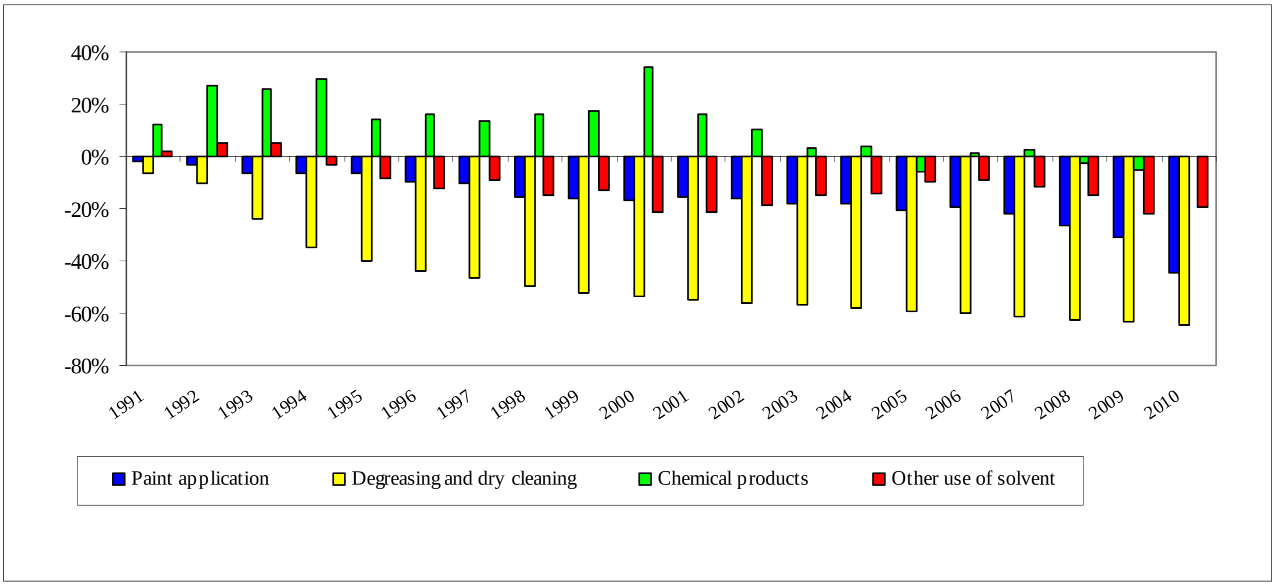


Figure 5.2 *Trend of NMVOC emissions from 1991 to 2010 as compared to 1990*

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

Table 5.1 *Key categories in the solvent and other product use sector in 2010*

	3A1	3A2	3B1	3B2	3C	3D1	3D2	3D3
					%			
SO_x								
NO_x								
NH_3								
NMVOC	9.63	4.29	1.59	0.29	7.15	1.80	10.21	2.84
CO								
PM10					0.01			
PM2.5					0.01			
Pb								
Cd								
Hg								
PAH							0.01	
Dioxin								
HCB								
PCB								

Note: key categories are shaded in blue

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 deriving from polyurethane processing, paints manufacturing and leather tanning.

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 nineties is observed.

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

			1990	1995	2000	2005	2006	2007	2008	2009	2010
06 01	**Paint application**										
06 01 01	Paint application : manufacture of automobiles	*vehicles*	2,850,993	2,511,971	2,754,968	1,744,755	1,926,234	1,988,207	1,676,036	1,330,141	1,299,439
06 01 02	Paint application : car repairing	*Mg paint*	22,250	17,850	24,276	23,475	24,422	25,417	23,184	19,320	18,545
06 01 03	Paint application : construction and buildings (except item 06.01.07)	*Mg paint*	111,644	120,736	125,928	163,455	173,907	174,033	160,558	163,455	168,358
06 01 04	Paint application : domestic use (except 06.01.07)	*Mg paint*	420,000	420,000	420,000	420,000	420,000	420,000	420,000	420,000	420,000
06 01 05	Paint application : coil coating	*Mg paint*	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500
06 01 06	Paint application : boat building	*Mg paint*	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
06 01 07	Paint application : wood	*Mg paint*	150,000	150,000	140,000	140,000	145,000	145,000	145,000	123,250	123,250
	Other industrial paint application	*Mg paint*	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000
06 02	**Degreasing, dry cleaning and electronics**										
06 02 01	Metal degreasing	*Mg solvents*	52,758	32,775	25,895	22,237	21,569	20,922	20,295	19,686	19,095
06 02 02	Dry cleaning	*machines*	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
06 03	**Chemical products manufacturing or processing**										
06 03 01	Polyester processing	*Mg product*	179,852	197,882	168,704	112,188	118,767	122,985	116,068	78,279	89,638
06 03 02	Polyvinylchloride processing	*Mg product*	617,600	575,600	405,285	348,497	316,296	318,225	296,993	77,559	0
06 03 03	Polyurethane processing	*Mg product*	145,700	230,633	350,187	175,278	201,400	210,148	196,585	196,585	196,585
06 03 04	Polystyrene foam processing (c)	*Mg product*	85,004	80,400	90,200	35,200	36,900	35,300	32,800	28,100	33,692
06 03 05	Rubber processing	*Mg product*	671,706	700,859	810,124	831,187	827,947	858,731	789,871	625,884	766,355
06 03 06	Pharmaceutical products manufacturing	*Mg product*	80,068	88,094	104,468	106,861	111,666	104,041	104,250	109,760	108,689
06 03 07	Paints manufacturing	*Mg product*	697,129	747,417	900,683	964,631	1,008,765	1,028,580	969,135	885,049	900,403
06 03 08	Inks manufacturing	*Mg product*	87,527	110,667	132,256	132,521	129,611	140,060	136,224	123,388	133,979
06 03 09	Glues manufacturing	*Mg product*	111,683	266,169	302,087	315,016	315,016	315,016	315,016	315,016	315,016
06 03 12	Textile finishing	*1000 m2*	1,332,679	1,301,105	1,173,047	987,705	1,024,070	1,044,012	899,727	730,244	842,430
06 03 13	Leather tanning	*1000 m2*	173,700	183,839	200,115	157,891	169,897	168,697	159,892	172,995	188,929
06 04	**Other use of solvents and related activities**										
06 04 01	Glass wool enduction	*Mg product*	105,029	119,120	139,421	129,958	153,254	158,264	136,768	68,228	115,923
06 04 03	Printing industry	*Mg ink*	73,754	91,667	100,690	111,550	111,550	111,550	111,550	111,550	111,550
06 04 04	Fat, edible and non edible oil extraction	*Mg product*	5,327,560	7,348,480	6,965,380	9,466,060	7,493,497	7,324,272	7,347,039	7,167,343	7,166,749
06 04 05	Application of glues and adhesives	*Mg product*	98,500	234,751	266,996	278,495	278,495	278,495	278,495	278,495	278,495
06 04 08	Domestic solvent use (other than paint application)(k)	*Mg product*	1,938,779	2,282,020	2,410,338	2,767,759	2,790,264	2,717,561	2,723,252	2,599,536	2,614,249
06 04 09	Vehicles dewaxing	*vehicles*	2,540,597	1,740,212	2,361,075	2,238,344	2,353,249	2,514,905	2,193,570	2,177,601	1,972,070

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

			1990	1995	2000	2005	2006	2007	2008	2009	2010
06 01	**Paint application**										
06 01 01	Paint application : manufacture of automobiles	*g/vehicles*	8,766	6,361	4,884	4,117	4,003	3,903	3,299	2,911	2,679
06 01 02	Paint application : car repairing	*g/Mg paint*	700,000	700,000	605,500	605,500	605,500	520,141	502,999	574,749	435,298
06 01 03	Paint application : construction and buildings (except item 06.01.07)	*g/Mg paint*	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	200,000
06 01 04	Paint application : domestic use (except 06.01.07)	*g/Mg paint*	126,450	113,100	99,750	99,750	99,750	99,750	99,750	99,750	67,710
06 01 05	Paint application : coil coating	*g/Mg paint*	200,000	200,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
06 01 06	Paint application : boat building	*g/Mg paint*	750,000	750,000	622,500	475,417	448,333	421,250	394,167	367,083	340,000
06 01 07	Paint application : wood	*g/Mg paint*	446,500	425,000	406,300	385,417	376,333	367,250	358,167	349,083	340,000
	Other industrial paint application	*g/Mg paint*	530,000	530,000	439,900	355,250	334,200	313,150	292,100	271,050	250,000
06 02	**Degreasing, dry cleaning and electronics**										
06 02 01	Metal degreasing	*g/Mg solvents*	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000
06 02 02	Dry cleaning	*g/machines*	306,000	154,000	103,000	103,000	103,000	103,000	103,000	103,000	103,000
06 03	**Chemical products manufacturing or processing**										
06 03 01	Polyester processing	*g/Mg product*	325	325	325	325	325	325	325	325	325
06 03 02	Polyvinylchloride processing	*g/Mg product*	0	0	0	0	0	0	0	0	0
06 03 03	Polyurethane processing	*g/Mg product*	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000
06 03 04	Polystyrene foam processing (c)	*g/Mg product*	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000
06 03 05	Rubber processing	*g/Mg product*	12,500	10,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
06 03 06	Pharmaceutical products manufacturing	*g/Mg product*	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000
06 03 07	Paints manufacturing	*g/Mg product*	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000
06 03 08	Inks manufacturing	*g/Mg product*	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
06 03 09	Glues manufacturing	*g/Mg product*	20,000	5,041	3,603	2,806	2,806	2,806	2,806	2,806	2,806
06 03 12	Textile finishing	*g/1000 m2*	296	296	296	296	296	296	296	296	296
06 03 13	Leather tanning	*g/1000 m2*	150,000	150,000	125,000	110,000	110,000	110,000	110,000	110,000	110,000
06 04	**Other use of solvents and related activities**										
06 04 01	Glass wool enduction	*g/Mg product*	800	800	800	800	800	800	800	800	800
06 04 03	Printing industry	*g/Mg ink*	234,649	228,190	184,332	174,227	174,227	174,227	174,227	174,227	174,227
06 04 04	Fat, edible and non edible oil extraction	*g/Mg product*	752	713	703	719	724	721	720	724	724
06 04 05	Application of glues and adhesives	*g/Mg product*	600,000	151,230	108,086	84,190	84,190	84,190	84,190	84,190	84,190
06 04 08	Domestic solvent use (other than paint application)(k)	*g/Mg product*	60,117	52,262	42,356	46,117	46,859	46,141	40,484	47,145	42,414
06 04 09	Vehicles dewaxing	*g/vehicles*	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000

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.

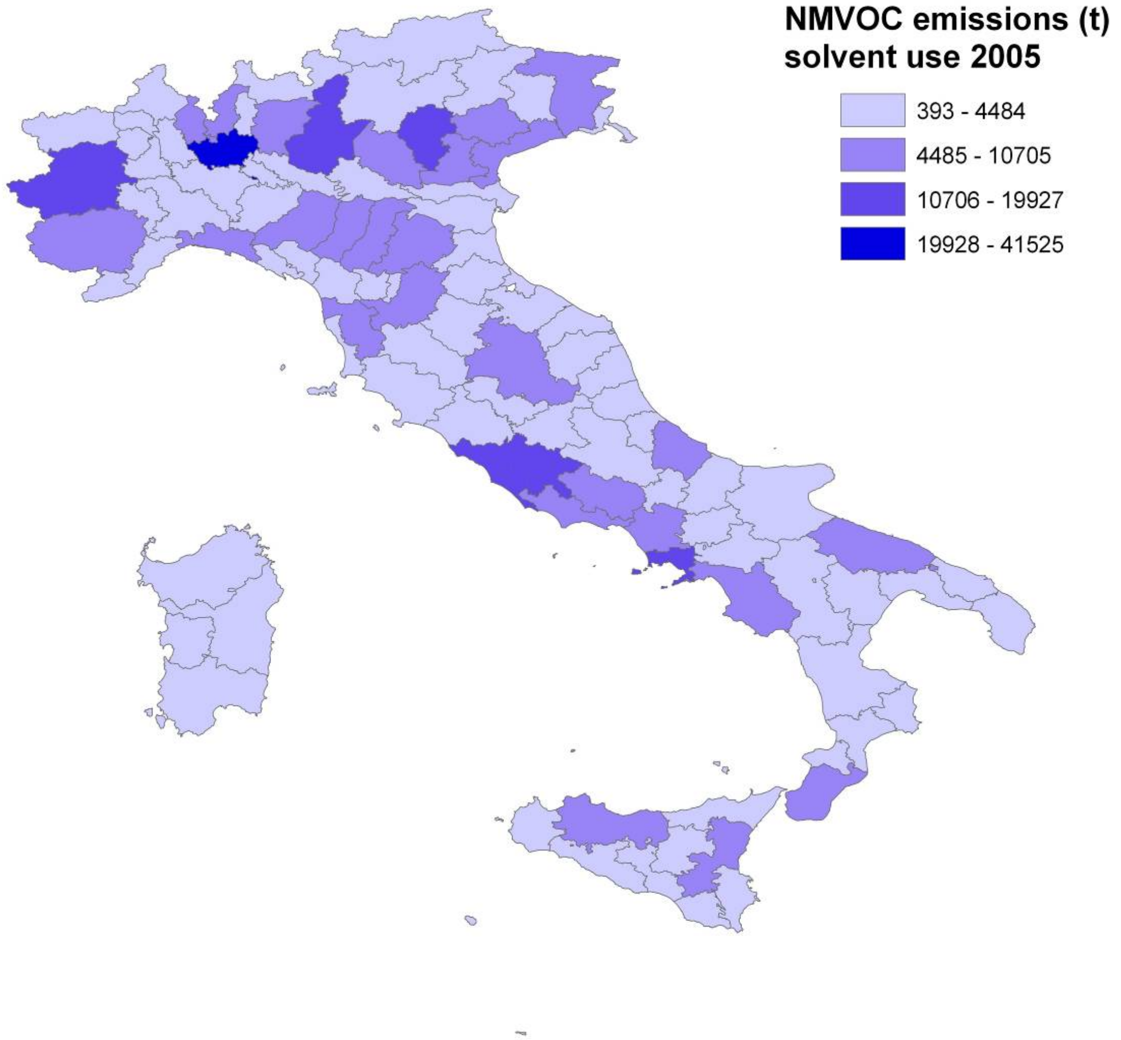


Figure 5.3 *NMVOC emissions from solvent and other product use in 2005 (t)*

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 3A with respect to NMVOC emissions, due to the update, from 2005, of emission factors for paint application in boat building, wood and other industrial paint application and, from 2007, to the change of emission factors for car repairing on account of information communicated within the Legislative Decree 161/2006. Recalculations are also observed, for the year 2009, in category 3C, due to the update of activity data in rubber processing and in category 3D, considering an updating of the apparent consumption of cosmetics in domestic solvent use.

Table 5.4 *Recalculations of NMVOC emissions between 2012 and 2011 submissions*

	NMVOC		
	3A. Paint application	3C. Chemical products	3D. Other
2005	-1.66%		
2006	-2.66%		
2007	-5.50%		
2008	-7.74%		
2009	-9.05%	-0.12%	-0.34%

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_3 emissions, and contributes also to PM10, PM2.5, TSP, NMVOC, CO and HCB emissions. Italy estimates agricultural emissions for manure management (4B), agricultural soils (4D), field burning of agricultural wastes (4F) and use of pesticides that are reported in 4G.

Last update of estimations for the agricultural emission inventory was performed on March 2012.

In 2010, key categories level were identified for NH_3 (4B1a, 4B1b, 4B2, 4B8, 4B9b, 4D1a) and for PM10 (4B9b) emissions. In 1990 similar figures were obtained, however, for NH_3 emissions, 4B2 and 4B9b were not key categories. In addition 4G was the main category for HCB emissions. For the trend analysis, key categories were only related to NH_3 emissions (4B1a, 4B1b, 4B2, 4B8, 4B9b, 4D1a) and HCB (4G).

In 2010, NH_3 emissions from the agriculture sector were 358 Gg (95% of national emissions) where 4B and 4D categories represent 78% and 17% of total national emissions. The trend of NH_3 from 1990 to 2010 shows a 22% decrease due to the reduction in the number of animals, cultivated surface/crop production, and use of N-fertilisers. A representation of the contribution by source of agriculture NH_3 emissions for 1990 and 2010 is shown in Figure 6.1.

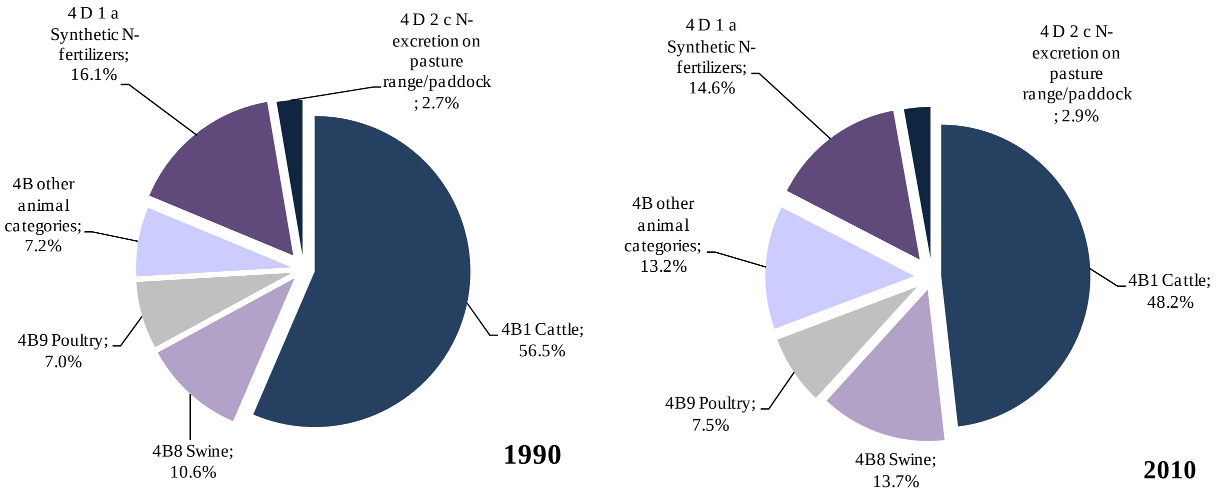


Figure 6.1 *Share of NH_3 emissions in the agriculture sector for 1990 and 2010*

Agricultural official statistics are mainly collected from the National Institute of Statistics, ISTAT. 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.

Agricultural statistics reported by ISTAT are also published in European statistics database[1] (EUROSTAT). The verification of statistics is done as part of the QA/QC procedures; therefore, as soon as

[1] http://epp.eurostat.ec.europa.eu/portal/page/portal/agriculture/data/database

outliers are identified ISTAT and category associations are contacted. In Table 6.1 the time series of main animals' categories is shown.

Table 6.1 *Time series of animals*

Year	Dairy cattle	Non-dairy cattle	Buffalo	Sheep	Goats	Horses	Mules and asses	Swine	Rabbits	Poultry	Fur animals
	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	325,121
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	303,296
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	281,453
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	249,917
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	213,506
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	220,000
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	220,000
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	220,000
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	220,000
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	220,000
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	230,000
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	230,000
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	230,000
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	230,000
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	230,000
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	230,000
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	230,000
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	230,000
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	230,000
2009	1,878,421	4,224,396	344,007	8,012,651	960,950	343,519	40,608	7,473,207	17,689,669	199,924,644	230,000
2010	1,746,140	4,086,317	365,086	7,900,016	982,918	373,324	46,475	7,588,658	17,957,421	198,346,719	230,000

In Table 6.2 the nitrogen content of 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).

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

Type of fertilizers	Emission factor	Nitrogen content ($t\ N\ yr^{-1}$)										
		1990	**1995**	**2000**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Ammonium sulphate	10%	50,762	61,059	36,698	26,550	30,211	27,855	30170.3	35,039	28,431	23,803	32,568
Calcium cyanamide	2%	3,310	507	3,003	2,751	2,437	2,357	2454.9	2,847	3,595	3,864	4,958
Nitrate (*)	2%	157,221	189,907	164,134	173,187	169,195	167,872	156,957	153,526	135,710	78,859	72,833
Urea	15%	291,581	321,196	329,496	354,208	361,048	317,814	338026.9	336,686	312,427	232,815	209,829
Other nitric nitrogen	2%	-	-	3,204	6,112	5,326	5,219	4882	3,749	3,952	3,671	3,332
Other ammoniacal nitrogen	2%	-	-	6,278	13,127	15,900	18,069	17497.2	17,063	15,620	13,018	12,412
Other amidic nitrogenous	15%	-	-	6,988	10,487	14,546	17,420	17037.8	19,470	20,634	16,101	15,366
Phosphate nitrogen	5%	112,237	99,468	77,916	85,079	77,949	69,758	70718.9	55,674	29,702	47,397	45,837
Potassium nitrogen	2%	3,937	2,876	5,291	10,105	12,201	12,289	13336.2	18,047	16,887	17,369	15,955
NPK nitrogen	2%	138,018	101,528	113,897	108,358	116,361	106,384	99965.3	83,694	63,712	56,191	64,462
Organic mineral	2%	444	20,960	38,688	34,684	36,191	34,809	34218.3	39,695	29,254	25,691	19,085
TOTAL		**757,509**	**797,500**	**785,593**	**824,649**	**841,363**	**779,846**	**785,265**	**765,490**	**659,922**	**518,778**	**496,637**

(*) includes ammonim nitrate < 27% and ammonium nitrate > 27% and calcium nitrate

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 NO_X emissions according to the EMEP/EEA 2009 air pollutant emission inventory guidebook, including those categories which have not been estimated yet. 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 (Cóndor and De Lauretis, 2007). Information reported in the *National Inventory Report/Common Reporting Format (NIR/CRF)* for the GHG inventory is coherent and consistent with information reported in the *Informative Inventory Report*/*Nomenclature for Reporting* (*IIR/NFR*).

Manure management (4B)

For 4B category, Italy has estimated emission for pollutants recommended in the EMEP/EEA 2009 Guidebook (NH_3, NMVOC, PM10, and PM2.5). NO emissions from 4B were not estimated. Emission factors involved in the estimation process of NO emissions are high uncertain, and further studies are necessary to carry out the estimates. A detailed and updated description of the methodologies for the estimation of NH_3 emissions, as well as of national specific circumstances and reference material, is provided in sectoral reports (APAT, 2005; Cóndor *et al.*, 2008; Cóndor, 2011), and in the NIR (ISPRA, 2012[b]). The national NH_3 emission inventory has been prepared by ISPRA with the support of *Research Centre on Animal Production* (CRPA). Detailed information on activity data sources, methods and EFs by pollutant for 4B category is shown in Table 6.3.

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

NFR code	Animal category	Method	Activity data	Emission Factor
4B1a, 4B1b	Cattle	T2 (NH_3), T1 (NMVOC, PM10, PM2.5)	NS	CS (NH_3), D (NMVOC, PM10, PM2.5)
4B3,4,5,6,7	Buffalo, Sheep, Goats, Horses, Mules and Asses	T1 (NH_3, NMVOC, PM10, PM2.5)	NS, IS	CS (NH_3), D (NMVOC, PM10, PM2.5)
4B8	Swine	T2 (NH_3), T1 (NMVOC, PM10, PM2.5)	NS	CS (NH_3), D (NMVOC, PM10, PM2.5)
4B9a,b,c,d	Poultry	T2 (NH_3), T1 (NMVOC, PM10, PM2.5)	AS	CS (NH_3), D (NMVOC, PM10, PM2.5)
4B13	Other	T1 (NH_3, NMVOC, PM10, PM2.5)	NS	CS (NH_3), D (NMVOC)

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

Concerning the 4B category, the estimation procedure for NH_3 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_3 estimations are reported in Table 6.4.

Table 6.4 *Average weight and nitrogen excretion rates from livestock categories in 2010*

Category	Weight	Housing	Grazing	TOTAL
	kg	*kg head^{-1} yr^{-1}*		
Non-dairy cattle	381	48.54	1.29	**49.83**
Dairy cattle	603	110.20	5.80	**116.00**
Buffalo	525	92.20	2.75	**94.96**
Other swine (*)	84	12.85	-	**12.85**
Sow (*)	172	28.36	-	**28.36**
Sheep	48	1.62	14.58	**16.20**
Goats	48	1.62	14.58	**16.20**
Horses	550	20.00	30.00	**50.00**
Mules and asses	300	20.00	30.00	**50.00**
Poultry	1.7	0.53	-	**0.53**
Rabbit	1.6	1.02	-	**1.02**

(*) other swine and sow are sources that represent the ‘swine’ category

Average emission factors for NH_3 per head are reported in Table 6.5.

Table 6.5 *NH_3 emission factors for manure management for the year 2010*

Category	Housing	Storage	Land spreading	TOTAL
		kg NH_3 head^{-1} yr^{-1}		
Non-dairy cattle	6.81	9.16	5.58	**21.55**
Dairy cattle	15.46	20.36	12.65	**48.47**
Buffalo	12.93	17.04	12.59	**42.56**
Other swine (*)	2.38	2.07	1.38	**5.84**
Sow (*)	4.87	4.47	3.11	**12.46**
Sheep	0.22	0.00	0.46	**0.68**
Goats	0.22	0.00	0.46	**0.68**
Horses	3.24	0.00	2.75	**5.99**
Mules and asses	3.24	0.00	2.75	**5.99**
Hens	0.09	0.06	0.04	**0.19**
Chicken	0.08	0.05	0.03	**0.15**
Other poultry	0.18	0.11	0.06	**0.35**
Rabbit	0.34	0.13	0.07	**0.54**
Fur animal	1.37	0.00	0.34	**1.70**

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 (http://www.epa.gov/ttn/chief/ap42/index.html).

For 4B particulate matter emissions a tier 1 method was used for calculations. EFs for PM10 and PM2.5 are derived from the EMEP/CORINAIR guidebook, modified on the basis of the Italian animal breeding characteristics and weight parameters (Cóndor *et al*., 2008; Cóndor, 2011). In particular, for the category 4B9b (broilers), the annual PM10 emission factor is equal to 0.083 kg/head.

Agricultural soils (4D)

For *agricultural soils* (4D), estimations of NH_3 emissions account for the direct application of synthetic N-fertilizers (4D1a), animal grazing (4D2c) and N fixed by leguminous cultivation (included in 4D2c since there is no specification where to report). For 4D1a category, no estimations were performed for NMVOC, NO_X, PM10, and PM2.5; for 4D2c category, NO emissions have been not estimated. 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_3 emissions from synthetic N-fertilizers are obtained with the amount of the N content by type of fertilizer multiplied by the 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]; Cóndor and Valli, 2011).

For 4D2c the time series of the quantity of N from animal grazing is the same as that reported in the NIR 2012 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 (ISPRA, 2012[b]).

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

NFR code	Category	Method	Activity data	Emission Factor
4D1a	Synthetic N-fertilizers	T1/T2 (NH_3)	NS	D (NH_3)
4D2a	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_3)	NS	CS (NH_3)

Field burning of agricultural wastes (4F)

For 4F category, NMVOC, CO, NO_X, PM10, and PM2.5 emissions have been estimated, applying the tier 1 approach. Concerning NO_X, CO, NMVOC, IPCC emission factors have been used (IPCC, 1997), while for PM10 and PM2.5 EFs from the EMEP/CORINAIR guidebook have been applied No estimations were performed for NH_3 and SO_X emissions.

Other (4G)

For this category HCB emissions from the use of pesticides have been estimated. The category is key category at level assessment in 1990. HCB emissions result from the use of HCB as pesticide but also by the use of other pesticides which contain HCB as an impurity.

The lack of data on the use of HCB as a pesticide did not allow the first type of estimate but it was possible to estimate emissions from pesticides where HCB is found as an impurity and with available data: lindane, DCPA, clorotalonil and Picloram.

On the basis of the amount of HCB contained in these pesticides (lindane: 0.01%; DCPA: 0.1%; clorotalonil: 0.005%; Picloram: 0.005%) and applying the HCB emission factor provided from the Guidebook EMEP/EEA, HCB emissions result in 23 kg for 1990 and 1 kg in 2010 for Italy.

An international research work at European level (Berdowski et al., 1997) estimated 400kg of HCB emissions from pesticide use for Italy in 1990 while in the last years these emissions should be null.

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_3 emissions in Italy; for the main pollutants, in 2010 the sector accounts for:

- 95% in national total NH_3 emissions;
- 9% in national total PM10 emissions;
- 3% in national total PM2.5 emissions; and
- 2% in national total HCB emissions.

Moreover, the sector comprises 0.4% of total CO emissions, 0.1% of NMVOC, and 0.05% of NO_x. There are no particular differences as compared to the sectoral share in 1990 when the agriculture sector accounted for 98% of NH_3 emissions, 7% of PM10 and 3% of PM2.5 except for HCB emissions where agriculture accounted for 55% of total national emissions.

Table 6.7 reports the key categories identified in the agriculture sector while the time series of NH_3 emissions by sources is shown in Table 6.8.

Concerning NH_3 emissions, the category *manure management (4B)* represents, in 2010, 78% of total ammonia emissions (79% in 1990). In particular, NH_3 emissions from *cattle* (4B1) stand for 58% of 4B emissions, while emissions from *swine* (4B8) and *poultry* (4B9) represent 17% and 9%, respectively. *Direct soil emissions (4D)*, specifically for the use of synthetic N-fertilisers (4D1a) represent 14% in 2010 of NH_3 emissions (16% in 1990).

Regarding PM10 emissions, the category *manure management (4B)* accounts for 8.1% in 2010 (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).

For PM2.5 emissions, the category *manure management* (4B) contributes for 2.1% in 2010 (1.8% in 1990). *Cattle* (4B1) accounts for 42%, while *poultry* (4B9) stands for 37% to the total PM2.5 emissions from category 4B.

Table 6.7 *Key categories in the agriculture sector in 2010*

	4B1a	4B1b	4B2	4B3	4B4	4B6	4B7	4B8	4B9a	4B9b	4B9d	4B13	4D1a	4D2c	4F	4G
								%								
SO_x																
NO_x															0.05	
NH_3	22.3	23.2	4.1	1.4	0.2	0.6	0.1	12.9	2.6	4.4	3.4	2.7	13.8	2.7		
NMVOC	0.01	0.02	0.002	0.004	0.000	0.001	0.0001	0.01							0.1	
CO															0.4	
PM10	0.5	0.6	0.1	-	-	0.05	0.01	1.8	0.5	4.5					1.1	
PM2.5	0.4	0.5	0.1	-	-	0.04	0.004	0.3	0.1	0.7					1.2	
Pb																
Cd																
Hg																
PAH																
Dioxin																
HCB																2.3
PCB																

Note: key categories are shaded in blue

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

NFR SECTOR 4	1990	1995	2000	2004	2005	2006	2007	2008	2009	2010
4 B 1 a Cattle Dairy	139	106	102	89	89	88	89	89	91	85
4 B 1 b Cattle Non-Dairy	119	117	110	97	95	90	96	94	92	88
4 B 2 Buffalo	4	6	8	9	9	10	12	13	14	16
4 B 3 Sheep	6	7	7	5	5	6	6	6	5	5
4 B 4 Goats	1	1	1	1	1	1	1	1	1	1
4 B 6 Horses	2	2	2	2	2	2	2	2	2	2
4 B 7 Mules and Asses	1	0	0	0	0	0	0	0	0	0
4 B 8 Swine	49	46	46	47	49	49	49	49	49	49
4 B 9 a Laying Hens	17	15	12	12	10	10	10	10	10	10
4 B 9 b Broilers	15	16	15	15	15	14	15	16	17	17
4 B 9 c Turkeys	0	0	0	0	0	0	0	0	0	0
4 B 9 d Other Poultry	11	14	13	14	13	13	13	14	13	13
4 B 13 Other (*)	9	10	10	11	12	11	12	11	10	10
4 D 1 a Synthetic N-fertilizers	73	80	79	85	77	81	80	72	56	52
4 D 2 c N-excretion on pasture range/paddock	12	13	13	10	10	10	10	10	10	10
TOTAL	**457**	**432**	**417**	**398**	**387**	**384**	**395**	**386**	**371**	**358**

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

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_3 emissions is mainly related to the reduction in the number of animals. Between 1990 and 2010 total 4B NH_3 emissions have reduced by 18%. Cattle livestock decreased by 25% (from 7,752,152 to 5,832,457 heads). Dairy cattle and non-dairy cattle have decreased by 34% and 20%, 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 2010 by 9% and 14%, respectively (see Table 6.1). Abatement technologies are considered in the EFs used for NH_3 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]; Cóndor et al., 2008; CRPA, 2010[b]).

NH_3 emissions of 4D1a category are driven by the use of N-fertilizers. Between 1990-2010 emissions have reduced by 29% while the use of N-fertilizers by 34%. Between 2007/2008 and 2008/2009 N fertiliser distribution has decreased by 14% and 21%, 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, as a consequence of agriculture product price decreasing, minor amount of fertilisers has been used by farmers to reduce costs (Perelli, 2007).

Every 5 years the national agriculture UNFCCC/CLRTAP emission inventory is disaggregated at NUTS3 level as requested by CLRTAP (Cóndor *et al*., 2008). A database with the time series for all sectors and pollutants has been published (ISPRA, 2008; ISPRA, 2009; ISPRA, 2012[d]; ISPRA, 2012[e]). The disaggregation (NUTS3) of the NH_3 agricultural emissions is shown in Figure 6.2. In 2005, four regions from Italy contributed with 63% of agricultural NH_3 emissions: Lombardia (25%), Veneto (15%), Emilia Romagna (13%) and Piemonte (10%). The disaggregation (NUTS3) of 2010 agricultural emissions will be finalised in the course of this year.

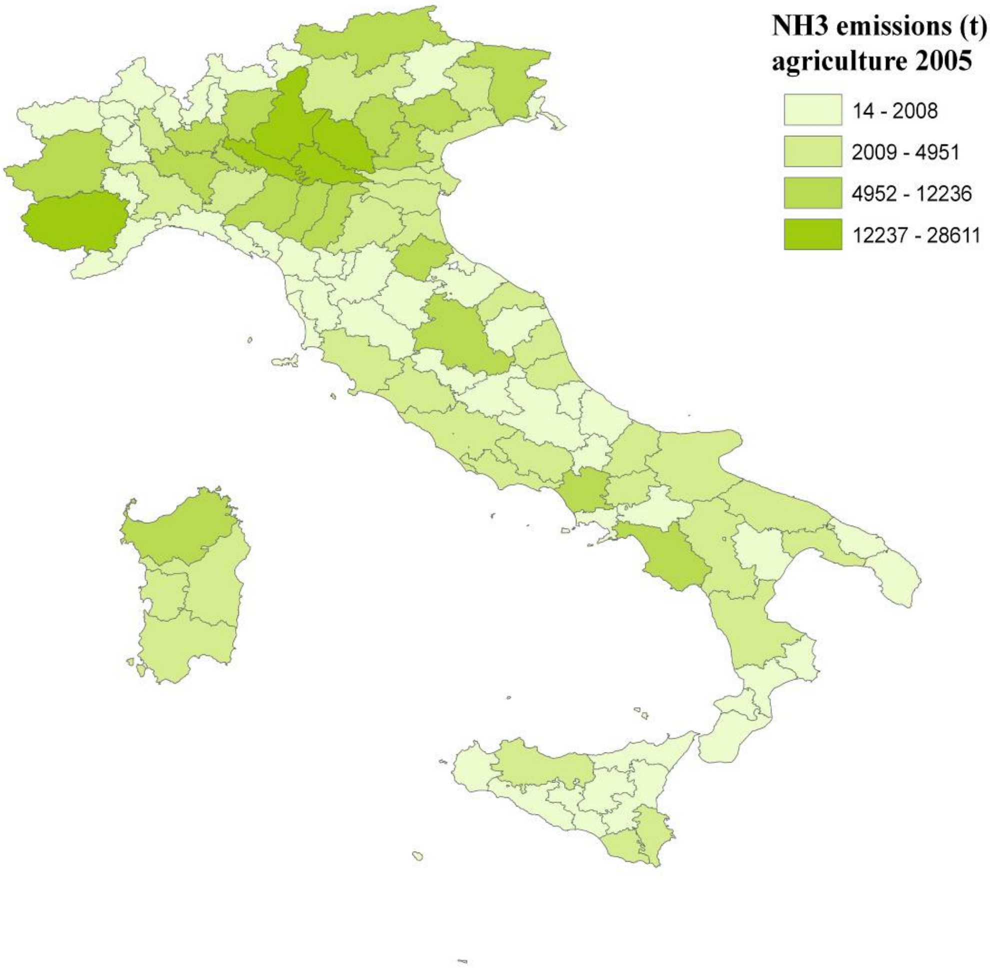


Figure 6.2 *NH_3 emissions from Agriculture in 2005 (t)*

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_3 emissions improvements are specified (ISPRA, 2012[c]). Furthermore, feedbacks for the agricultural emission inventory derive also from communication of data to different institutions (ISTAT, UNA, CRPA 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 2012, recalculations were implemented for the agricultural emission inventory. HCB emissions from the use of pesticides have been estimated for the whole time series and reported in the 4G ‘other’ category. In addition, for the year 2009, the number of animals for non-dairy cattle (animals between 1-2 years old) and rabbits has been updated. Minor recalculation, for the whole time series, regarded non dairy cattle and buffaloes NH_3 emissions (4B1b and 4B2 category respectively) due to the update of the percentages of nitrogen emitted in the spreading.

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_3 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_3 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, 2012[b]).

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 categories.

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 was 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.

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_4 and N_2O 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

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

Table 7.1 *Air pollutant emissions estimated for each sector*

Main pollutants	6A	6Ca	6Cb	6Cc	6Ce	6Cd	6D
NO_x		x	x	x	x	x	x
CO		x	x	x	x	x	
NMVOC	x	x	x	x	x	x	x
SO_x		x	x	x		x	
NH_3	x						x
Particulate matter							
TSP		x	x	x	x	x	
PM10		x	x	x	x	x	
PM2.5		x	x	x	x	x	
Priority heavy metals							
Pb		x	x	x		x	
Cd		x	x	x		x	
Hg		x	x	x		x	
POPs Annex II							
PCB		x	x	x			
POPs Annex III							
Dioxins		x	x	x	x	x	
PAH		x	x	x	x	x	
HCB		x	x	x			
Other heavy metals							
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			

In 2010, *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 and *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 and dioxins; *industrial waste incineration* (6Cb) is a key category for what concern HCBs and dioxins *whereas municipal waste incineration* (6Cc) are key categories for dioxins.

The waste sector, and in particular Waste incineration (6C), is a relevant source of different pollutants; for the main pollutants, in 2010, the sector accounts for:

- 48.0% in national total HCB emissions;
- 19.9% in national total PAH emissions.
- 13.5% in national total Dioxin emissions;

Moreover, the sector comprises 5.8% of total PM10 and PM2.5 emissions, 9.6% of CO, 2.4% of NH_3, 2.1% of NMVOC, 1.5% of NO_X, and for what concern priority heavy metals 1.9% of Cd, 1.6% of Hg and 1.4% 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_3 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, 2012 [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 et al., 1993).

Methane, and consequently NMVOC and NH_3 air pollutants, is emitted from the degradation of waste occurring 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 through the years in the model); the fraction of methane in the landfill gas (which has been assumed equal to 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 consist of: waste generation, collection and transportation, separation for resource recovery, treatment for volume reduction, stabilisation, recycling and energy recovery and disposal 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 2010, the non hazardous landfills in Italy disposed 16,187 kt of MSW and 3,343 kt of industrial wastes, as well as 370 kt 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.

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

ACTIVITY DATA (Gg)	1990	1995	2000	2005	2006	2007	2008	2009	2010
MSW production	22,231	25,780	28,959	31,664	32,511	32,542	32,467	32,110	34,793
MSW disposed in landfills for non hazardous waste	17,432	22,459	21,917	17,226	17,526	16,912	16,069	15,418	16,187
Assimilated MSW disposed in landfills for non hazardous waste	2,828	2,978	2,825	2,914	2,481	2,777	3,703	3,181	3,343
Sludge disposed in managed landfills for non hazardous waste	2,454	1,531	1,326	544	525	407	364	335	370
Total Waste to managed landfills for non hazardous waste	16,363	21,897	26,069	20,684	20,532	20,095	20,136	18,934	19,900
Total Waste to unmanaged landfills for non hazardous waste	6,351	5,071	0	0	0	0	0	0	0
Total Waste to landfills for non hazardous waste	22,714	26,968	26,069	20,684	20,532	20,095	20,136	18,934	19,900

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

Regarding waste incineration, methodology used for estimating emissions is based on and consistent with 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 2010, 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 by 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 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, energy recovery section (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.

Table 7.3 *Emission factors for waste incineration*

Air Pollutant	u.m	Municipal	Industrial	Clinical	Sludge	Oil
NO_x	*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_2	*kg/t*	0.39	1.28	0.02594	1.28	1.28
PM10	*g/t*	46	240	25.676	180	240
PM2.5	*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	-

Concerning 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 national EPER/PRTR register, verification of emissions has been carried out.

In Table 7.4 dioxin emission factors for waste incineration are reported for 1990 and 2010.

Table 7.4 *Dioxin emission factors for 1990 and 2010*

Waste Typology	u.m	1990	2010
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

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

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

Waste incinerated	1990	1995	2000	2005	2006 *Gg*	2007	2008	2009	2010
Total waste	1,656.2	2,149.1	3,061.7	4,964.2	5,066.4	6,013.8	6,066.8	6,535.6	7,386.9
with energy recovery	911.2	1,557.8	2,751.9	4,721.4	4,824.2	5,794.1	5,857.6	6,306.2	7,159.5
without energy recovery	745.0	591.3	309.8	242.8	242.2	219.6	209.2	229.4	227.4
Clinical waste (6Ca)	134.5	151.7	110.3	126.2	145.3	131.9	139.7	135.8	145.0
with energy recovery	25.3	41.1	76.7	105.7	119.0	104.1	106.1	102.2	114.1
without energy recovery	109.2	110.6	33.6	20.5	26.3	27.8	33.6	33.6	30.9
Industrial waste (6Cb)	496.1	560.7	626.5	1,618.1	1,651.7	2,574.4	2,545.9	2,557.8	2,920.7
with energy recovery	259.5	331.2	513.8	1,447.8	1,458.7	2,410.9	2,394.7	2,392.8	2,743.6
without energy recovery	236.6	229.6	112.6	170.4	193.0	163.5	151.2	164.9	177.1
Municipal waste (6Cc)	1,025.6	1,436.6	2,324.9	3,219.9	3,269.3	3,307.4	3,381.1	3,842.1	4,321.2
with energy recovery	626.4	1,185.5	2,161.4	3,168.0	3,246.5	3,279.1	3,356.8	3,811.2	4,301.7
without energy recovery	399.2	251.1	163.5	51.9	22.8	28.3	24.4	30.9	19.5

Cremation of corpses (6Cd)

Emissions from incineration of human bodies in crematoria have been carried out 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.

Up to 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 76,868 in 2010.

In Table 7.6 time series of number of cremations as well as annual deaths and crematoria in Italy are reported.

Table 7.6 *Cremation time series (activity data)*

Cremation of corpses	1990	1995	2000	2005	2006	2007	2008	2009	2010
Cremations	5,809	15,436	30,167	48,196	53,013	58,554	63611	71,898	76,868
Deaths	543,700	555,203	560,241	567,304	557,892	570,801	585126	591,663	587,488
% of cremation	1.07	2.78	5.38	8.50	9.50	10.26	10.87	12.15	13.08
Crematoria	NA	31	35	43	44	45	46	51	54

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.

Table 7.7 *Emission factors for cremation of corpses*

Air pollutant	u.m.	Cremation
NO_x	kg/body	0.309
CO	kg/body	0.141
NMVOC	kg/body	0.013
SO_x	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 (benzo(a)pyrene)	μg/body	0.0103
Dioxins	μg/body	0.0168

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, TSP, NMVOC and NO_X emissions have been estimated. No estimations were performed for NH_3 and SO_X emissions.

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

1. Amount of removable residues (t), estimated with annual crop production (ISTAT, several years [a], [b]; ISTAT, 2012 [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 fixed 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. $C\text{-}CH_4$ from removable residues burning (t $C\text{-}CH_4$), calculated with the amount of carbon from removable residues burning release in air and default emissions rate for $C\text{-}CH_4$, 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. $N\text{-}NO_X$ from removable residues burning (t $N\text{-}NO_X$), calculated with the amount of nitrogen from removable residues burning release in air and the default emissions rate for N- NO_X, equal to 0.121 (IPCC, 1997).

NMVOC emissions have been considered equal to CH_4 emissions. As regards the other pollutants, the following emission factors have been used to estimate PAH, dusts and dioxins (Table 7.8).

Table 7.8 *Emission factors for burning of agriculture residues*

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

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, 2012 [a], [b]); most of these wastes refer especially to the prunes of olives and vineyards, because of the typical national cultivation. Activity data (agricultural production) used for estimating burning of agriculture residues are reported in Table 7.9.

In 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.

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

Agricultural production	1990	1995	2000	2005	2006	2007	2008	2009	2010
					kt				
Cereals									
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	6,849.7
Rye	20.8	19.8	10.3	7.9	8.6	9.0	10.8	12.2	13.9
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	944.3
Oats	298.4	301.3	317.9	429.2	394.9	361.1	356.1	314.4	288.9
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	1,564.4
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	8,495.9
Sorghum	114.2	214.8	215.2	184.9	221.4	193.2	224.6	243.4	275.6
Woody crops									
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	7,839.7
Olives	912.5	3,323.5	2,810.3	3,774.8	3,415.7	3,249.8	3,473.9	3,600.5	3,117.8
Citrus Orchards	2,868.8	2,607.7	3,100.2	3,518.1	3,646.2	3,892.6	3,484.3	3,825.9	3,789.1
Orchards	5,793.5	5,406.6	5,948.6	6,036.0	5,998.0	5,955.5	5,855.7	6,144.6	5,775.8
Carobs	29.2	44.4	38.1	31.7	26.1	32.8	31.2	30.0	25.3
Total	***35,441***	***39,474***	***41,384***	***43,340***	***41,593***	***40,831***	***42,402***	***39,120***	***38,980***

Other waste (6D)

Under this category, NMVOC emissions from compost production and NO_X 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 2010 (from 363,319 tons to 8,395,700 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 (51g NMVOC kg^{-1} treated waste) is from international scientific literature too (Finn and Spencer, 1997).

Concerning 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, 2012 [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. The dry matter contained in sludge at national level is assumed to be 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 $N\text{-}NH_3$+NO_X emissions is 20% (IPCC, 1997), whereas 16% is emitted as $N\text{-}NH_3$ and 4% as $N\text{-}NO_X$.

Table 7.10 *Sludge spreading activity data and parameters, 1990 – 2010*

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
2010	3,695,505	1,293,427	323,357	3.9	12,689

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 2010. Key categories are those shaded.

Table 7.11 *Key categories in the waste sector in 2010*

	6A	6Ca	6Cb	6Cc	6Cd	6Ce	6D
				%			
SO_x		0.0004	0.1	0.004	0.02		
NO_x		0.002	0.04	0.002	0.003	1.3	0.2
NH_3	1.7						0.7
NMVOC	0.7	0.02	0.1	0.001	0.0001	1.2	0.04
CO		0.0001	0.004	0.0001	0.0005	9.6	
PM_{10}		0.0004	0.02	0.000	0.001	5.8	
$PM_{2.5}$		0.0005	0.02	0.001	0.001	5.8	
Pb		0.0003	1.4	0.01	0.000001		
Cd		0.0004	1.8	0.06	0.000004		
Hg		0.01	1.6	0.03	0.001		
PAH		0.000003	0.06	0.001	0.000000001	19.8	
Dioxins		0.01	0.04		0.000001	13.4	
HCB		2.5	45.4	0.08			
PCB		0.3	0.4	0.04			

Note: key categories are shaded in blue

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 2010 (Figure 7.1, Figure 7.2, Figure 7.3 and Figure 7.4).

In particular, as regard dioxin emissions, waste sector accounts for 13.5% on the national total: from 1990 emissions have decreased by 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).

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, 10.4 Kg in 2010, which shows no differences with respect to the reference year (Figure 7.2).

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

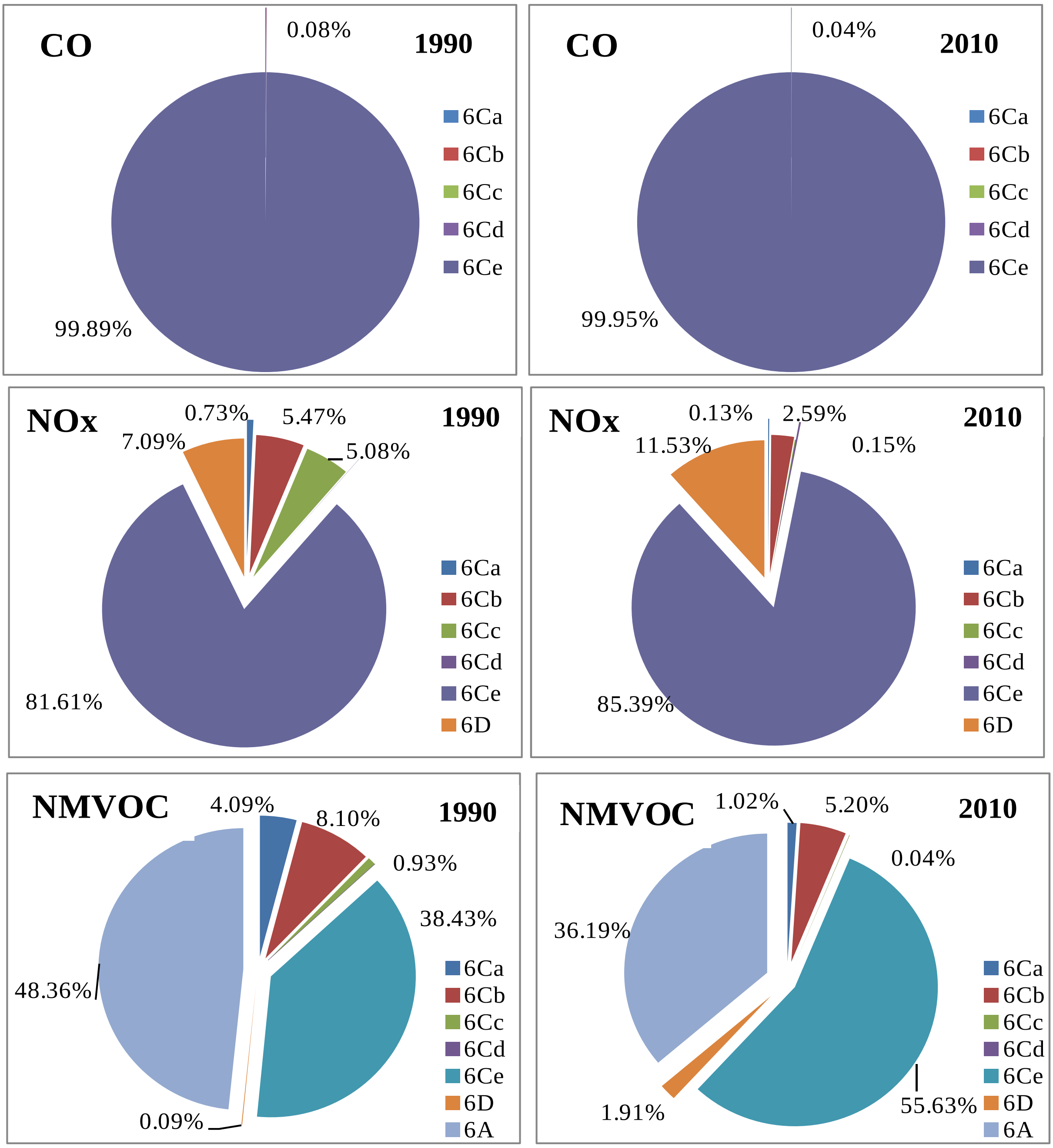


Figure 7.1 *Contribution of CO, NO_X and NMVOC sub-category emissions to waste sector total emissions*

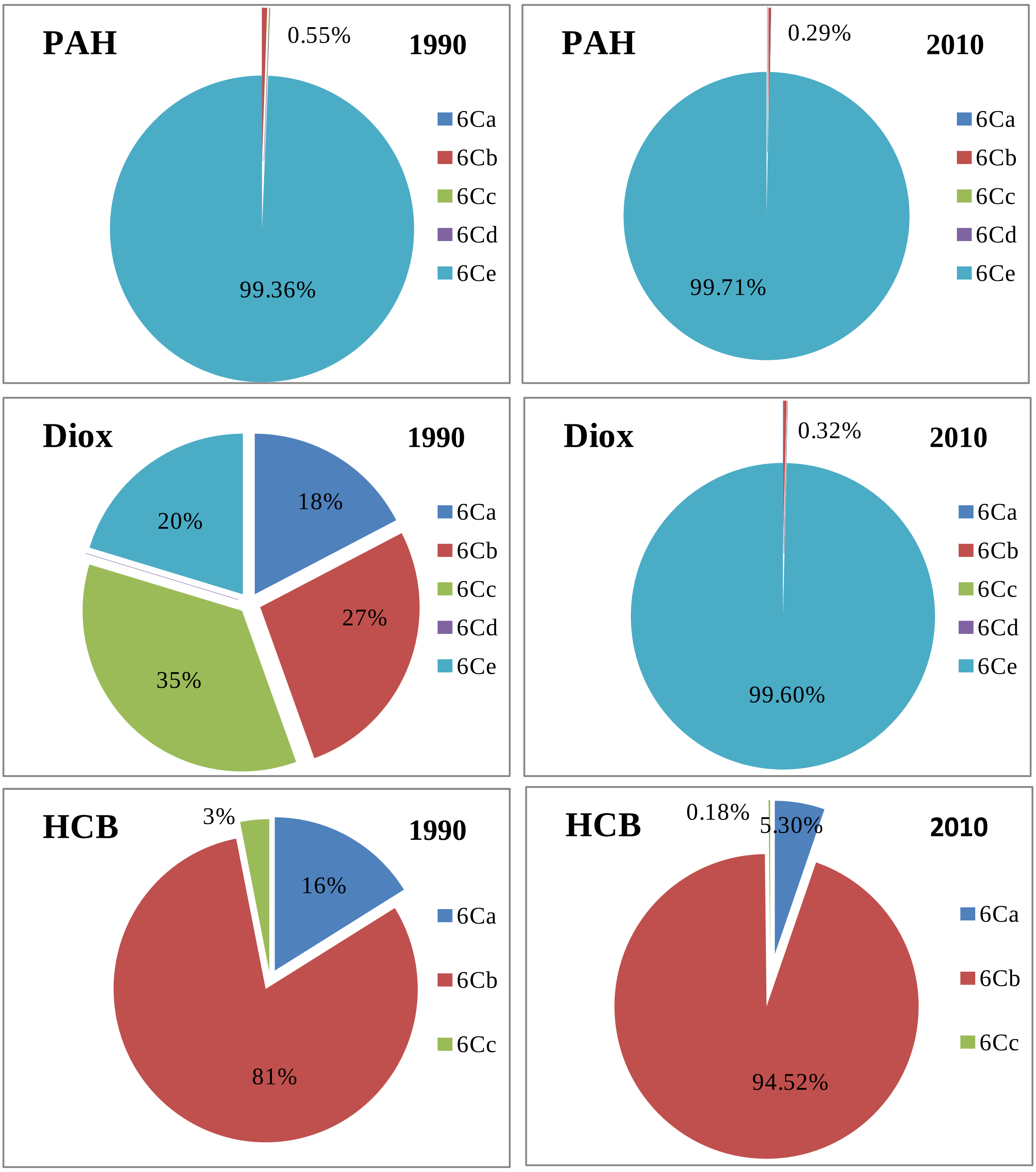


Figure 7.2 *Contribution of POPs Annex III sub-category emissions to waste sector total emissions*

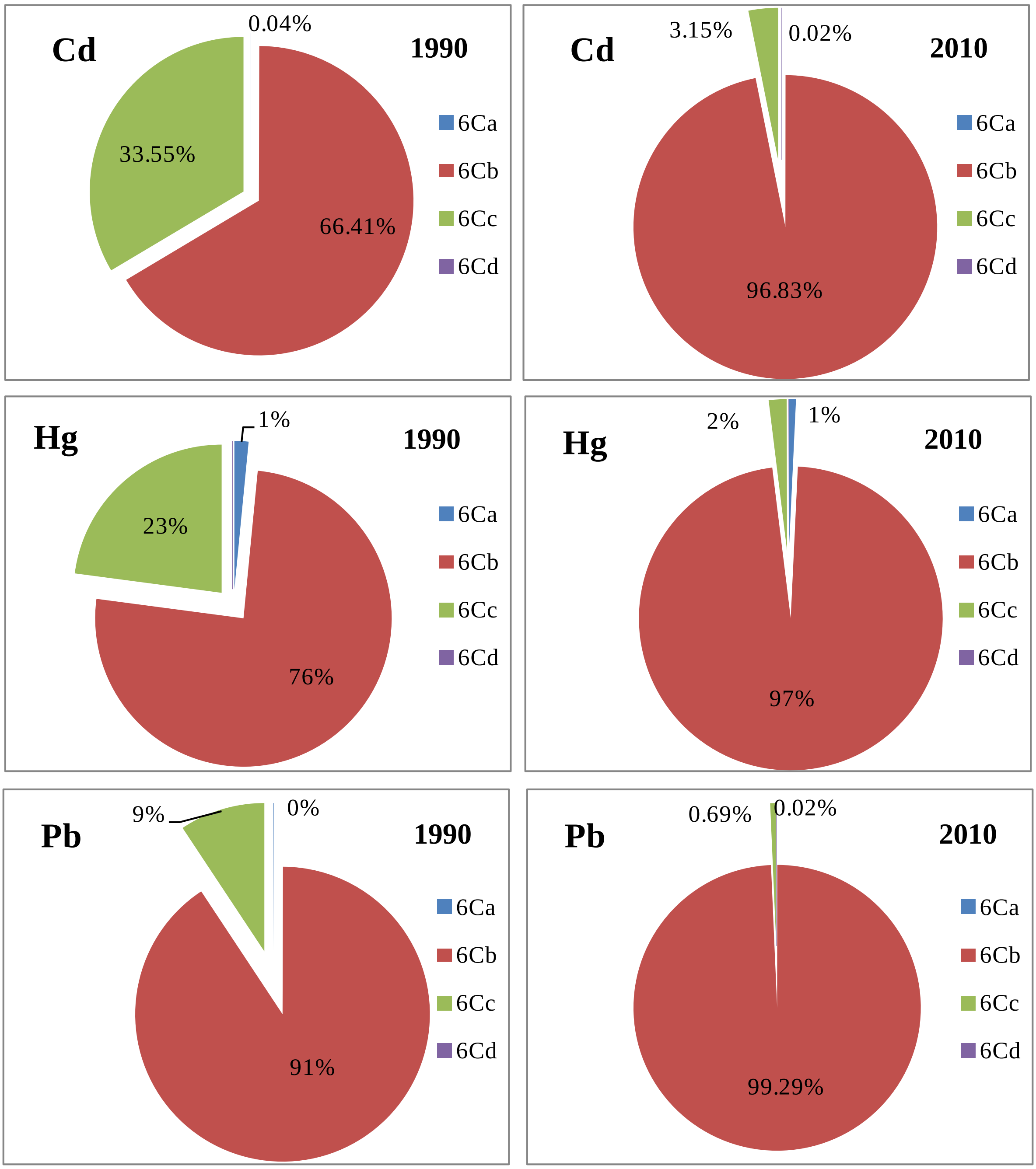


Figure 7.3 *Contribution of priority heavy metals sub-category emissions to waste sector total emissions*

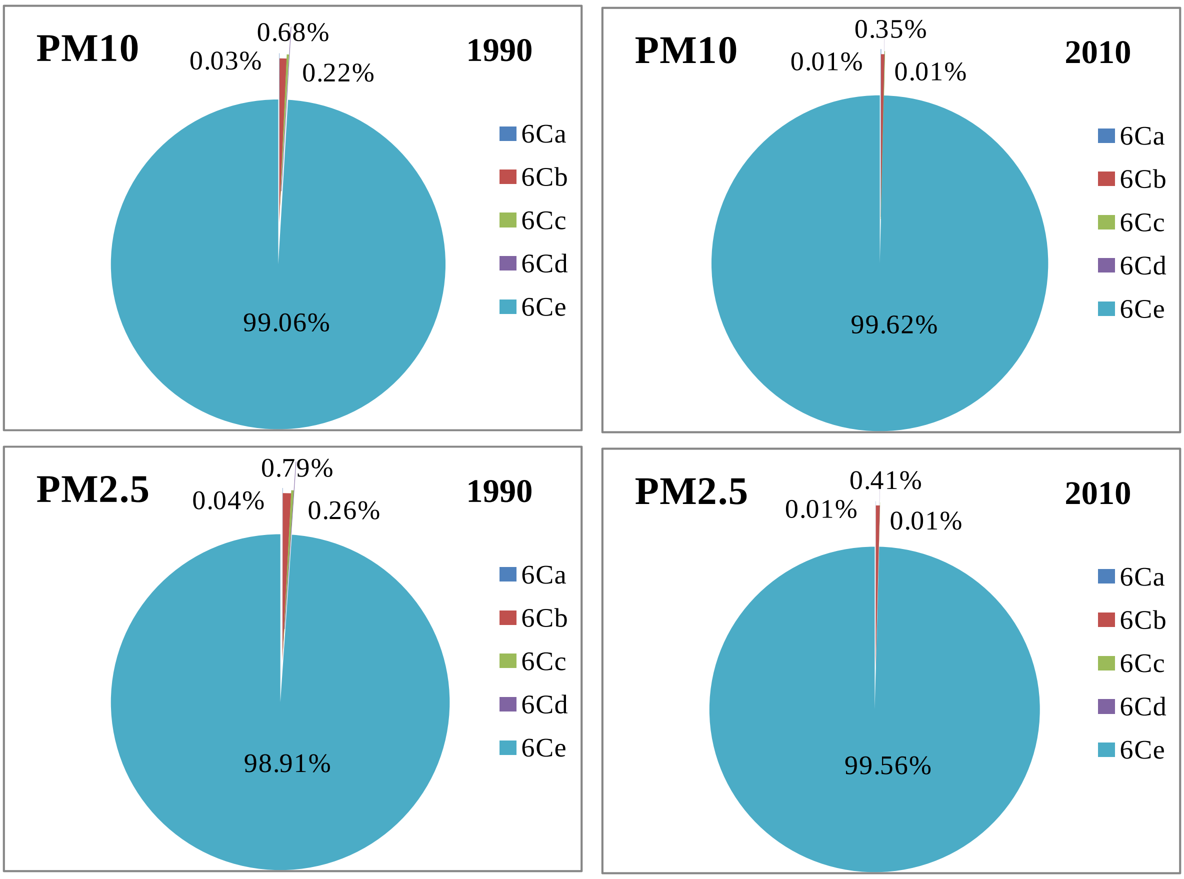


Figure 7.4 *Contribution of PM10 and PM2.5 sub-category emissions to waste sector total emissions*

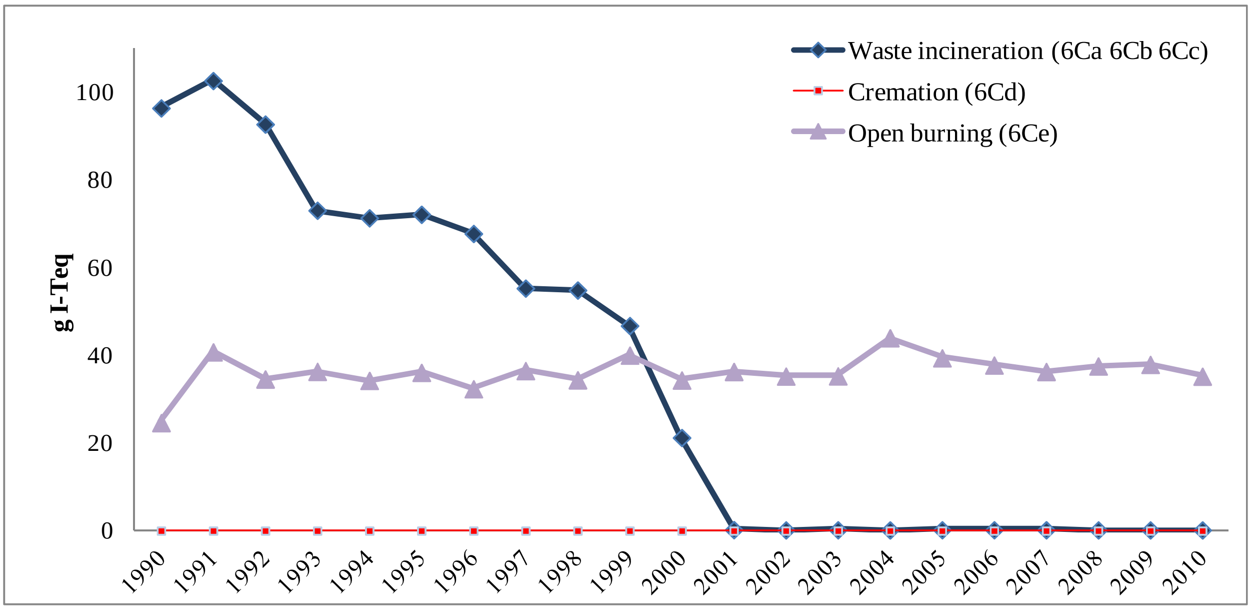


Figure 7.5 *Time series of dioxin emissions of the waste sector by category (g I-Teq)*

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

WASTE SECTOR	1990	1995	2000	2005	2006	2007	2008	2009	2010
Solid waste disposal (6A)									
NMVOC (Gg)	9.567	9.978	11.514	9.731	9.315	8.902	8.382	8.302	8.086
NH_3 (Gg)	7.757	8.090	9.335	7.889	7.552	7.218	6.796	6.731	6.556
Waste incineration (6C)									
CO (Gg)	159.18	269.29	249.23	295.74	281.37	269.37	280.59	283.92	259.63
NO_x (Gg)	8.39	13.65	12.26	14.52	13.88	13.26	13.71	14.02	12.80
NMVOC (Gg)	10.20	15.34	12.95	15.45	14.90	14.12	14.62	14.89	13.83
SO_x (Gg)	0.48	0.42	0.24	0.28	0.30	0.27	0.26	0.28	0.30
PM10 (Gg)	8.20	11.98	11.37	13.05	12.51	12.02	12.43	12.55	11.67
PM2.5 (Gg)	7.04	10.27	9.75	11.19	10.73	10.30	10.66	10.77	10.01
PAH (t)	21.27	31.09	29.54	33.90	32.50	31.22	32.29	32.62	30.30
Dioxins (g I-Teq))	121.09	108.25	55.58	39.58	37.95	36.45	37.71	38.07	35.36
HCB (kg)	12.86	13.96	9.86	8.26	13.53	13.60	12.68	12.69	11.05
PCB (kg)	5.36	4.61	2.05	1.52	1.61	1.51	1.55	1.65	1.60
As (t)	0.06	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Cd (t)	0.30	0.26	0.14	0.16	0.17	0.15	0.14	0.15	0.15
Cr (t)	0.59	0.51	0.28	0.32	0.36	0.31	0.29	0.31	0.32
Cu (t)	0.93	0.79	0.48	0.41	0.50	0.47	0.44	0.46	0.43
Hg (t)	0.26	0.23	0.12	0.15	0.17	0.15	0.14	0.15	0.15
Ni (t)	6.76	4.34	2.80	1.02	0.59	0.65	0.57	0.69	0.51
Pb (t)	5.78	5.36	2.54	3.83	4.12	3.42	3.16	3.50	3.84
Se (t)	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zn (t)	2.93	2.84	1.37	2.11	2.36	1.99	1.84	2.02	2.18
Compost production (6D)									
NMVOC (Gg)	0.018	0.040	0.168	0.346	0.369	0.380	0.364	0.363	0.427
Sludge spreading (6D)									
NO_x	0.641	1.028	1.440	1.166	1.022	1.092	1.162	1.494	1.668
NH_3	0.956	1.539	2.207	1.888	1.685	1.793	1.890	2.379	2.667

7.4 Recalculations

A revision concerned all pollutants on the basis of the update of data on plants with or without energy recovery and a construction of a new database. As planned in the previous submission a rearrangement of incinerators database has been made. During this process an in depth analysis about all incineration plants has been carried out with the target to eliminate double counting and to add eventual no counted plants.

Moreover, mortal remains have been added to cremation of corpses. The analysis regarding incineration plants has been conducted through verifications and comparisons with data reported in E-PRTR registry, Emissions Trading Scheme and updated data of incinerated waste amount by plants. These investigations have shown that some plants have been erroneously reported as incinerators whilst they are boilers and have been already considered in the energy sector, another facility is a cement kiln and already considered in that sector. Some of the plants were erroneously classified without energy recovery system whereas they were already equipped. On the other hand, since 2007 co-incinerators have been identified and considered during the estimation process in 1A4a because modern plants with energy recovery.

Once the list of plants was updated, a new and unique database has been developed to manage activity data, emissions of greenhouse gases and other pollutants, and spatial disaggregation, supporting QA / QC processes.

Recalculations results in negligible differences with respect to the previous submission.

NMVOC and NH_3 emissions from landfills have been updated on the basis of a change in the quantities of methane recovered and waste landfilled for the last two years.

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 EFs and emissions from the exceeding biogas flared at wastewater treatment plants are under investigation, outcoming results will be included in further submissions.

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 2010 have been submitted.

The percentage difference between the time series reported in the 2011 submission and the series reported this year (2012 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 2009 show a decrease for HCB and NO_X whereas an increase is observed for PM2.5, PAH, PM10, Cd, Pb, Hg, dioxins, PCB, CO, NMVOC, SO_X and NH_3.

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) from 2001 taking into account the update of activity data time series. The recalculation involved all the pollutants and resulted in high different figures for PM10, PM2.5 and PAH which increase the emission levels. In addition energy recovery from waste reported in the commercial heating has been updated for the whole time series as a consequence of the reorganization of the waste incinerators database resulting in slight differences for all the pollutants.

In the *energy* sector a further revision of the emission estimates regarded the road transport sector. Specifically, the upgraded version of COPERT model, version 9.0 (EMISIA SA, 2011), has been applied to calculate emissions of all pollutants for the whole period 1990-2009. 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. Moreover, additional information regarding the distribution of two strokes and four strokes engines for motorcycles have been introduced from 2005 resulting in an increase of 3% of total national NMVOC emissions. HCB emissions from road transport have been deleted according to the EMEP/EEA Guidebook and to the information collected from the fuel producers.

Regarding the *navigation* category, the composition of the fleet of gasoline fuelled recreational craft has been updated from 2001 revising the two strokes and four strokes engine distribution. This change resulted in a recalculation of NO_X, CO, NMVOC, NH3 and Benzene emission factors for this category resulting in a decrease of emissions. Minor update occurred for 2008 and 2009, in the sector 1A1, 1A2 and 1B, affecting EF and activity data on the basis of new information.

In the industrial processes sector minor recalculations occurred due to the update of activity data and regarded CO and NH3 emissions from soda ash production from 2007 to 2009, NMVOC emission from road paving from 2006 to 2009, NMVOC emission for Ethylene, Polypropilene and Acrilonitrile Butadiene Styrene productions, NMVOC, PAH and PM emissions from iron and steel and NMVOC emissions from bread production for 2009.

Moreover, from 2006, Hg emission factor and activity data regarding chlorine production have been updated on the basis of producers' communication.

For the *solvent* sector the main modifications involved category 3A with respect to NMVOC emissions, due to the update, from 2005, of emission factors for paint application in boat building, wood and other industrial paint application and, from 2007, to the change of emission factors for car repairing on account of information communicated within the Legislative Decree 161/2006. Minor recalculations are also observed, for the year 2009, in category 3C, due to the update of activity data in rubber processing and in category 3D, considering an updating of the apparent consumption of cosmetics in domestic solvent use.

Recalculations were implemented for the *agriculture* sector. Specifically, HCB emissions from the use of pesticides have been estimated for the whole time series and reported in the 4G ‘other’ category. In addition, for the year 2009, the number of animals for non-dairy cattle (animals between 1-2 years old) and rabbits has been updated. Minor recalculation, for the whole time series, regarded non dairy cattle and buffaloes NH_3 emissions.

Table 8.1 *Recalculation between 2011 and 2012 submissions*

	SO_X	NO_X	NH_3	NMVOC	CO	PM10	PM2.5	Pb	Hg	Cd	DIOX	PAH	HCB	PCB
						%								
1980	0.0	-0.0	2.3	-0.4	-0.5									
1981	0.0	-0.0	2.0	-0.3	-0.5									
1982	0.0	-0.0	1.8	-0.3	-0.5									
1983	0.0	-0.0	1.5	-0.3	-0.5									
1984	0.0	-0.1	1.3	-0.3	-0.5									
1985	0.0	-0.0	1.0	-0.3	-0.5									
1986	0.0	-0.0	0.8	-0.3	-0.5									
1987	0.0	-0.1	0.5	-0.3	-0.5									
1988	0.0	-0.1	0.2	-0.3	-0.5									
1989	0.0	-0.1	-0.0	-0.3	-0.5									
1990	-0.0	-0.1	-0.0	-0.3	-0.5	-0.0	-0.0	0.0	-0.4	-0.5	-1.5	-0.0	47.3	-0.1
1991	-0.0	-0.1	-0.0	-0.3	-0.5	-0.0	-0.0	0.0	-0.4	-0.4	-1.4	-0.0	45.5	-0.1
1992	-0.0	-0.1	-0.0	-0.3	-0.6	-0.0	-0.0	0.1	-0.4	-0.5	-1.5	-0.0	43.7	-0.1
1993	-0.0	-0.1	-0.0	-0.4	-0.7	-0.1	-0.1	0.3	-0.4	-0.5	-1.6	-0.0	40.9	-0.1
1994	-0.0	-0.1	-0.0	-0.4	-0.7	-0.1	-0.1	0.5	-0.5	-0.5	-1.6	-0.0	39.1	-0.1
1995	-0.0	-0.1	-0.0	-0.4	-0.7	-0.0	-0.0	0.7	-0.4	-0.5	-1.5	-0.0	35.7	-0.1
1996	-0.0	0.1	-0.1	-0.0	-0.0	-0.0	-0.0	0.9	-0.4	-0.4	-1.2	-0.0	41.9	-0.1
1997	-0.0	0.1	-0.0	-0.1	0.1	-0.1	-0.1	1.1	-0.4	-0.4	-1.2	-0.0	41.3	-0.1
1998	-0.0	-0.8	0.1	-1.2	-1.6	-0.1	-0.0	1.4	-0.4	-0.4	-1.2	-0.0	36.7	-0.1
1999	0.0	-0.3	-0.0	-0.5	-0.7	-0.2	-0.2	1.8	-0.0	-0.0	-0.0	-0.0	-0.8	-0.0
2000	0.0	-0.7	0.0	-0.8	-1.1	-0.2	-0.3	-0.0	-0.0	-0.0	-0.0	-0.0	3.7	-0.0
2001	0.0	-0.7	0.0	-0.5	-0.3	1.2	1.4	0.0	0.0	0.1	0.7	2.4	2.7	0.1
2002	0.0	-0.6	0.0	0.3	1.3	6.0	7.1	0.2	0.0	0.3	2.8	9.2	-9.8	0.4
2003	0.0	-0.8	0.0	0.0	1.1	6.5	7.7	0.2	0.0	0.3	3.0	9.6	-9.2	0.4
2004	0.1	-1.1	0.1	-0.1	1.1	7.6	8.9	0.3	0.1	0.4	3.5	9.9	-9.8	0.5
2005	0.1	-0.2	0.0	3.3	2.4	7.9	9.3	0.2	0.1	0.4	3.2	9.4	-16.6	0.5
2006	0.1	-0.4	-0.0	3.2	2.5	8.9	10.3	0.3	0.1	0.4	3.4	10.0	-12.4	0.5
2007	0.5	-0.4	0.0	3.3	3.1	10.9	12.6	7.0	6.4	8.2	4.4	12.2	-17.9	2.3
2008	0.6	-0.4	0.1	2.8	3.3	11.6	13.5	6.4	5.8	7.5	4.7	12.6	-18.6	2.2
2009	0.7	-0.8	0.4	2.2	4.0	12.6	14.7	9.5	8.9	11.8	7.0	14.2	-28.7	4.3

In the *waste* sector, a revision concerned all pollutants on the basis of the update of data on plants with or without energy recovery and a construction of a new database. As planned in the previous submission a rearrangement of incinerators database has been made. During this process an in depth analysis about all incineration plants has been carried out with the target to eliminate double counting and to add eventual no counted plants. Moreover, mortal remains have been added to cremation of corpses and NMVOC and NH_3 emissions from landfills have been updated on the basis of a change in the quantities of methane recovered and waste landfilled for the last two years.

8.2 Planned improvements

Specific improvements are specified in the 2012 QA/QC plan (ISPRA, 2012[c]); they can be summarized as follows.

For the *energy* and *industrial processes* sectors, a major progress will regard the harmonisation of information collected in the framework of different obligations, Large Combustion Plant, E-PRTR and Emissions Trading, thus highlighting the main discrepancies in data 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 practices 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 EMEP/EEA Guidebook 2009 chapters (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_2, NO_X, NMVOC, PM2.5 and NH_3 are based on an assessment of economic activities and a control strategy, explained by economic sector, set of abatement technologies planned in terms of rates of application for the current and future years (Pignatelli et al., 2007). Emission factors are those used for the national emission inventory estimations as well as national references and personal communication with sectoral experts.

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

- an energy scenario to estimate emissions from energy sources. The Markal (MARket Allocation) model (Goldstein et al., 1999) is used to implement the scenario at 2010 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_2, NO_X e SO_X. 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 (i.e. the whole set of abatement technological measures to be implemented in the time interval considered) need to be defined.

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

In 2011 a review process of national emission projections has been undertaken to give the necessary contribution to the review of the Gothenburg Protocol and of the EU Thematic Strategy on Air Pollution.

The latest Italian emission projections elaborated by the GAINS Italy model have been submitted to the European Commission according to the NEC Directive and are available, as well as national emission inventories, at http://nfp-it.eionet.europa.eu:8980/Public/irc/circa-it/reportnet/home.

These projections, regarding SO_2, NO_X, NMVOC and NH_3, cover the years from 2000 till 2030 and are harmonized with the national emission inventory at 2000 and 2005. Nevertheless, there are some critical aspects that should be pointed out.

1. These scenarios do not completely include the climate policies and, in particular, the measures to be implemented at regional and local level, since they were not defined when the scenario was produced. It is clear that the scenario needs to be updated to take into account the effects of the Italian climate policies especially the increasing in biomass consumption that is well documented in the NAT scenario developed by IIASA in report CIAM4/2011 (http://gains.iiasa.ac.at/index.php/policyapplications/gothenburg-protocol-revision/369-ciam-report-4-2011).
2. Till June 2011, Italy had a nuclear plan including the installation of several nuclear power plants in the next years, but after a public referendum, held last spring, this program has been cancelled. As a consequence, the national energy projections have to be updated with regard to electricity production. In particular, according to national data and available information, it seems likely that this will lead to the installation of new coal power plants, thus resulting in higher emissions of NO_X, SO_2 and PM2.5.
3. The fuel consumption, in the transport sector, considered in the scenario, seems to be not adequate. Up to now, it seems that, as a side effect of the international economic crisis, both the total energy consumption of the sector and the shares between fuel type and vehicle classes, need to be re-assessed.
4. The emission projections do not take into account the latest update of COPERT emission factors that will probably leads to a sizeable increase in 2020 related emissions, especially from the heavy duty vehicles sub-sector.

Considering all these issues, current national estimates indicate that in 2020 the emission levels reported in Table 9.1 will be achieved, but Italy is working on completely new projections that should be available by May 2012.

Table 9.1 *Comparison between emission levels in 2005 and 2010 and preliminary estimates for 2020*

National emission levels	2005	2010	2020
		kt	
SO_2	403	210	262
NO_X	1212	964	727
PM2.5	166	173	158
NH_3	416	379	395
VOC	1,317	1,080	922

Estimates for PM2.5 emission level are particularly uncertain and show large discrepancies if compared to projections made by IIASA, because of very different estimates of biomass burning in residential heating. Policies put in place to meet 20/20/20 objectives are leading to an increase in biomass burning, that is not reflected in the PRIMES scenarios used by IIASA. The trend in biomass consumption is also confirmed by the official national energy balance, that shows for 2010 a huge increase in wood burning for residential heating, partially due to a fuel switch from natural gas (there is no significant combustion of coal, coke and fuel oil in Italian residential heating). As a consequence, PM2.5 emissions in 2010 are significantly higher than in 2005.

Also for VOC the increment in wood burning registered in the last years and foreseen for the next future leads to a raise in emissions from the residential heating, but the uncertainty associated to the emission from this sector is notably high.

With regard to ammonia, emission decrease in recent years is due to the decrease in the consumption of urea as fertilizer as a consequence of the rising of its cost, but there is no evidence that this is a structural change in farmers behaviour, so it’s not possible to consider this reduction as permanent in future years.

Moreover the latest IIASA scenario used for EC4MACS project, presented in the second meeting of the Stakeholder Expert Group on the Review of the EU Air Policy held in Brussels last January (http://circa.europa.eu/Public/irc/env/cafe_baseline/library?l=/thematic_strategy/01-meetings/01-stakeholder_expert/2012-01-1920_meeting/presentations&vm=detailed&sb=Title), shows, for Italy, a minor decrease in ammonia emissions at 2020, but an increase in the number of cattle that leads to a raise in NH_3 emission (+9%).

At the moment projections for ammonia are quite uncertain, as those for PM2.5 and VOC.

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ANNEX

A1 NFR codes

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

2 B 1	Ammonia Production	**6 C e**	Small Scale Waste Burning
2 B 2	Nitric Acid Production	**6 D**	Other waste
2 B 3	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. electricial 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	→	Q_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 wasteincineration (d)	→	N_WasteIncin
SNAP 9	←	6 C b	Industrial waste incineration (d)	→	N_WasteIncin
SNAP 9	←	6 C c	Municipal waste incineration (d)	→	N_WasteIncin
SNAP 9	←	6 C d	Cremation	→	N_WasteIncin
SNAP 9	←	6 C e	Small scale waste burning	→	N_WasteIncin
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 nationaltotal 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