ISPRA
Istituto superiore per la protezione
e la ricerca ambientale

ITALIAN EMISSION INVENTORY 1990-2011

INFORMATIVE INVENTORY REPORT 2013

Rapporti

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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 2011, 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 1990-2011, emissions from almost all the pollutants described in this report show a downward trend. Reductions are especially relevant for the main pollutants (SO_X -89%; NO_X -54%; CO -65%; NMVOC -49%) and lead (-94%) whereas a raise is observed for polycyclic aromatic hydrocarbons (+14%). 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, for many pollutants (SO_X 90%; NO_X 99%; CO 93%; PM2.5 88%; Cd 81%). 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 and PAH emissions (30% and 8%, respectively).

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

The following table shows the dates of signature and ratification of Convention and Protocols for Italy.

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 (reviewed in 2012)	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 2011, 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 2011 are reported in Table 1.2.

Table 1.2 *Emission time series by pollutant*

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
SO_X	*Gg*	1,799	1,325	752	405	383	339	284	233	215	195
NO_X	*Gg*	2,022	1,896	1,424	1,213	1,158	1,117	1,051	982	950	930
NMVOC	*Gg*	1,925	1,958	1,514	1,253	1,225	1,174	1,115	1,057	1,003	989
NH_3	*Gg*	468	448	449	416	411	420	410	393	379	382
CO	*Gg*	6,971	6,970	4,657	3,270	3,039	2,838	2,721	2,477	2,516	2,464
As	*Mg*	37	27	45	40	41	41	42	42	45	46
Cd	*Mg*	10	9	9	8	8	9	9	7	7	7
Cr	*Mg*	93	75	52	60	61	63	61	50	52	54
Cu	*Mg*	184	200	200	209	210	213	208	191	190	194
Hg	*Mg*	11	10	9	10	10	11	10	8	9	9
Ni	*Mg*	123	114	105	111	109	106	103	104	40	39
Pb	*Mg*	4,415	2,029	945	281	289	312	301	228	260	277
Se	*Mg*	10	10	11	12	12	12	12	10	11	11
Zn	*Mg*	929	911	873	946	1,017	1,023	1,002	728	871	948
TSP	*Gg*	285	285	244	216	212	214	209	196	200	197
PM10	*Gg*	239	237	199	173	169	171	166	156	159	156
PM2.5	*Gg*	206	205	170	143	140	140	137	129	131	128
PAH	*Mg*	78	82	80	84	86	89	87	67	82	88
Dioxin	*$g\ ITe_q$*	458	442	362	283	291	305	294	221	228	242
HCB	*kg*	43	38	24	21	27	26	26	15	13	14
PCB	*kg*	286	298	262	275	282	282	275	202	201	219

The NRF files and other related documents can be found on website at the following address:

http://www.sinanet.isprambiente.it/it/sinanet/serie_storiche_emissioni.

1.3 Institutional arrangements

The Institute for Environmental Protection and Research (ISPRA) has the overall responsibility for the compilation of the national emission inventory and submissions to CLRTAP. The institute is also responsible for the communication of pollutants under the NEC directive as well as, jointly with the Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), the development of emission scenarios, as established by the Legislative Decree n. 171 of 21st May 2004. Every five years, from 2012 with reference to 2010 emissions, ISPRA shall provide the disaggregation of the national inventory at provincial level as instituted 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 and for the communication of the inventory 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, 2013[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 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 (ISPRA).

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.

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.isprambiente.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, 2000; IPCC, 2006;); 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, 2013 [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, amended by Directive 2009/29/EC, 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. Results are reported in the following tables for the year 1990 (Table 1.4) and 2011 (Table 1.5) by pollutant.

The trend analysis has also been applied considering 1990 and 2011. 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 (42.8%)	1A2 (16.8%)	1A1b (10.7%)	1A3d ii (4.3%)	1B2a iv (3.7%)	1A3b i (3.4%)							81.8
NO_x	1A3b i (26.6%)	1A1a (20.2%)	1A3b iii (16.7%)	1A2 (12.3%)	1A4c ii (5.1%)								80.9
NH_3	4B1a (29.6%)	4B1b (25.5%)	4D1a (15.7%)	4B8 (10.4%)									81.2
NMVOC	1A3b i (25.2%)	1A3b v (9.7%)	1A3b iv (8.0%)	3A1 (8.0%)	3A2 (6.1%)	3D2 (6.1%)	1A3d ii (5.0%)	3C (4.0%)	1A4c ii (3.5%)	3D3 (3.4%)	1B2a v (3.1%)		82.0
CO	1A3b i (66.3%)	1A3b iv (7.3%)	1A4b i (4.6%)	1A2 (4.4%)									82.7
PM10	1A1a (15.8%)	1A2 (15.1%)	1A4b i (11.6%)	1A3b i (7.8%)	1A4c ii (6.7%)	1A3b iii (5.8%)	1A3b ii (4.2%)	4B9b (3.4%)	1A3b vi (3.3%)	2C1 (3.1%)	1A3d ii (3.0%)	1A2f ii (2.3%)	82.1
PM2.5	1A1a (17.4%)	1A2 (16.5%)	1A4b i (12.8%)	1A3b i (9.0%)	1A4c ii (7.7%)	1A3b iii (6.7%)	1A3b ii (4.9%)	1A3d ii (3.5%)	2C1 (2.8%)				81.4
Pb	1A3b i (77.5%)	1A2 (6.0%)											83.5
Cd	1A2 (55.6%)	2C1 (13.1%)	1A4a i (7.7%)	1A4b i (7.3%)									83.6
Hg	1A2 (36.5%)	2B5a (24.5%)	2C1 (20.0%)										81.0
PAH	2C1 (57.2%)	1A4b i (15.8%)	1A1c (10.7%)										83.7
Dioxin	1A2 (25.6%)	1A4a i (23.0%)	2C1 (14.7%)	6Cc (9.3%)	6Cb (7.2%)	1A4b i (7.0%)							86.7
HCB	4G (54.8)	6Cb (24.2%)	1A2 (11.3%)										90.3
PCB	1A1a (39.6%)	2C1 (32.0%)	1A2 (19.6%)										91.2

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

Table 1.5 *Key categories for the Italian Emission Inventory in 2011*

	Key categories in 2011												Total (%)
SO_x	1A2 (21.3%)	1A1b (16.5%)	1A1a (14.8%)	1A3d ii (13.7%)	1B2a iv (12.8%)	2A1 (5.0%)							84.4
NO_x	1A3b iii (22.8%)	1A3b i (20.7%)	1A2 (10.7%)	1A3d ii (9.4%)	1A3b ii (7.5%)	1A1 a (5.3%)	1A4c ii (5.2%)						81.6
NH_3	4B1b (23.2%)	4B1a (22.2%)	4D1a (14.2%)	4B8 (12.9%)	4B9b (4.5%)	4B2 (3.9%)							80.9
NMVOC	1A3b iv (14.6%)	3A1 (12.7%)	3D2 (10.3%)	1A4b i (8.9%)	3C (6.1%)	1A3b v (6.0%)	1A3d ii (5.4%)	3A2 (4.9%)	1A3b i (4.0%)	3D3 (3.1%)	2D2 (2.7%)	1B2b (2.5%)	81.3
CO	1A4b i (29.8%)	1A3b iv (17.5%)	1A3b i (17.0%)	1A2 (10.8%)	1A3d ii (6.2%)								81.3
PM10	1A4b i (34.7%)	1A2 (8.4%)	1A3b vi (6.2%)	4B9b (5.9%)	1A3b i (5.3%)	2C1 (4.1%)	1A3d ii (4.0%)	1A3b ii (3.6%)	1A3b iii (3.3%)	1A4c ii (3.0%)	2A1 (2.7%)		81.2
PM2.5	1A4b i (41.8%)	1A2 (9.7%)	1A3b i (6.4%)	1A3d ii (4.8%)	1A3b ii (4.4%)	1A3b vi (4.1%)	1A3b iii (4.0%	2C1 (4.0%)	1A4c ii (3.6%)				82.8
Pb	1A2 (40.2%)	2C1 (26.5%)	1A4a i (23.4%)										90.0
Cd	1A2 (37.0 %)	1A4a i (28.7%)	2C1 (16.3%)										82.0
Hg	2C1 (31.2%)	1A2 (27.8%)	1A4a i (24.4%)										83.4
PAH	2C1 (43.1%)	1A4b i (32.5%)	6Ce (7.8%)										83.4
Dioxin	2C1 (34.5%)	1A2 (28.5%)	1A4b i (25.4%)										88.4
HCB	1A2 (26.6%)	6Cb (22.0%)	4G (20.7%)	1A4a i (12.8%)									82.1
PCB	2C1 (47.2%)	1A1a (29.9%)	1A2 (8.2%)										85.2

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 1990-2011*

	Key categories in trend												**Total** (%)
SO_X	1A1a (35.6%)	1B2 a iv (16.4%)	1A3 d ii (12.0%)	1A1b (7.5%)	1A2 (5.8%)	2A1 (5.0%)							82.3
NO_X	1A1a (31.7%)	1A3b iii (12.9%)	1A3b i (12.6%)	1A3d ii (9.9%)	1A3b ii (8.9%)	1A4a i (8.0%)							84.0
NH_3	4B1a (30.1%)	4B2 (12.5%)	4B8 (10.3%)	4B1b (9.5%)	1A3b i (8.9%)	4D1 a (6.1%)	4B9 b (4.8%)						82.2
NMVOC	1A3b i (32.1%)	1A4b i (10.3%)	1A3b iv (10.0%)	3A1 (7.2%)	3D2 (6.4%)	1A3b v (5.6%)	1A4c ii (3.6%)	1A4a i (3.4%)	3C (3.1%)				81.6
CO	1A3b i (46.3%)	1A4b i (23.6%)	1A3b iv (9.5%)	1A2 (6.0%)									85.5
PM10	1A4b i (31.6%)	1A1a (20.7%)	1A2 (9.1%)	1A4c ii (5.0%)	1A3b vi (4.0%)	1A3b i (3.5%)	4B9 b (3.5%)	1A3b iii (3.4%)					80.7
PM2.5	1A4b i (36.9%)	1A1 a (21.2%)	1A2 (8.7%)	1A4c ii (5.2%)	1A3b iii (3.5%)	1A3b i (3.4%)	1A1b (2.9%)						81.8
Pb	1A3 b i (42.2%)	1A2 (18.6%)	2C1 (13.7%)	1A4a i (12.6%)									87.1
Cd	1A4a i (39.5%)	1A2 (34.9%)	1A4b i (6.5%)										80.9
Hg	2B5 (33.5%)	1A4a i (30.7%)	2C1 (16.4%)										80.6
PAH	1A4b i (41.4%)	2C1 (34.9%)	1A1 a (9.0%)										85.3
Dioxin	1A4 a i (23.6%)	2C1 (21.4%)	1A4b i (19.8%)	6Cc (10.0%)	6Cb (7.6%)								82.4
HCB	4G (45.8%)	1A2 (20.5%)	1A4a i (13.7%)	1A4b i (6.6%)									86.6
PCB	2C1 (33.5%)	1A2 (25.2%)	1A1a (21.6%)										80.3

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, 2013 [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 (UNECE, 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.

Additionally, an agreement to conduct a bilateral independent review between Italy and Spain was established last year, with a focus on the revision of emission inventories of both the Parties. Two in-country visits were already held, in September and October 2012; the Italian team revised part of the energy sector of Spain, specifically the public power plants, petroleum refining plants, road transport and off-road categories, whereas the Spanish team revised the Industrial processes and solvent and other product use, and the LULUCF sectors of Italy. Results of these analyses are not finalized yet but a report will be published as soon as possible. Aim of the review was to carry out a general quality assurance analysis of the inventories in terms of methodologies, EFs and references used, as well as analysing critical cross cutting issues such as the details of the national energy balances and comparison with international data (Eurostat and IEA) and use of plant specific information. Revisions of other inventory sectors are planned during the year 2013.

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 the current year, ISPRA has finalised the provincial inventory at local scale for the years 1990, 1995, 2000, 2005 and 2010 applying a top down approach. Methodologies and results were checked out by regional and local environmental agencies and authorities, and figures are available at ISPRA web address http://www.sinanet.isprambiente.it/it/inventaria. Methodologies used for the previous reporting cycle are described in a related publication (ISPRA, 2009).

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 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 regard the progress on management of information collected in the framework of different European obligations, Large Combustion Plant, E-PRTR and Emissions Trading, which is 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 the 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 and 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, 2013 [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 because for many categories emission factors are not available by compound. 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 and 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. No information on activity data and emission factors are available for these sources at the moment and verification is needed to assess if these emissions actually occur within the national area.

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

Further investigation will be carried out about these source categories and pollutants in order to calculate and improve figures.

2 ANALYSIS OF KEY TRENDS BY POLLUTANT

2.1 Main pollutants

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

2.1.1 Sulphur dioxide (SO_X)

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

Figure 2.1 and Table 2.1 show the emission trend from 1990 to 2011. Figure 2.1 also illustrates the share of SO_X emissions by category in 1990 and 2011 as well as the total and sectoral variation from 1990 to 2011.

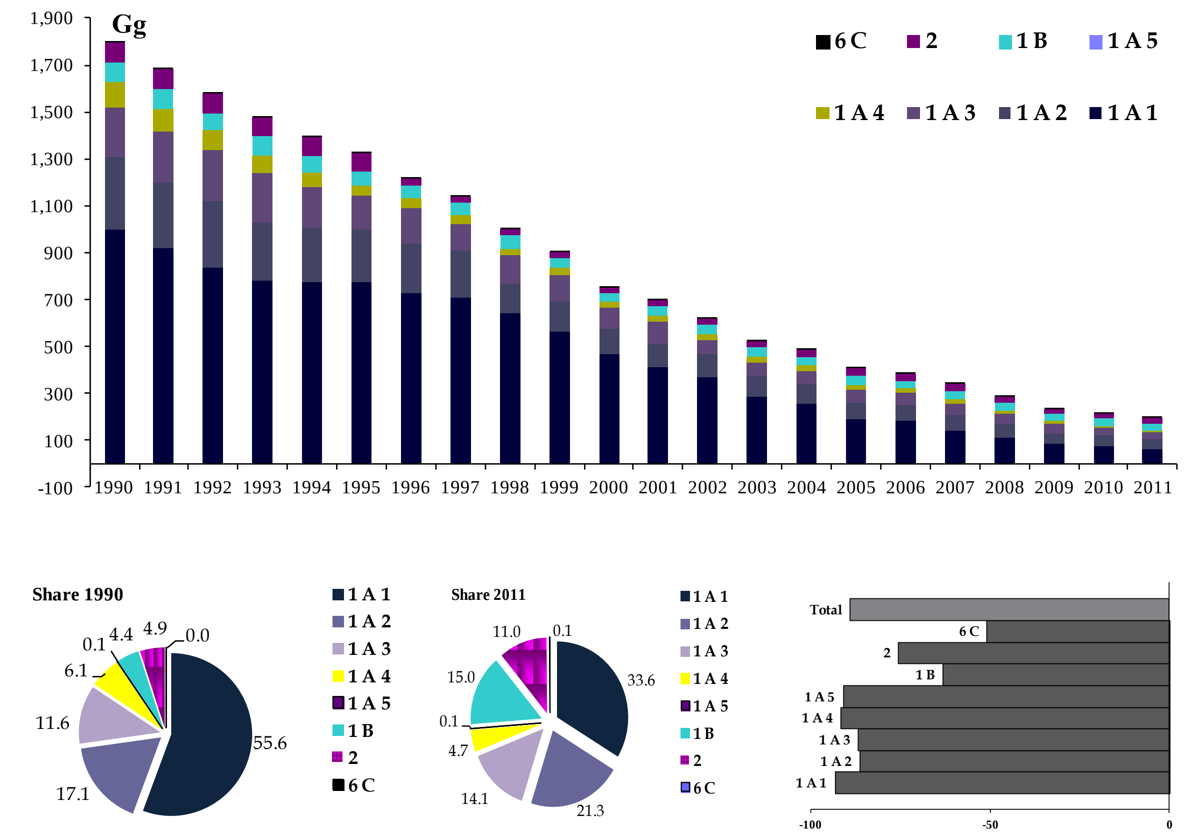

Figure 2.1 *SO_X emissions trend, percentage share by sector and variation 1990-2011*

Table 2.1 *SO_X emission trend from 1990 to 2011 (Gg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
					Gg					
Combustion in energy and transformation industries	1,001	776	467	187	184	139	113	88	77	66
Non industrial combustion plants	96	36	23	20	18	17	12	11	9	9
Combustion - Industry	303	220	107	75	67	68	60	43	46	42
Production processes	156	125	50	59	53	59	51	45	46	46
Road transport	130	72	12	2	2	2	2	0	0	0
Other mobile sources and machinery	100	86	84	51	48	46	39	38	29	27
Waste treatment and disposal	13	11	10	11	9	9	8	6	7	5
Total	***1,799***	***1,325***	***752***	***405***	***383***	***339***	***284***	***233***	***215***	***195***

Figures show a general decline of SO_X emissions during the period, from 1,799 Gg in 1990 to 195 Gg in 2011. The national target of SO_X emissions, set by the National Emission Ceilings Directive at 475 Gg for 2010 (EC, 2001) was reached as reported in the last year submission and continues to be respected after this year revision of the time series.

The decreasing trend is determined mainly by the reduction in emissions from *combustion in energy* (-93%) and in *industry* (-86%), representing in 2011 about 34%, and 21% of the total, respectively. Emissions deriving from *non industrial combustion plants* and *road transport* show a strong decrease too (-91% and -100%, respectively), but these emissions represent only about 5% and 0.2% of the total in 2011. *Production processes* and *other mobile sources and machiner*y also present a significant decreasing trend, showing an influence on the total of 24% and 14% and dropping by about -70% and -73%, 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 DM 8th May 1989 (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 DM 12th July 1990 (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 show a decrease due the introduction of Directives regulating the sulphur content in fuels.

2.1.2 *Nitrogen oxides (NO_X)*

The national atmospheric emissions of nitrogen oxides show a decreasing trend in the period 1990-2011, from 2,022 Gg to 930 Gg. Figure 2.2 and Table 2.2 show emission figures from 1990 to 2011. Figure 2.2 also illustrates the share of NO_X emissions by category in 1990 and 2011 as well as the total and sectoral variation from 1990 to 2011.

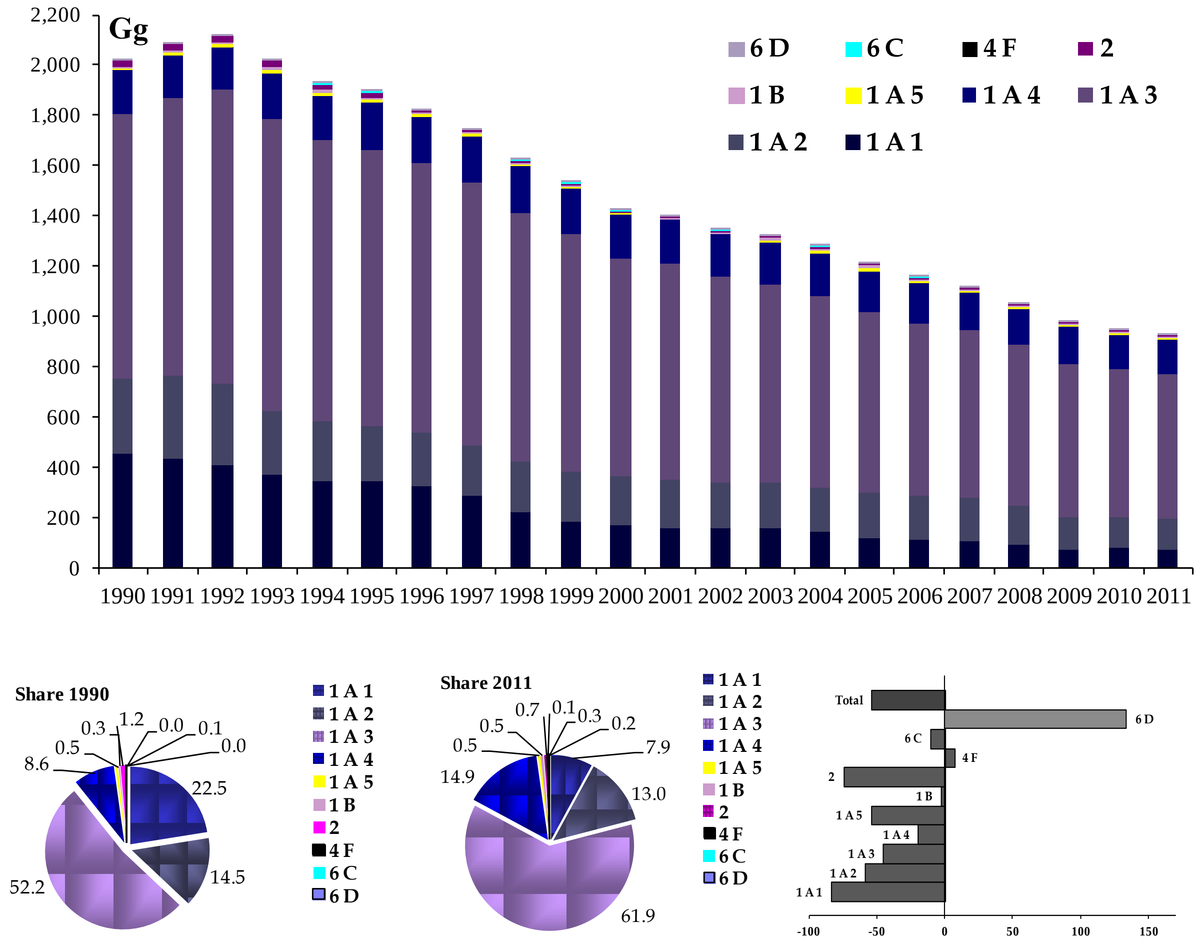

Figure 2.2 *NO_X emission trend, percentage share by sector and variation 1990-2011*

Table 2.2 *NO_X emission trend from 1990 to 2011 (Gg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
					Gg					
Combustion in energy and transformation industries	457	344	173	118	115	103	93	75	81	75
Non industrial combustion plants	62	63	66	78	75	75	79	81	83	83
Combustion - Industry	249	180	152	153	150	152	132	106	100	99
Production processes	30	31	9	16	13	11	9	12	10	11
Road transport	949	998	753	613	584	570	544	517	484	482
Other mobile sources and machinery	270	275	268	232	217	201	190	187	186	176
Waste treatment and disposal	4	4	4	4	4	4	4	4	4	4
Agriculture	0	1	0	0	1	1	0	0	0	0
Total	***2,022***	***1,896***	***1,424***	***1,213***	***1,158***	***1,117***	***1,051***	***982***	***950***	***930***

Total emissions show a reduction of about 54% from 1990 to 2011, 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) at 990 Gg has been reached and continues to be respected.

The main source of emissions is *road transport* (about 52% in 2011), which shows a reduction of 49% between 1990 and 2011; *other mobile sources and machinery* in 2011 contributes to the total emissions for 19% and have reduced by 35% from 1990. Combustion in energy and in industry shows a decrease of about 84% and 60%, respectively, having a share on the total of about 8% and 11%, respectively. Among the sectors concerned, the only ones which highlight an increase in emissions are: *non industrial combustion plants and waste treatment and disposal*, showing an increase by 33%and 16%, respectively, but accounting only for 9% and 0.5% 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 2011 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 [a]), 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 1990-2011, from 468 Gg to 382 Gg. Figure 2.3 and Table 2.3 report the emission figures from 1990 to 2011. Figure 2.3 also illustrates the share of NH_3 emissions by category in 1990 and 2011 as well as the total and sectoral variation from 1990 to 2011.

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

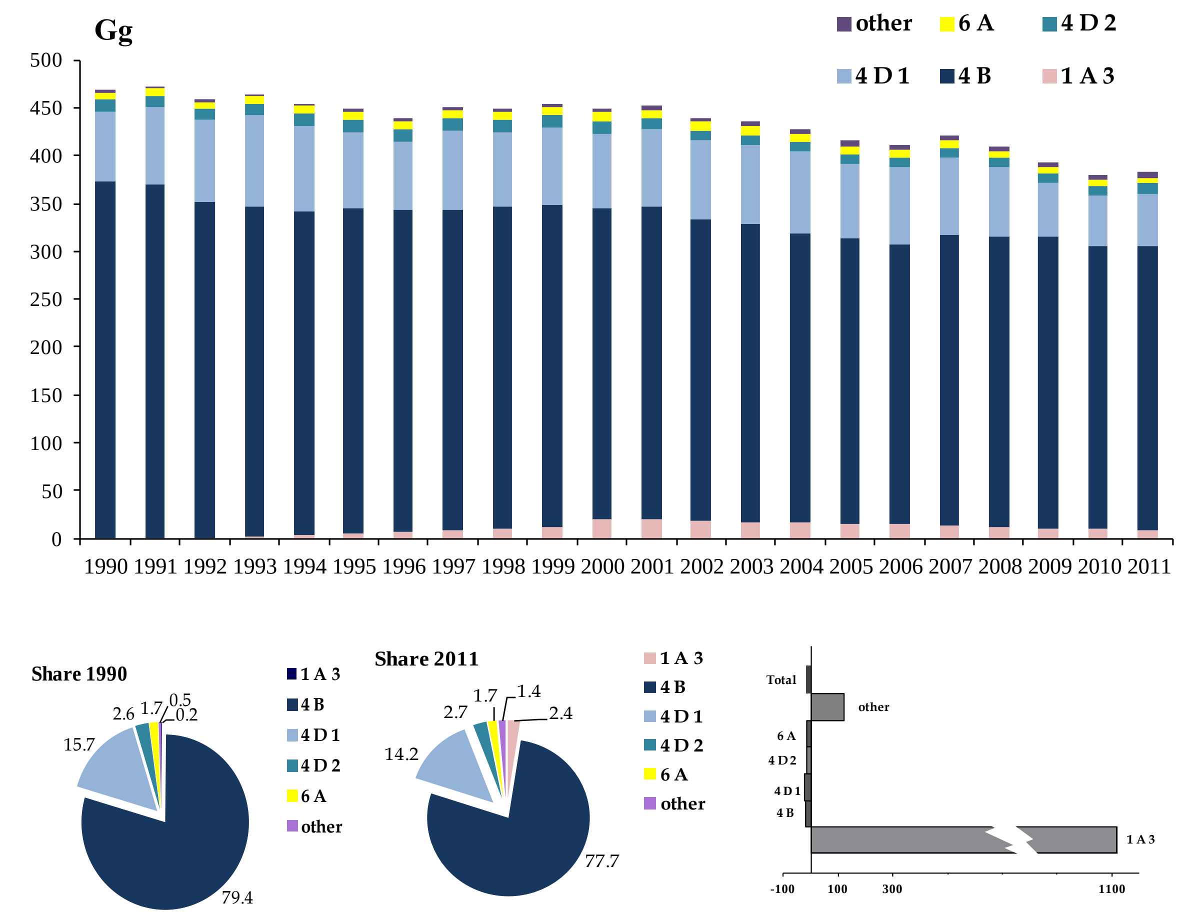

Figure 2.3 *NH_3 emission trend, percentage share by sector and variation 1990-2011*

Table 2.3 *NH_3 emission trend from 1990 to 2011 (Gg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
					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	0.2
Non industrial combustion plants	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.8
Combustion - Industry	0.1	0.1	0.1	3.4	2.3	1.6	1.8	1.5	1.2	1.3
Production processes	0.8	0.4	0.3	0.5	0.6	0.5	0.4	0.3	0.5	0.4
Road transport	0.7	5.0	19.6	15.1	14.3	13.0	11.7	10.5	9.5	9.2
Other mobile sources and machinery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste treatment and disposal	8.8	9.7	11.5	9.8	9.2	9.0	8.7	9.1	8.9	8.9
Agriculture	457.3	432.4	416.7	386.5	384.0	395.2	386.0	370.8	358.4	361.5
Total	***468***	***448***	***449***	***416***	***411***	***420***	***410***	***393***	***379***	***382***

In 2011 *agriculture* is the main source of emissions, with a 95% contribution out of the total NH_3 emissions; from 1990 to 2011 emissions from this sector show a decrease of about 21%. 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 2%. Emissions from *combustion in energy and transformation industries* show a relevant increase, but in 2011 the contribution to total emissions is 0.2%. Emissions from *non industrial combustion plants* as emissions from *combustion in industry* show a significant increase, but their contribution to total emissions is not relevant. Emissions from *production processes* show a reduction of about 53%, 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 1990-2011. Figure 2.4 and Table 2.4 illustrate the emissions values from 1990 to 2011. Figure 2.4 also illustrates the share of NMVOC emissions by category in 1990 and 2011 as well as the total and sectoral variation from 1990 to 2011.

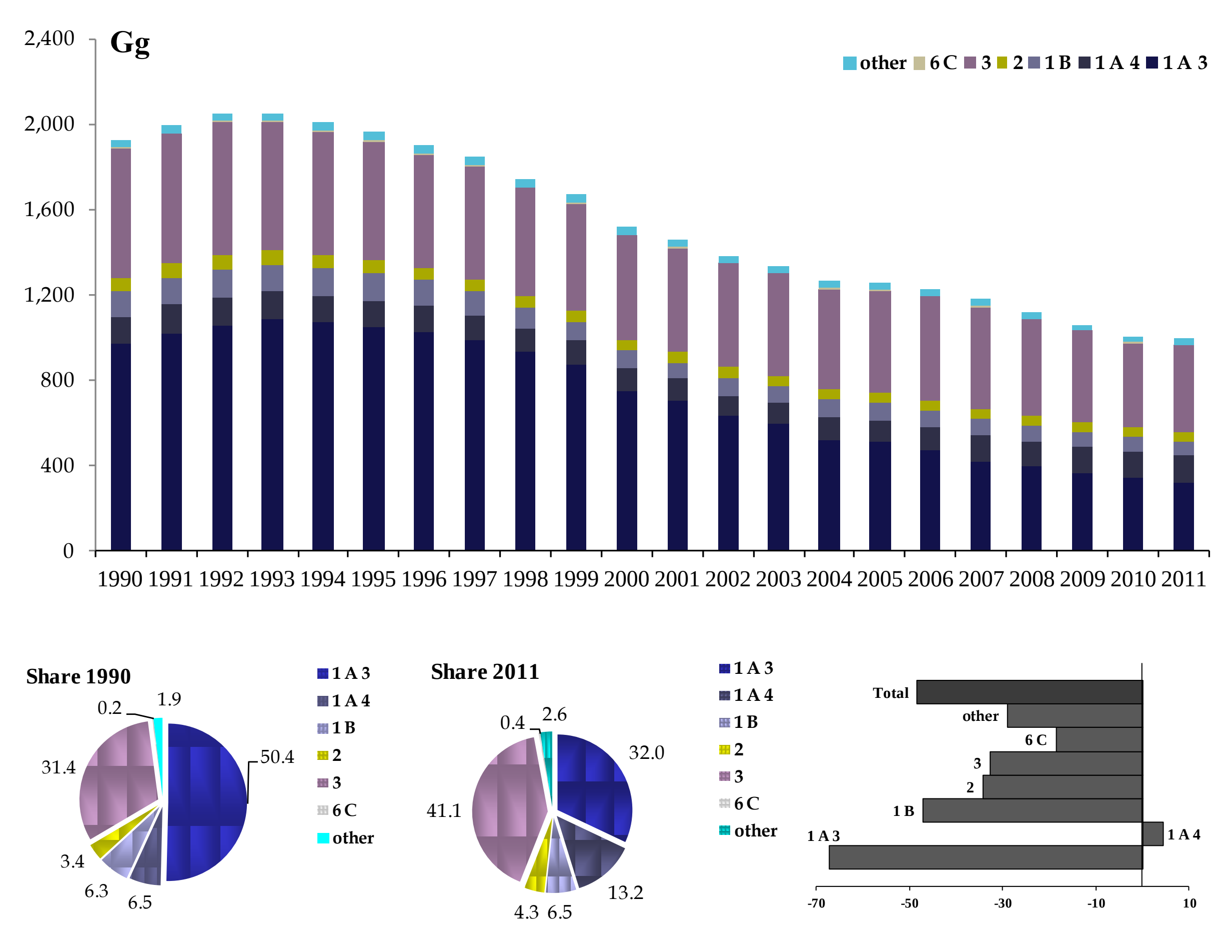

Figure 2.4 *NMVOC emission trend, percentage share by sector and variation 1990-2011*

The global emission trend shows a reduction of about 49% between 1990 and 2011, from 1,925 Gg to 989 Gg.

In the framework of the National Emission Ceilings Directive (EC, 2001), the target value of NMVOC for 2010 fixed at 1,159 Gg was reached.

Solvent and other product use is the main source of emissions, contributing to the total with 41% and showing a decrease of about 32%. The main reductions relate to the *road transport* sector (-70%), accounting for 26% of the total and to the sector of *extraction and distribution of fossil fuels/geothermal energy* (-51%), accounting only for 5%. Emissions from *other mobile sources and machinery*, accounting for 7% of the total, decrease of about 60%. Emissions from *non industrial combustion plants* show the largest increase (162%), accounting for 12%. Emissions from *waste treatment and disposal* and *combustion in industry* show a decrease of about 15% and 10%, respectively, but both these sources account only for about 1%. Emissions from *agriculture* decrease of about 9%, but their contribution is irrelevant.

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

Table 2.4 *NMVOC emission trend from 1990 to 2011 (Gg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
					Gg					
Combustion in energy and transformation industries	8	7	6	6	6	6	5	5	5	5
Non industrial combustion plants	45	61	68	81	83	100	104	108	115	117
Combustion - Industry	7	8	8	8	8	8	7	6	6	7
Production processes	95	86	71	76	78	78	70	65	62	62
Extraction and distrib. of fossil fuels / geothermal energy	91	104	57	54	51	48	48	47	49	44
Solvent and other product use	604	555	492	477	487	477	455	427	397	406
Road transport	873	937	642	413	382	334	313	295	271	261
Other mobile sources and machinery	187	184	155	122	115	108	99	91	84	74
Waste treatment and disposal	14	15	15	14	14	13	13	13	12	12
Agriculture	1	1	1	1	1	1	1	1	1	1
Total	***1,925***	***1,958***	***1,514***	***1,253***	***1,225***	***1,174***	***1,115***	***1,057***	***1,003***	***989***

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 [b]) 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 1990-2011, from 6,971 Gg to 2,464 Gg. The emission figures from 1990 to 2011 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 2011, as well as the total and sectoral variation from 1990 to 2011.

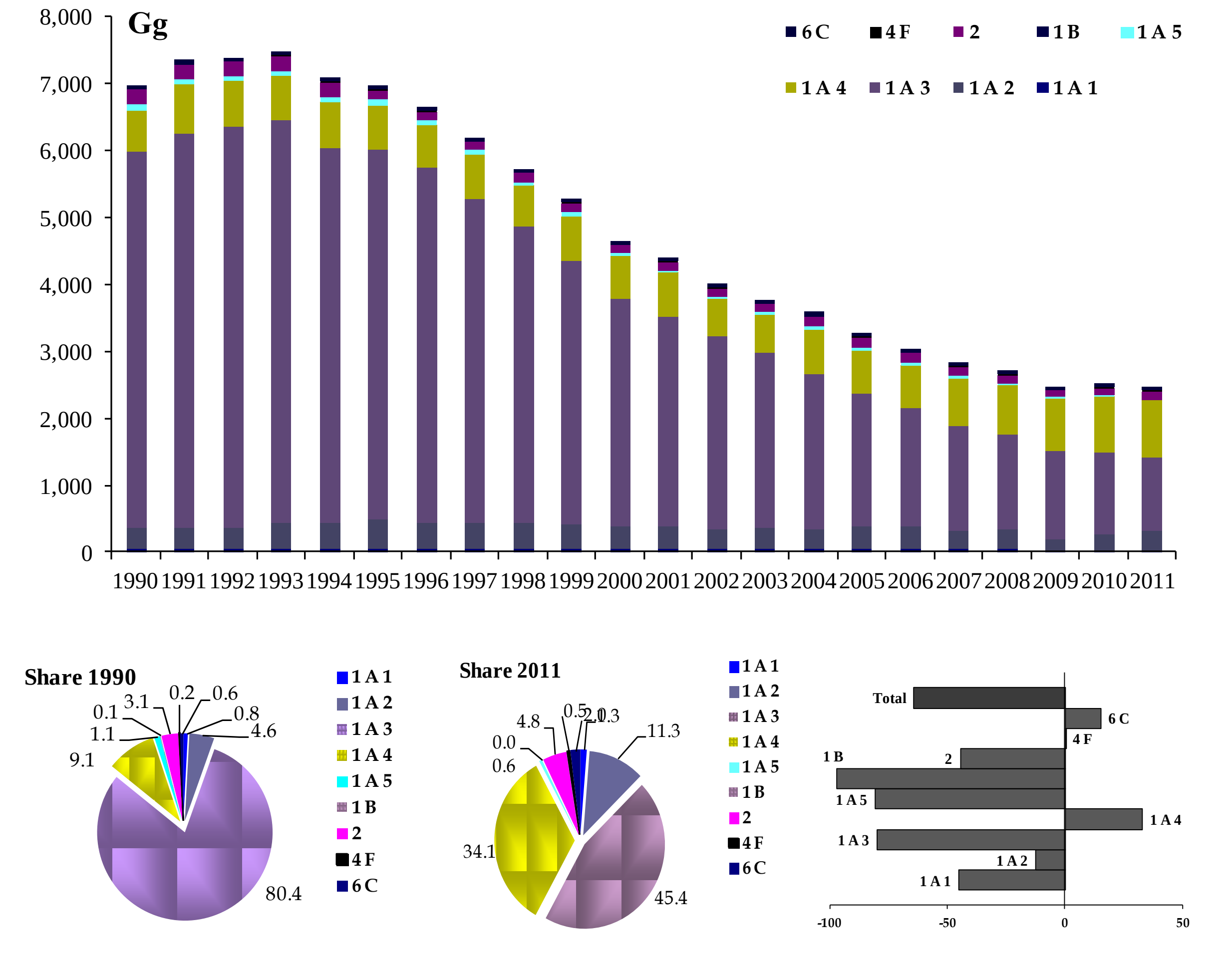

Figure 2.5 *CO emission trend, percentage share by sector and variation 1990-2011*

Table 2.5 *CO emission trend from 1990 to 2011 (Gg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
					Gg					
Combustion in energy and transformation industries	59	54	56	54	54	40	38	32	33	32
Non industrial combustion plants	337	472	521	554	574	661	690	737	784	791
Combustion - Industry	306	411	312	326	323	267	283	155	233	265
Production processes	224	140	129	144	149	141	136	93	106	119
Road transport	5,423	5,329	3,183	1,777	1,545	1,345	1,219	1,124	1,035	959
Other mobile sources and machinery	567	503	396	348	330	319	289	272	263	237
Waste treatment and disposal	43	49	47	53	51	51	53	51	49	49
Agriculture	13	13	13	14	13	14	14	13	13	13
Total	***6,971***	***6,970***	***4,657***	***3,270***	***3,039***	***2,838***	***2,721***	***2,477***	***2,516***	***2,464***

The decrease in emissions (-65%) 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 2011 of about 78%. Specifically by sector, emissions from *road transport* and *other mobile sources and machinery*, accounting in 2011 respectively for 39% and 10% of the total, show a decrease from 1990 to 2011 of about 82% and 58% respectively. On the other hand, emissions from *non industrial combustion plants*, representing about 32% of the total, show a strong increase between 1990 and 2011, equal to 135% due to the increase of wood combustion for heating; figures show an increase in emissions from *waste treatment and disposal* too (15%), whose share is 2% of the total.

2.2 Particulate matter

2.2.1 *PM10*

The national atmospheric emissions of PM10 show a decreasing trend in the period 1990-2011, from 239 Gg to 156 Gg. Figure 2.6 and Table 2.6 illustrate the emission trend from 1990 to 2011. Figure 2.6 also illustrates the share of PM10 emissions by category in 1990 and 2011 as well as the total and sectoral variation from 1990 to 2011.

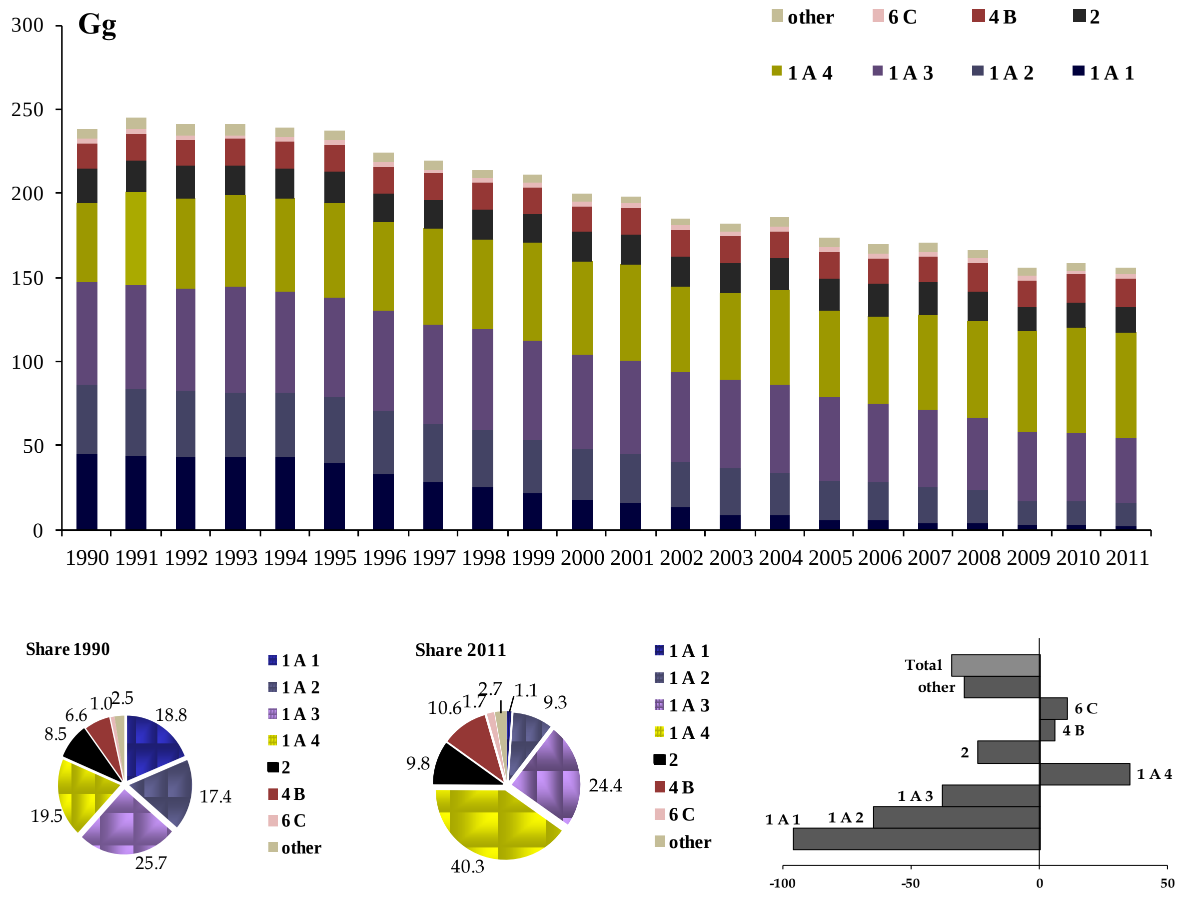

Figure 2.6 *PM10 emission trend, percentage share by sector and variation 1990-2011*

Table 2.6 *PM10 emission trend from 1990 to 2011 (Gg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
					Gg					
Combustion in energy and transformation industries	45	40	18	6	6	4	4	3	3	2
Non industrial combustion plants	30	38	39	40	41	48	50	53	57	57
Combustion - Industry	36	34	25	21	21	19	18	12	13	13
Production processes	22	20	19	20	21	20	19	15	16	16
Extraction and distribution of fossil fuels / geothermal energy	1	1	1	1	1	1	1	1	1	1
Solvent and other product use	0	0	0	0	0	0	0	0	0	0
Road transport	54	52	49	41	39	39	37	35	33	32
Other mobile sources and machinery	32	33	30	24	21	19	17	16	15	14
Waste treatment and disposal	2	3	3	3	3	3	3	3	3	3
Agriculture	18	18	17	18	17	18	19	19	19	19
Total	***239***	***237***	***199***	***173***	***169***	***171***	***166***	***156***	***159***	***156***

A considerable amount of emissions is mostly to be attributed to *non industrial combustion plant* and *road transport* (37% and 20%, respectively, in 2011); from 1990 to 2011 the trend shows a reduction of about 35%. In 2011 *other mobile sources and machinery*, accounting for 9% of the total, shows a reduction of about 56%. Emissions from *non industrial combustion plants* and from *combustion in industry* account for about 37% and 8% of the total respectively, but while the former shows an increase of about 93%, the latter decreases of by about 64%. Emissions from *production processes* accounting for 10% of the total in 2011 decrease of about 28% between 1990 and 2011. The largest decrease (-96%) is observed in emissions deriving from *combustion in energy and transformation industries*, whose contribution to total emissions is almost irrelevant in 2011 and equal to 1%.

2.2.2 PM2.5

The trend of the national atmospheric emissions of PM2.5 is decreasing between 1990 and 2011, with a variation from 206 Gg to 128 Gg. Figure 2.7 and Table 2.7 illustrate the emission trend from 1990 to 2011. Figure 2.7 also illustrates the share of PM2.5 emissions by category in 1990 and 2011 as well as the total and sectoral variation from 1990 to 2011.

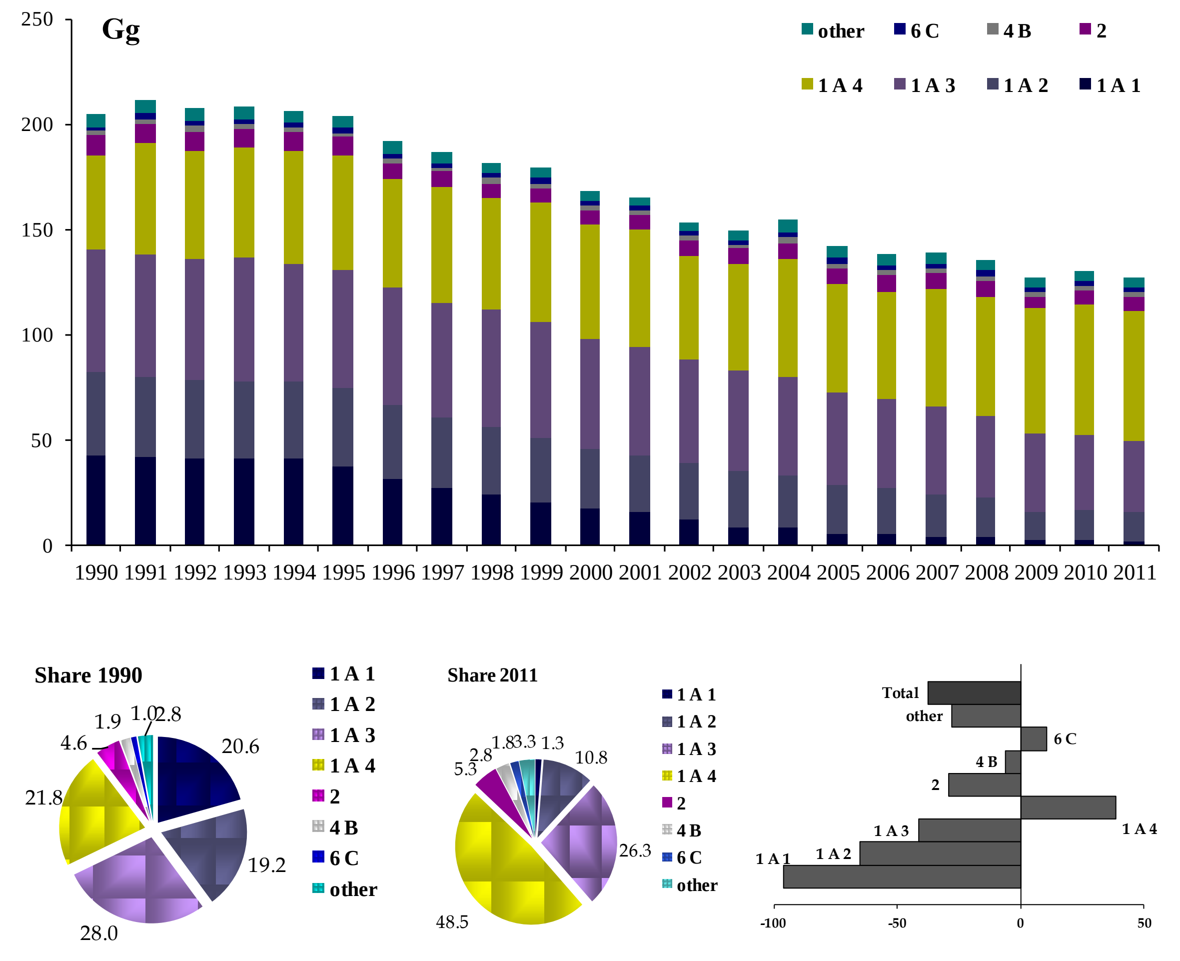

Figure 2.7 *PM2.5 emission trend, percentage share by sector and variation 1990-2011*

Table 2.7 *PM2.5 emission trend from 1990 to 2011 (Gg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
					Gg					
Combustion in energy and transformation industries	43	38	18	6	5	4	3	3	3	2
Non industrial combustion plants	28	36	38	40	41	47	49	53	56	57
Combustion - Industry	34	32	23	20	20	18	17	12	12	12
Production processes	11	10	8	8	9	9	8	6	7	7
Extraction and distribution of fossil fuels / geothermal energy	1	1	1	1	1	1	1	1	1	1
Solvent and other product use	0	0	0	0	0	0	0	0	0	0
Road transport	50	48	44	37	35	34	32	31	29	27
Other mobile sources and machinery	32	33	30	24	21	19	17	16	15	14
Waste treatment and disposal	2	2	2	2	2	2	2	2	2	2
Agriculture	6	6	6	6	6	6	6	6	6	6
Total	***206***	***205***	***170***	***143***	***140***	***140***	***137***	***129***	***131***	***128***

Total emissions show a global reduction from 1990 to 2010 of about 38%. Specifically, emissions from *road transport*, accounting for 21% of total emissions, decrease of about 45%. Emissions from *other mobile sources and machinery* show a reduction of 56%, accounting in 2011 for 11% of total emissions. Emissions from *non industrial combustion plants* and from *combustion in industry* account for 44% and 10% of the total respectively, but while the former shows an increase of about 102%, the latter decreases by about 64%. Emissions from *waste treatment and disposal*, accounting for 2% of the total in 2011, show an increase of about 10%. The largest decrease is observed for *combustion in energy* and *transformation industries* (-96%), being the influence on the total in 2011 equal to 1%.

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 2011, varying from 4,415 Mg to 277 Mg. Figure 2.8 and Table 2.8 illustrate the emission trend from 1990 to 2011. Figure 2.8 also illustrates the share of Pb emissions by category in 1990 and 2011 as well as the total and sectoral variation from 1990 to 2011.

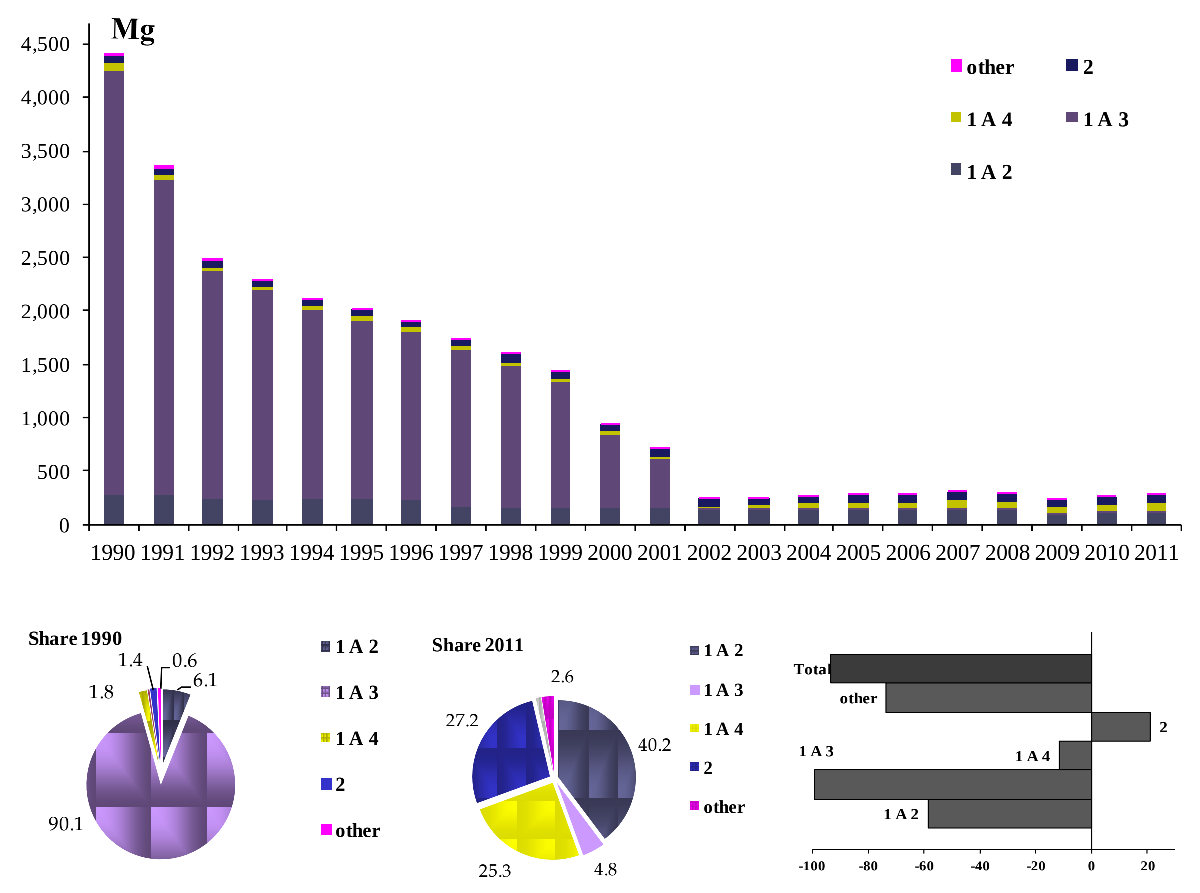

Figure 2.8 *Pb emission trend, percentage share by sector and variation 1990-2011*

Table 2.8 *Pb emission trend from 1990 to 2011 (Mg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
					Mg					
Combustion in energy and transformation industries	4	4	4	4	4	4	4	3	3	3
Non-industrial combustion plants	12	14	20	44	44	67	67	64	66	70
Combustion - industry	263	235	153	142	142	142	134	89	104	111
Production processes	64	68	67	74	82	82	80	56	70	77
Road transport	3,922	1,645	685	13	12	13	12	12	12	12
Other mobile sources and machinery	144	46	13	1	1	1	1	1	1	1
Waste treatment and disposal	6	5	3	4	4	3	3	3	3	3
Total	***4,415***	***2,029***	***945***	***281***	***289***	***312***	***301***	***228***	***260***	***277***

In 2011 emissions from *combustion in industry* have the most significant impact on the total (40%) and show a reduction of about 58%; this reduction is to be attributed primarily to *processes with contact*, which contribute with 51% to the sectoral reduction and account for almost the total share of the sector. Emissions from *production processes* and, in particular, from processes in iron and steel industries and collieries increased by about 19%, and represent 27% of the total. Emissions from *non industrial combustion plants* show a strong increase and represent, in 2011, 25% 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.

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 2011. Figure 2.9 also illustrates the share of Cd emissions by category in 1990 and 2011 as well as the total and sectoral variation from 1990 to 2011.

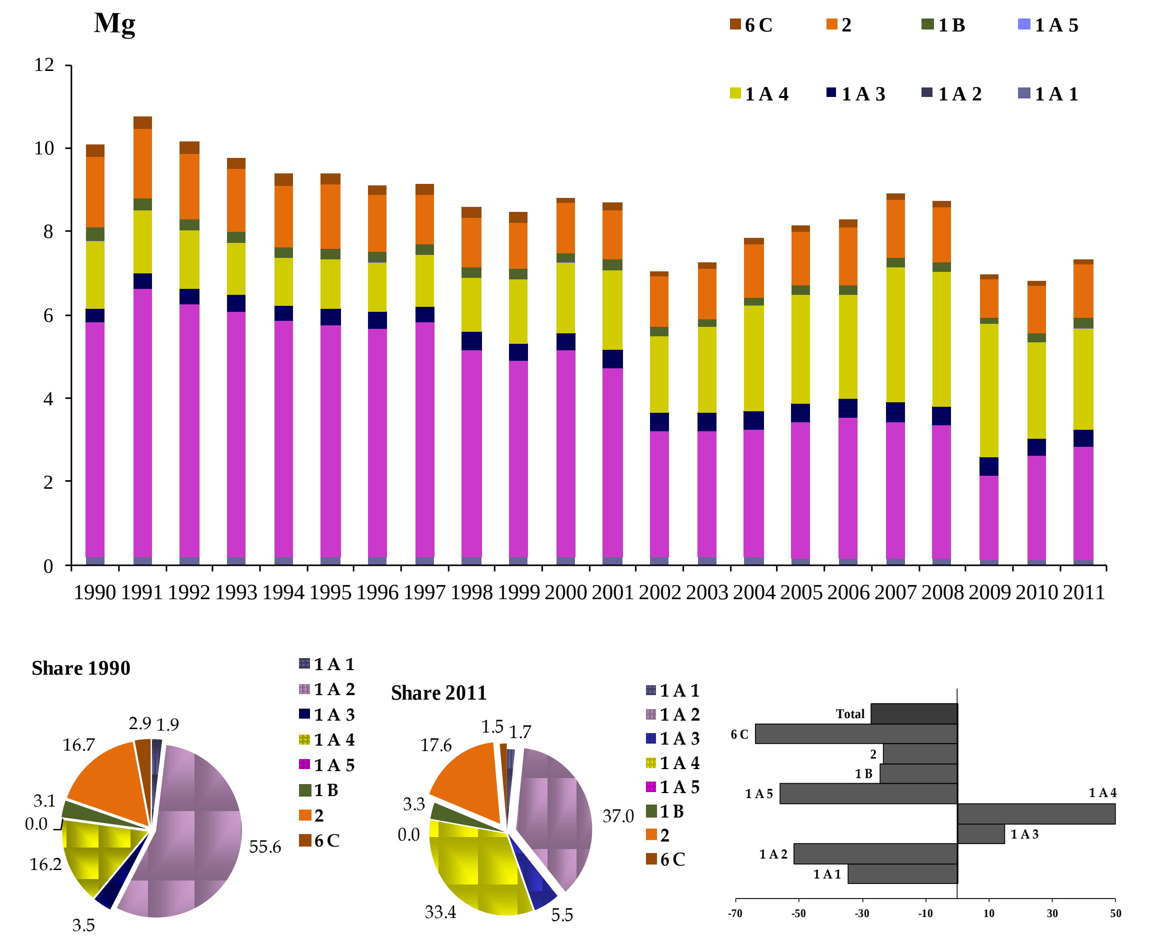

Figure 2.9 *Cd emission trend, percentage share by sector and variation 1990-2011*

Table 2.9 *Cd emission trend from 1990 to 2011 (Mg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
					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	0.1
Non-industrial combustion plants	1.6	1.2	1.7	2.6	2.5	3.2	3.2	3.2	2.3	2.4
Combustion - industry	5.6	5.6	5.0	3.3	3.4	3.3	3.2	2.0	2.5	2.7
Production processes	2.0	1.8	1.4	1.5	1.6	1.6	1.6	1.1	1.4	1.5
Road transport	0.3	0.4	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	0.0
Waste treatment and disposal	0.3	0.3	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Total	***10.1***	***9.4***	***8.8***	***8.1***	***8.3***	***8.9***	***8.7***	***7.0***	***6.8***	***7.3***

Emissions show a global reduction of 27% between 1990 and 2011, from 10.1 Mg to 7.3 Mg. Among the most significant variations, emissions from *combustion in industry* and from *non industrial combustion plants* represent 37% and 33% of the total respectively, showing the former a decrease (-52%) and the latter an increase (50%). Emissions from *production processes* decrease by about 24% and represent 21% of the total. Emissions from *waste treatment and disposal* (i.e. waste incineration), accounting for 2% of the total, register a reduction of about 64%. The sectors which show an increase in emissions are non industrial combustion plants (+50%) and road transport (+16%) accounting for 33% and 5.3%, respectively, of the total levels.

2.3.3 Mercury (Hg)

The national atmospheric emissions of mercury show a quite stable trend in the period 1990-2011. Figure 2.10 and Table 2.10 illustrate the emission trend from 1990 to 2011. Figure 2.10 also illustrates the share of Hg emissions by category in 1990 and 2011 as well as the total and sectoral variation from 1990 to 2011.

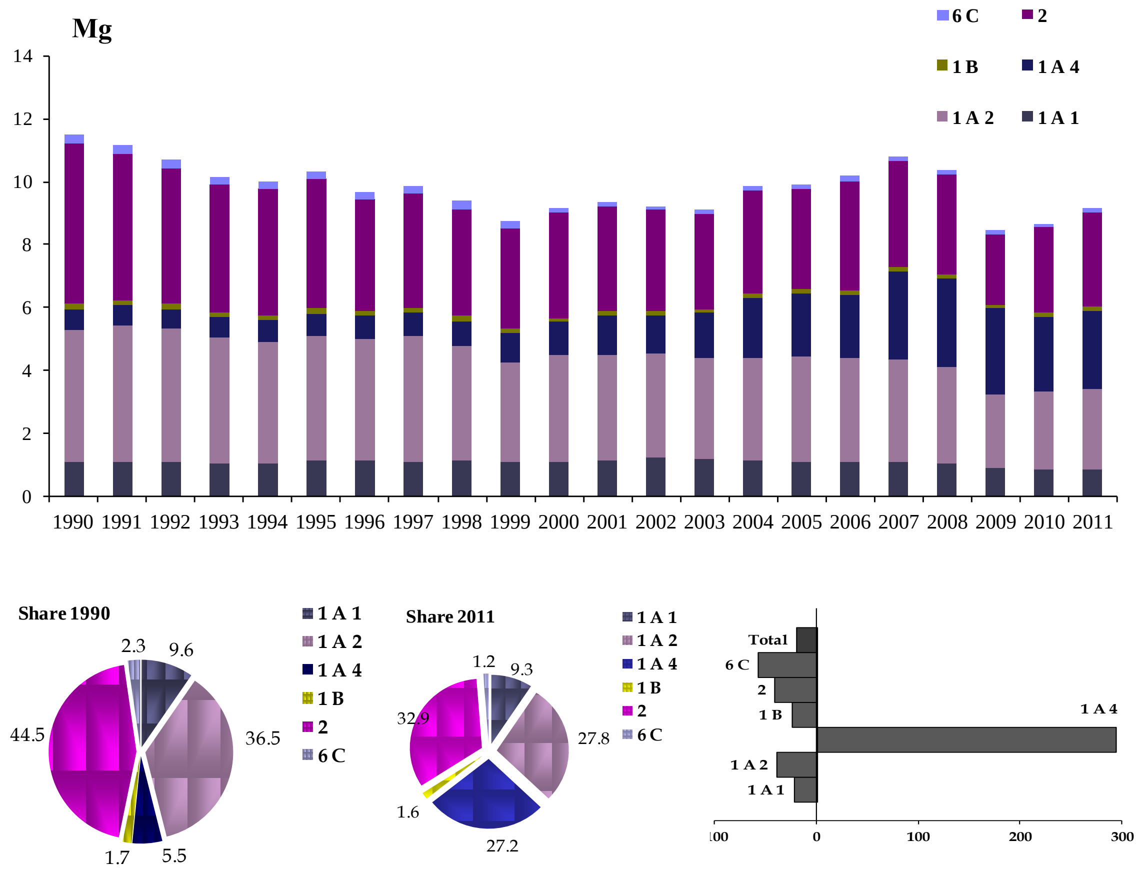

Figure 2.10 *Hg emission trend, percentage share by sector and variation 1990-2011*

Table 2.10 *Hg emission trend from 1990 to 2011 (Mg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
					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	0.9
Non-industrial combustion plants	0.6	0.7	1.1	2.0	2.0	2.8	2.8	2.7	2.4	2.5
Combustion - industry	4.2	4.0	3.4	3.4	3.3	3.3	3.1	2.4	2.5	2.5
Production processes	5.3	4.3	3.5	3.3	3.6	3.5	3.3	2.3	2.8	3.2
Waste treatment and disposal	0.3	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Total	***11.5***	***10.3***	***9.2***	***9.9***	***10.2***	***10.8***	***10.4***	***8.4***	***8.7***	***9.2***

Emission trend shows a global reduction of about 20% from 1990 to 2011, varying from 11.5 Mg to 9.2 Mg. The main variations concern: emissions from *combustion in industry - processes with contact*, accounting for 24% and decreasing by 39%; emissions from *production process - processes in iron and steel industries and collieries*, representing 33% of the total and increasing by 20%; emissions from *non industrial combustion plants* which represent 24% of the total and showing the strongest increase (441%). Emissions deriving from *combustion in energy and transformation industries*, accounting for 7%, show a 33% reduction. Emissions from *production process - processes in inorganic chemical industries*, contributing to the total only for 2%, show a large reduction, equal to 94%. Emissions from *waste treatment and disposal*, contributing to the total only for 1%, show a large reduction, equal to 58%.

2.4 Persistent organic pollutants (POPs)

In this section, the most significant peculiarities of polycyclic aromatic hydrocarbons and dioxins, occurred between 1990 and 2011, 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 2011, from 78 Mg to 88 Mg. Figure 2.11 and Table 2.11 illustrate the emission trend from 1990 to 2011. Figure 2.11 also illustrates the share of PAH emissions by category in 1990 and 2011 as well as the total and sectoral variation from 1990 to 2011.

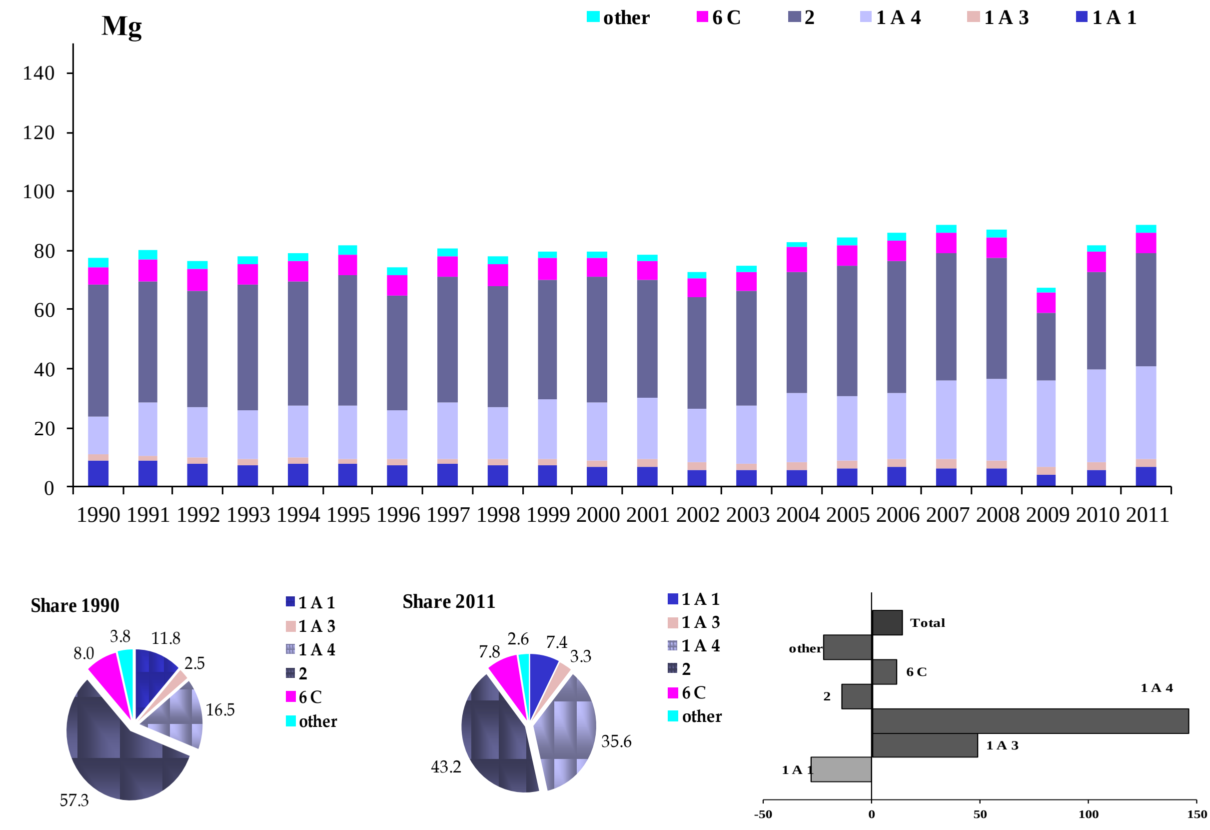

Figure 2.11 *PAH emission trend, percentage share by sector and variation 1990-2011*

Table 2.11 *PAH emission trend from 1990 to 2011 (Mg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
					Mg					
Combustion in energy and transformation industries	9	8	7	6	7	7	6	4	6	7
Non-industrial combustion plants	13	18	20	22	22	26	27	29	31	31
Combustion - industry	3	3	2	2	2	2	2	1	2	2
Production processes	44	44	42	44	45	43	41	23	33	38
Road transport	2	2	2	3	3	3	3	3	3	3
Other mobile sources and machinery	0	0	0	0	0	0	0	0	0	0
Waste treatment and disposal	6	7	7	7	7	7	7	7	7	7
Total	***78***	***82***	***80***	***84***	***86***	***89***	***87***	***67***	***82***	***88***

Between 1990 and 2011, total emissions show a growth of about 14%. Among the most significant changes, emissions from emissions from *production processes* - *processes in iron* and *steel industries* and *collieries* account for 43.2% of the total and show a decrease of 14.2%; *non industrial combustion plants* - *residential plants* account for 35.4% of the total and show a strong increase (about 148.6%) due to the increase in wood consumption for heating; emissions from *waste treatment and disposal* - *open burning of agricultural wastes*, except stubble burning, accounting for 7.8% of the total, show an increase of 12.8%. Emissions from combustion in iron and steel integrated plants account for 7.0% of the total and show a decrease of 24.8%. Emissions from *plants in agriculture, forestry and aquaculture*, accounting for 1.4% in 2011, show a considerably 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 2011, with values varying from 458 g I Teq to 242 g I Teq. Figure 2.12 and Table 2.12 illustrate the emission trend from 1990 to 2011. Figure 2.12 also illustrates the share of dioxin emissions by category in 1990 and 2011 as well as the total and sectoral variation from 1990 to 2011.

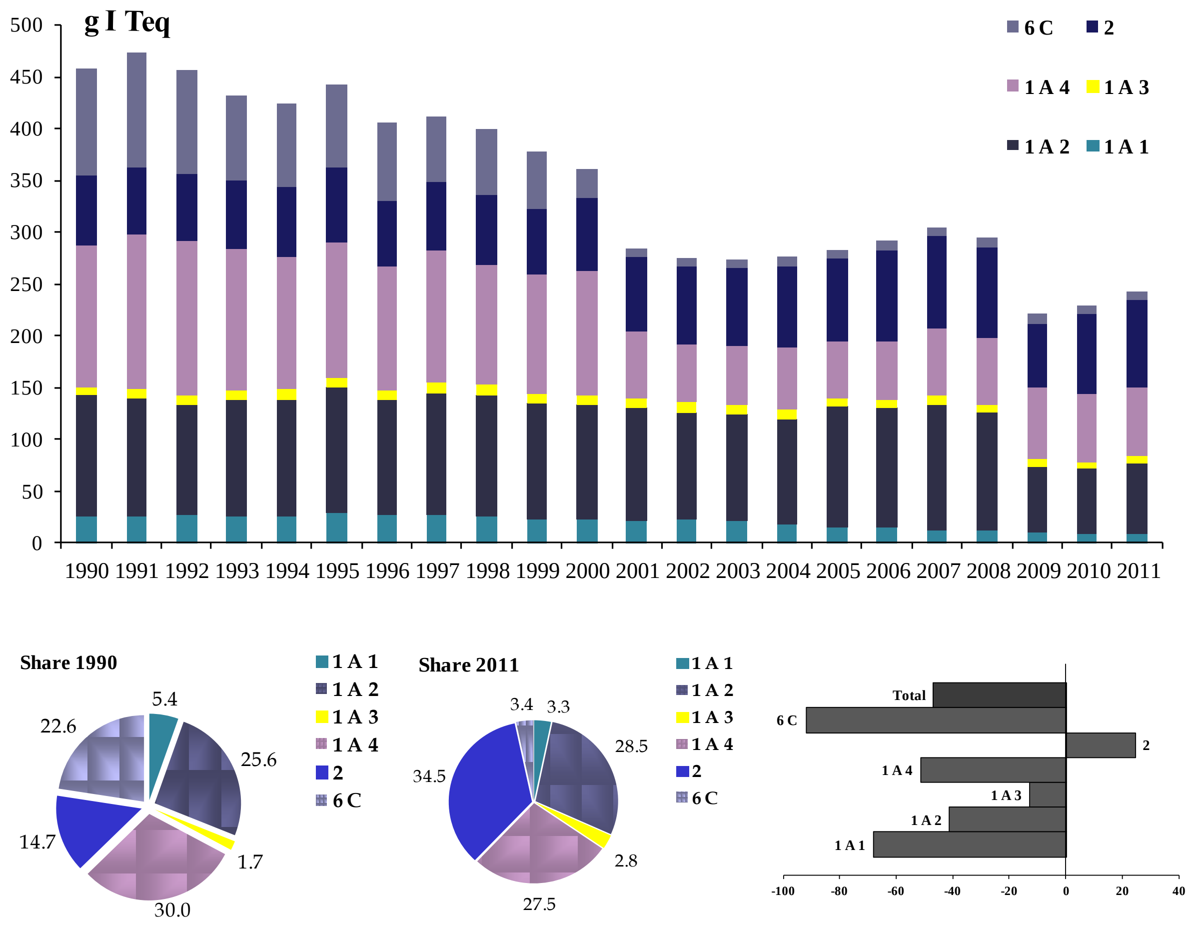

Figure 2.12 *Dioxin emission trend, percentage share by sector and variation 1990-2011*

Table 2.12 *Dioxin emission trend from 1990 to 2011 (g I Teq)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
	g I Teq									
Combustion in energy and transformation industries	25	28	22	15	14	12	11	10	9	8
Non-industrial combustion plants	137	131	119	56	57	66	65	69	66	67
Combustion - industry	117	121	111	116	116	122	115	64	63	69
Production processes	67	72	71	79	88	89	87	62	76	84
Road transport	8	10	10	9	8	8	7	7	7	7
Waste treatment and disposal	104	80	29	9	8	8	9	8	8	8
Total	***458***	***442***	***362***	***283***	***291***	***305***	***294***	***221***	***228***	***242***

The general trend shows a decrease from 1990 to 2011 equal to 47.2%, with a noticeable decline between 1995 and 2003 and between 2008 and 2011. The most considerable reductions, between 1990 and 2011, are observed in *waste treatment and disposal, combustion in energy and transformation industries, non-industrial combustion plants* and *combustion in industry*, (-92.1%, -68.2%,-51.5% and -41.2%, 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 20101, the subsectors which have contributed most to total emissions are *production processes, combustion in industry* and *non-industrial combustion plants* accounting for 34.5%, 28.5% and 27.5% of the total respectively. In particular emissions from production processes show an increase of 24.5% in the period 1990-2011.

2.4.3 *Hexachlorobenzene (HCB)*

The national atmospheric emissions of hexachlorobenzene show a decreasing trend in the period 1990-2011, varying from 43 kg to 14 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 2011. Figure 2.13 also illustrates the share of HCB emissions by category in 1990 and 2011 as well as the total and sectoral variation from 1990 to 2011.

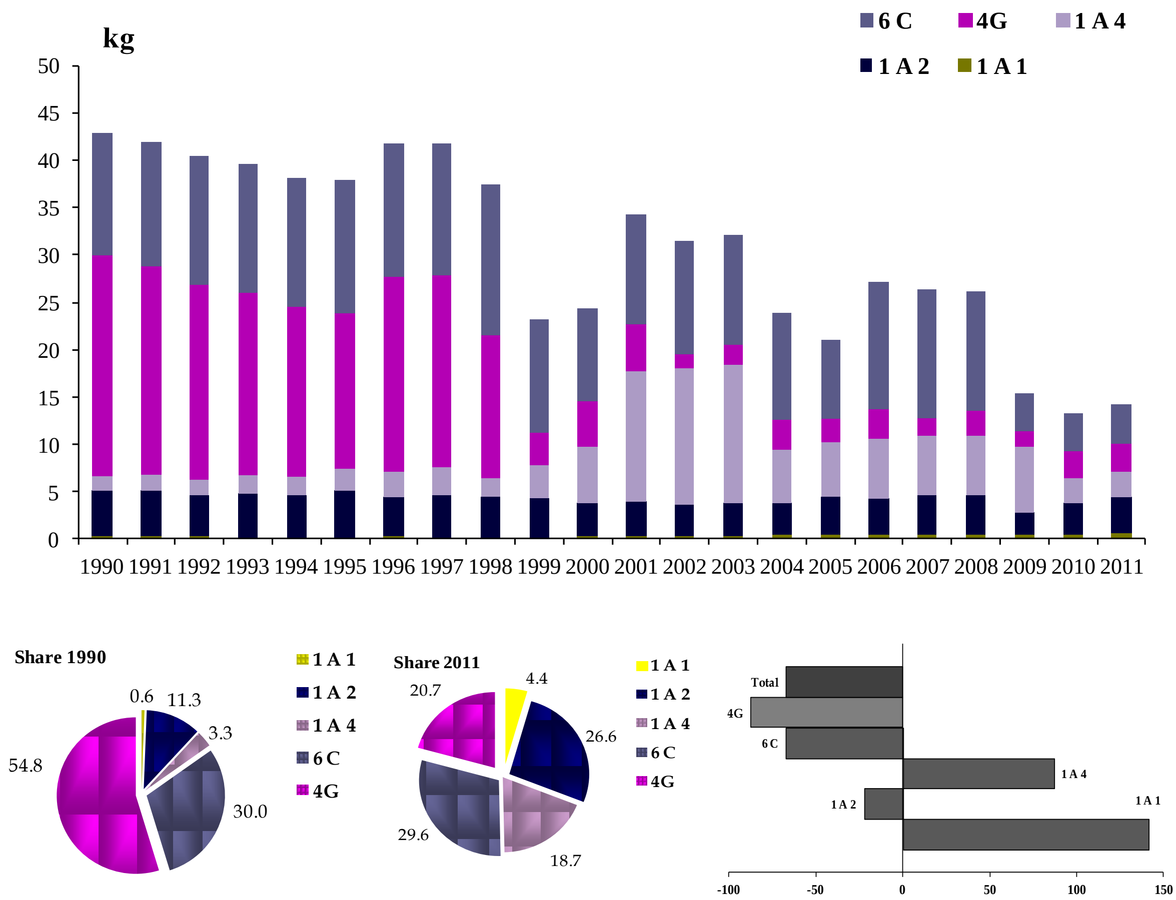

Figure 2.13 *HCB emission trend, percentage share by sector and variation 1990-2011*

Table 2.13 *HCB emission trend from 1990 to 2011 (Mg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
					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	0.001
Non-industrial combustion plants	0.001	0.002	0.006	0.006	0.006	0.006	0.006	0.007	0.003	0.003
Combustion - industry	0.005	0.005	0.004	0.004	0.004	0.004	0.004	0.002	0.003	0.004
Agriculture	0.023	0.016	0.005	0.002	0.003	0.002	0.003	0.002	0.003	0.003
Waste treatment and disposal	0.013	0.014	0.010	0.008	0.014	0.014	0.013	0.004	0.004	0.004
Total	***0.043***	***0.038***	***0.024***	***0.021***	***0.027***	***0.026***	***0.026***	***0.015***	***0.013***	***0.014***

The sector contributing most to the general trend is *waste treatment and disposal*, waste incineration (29.6% 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 of sludge burnt at a specific incinerator is the reason of the peaks observed. The other three relevant sectors are *combustion in industry*, *agriculture* and *non industrial combustion plants* accounting for 26.6%, 20.6% and 18.7% respectively; emissions from combustion in energy and transformation industry show a 141.3% increase between 1990 and 2011, emissions from *non industrial combustion plants* show a 87% increase between 1990 and 2011. In the same years for emissions from *waste treatment and disposal* and *combustion in industry* a decrease of 67.2% and 22% respectively has to be noted. The use of pesticide in *agriculture* category is the main driver for the decreasing trend of the HCB national emissions, emissions from this category show a 87.4% decrease between 1990 and 2011.

2.4.4 Polychlorinated biphenyl (PCB)

The national atmospheric emissions of polychlorinated biphenyl show a decreasing trend in the period 1990-2011, about -23%, from 286 kg to 219 kg.

Figure 2.14 and Table 2.14 illustrate the emission trend from 1990 to 2011. Figure 2.14 also illustrates the share of PCB emissions by category in 1990 and 2011 as well as the total and sectoral variation from 1990 to 2011.

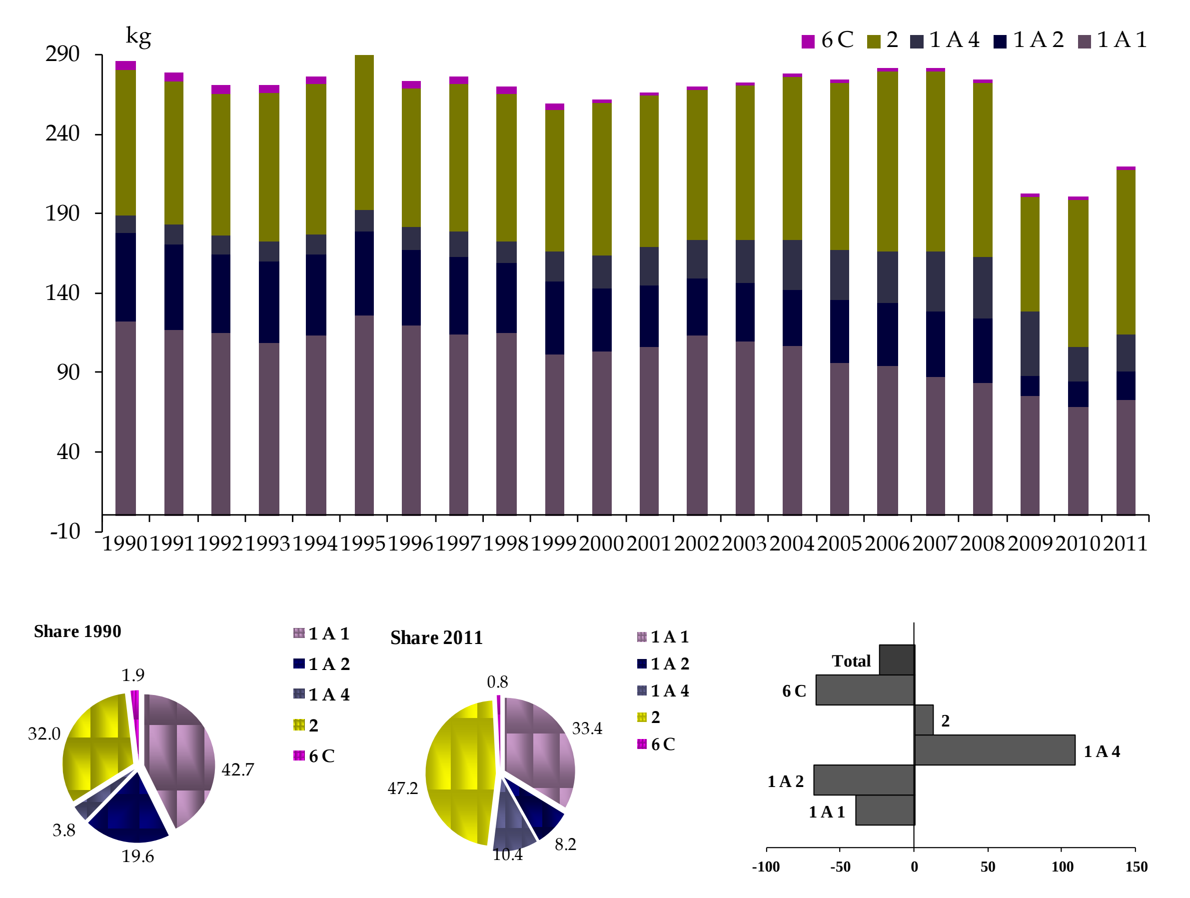

Figure 2.14 *PCB emission trend, percentage share by sector and variation 1990-2011*

Table 2.14 *PCB emission trend from 1990 to 2011 (Mg)*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
					Mg					
Combustion in energy and transformation industries	0.122	0.126	0.104	0.096	0.095	0.087	0.084	0.076	0.068	0.073
Non-industrial combustion plants	0.011	0.014	0.021	0.032	0.032	0.038	0.038	0.040	0.022	0.023
Combustion - industry	0.056	0.053	0.039	0.040	0.039	0.041	0.041	0.013	0.016	0.018
Production processes	0.092	0.100	0.096	0.106	0.114	0.114	0.110	0.071	0.093	0.103
Waste treatment and disposal	0.005	0.005	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Total	***0.286***	***0.298***	***0.262***	***0.275***	***0.282***	***0.282***	***0.275***	***0.202***	***0.201***	***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 47.2% and 33.4% of the total emissions respectively, the former showing an increase of 12.8%, the latter a reduction of 40%. The other relevant subsectors are *non industrial combustion plants* accounting for 10.4% and relevantly increasing (108.8%) and *combustion in industry* which accounts for 8.2% and decreases between 1990 and 2010 by 68%.

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 2011, more than 95% of the total amount of waste incinerated is treated in plants with energy recovery system. Different emission factors for municipal, industrial and oils, hospital waste, and sewage sludge are applied, as reported in the waste chapter. Waste amount is then converted in energy content applying an emission factor equal to 9.2 GJ/t of waste.

Emissions from landfill gas recovered are used for heating and power in commercial facilities and reported under 1.A.4.a. Biogas recovered from the anaerobic digester of animal waste is used for utilities in the agriculture sector and relative emissions are reported under 1.A.4.c. In consideration of the increasing of the share of waste used to produce electricity, we plan to revise the allocation of these emissions under category 1.A.1.a.

The energy sector account in 2011 for more than 49% of total emissions for all the pollutants estimated, except for ammonia where they account for 3%. In particular, emissions from the energy sector are 99% of NO_X, 93% of CO, 89% of SO_X, and 88% of PM2.5 national total emissions.

In 2011, the following categories are key categories 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 categories with exception of natural gas distribution (1B2b). In addition, for 1990 and trend, *manufacture of solid fuels and other energy industries* (1A1c) for PAH emissions is also a key category while *mobile combustion in manufacturing industries and construction* (1A2f ii) is a key category for PM10 in 1990.

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 10.0, has been used to calculate emissions (EMISIA SA, 2012); 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, 2013[b]). At national level, trends of the CLRTAP pollutants are described in the environmental data yearbook published by ISPRA (ISPRA, 2013[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 on national sources, or else on values specified in the EMEP/EEA guidebook and/or IPCC guidelines which are appropriate for Italy. Emission factors used for energy and manufacturing industries and non industrial combustion, specifically categories 1A1, 1A2, 1A4 are available on the ISPRA website at http://www.sinanet.isprambiente.it/it/inventaria.

The Institute, specifically the same unit responsible for the inventory, also collects data in the context 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; whenever data cannot be straight used for the inventory compilation, they are considered 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% for different pollutants under the UNECE convention; specifically, for the main pollutants, in 2011 the sector accounts for:

- 99% in national total NO_X emissions;
- 93% in national total CO emissions;
- 89% in national total SO_X emissions;
- 88% in national total PM2.5 emissions.

Moreover, the sector is also an important source for heavy metals; specifically in 2011, energy sector is responsible for 81% of total Cd emissions and accounts for a high share of other heavy metals, i.e As (99%), Cu (96%), Ni (88%), Se (91%).

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 26% higher than in 2011.

The most important source of emissions in the sector, in 2011, is represented by *road transport* (1A3), at least for the main pollutants: NO_X (51.8%), CO (38.9%), NMVOC (26%), and particulate matter (PM10 20.3%, PM2.5 21.3%). There has been a strong reduction in lead emissions from 1990 to 2011 in *road transport* due to replacement of lead gasoline. An in depth analysis of the road transport category is reported in paragraph 3.7.

Manufacturing industries and *construction* (1A2) is a main source of heavy metals and POPs, accounting for about 40% of lead total emissions, 37% for cadmium, 28% for mercury, 28% for dioxin and HCB (28%). The source is also significant for PM10 and PM2.5, (8% and 10%, respectively) as well as SO_X and NO_X, about 21% and 11% of total emissions. The category is also key category for CO emissions (11%) and PCB (8%).

Public electricity and heat production (1A1a) is a main source of SO_X emissions in 2011 with a share of 15.0%, together with *manufacturing industries and construction* (21.3%), *petroleum refining* (16.5%), national *navigation* (13.7%), fugitive emissions from *processes in refinery* (12.8%), and cement production (5.0%). The same category is also a significant source of PCB emissions (30%).

National *navigation* (1A3d ii) is also key category for NO_X (9.4%), NMVOC (5.4%), CO (6.2%), PM10 (4.0%) and PM2.5 (4.8%).

A sector which seems of increasing importance in terms of emissions is the *non-industrial combustion* (1A4): NO_X, NMVOC, emissions of this category range between 13-15% of national total; CO emissions account for 34%; PM10 and PM2.5 emissions account for 40.3% and 48.5% respectively; dioxin is 27.5% and PAH is 35.6% 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 and HCB 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 (12.8%) due to fugitive emissions in refinery (1B2a iv), and for NMVOC (2.5%) due to emissions from natural gas distribution (1B2b).

Table 3.1 *Key categories in the energy sector in 2011*

	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	15.0	16.5	2.1	21.3	0.0	0.1	0.1	0.1	0.0	0.1	0.0			0.0	13.7	0.0	2.0	2.7	0.0	0.1	0.1			15.0
NO_X	5.3	1.9	0.7	10.7	2.4	0.2	0.2	20.7	7.5	22.8	0.8			0.2	9.4	0.1	4.5	3.9	0.0	6.4	0.5			0.5
NH_3	0.1			0.3	0.0			2.3	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	0.7	0.4	0.1	0.1	4.0	0.7	1.1	14.6	6.0		0.0	5.4	0.0	2.5	8.9	0.1	1.7	0.1	0.0	0.2	6.2
CO	0.9	0.2	0.2	10.8	0.6	0.1	0.1	17.0	2.2	2.2	17.5			0.0	6.2	0.0	0.9	29.8	0.1	3.2	0.6			0.0
PM10	0.7	0.2	0.2	8.4	0.9	0.0	0.0	5.3	3.6	3.3	2.0		6.2	0.1	4.0	0.0	0.8	34.7	0.0	4.7	0.4	0.5	0.2	0.2
PM2.5	0.8	0.2	0.2	9.7	1.1	0.0	0.0	6.4	4.4	4.0	2.4		4.1	0.2	4.8	0.0	1.0	41.8	0.0	5.7	0.5	0.6	0.2	0.3
Pb	0.9	0.2	0.0	40.2		0.1	0.2						4.4		0.0		23.4	1.9		0.0	0.0		0.4	
Cd	1.3	0.4	0.0	37.0	0.0	0.0	0.0	2.6	0.7	1.0	0.2		0.8	0.0	0.2		28.7	3.8	0.0	0.9	0.0		3.3	
Hg	7.2	1.9	0.3	27.8													24.4	2.1		0.6			1.6	
PAH	0.3	0.1	7.0	2.5	0.1	0.0	0.0	2.1	0.5	0.6	0.1			0.0	0.1	-	1.5	32.5	0.0	1.6	0.0			
Dioxin	1.2	2.1	0.0	28.5				2.1	0.1	0.2	0.5						1.0	25.4		1.1				
HCB	4.4	-	-	26.6													12.8	5.6		0.2				
PCB	29.9	3.5	0.0	8.2													6.6	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, 2013[c]).

The analysis of data collected from point sources allowed to distribute emissions at local level, for 2010 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.

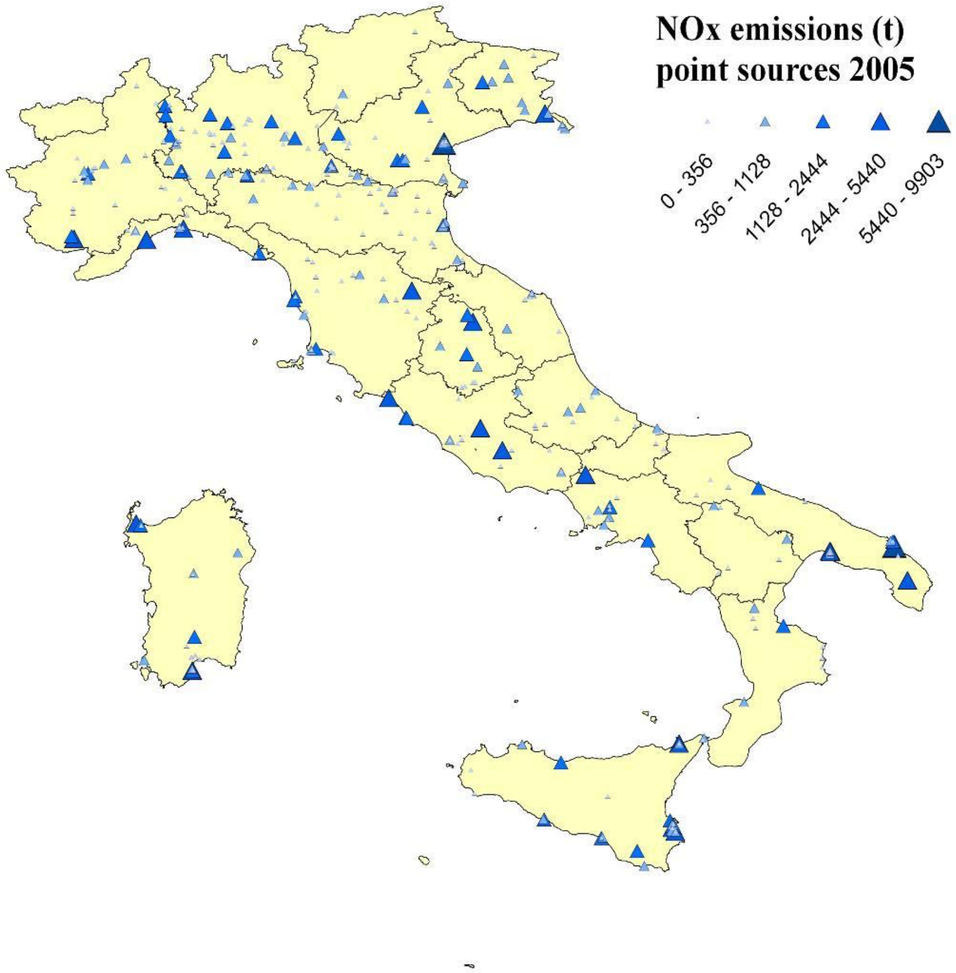

Figure 3.1 *NO_X emissions from point sources in 2005 (t)*

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 E-PRTR 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. 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; the disaggregation related to the year 2010 is reported in Figure 3.3 whereas methodologies are described in the relevant publication (ISPRA, 2009).

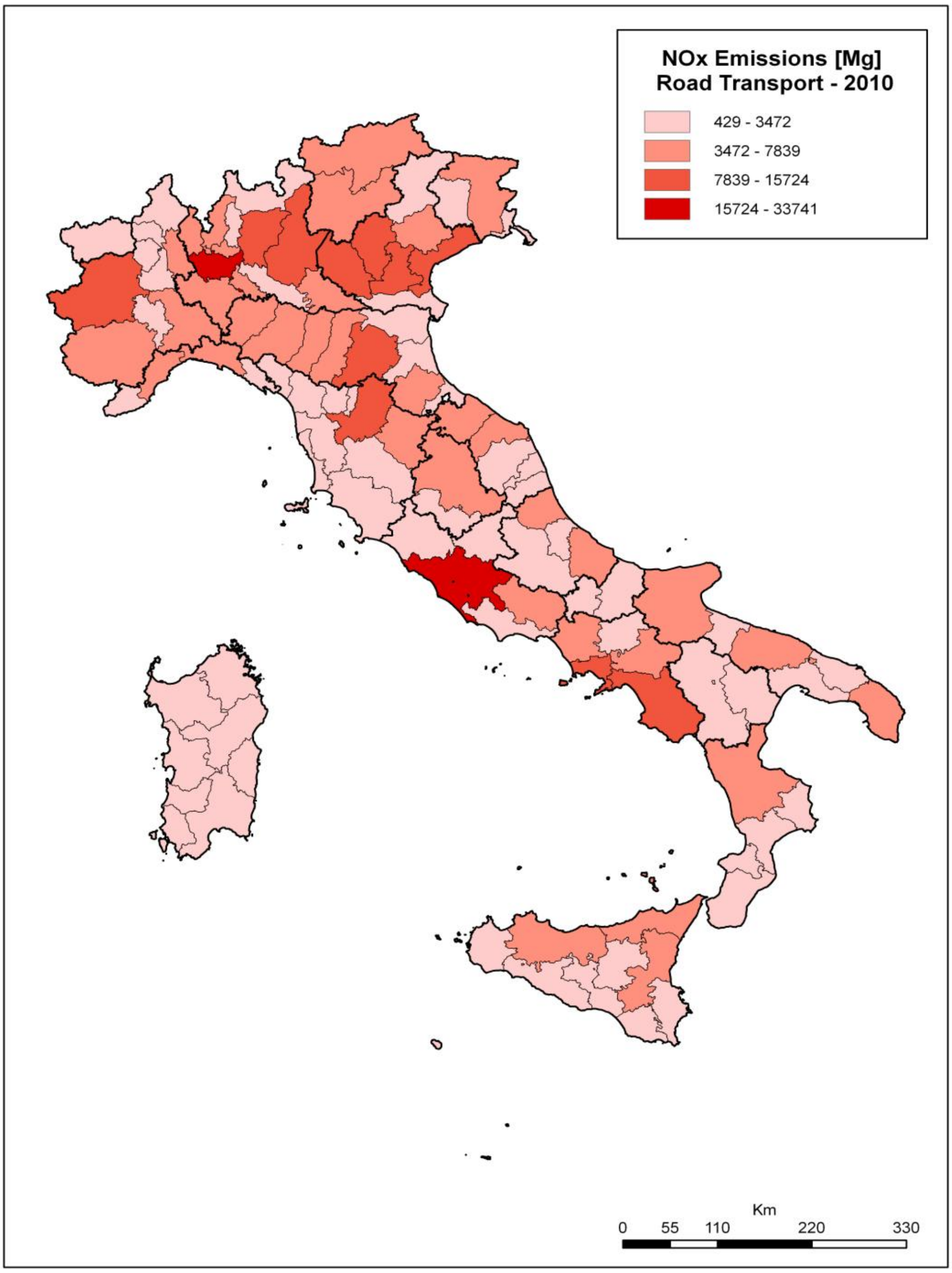

Figure 3.3 *NO_X emissions from road transport in 2010 (t)*

3.5 Recalculations

In the 2013 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. Emissions from *Non industrial stationary combustion* have been recalculated for the whole time series taking into account the update of activity data. Biomass fuel combustion in residential has been revised for the whole time series according to the relevant data supplied in the national energy balance for 2010 and 2011. More in detail, activity data related to pruning biomass and its pertinent emissions have been moved from the waste to the energy sector, under residential combustion, from 1990 to 2009, with the aim to reconstruct a consistent time series based on figures available in the energy balance only for the last two years. In fact, from 2010 biomass consumption reported in the energy balance is calculated with a new methodology which accounts for all the biomass consumption (including pruning biomass) and not only market data (production, import and export). Moreover NMVOC, PAH and PM emission factors have been updated for the whole time series according to the results of the experimental study on emissions from the biomass combustion for heating with different technologies funded by the Ministry of Environment and developed by the research institute 'Stazione Sperimentale dei Combustibili' (SSC, 2012). Recalculations affected the main pollutants, heavy metals and POPs and had a strong impact resulting in an increase of previously submitted emission estimates of the category but a general reduction in the national total of PM and PAH emissions. In addition, waste fuel consumption for commercial heating activity data have been updated from 2007 as a consequence of a check of the waste incinerators database with other sources of information at plant level; emission factors of many pollutants at plant level have been updated from 2010 on the basis of the data collected by ENEA in the framework of a study on emissions from incinerators of urban solid wastes (ENEA-federAmbiente, 2012). More detailed information is reported in paragraph 3.8.

Concerning mobile fuel combustion (1A3) the upgraded version of COPERT 4, v.10.0, has been used for road transport sector resulting in a general revision of emission estimates. More detailed results are reported in paragraph 3.7.

The composition of the fleet of gasoline fuelled recreational craft has been updated from 2005 revising the two strokes and four strokes engine distribution in consideration of a change from two strokes to four strokes engines of the national fleet due to the introduction in the market of new models; this information was supplied by the industrial category association (UCINA, several years). In 2000, the composition of the fleet was 90% two stroke engine equipped and 10% four stroke while in 2011the last one is about 36% of the fleet. This change resulted in a recalculation of NO_X, CO, NMVOC, NH_3 and Benzene emission factors for this category.

Activity data for maritime navigation have been updated for 2010 as well as SO_X emission factor for residual oil consumption in domestic cruise resulting in an increase of emissions from this category.

Under the combustion in industry category (1A2), SO_X and NO_X emissions for *paper production* have been added, for the whole time series, on the basis of the environmental reports of the industrial association (ASSOCARTA, several years) and the information on fuel consumption at plant level supplied in the framework of the EU ETS scheme. Activity data for glass, secondary zinc, brick and tiles, asphalt concrete and paper production have been updated for 2010 resulting in a minor recalculation of emissions.

PM10 and Benzene emission factors for *coke production* (1A1c) have been updated from 2009 on the basis of new information from the E-PRTR register.

NO_X emissions from 2005 for the energy production (1A1a) have been updated taking in account gasoil fuel consumption in stationary engines for energy production in the Italian minor islands and the relevant emissions.

3.6 Planned improvements

Specific improvements are detailed in the 2013 QA/QC plan (ISPRA, 2013[c]).

For the *energy* sector, a major progress regards the management 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 the total national emissions in 2011 as follows: nitrogen oxides emissions for 51.8% of the total; emissions of carbon monoxide for 38.9%, non-methane volatile organic compounds for 26.4%, PM10 and PM2.5, for 20.3% and 21.3%, 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. Although emission factors are available on the EMEP/EEA Guidebook they have been not included in the COPET model because considered not sufficiently reliable.

3.7.2 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 10.0 of the model COPERT 4 (EMISIA SA, 2012) has been used for the whole time series of the 2013 submission. This new version of the model, which upgrades the methodology and the software, determines a recalculation of emission estimates with respect to last submission. More in detail, the updated version of the model considers, compared to the previous version, a new subsector classification for gasoline and diesel passenger cars, updated emission factors for diesel passenger cars Euro 5 and 6, emissions update for mopeds, methane update for gasoline passenger cars, a new CNG subsector for passenger cars and update of the evaporative emission model (Katsis P., Mellios G., Ntziachristos L., 2012). In general, 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, NOX, N_2O, NH_3, PM2.5, PM10, PM exhaust (the emission factors of particulate matter from combustion refer to particles smaller than 2.5 µm, 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. Resulting national emission factors at the detailed level are available on the following public web address: http://www.sinanet.isprambiente.it/it/sinanet/fetransp/ .

Data on fuel consumption of gasoline, diesel, liquefied petroleum gas (LPG), natural gas (LNG) and biofuels are those reported in the national energy balance (MSE, several years). Time series of consumptions, by fuel and vehicle categories, are detailed in the NFR.

3.7.2.1 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, 2012). 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 fuel 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 1990-2011 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 10.0. Emissions of sulphur dioxide and heavy metals are calculated applying specific factors to consumption of gasoline, diesel, liquefied petroleum gas (LPG) and natural gas (LNG), 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).

3.7.2.2 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).

3.7.2.3 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).

3.7.3 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 different fuels types powered 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. For 2013 submission specific fleet composition data were provided by MIT for all vehicle categories from 2007 to 2011, except mopeds for which National Association of Cycle-Motorcycle Accessories (ANCMA, several years) data elaboration by ISPRA was used for the whole time series, regarding fleet composition and mileages. For previous years and for categories different from mopeds, detailed data on the national fleet composition are found in the yearly report from ACI (ACI, several years). Furthermore since 2012 MIT supplied updated information relating the breakdown of the heavy duty trucks, buses and coaches fleet according to the different weight classes (data were used for the updating of the whole time series) and data about motorcycles fleet in the detail of subsector and legislation standard of both 2-stroke and 4-stroke categories (this kind of information has been used for the updating of the years 2005 – 2011). 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 3.2, 3.3 and 3.4 detailed data on the relevant vehicle mileages in the circulating fleet are reported, subdivided according to the main emission regulations (ISPRA elaborations on ACI, ANCMA and MIT data).

Table 3.2 *Passenger Cars and Light Duty Vehicles technological evolution: circulating fleet calculated as stock data multiplied by actual mileage (%)*

	1990	1995	2000	2005	2010	2011
PRE ECE, pre-1972	0.05	0.03	0.01	0.01	0.00	0.00
ECE 15/00-01, 1972-1977	0.11	0.04	0.01	0.005	0.003	0.002
ECE 15/02-03, 1978-1986	0.32	0.15	0.03	0.01	0.01	0.005
ECE 15/04, 1987-1992	0.53	0.57	0.28	0.10	0.04	0.04
PC Euro 1 - 91/441/EEC, from 1/1/93	0.001	0.225	0.279	0.172	0.066	0.058
PC Euro 2 - 94/12/EEC, from 1/1/97	-	-	0.38	0.35	0.24	0.23
PC Euro 3 - 98/69/EC Stage2000, from 1/1/2001	-	-	-	0.26	0.21	0.20
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006	-	-	-	0.09	0.40	0.38
PC Euro 5 - EC 715/2007, from 1/1/2011	-	-	-	-	0.04	0.08
PC Euro 6 - EC 715/2007, from 9/1/2015	-	-	-	-	-	0.0000001
a. Gasoline cars technological evolution						
Conventional, pre-1993	1.00	0.92	0.35	0.06	0.01	0.01
PC Euro 1 - 91/441/EEC, from 1/1/93	-	0.08	0.10	0.03	0.01	0.01
PC Euro 2 - 94/12/EEC, from 1/1/97	-	-	0.55	0.25	0.09	0.07
PC Euro 3 - 98/69/EC Stage2000, from 1/1/2001	-	-	-	0.53	0.26	0.23
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006	-	-	-	0.13	0.56	0.52
PC Euro 5 - EC 715/2007, from 1/1/2011	-	-	-	-	0.07	0.15
PC Euro 6 - EC 715/2007, from 9/1/2015	-	-	-	-	0.0001	0.0002
b. Diesel cars technological evolution						
Conventional, pre-1993	1.00	0.90	0.71	0.47	0.04	0.03
PC Euro 1 - 91/441/EEC, from 1/1/93	-	0.10	0.20	0.26	0.03	0.03
PC Euro 2 - 94/12/EEC, from 1/1/97	-	-	0.09	0.19	0.08	0.11
PC Euro 3 - 98/69/EC Stage2000, from 1/1/2001	-	-	-	0.06	0.08	0.10

	1990	1995	2000	2005	2010	2011
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006	-	-	-	0.01	0.75	0.66
PC Euro 5 - EC 715/2007, from 1/1/2011	-	-	-	-	0.03	0.07
PC Euro 6 - EC 715/2007, from 9/1/2015	-	-	-	-	-	-
c. Lpg cars technological evolution						
Conventional, pre-1993	1.00	0.89	0.56	0.29	0.04	0.03
PC Euro 1 - 91/441/EEC, from 1/1/93	-	0.11	0.23	0.21	0.04	0.03
PC Euro 2 - 94/12/EEC, from 1/1/97	-	-	0.21	0.26	0.17	0.15
PC Euro 3 - 98/69/EC Stage2000, from 1/1/2001	-	-	-	0.19	0.12	0.11
PC Euro 4 - 98/69/EC Stage2005, from 1/1/2006	-	-	-	0.05	0.55	0.53
PC Euro 5 - EC 715/2007, from 1/1/2011	-	-	-	-	0.09	0.15
PC Euro 6 - EC 715/2007, from 9/1/2015	-	-	-	-	-	-
d. CNG cars technological evolution						
Conventional, pre 10/1/94	1.00	0.93	0.60	0.38	0.12	0.11
LD Euro 1 - 93/59/EEC, from 10/1/94	-	0.07	0.24	0.19	0.14	0.12
LD Euro 2 - 96/69/EEC, from 10/1/98	-	-	0.16	0.15	0.27	0.24
LD Euro 3 - 98/69/EC Stage2000, from 1/1/2002	-	-	-	0.28	0.24	0.22
LD Euro 4 - 98/69/EC Stage2005, from 1/1/2007	-	-	-	0.01	0.23	0.22
LD Euro 5 - 2008 Standards 715/2007/EC, from 1/1/2012	-	-	-	-	0.003	0.08
LD Euro 6 - EC 715/2007, from 9/1/2016	-	-	-	-	-	-
e. Gasoline Light Duty Vehicles technological evolution						
Conventional, pre 10/1/94	1.00	0.93	0.60	0.26	0.08	0.07
LD Euro 1 - 93/59/EEC, from 10/1/94	-	0.07	0.22	0.12	0.07	0.04
LD Euro 2 - 96/69/EEC, from 10/1/98	-	-	0.19	0.19	0.23	0.21
LD Euro 3 - 98/69/EC Stage2000, from 1/1/2002	-	-	-	0.41	0.33	0.33
LD Euro 4 - 98/69/EC Stage2005, from 1/1/2007	-	-	-	0.01	0.28	0.31
LD Euro 5 - 2008 Standards 715/2007/EC, from 1/1/2012	-	-	-	-	0.01	0.03
LD Euro 6 - EC 715/2007, from 9/1/2016	-	-	-	-	0.0000003	0.0000004
f. Diesel Light Duty Vehicles technological evolution						

Source: ISPRA elaborations on MIT and ACI data

Table 3.3 *Heavy Duty Trucks and Buses technological evolution: circulating fleet calculated as stock data multiplied by actual mileage (%)*

	1990	1995	2000	2005	2010	2011
Conventional, pre 10/1/93	1.00	0.90	0.67	0.39	0.19	0.18
HD Euro I - 91/542/EEC Stage I, from 10/1/93	-	0.10	0.10	0.06	0.05	0.05
HD Euro II - 91/542/EEC Stage II, from 10/1/96	-	-	0.22	0.27	0.22	0.21
HD Euro III - 2000 Standards, 99/96/EC, from 10/1/2001	-	-	-	0.28	0.35	0.33
HD Euro IV - 2005 Standards, 99/96/EC, from 10/1/2006	-	-	-	-	0.06	0.06
HD Euro V - 2008 Standards, 99/96/EC, from 10/1/2009	-	-	-	-	0.14	0.17
HD Euro VI – EC 595/2009, from 12/31/2013	-	-	-	-	-	-
a. Heavy Duty Trucks technological evolution						
Conventional, pre 10/1/93	1.00	0.93	0.65	0.34	0.17	0.16
HD Euro I - 91/542/EEC Stage I, from 10/1/93	-	0.07	0.07	0.08	0.06	0.05
HD Euro II - 91/542/EEC Stage II, from 10/1/96	-	-	0.28	0.32	0.29	0.27
HD Euro III - 2000 Standards, 99/96/EC, from 10/1/2001	-	-	-	0.26	0.30	0.29
HD Euro IV - 2005 Standards, 99/96/EC, from 10/1/2006	-	-	-	-	0.10	0.10
HD Euro V - 2008 Standards, 99/96/EC, from 10/1/2009	-	-	-	-	0.09	0.13
HD Euro VI – EC 595/2009, from 12/31/2013	-	-	-	-	-	-
b. Diesel Buses technological evolution						
Urban CNG Buses Euro I - 91/542/EEC Stage I, from 10/1/93	1.00	1.00	0.10	0.01	0.004	0.001
Urban CNG Buses Euro II - 91/542/EEC Stage II, from 10/1/96	-	-	0.90	0.22	0.10	0.09
Urban CNG Buses Euro III - 2000 Standards, 99/96/EC, from 10/1/2001	-	-	-	0.76	0.10	0.10
Urban CNG Buses Euro IV, Euro V and EEV (Enhanced environmentally friendly vehicle; ref. 2001/27/EC and 1999/96/EC line C, optional limit emission values)	-	-	-	-	0.80	0.81
c. CNG Buses technological evolution						

Source: ISPRA elaborations on MIT and ACI data

Note: Fleet classification derives from Copert, so for CNG buses, in the EEV category also Buses Euro IV and Euro V are included.

Table 3.4 *Mopeds and motorcycles technological evolution: circulating fleet calculated as stock data multiplied by actual mileage (%)*

	1990	1995	2000	2005	2010	2011
Conventional, pre 6/17/1999	1.00	1.00	0.86	0.53	0.37	0.35
Euro I, 97/24/EC, from 6/17/1999	-	-	0.14	0.27	0.22	0.22
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	0.23
Euro III, 2002/51/EC, 2003/77/EC, from 1/1/2007 (for mopeds not defined yet)	-	-	-	0.03	0.18	0.20

Source: ISPRA elaborations on ANCMA, ACI and MIT data

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 3.5, based on data from various sources:

- Ministry of Transport (MIT, several years) for rural roads and on other motorways; 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 3.5 *Evolution of fleet consistency and mileage*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
All passenger vehicles, total mileage (10^9 veh-km/y)	308	365	397	418	427	424	407	391	403	411
Car fleet (10^6 veh)	27	30	33	35	35	36	37	37	37	38
Moto, total mileage (10^9 veh-km/y)	31	39	45	48	48	50	51	52	51	50
Moto fleet (10^6 veh)	7	7	9	10	10	10	10	10	11	11
Goods transport, total mileage (10^9 veh-km/y)	70	75	89	99	102	105	105	106	105	101
Truck fleet (10^6 veh), including LDV	2	3	3	4	4	5	5	5	5	5

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 Table 3.6 the list of key categories by pollutant identified for road transport in 2011, 1990 and at trend assessment is reported.

Table 3.6 *List of key categories for pollutant in the road transport in 2011, 1990 and in the trend*

	Key categories in 2011				*Key categories in 1990*				*Key categories in trend*		
SOx					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 bv		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	1 A 3 bvi
PM2.5	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 bi	1 A 3 biii	
Pb					1 A 3 bi				1 A 3 bi		

In 2011 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 49.2%. 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 2011, 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 categories in trend; in 1990 passenger cars and heavy-duty vehicles including buses are key categories while light-duty trucks are not a 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**	**2011**
					Gg					
1.A.3.b.i Passenger cars	538	591	367	254	245	221	204	184	190	193
1.A.3.b.ii Light-duty vehicles	67	71	80	81	80	80	77	77	78	70
1.A.3.b.iii Heavy-duty vehicles including buses	338	330	296	270	252	262	256	248	208	212
1.A.3.b.iv Mopeds and motorcycles	6	7	9	8	8	8	8	8	8	8
Total emissions	**949**	**998**	**753**	**613**	**584**	**570**	**544**	**517**	**484**	**482**

As regards non methane volatile organic compounds, emissions from passenger cars, mopeds and motorcycles and gasoline evaporation are key categories in 2011, 1990 and in trend.

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 2011) 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	2011
						Gg				
1.A.3.b.i Passenger cars	485	503	272	118	96	73	61	51	46	40
1.A.3.b.ii Light-duty vehicles	17	17	14	11	10	9	8	8	8	7
1.A.3.b.iii Heavy-duty vehicles including buses	29	25	20	16	16	15	14	13	10	10
1.A.3.b.iv Mopeds and motorcycles	155	205	198	189	182	173	167	160	150	145
1.A.3.b.v Gasoline evaporation	187	186	138	80	79	65	63	62	56	59
Total emissions	**873**	**937**	**642**	**413**	**382**	**334**	**313**	**295**	**271**	**261**

Carbon monoxide emissions from passenger cars, mopeds and motorcycles are key categories in 2011, 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 2011 a general decrease, of about 80%, 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	2011
						Gg				
1.A.3.b.i Passenger cars	4,625	4,413	2,301	1,079	881	708	600	521	476	418
1.A.3.b.ii Light-duty trucks	202	200	137	94	79	69	64	66	60	54
1.A.3.b.iii Heavy-duty vehicles including buses	84	79	67	64	59	63	63	61	53	55
1.A.3.b.iv Mopeds and motorcycles	512	636	678	541	527	506	492	475	446	432
Total emissions	**5,423**	**5,329**	**3,183**	**1,777**	**1,545**	**1,345**	**1,219**	**1,124**	**1,035**	**959**

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 2011 and in 1990; emissions from passenger cars, heavy-duty vehicles including buses and road vehicle tyre and brake wear are key categories in trend (Table 3.10).

As regards PM2.5, emissions from passenger cars, light-duty vehicles, heavy-duty vehicles including buses and road vehicle tyre and brake wear are key categories in 2011; while emissions from passenger cars, light-duty vehicles, heavy-duty vehicles including buses are key categories in 1990; only emissions from passenger cars and heavy-duty vehicles including buses are key categories 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	2011
					Gg					
1.A.3.b.i Passenger cars	19	14	12	11	11	10	10	9	9	8
1.A.3.b.ii Light-duty vehicles	10	12	13	9	8	8	7	7	7	6
1.A.3.b.iii Heavy-duty vehicles including buses	14	13	10	8	7	7	7	6	5	5
1.A.3.b.iv Mopeds and motorcycles	3	4	4	4	4	4	4	3	3	3
1 A 3 b vi Road Transport:, Automobile tyre and brake wear	8	9	9	10	10	10	10	10	10	10
Total emissions	**54**	**52**	**49**	**41**	**39**	**39**	**37**	**35**	**33**	**32**

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	2011
					Gg					
1.A.3.b.i Passenger cars	19	14	12	11	11	10	10	9	9	8
1.A.3.b.ii Light-duty vehicles	10	12	13	9	8	8	7	7	7	6
1.A.3.b.iii Heavy-duty vehicles including buses	14	13	10	8	7	7	7	6	5	5
1.A.3.b.iv Mopeds and motorcycles	3	4	4	4	4	4	4	3	3	3
1 A 3 b vi Road Transport:, Automobile tyre and brake wear	4	5	5	5	5	5	5	5	5	5
Total emissions	**50**	**48**	**44**	**37**	**35**	**34**	**32**	**31**	**29**	**27**

Emissions of particulate matter with diameter less than 10µm and less than 2.5µm show a decreasing trend from 1990 (respectively of about -40.9% and -45.3%); despite the decrease, diesel vehicles, passenger cars, light duty vehicles and heavy duty trucks, are in 2011 mainly responsible for road transport emissions.

Emissions of SO_X, NH_3 and Pb are not key categories in 2011, despite emissions of SO_X and Pb from passenger cars are key categories in 1990 and emissions of NH_3 and Pb from passenger cars are key categories in trend. Emissions of these pollutants are irrelevant in 2011, 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 2011. Emissions of Pb decrease of 99.7% and represent, in 2011, 4.4% of total national emissions. Emissions of NH_3, despite the strong increase from 1990, in 2011 represent only 2.4% 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 version of COPERT 4 revised the estimation methodology, fixing some bugs. The most recent update of the software is COPERT 4, version 10.0 (EMISIA SA, 2012). The updating to version COPERT 4 v 10.0 introduces important elements such as a new subsector classification of gasoline and diesel passenger cars, updated emission factors of Euro 5 and Euro 6 diesel passenger cars, updated emissions for mopeds, updated methane for gasoline passenger cars, a new CNG subsector for passenger cars.

The updating of the tool also includes a CO_2 correction option for gasoline and diesel passenger cars, a new E85 subsector for passenger cars and the introduction of the splitting of mopeds categories in 2-strokes and 4-strokes (updates currently not yet used).

Important changes with respect to the previous submission derive from the different classification used for input fleet data (MIT and ACI data) and from the introduction of CNG passenger cars categories (subsectors: Natural Gas <1.4l; Natural Gas 1.4 – 2.0l; Natural Gas >2.0l), reported in the following:

- Passenger Cars Natural Gas < 1,4 l Conventional
- Passenger Cars Natural Gas < 1,4 l PC Euro 1 - 91/441/EEC
- Passenger Cars Natural Gas < 1,4 l PC Euro 2 - 94/12/EEC
- Passenger Cars Natural Gas < 1,4 l PC Euro 3 - 98/69/EC Stage2000
- Passenger Cars Natural Gas < 1,4 l PC Euro 4 - 98/69/EC Stage2005
- Passenger Cars Natural Gas < 1,4 l PC Euro 5 - EC 715/2007
- Passenger Cars Natural Gas < 1,4 l PC Euro 6 - EC 715/2007
- Passenger Cars Natural Gas 1,4 - 2,0 l Conventional
- Passenger Cars Natural Gas 1,4 - 2,0 l PC Euro 1 - 91/441/EEC
- Passenger Cars Natural Gas 1,4 - 2,0 l PC Euro 2 - 94/12/EEC
- Passenger Cars Natural Gas 1,4 - 2,0 l PC Euro 3 - 98/69/EC Stage2000
- Passenger Cars Natural Gas 1,4 - 2,0 l PC Euro 4 - 98/69/EC Stage2005
- Passenger Cars Natural Gas 1,4 - 2,0 l PC Euro 5 - EC 715/2007
- Passenger Cars Natural Gas 1,4 - 2,0 l PC Euro 6 - EC 715/2007
- Passenger Cars Natural Gas > 2,0 l Conventional
- Passenger Cars Natural Gas > 2,0 l PC Euro 1 - 91/441/EEC
- Passenger Cars Natural Gas > 2,0 l PC Euro 2 - 94/12/EEC
- Passenger Cars Natural Gas > 2,0 l PC Euro 3 - 98/69/EC Stage2000
- Passenger Cars Natural Gas > 2,0 l PC Euro 4 - 98/69/EC Stage2005
- Passenger Cars Natural Gas > 2,0 l PC Euro 5 - EC 715/2007
- Passenger Cars Natural Gas > 2,0 l PC Euro 6 - EC 715/2007

As regards evaporative emissions, an update in both the methodology and the emission factors has been implemented. Compared to the previous versions of the model, the effect of (activated carbon) degradation, an updated parking table (extending over several days), a trip distribution (prior to parking), updated permeation factors, and other minor updates and corrections have been introduced.

Differences relate mainly to gasoline passenger cars, mopeds and motorcycles. In comparison with last submission, while differences in evaporative emissions show a strong increasing trend, total NMVOC emissions show discordant trends (higher emissions values for passenger cars and motorcycles and significantly lower values for mopeds, which compared to last submission 2012, present a mean decrease in annual emissions values by about -36.4%). Methane emissions do not show equally sensitive changes.

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, mileage, 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 2011, 1990 and in the trend is reported.

Table 3.12 *List of key categories by pollutant in the civil sector in 2011, 1990 and trend*

	Key categories in 2011		*Key categories in 1990*		*Key categories in trend*		
NOx	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 b i	1 A 4 c ii	1 A 4 a i
CO	1 A 4 b i		1 A 4 b i		1 A 4 b i		
PM_{10}	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	

	Key categories in 2011		Key categories in 1990		Key categories in trend	
$PM_{2.5}$	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	1 A 4 b 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 b i	1 A 4 a i	1 A 4 b i
HCB	1 A 4 a i				1 A 4 a i	1 A 4 b 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	2011
			TJ			
1 A 4 a i Commercial / Institutional: Stationary	267,848	295,625	357,283	460,231	535,374	498,802
1 A 4 b i Residential: Stationary plants	881,624	900,483	919,414	1,066,858	1,022,057	945,030
1 A 4 b ii Residential: Household and gardening (mobile)	466	571	373	154	66	57
1 A 4 c i Agriculture/Forestry/Fishing: Stationary	9,612	9,604	13,821	16,947	16,336	17,222
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	96,638	101,801	94,542	95,805	84,404	82,874
1A 4 c iii Agriculture/Forestry/Fishing: National Fishing	8,714	9,733	8,666	10,457	7,726	7,768
1 A 5 b Other, Mobile (Including military, land based and recreational boats)	14,830	20,800	11,587	16,935	8,995	7,110

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 emissions for wood combustion while emissions from waste combustion in incinerator with energy recovery have been calculated from the database of incinerator plants which includes plant specific emission factors on the basis of their technology and measurements data. More detail information is available in the relevant paragraph of the waste sector chapter.

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 plants, 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 years).

Data reported by ASSOTERMICA (ASSOTERMICA, several years) on the number of heating plants sold have 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 NO_X average emission 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**	**2011**
				g/Gj		
1 A 4 a i Commercial / Institutional: Stationary	50	48.5	40.2	35.2	34.8	34.8
1 A 4 b i Residential: Stationary plants	50	48.2	38.6	32.4	32.3	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	51.3	44.7
Stoves	28.4	27.6
Advanced fireplaces	15.4	20.2
Pellet stoves	0	3.1
Advanced stoves	5.2	4.4

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.

For NMVOC, PAH, PM10 and PM2.5 emission factors the results of the experimental study funded by the Ministry of Environment and conducted by the research institute 'Stazione Sperimentale dei Combustibili' (SSC, 2012) have been used. This study measured and compared NO_X, CO, NMVOC, SO_X, TSP, PM10, PM2.5, PAH and Dioxin emissions for the combustion of different wood typically used in Italy as beech, hornbeam, oak, locust and spruce-fir, in open and closed fireplaces, traditional and innovative stoves, and pellet stoves. Emissions from certificated and not certificated pellets have been also measured and compared. In general measured emission factors results in the ranges supplied by the EMEP/EEA Guidebook but for some pollutants and technologies results are sensibly different. In particular NMVOC emissions for all the technologies are close or lower to the minimum value of the range reported in the Guidebook, as well as PM emissions with exception of emissions from pellet stoves which are higher of the values suggested in the case of the use of not certificated pellet. For these pollutants the minimum values of the range in the Guidebook have been used when appropriate. For that concern PAH, measured emissions from open fireplaces are much lower than the minimum value of the range in the Guidebook while those from the advanced stoves are close to the superior values of the range for all the PAH compounds. In this case for open fireplaces experimental values have been used while for the other technologies the minimum or maximum values of the range in the Guidebook have been used as appropriate. For the other pollutants where differences with the values suggested by the Guidebook are not sensible, a more in depth analysis will be conducted with the aim to update the emission factors used if needed.

In Table 3.16 emission factors used for the Italian inventory are reported.

Table 3.16 *Emission factors for wood combustion*

	1990	**1995**	**2000**	**2005**	**2010**
			g/Gj		
NO_x	50	55	59	61	61
CO	6000	5791	5591	5427	5395
NMVOC	762	715	672	643	638
SO_2	10	11	12	13	13
NH_3	9	7	6	6	6
PM10	507	465	428	408	404
PM2.5	503	461	424	404	400
PAH	0.25	0.24	0.23	0.22	0.22
Dioxin (µg/GJ)	0.48	0.47	0.45	0.44	0.44
PCB	0.00006	0.00006	0.00006	0.00006	0.00006
HCB	0.00001	0.00001	0.00001	0.00001	0.00001
As	0.001	0.001	0.001	0.001	0.001
Cd	0.002	0.002	0.001	0.001	0.001
Cr	0.001	0.002	0.003	0.003	0.003
Cu	0.01	0.01	0.01	0.01	0.01
Hg	0.0004	0.0004	0.0004	0.0004	0.0004
Ni	0.002	0.002	0.002	0.002	0.002
Pb	0.04	0.04	0.04	0.04	0.04
Se	0.001	0.001	0.001	0.001	0.001
Zn	0.10	0.10	0.10	0.09	0.09
B(a)P	0.07	0.07	0.06	0.06	0.06

	1990	1995	2000	2005	2010
			g/Gj		
B(b)F	0.09	0.08	0.08	0.08	0.08
B(k)F	0.04	0.04	0.04	0.04	0.04
IND	0.05	0.05	0.05	0.04	0.04

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	2011
SO_x (Gg)	1 A 4	110.47	45.73	24.45	20.38	18.28	16.84	11.74	11.30	9.19	9.17
	1 A 5	1.19	0.81	0.21	0.17	0.14	0.12	0.10	0.11	0.13	0.11
NO_x (Gg)	1 A 4	172.96	184.56	172.83	165.89	156.69	147.52	143.90	145.16	141.68	138.72
	1 A 5	10.27	11.26	6.76	12.87	10.57	9.90	8.57	10.17	6.11	4.68
CO (Mg)	1 A 4	632.70	665.42	634.94	621.64	636.39	718.66	746.20	790.38	835.14	839.24
	1 A 5	74.10	86.31	50.26	60.79	46.98	41.48	21.28	17.02	17.35	14.13
PM10 (Mg)	1 A 4	46.52	56.04	54.97	51.96	51.76	56.52	57.04	59.95	62.60	62.78
	1 A 5	12.43	13.67	10.27	11.26	9.38	10.57	8.57	7.91	6.76	2.03
PM2.5 (Mg)	1 A 4	44.98	54.49	53.90	51.44	51.26	56.00	56.53	59.42	62.04	62.21
	1 A 5	12.43	13.67	10.27	11.26	9.38	10.57	8.57	7.91	6.76	2.03
Pb (Mg)	1 A 4	79.29	31.59	21.85	43.52	43.82	67.01	66.88	63.53	66.50	70.10
	1 A 5	16.34	4.22	1.16	0.00	0.00	0.00	0.03	0.00	0.00	0.00
Cd (Mg)	1 A 4	1.63	1.19	1.68	2.58	2.51	3.25	3.23	3.21	2.33	2.45
	1 A 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hg (Mg)	1 A 4	0.63	0.71	1.07	2.01	2.01	2.78	2.79	2.74	2.39	2.49
	1 A 5										
PAH (Mg)	1 A 4	12.80	18.04	19.72	21.69	22.55	26.56	27.63	29.41	31.07	31.51
	1 A 5	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.00
HCB (Kg)	1 A 4	1.42	2.43	5.88	5.89	6.25	6.19	6.33	6.87	2.55	2.66
	1 A 5										
PCB (Kg)	1 A 4	10.94	13.98	21.20	31.80	32.46	37.94	38.45	40.48	21.95	22.84
	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

Biomass fuel combustion in commercial and residential activity data has been revised for the whole time series according to the relevant data supplied in the national energy balance for 2010 and 2011. More in detail, the amount of pruning biomass used for energy purposes previously reported in the waste sector, in the waste incineration category, have been added to the wood consumption reported in the BEN from 1990 to 2009. On the basis of the methodology adopted for the energy balance, from 2010 the wood fuel statistic includes also pruning biomass.

Energy recovery from waste reported in the commercial heating has been updated from 2007 as a consequence of the check of the solid waste incinerators database with other sources at plant level and activity data have been updated for 2010 for urban waste and 2009 for sludge and industrial waste; further details are reported in the waste chapter. Emission factors at plant levels especially for heavy metals and POPs have been updated from 2010 on the basis of the study carried out by ENEA and Federambiente and regarding all the Italian incinerators (ENEA-federAmbiente, 2012). Recalculations affected mainly PAH and PM emissions for the whole time series and heavy metals, HCB and PCB for 2010.

3.8.7 Planned improvements

A survey on wood consumption and combustion technologies has been carried out by ISPRA and is still on going to provide data related to 2012. On the basis of these figures, the updating of average emission factors, for the period 2007-2011, is planned for the next submission.

An in depth analysis of emission factors resulting from the experimental study carried out by SSC (SSC, 2012) and their comparison with the values suggested by the Guidebook will be carried out and emission factors will be updated if needed.

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 2011, industrial processes account for 11.02% of SO_2 emissions, 0.68% of NO_X, 0.09% of NH_3, 4.31% of NMVOC and 4.82% of CO. About particulate matter, in 2011 this sector accounts for 9.83% of PM10 emissions and 5.27% 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 accounts for 27.19% of Pb emissions, 17.62% of Cd and 32.9% of Hg. Regarding POPs emissions, 43.17% of PAH total emissions is emitted from industrial processes as well as 34.54% of dioxins and 47.18% of PCB.

In 2011, *iron and steel* sector (2C1) is a key category at level assessment for PM10, PM2.5, Pb, Cd, Hg, PAH, PCDD/PCDF and PCB; *cement production* (2A1) is key category for SO_2 and PM10; emissions and *food and drink* (2D2) is a key category source for NMVOC emissions. In 1990 similar figures were obtained, however 2A1 and 2D2 were not key categories while *other chemical industry* (2B5a) was a key source for Hg emissions. In 1990 *iron and steel production* was not key category for Pb emissions.

At trend assessment, *iron and steel* sector is key category for Pb, Hg, PAH, PCDD/PCDF and PCB, *cement production* is a key category source for SO_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, the *Large Combustion Plant* directives and the *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 and PM10 emissions and accounts for 5.04% and 2.7% of the relevant total national emissions in 2011.

During the last 15 years, in Italy, changes in cement production sector have occurred, leading to a more stable structure. The oldest plants were closed, wet processes were abandoned in favour of dry processes so as to improve the implementation of more modern and efficient technologies. The effects of the global recession period have led at national level only to two plants closedown. In 2011 Italy was not the first cement producer country in the EU 27 and reduction of clinker production was observed too. Actually, 28 companies (81 plants of which: 57 full cycle and 24 grinding plants; i.e. 1 full cycle plant and 5 grinding plants were closed in 2011 compared to 2010) operate 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: 46% is in northern Italy, 16% 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 2011 the larger size cement plants (i.e. with cement production capacity > 1 Mt/y) contributed with 7.2% to the national cement production; due to resizing of plants during 2011, only 2 plants keep a cement production capacity >1 Mt/year. In Italy different types of cement are produced; as for 2011 AITEC, the national cement association, has characterised the national production as follows: 72% is CEM II (Portland composite cement); 14% is CEM IV (pozzolanic cement); 8.8% is CEM I (ordinary Portland Cement) and 3.9% is CEM III (blastfurnace cement). Clinker production has been decreasing since 2007 (about 10% in 2008 compared to 2007; about 19% in 2009 compared to 2008; about 4.7% in 2011 compared to 2010) and clinker demand in cement production was about 75% in 2011 (production of clinker out of production of cement).

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 2.74% 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 1.37% 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 2011 to 279,004 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 0.60 g Hg/t in 2011. 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 seven facilities carried out the chlor-alkali production, one facility had the membrane process in place, one facility was replacing mercury cells with membrane process while in the other five facilities the production was still based on the mercury cell process (Legambiente, 2007). In 2011 five facilities carried out the production of Chlor-alkali productions, in four of them the membrane process was in place while one 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 2011, there are only three of the above mentioned plants, one of which lacks sintering facilities; oxygen steel production represents about 34% of the total production and the arc furnace steel the remaining 66% (FEDERACCIAI, several years). Currently, long products represent about 42% of steel production in Italy, flat products about 47%, 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 1990-2011. 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 2002-2011 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 2011, *iron and steel sector* (2C1) is key category for PM10, PM2.5, 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 2011*

		PM10 [g/Mg]	PM2.5 [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	48						
Pig iron tapping		41.4	33.12	0.3	0.3	15		3450	
Basic oxygen furnace	*Areal*	62	49.6	25	3	850	3.6		
	Point	122	97.6	25	3	850	3.6		
Electric arc furnace		124	99.2	50	150	3450	3.6	1.9	4.45
Rolling mills	*Areal*	59	47.2					125	
	Point	28.2	22.56					125	
Sinter plant (except combustion)		16	12.8						

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. In the last years, a strict cooperation with some local environmental agencies allowed the acquisition of new data, the assessment of these data is still ongoing and improvements in emission estimates are expected for the next years.

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 1.41% 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 2011*

	2A1	2A2	2A4	2A5	2A6	2B1	2B2	2B3 %	2B5a	2C1	2C2	2C3	2D1	2D2	2G
SO_x	5.04					0.005			4.35	0.21	0.001	1.41			
NO_x						0.06	0.04	0.002	0.26	0.26	3E-4	0.05			
NH_3			0.04			0.003	0.001		0.05						
NMVOC				0.002	0.78	0.01			0.34	0.35		0.01	0.15	2.68	
CO			0.65			0.003			0.43	2.96	0.003	0.78			
PM10	2.73	1.02		0.05	1.37				0.41	4.08	0.02	0.13		0.01	
PM2.5	0.50	0.19		0.01	0.25				0.24	3.97	0.01	0.1		0.002	
Pb									-	26.47					0.73
Cd									1.17	16.26		0.19			
Hg									1.74	31.16					
PAH										43.09		0.08			
Dioxin										34.54					
HCB															
PCB										47.18					

Note: key categories are shaded in blue

There is a general reduction of emissions in the period 1990 - 2011 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 set constant from 1990 to 2011 while SO_2 emission factor reduced from 1990 to 1995 and is set 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 – 2011 (Gg)*

	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Activity data [Gg]	42,414	35,432	41,119	47,291	47,985	47,231	42,538	36,167	34,283	32,800
SO_2 emissions (Gg)	21.2	10.6	12.3	14.2	14.4	14.2	12.8	10.9	10.3	9.8
PM10 emissions [Gg]	5.5	4.6	5.3	6.1	6.2	6.1	5.5	4.7	4.5	4.3

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 0.60 g Hg/t in 2011. 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 – 2011*

	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Activity data [Gg]	1043	869	786	535	508	426	394	265	258	279
Hg emissions [Mg]	2.8	1.7	0.9	0.5	0.5	0.3	0.2	0.1	0.1	0.2

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, because of the economic crisis, steel production from electric arc has decreased substantially and since 2010 the production has been increasing again.

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 – 2011*

	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Steel production **EAF** [kt]	15,102	16,107	15,879	17,661	19,730	19,922	19,627	14,001	17,115	18,795
Cd emissions **EAF** [Mg]	1.1	1.1	0.8	0.9	1.0	1.0	1.0	0.7	0.9	0.9
Cd emissions **2C1** [Mg]	1.3	1.4	1.1	1.2	1.3	1.3	1.3	0.8	1.1	1.2
Hg emissions **EAF** [Mg]	2.3	2.4	2.4	2.6	3.0	3.0	2.9	2.1	2.6	2.8
Hg emissions **2C1** [Mg]	2.3	2.5	2.4	2.7	3.0	3.0	3.0	2.1	2.6	2.9
Pb emissions **EAF** [Mg]	52.1	55.6	54.8	60.9	68.1	68.7	67.7	48.3	59.0	64.8
Pb emissions **2C1** [Mg]	61.1	65.7	64.1	71.0	78.4	78.8	77.2	53.4	66.5	73.4
PCB emissions **EAF** [kg]	54.4	58.0	57.2	63.6	71.0	71.7	70.7	50.4	61.6	67.7
PCB emissions **2C1** [kg]	91.7	100.0	95.8	105.7	113.8	113.6	110.1	71.5	92.7	103.4
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	83.6
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	83.6

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 2011 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 – 2011*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Pig iron production [Gg]	11,852	11,678	11,209	11,424	11,497	11,111	10,441	5,687	8,555	9,837
Steel production BOF [Gg]	10,365	11,664	10,744	11,688	11,894	11,630	10,963	5,847	8,635	9,940
PAH emissions i.p.* [Mg]	41.9	41.3	39.7	40.6	41.0	39.7	37.3	20.5	30.6	35.1
PAH emissions 2C1 [Mg]	44.4	44.0	42.3	43.7	44.4	43.1	40.5	22.7	33.3	38.1

*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 – 2011*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Activity data - Bread [Gg]	4,153	3,882	3,565	4,109	4,489	4,787	4,516	4,214	4,161	4,440
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	4,270
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	1,341
Activity data – Spirits [10^6 dm^3]	268	232	206	161	180	118	80	127	115	103
NMVOC emissions [Gg]	31.7	29.2	26.8	27.5	29.8	28.6	26.2	26.5	25.9	26.5

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 frameworks 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 for 2010 is reported in Figure 4.1; methodologies are described in the relevant publication (ISPRA, 2009).

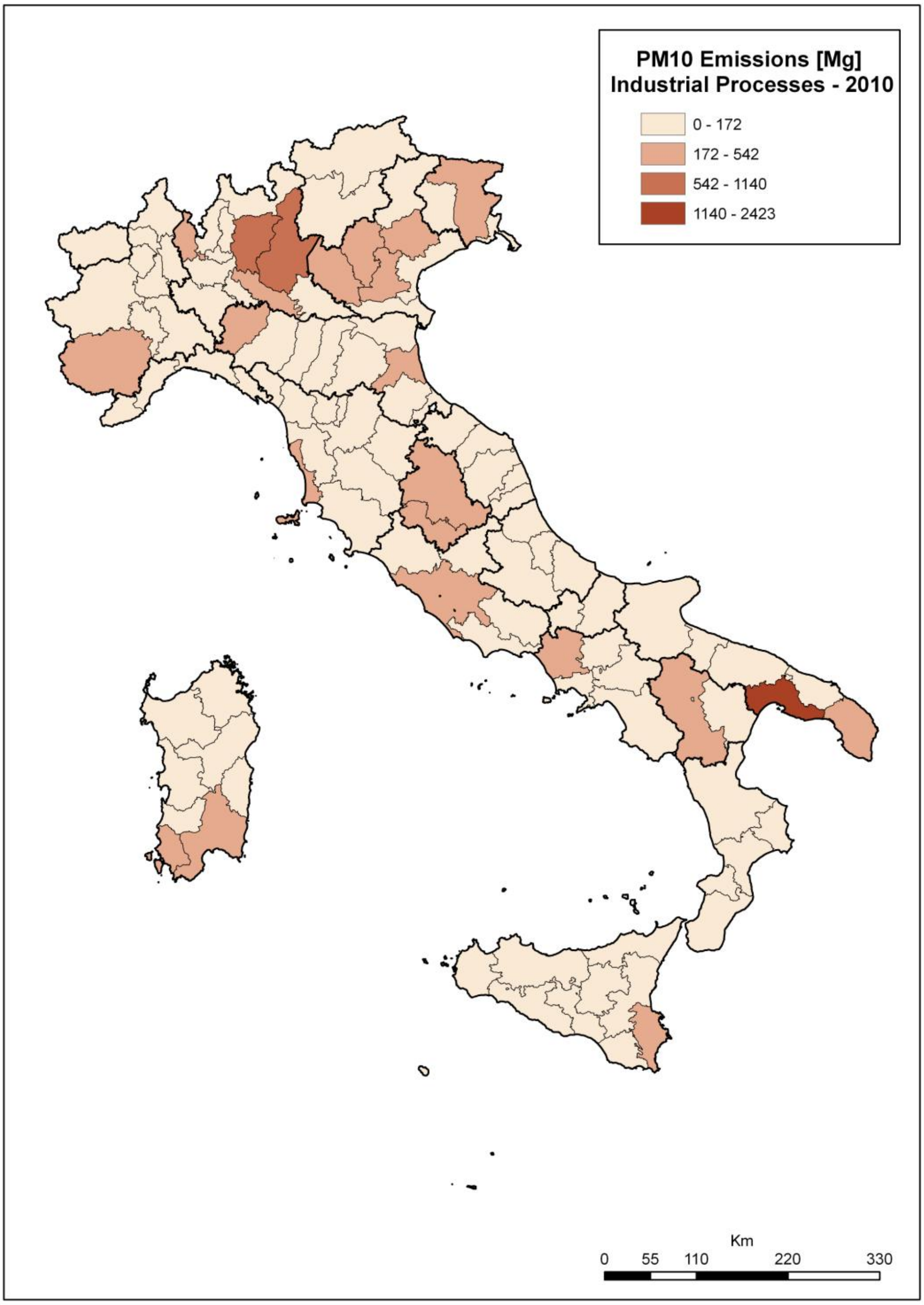

Figure 4.1 *PM10 emissions from industrial processes in 2010 (t)*

4.5 Recalculations

Mineral products (2A)

Soda ash production activity data have been revised from 2007 to 2010 due to an update of the information supplied by the relevant facilities; CO and NH_3 emission factors have been revised for the years 2007 to 2010 without significant changes in the emission values.

Recalculations also occurred for NMVOC emissions from road paving (only for 2010) and from roof covering (for the years 2007 to 2010) because updated activity data were supplied by the sectoral association. Consequently, for NMVOC emissions, recalculations for the mineral industry result in about -0.02% decrease in 2007, -0.03% decrease in 2008 and in 2009 and in a +0.17% increase in 2010.

Chemical industry (2B)

Recalculation for Hg emissions occurred for the years 2007-2010, Hg emission factor and activity data regarding *chlorine production* have been updated on the basis of producers' communication.

Metal production (2C)

No recalculations occurred for these activities in the present submission.

Other production (2D-2G)

No recalculations occurred for these activities in the present submission.

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, printing industry, 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 2011; the same categories were also key categories in 1990. Concerning the trend 1990-2011, 3A1, 3C and 3D2 result as key categories.

The sector accounts, in 2011, for 41% of total national NMVOC emissions, whereas in 1990 the weight out of the total was equal to 31%. Total NMVOC emissions of the sector decreased by 33% between 1990 and 2011.

PM and PAH emissions 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 2011.

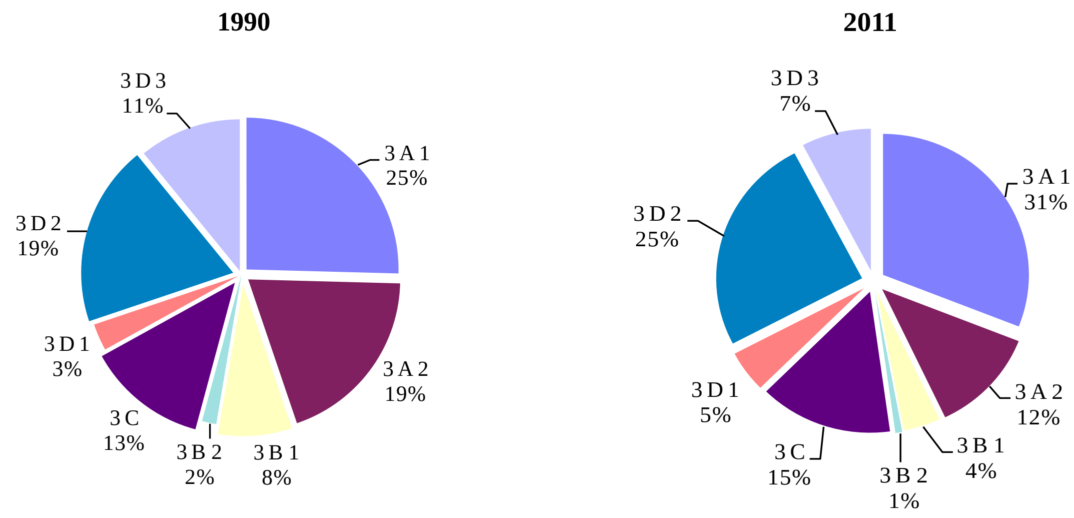

Figure 5.1 *Share of NMVOC emissions for the solvent use sector in 1990 and 2011*

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; EMEP/EEA, 2009). 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 [a] and [b]).

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 the 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. The purpose of this directive is to limit the total content of VOCs in certain paints and varnishes and vehicle refinishing products in order to prevent or reduce air pollution resulting from the contribution of VOCs to the formation of tropospheric ozone. The directive sets maximum VOCs content limit values for some paints and varnishes.

As for emission factors, those for construction and buildings are taken from the EMEP/EEA guidebook and are 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. In particular, the variation of emission factor from 1990 to 2000 is equal to 35%-65% up to 25%-75% in 2000, on the basis of qualitative information supplied by industry on the increase of water based paints products in the market. From 2010, emission factors are 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. The comparison of national emission estimates for this category with those produced by IIASA for 2010 resulted in similar values.

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). Emission factors have been calculated for 1990, 1998 and 2003 on the basis of information provided by the industrial association distinguishing the different type of products which contain different solvent percentages. Data have been supplied also for the years 2005 and 2006. Actually, we are keeping constant the 2006 value unless the association provides us with updated information. For previous years, values have been interpolated.

In this category, emissions from paint application in wood are one of the biggest contributors to national NMVOC emissions and the relevant share has grown considerably 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, to be respected from 2007 till 2009, did not lead to a significant reduction of NMVOC emissions, 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 number of vehicles 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 [a] and [b]). The default emission factor (provided by the EMEP guidebook) used from 1990 to 1995 equal to 700 g/kg paint is also confirmed by the European guidelines for car repairing provided by the Conseil Europeen de l'Industrie des Peintures (CEPE, 1999). The reduction of the emission factor in 1999 (13% of 1995) is applied on the basis of information on different shares between solvent and water based paint throughout the years provided by the national study PINTA (*Piano nazionale di tutela della qualità dell'aria*, ENEA 1997). From 1996 to 1999 the reduction is linear. From 1999 to 2006 the value is kept constant. From 2007 onwards emission factors have been calculated taking into account the 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 [a] and [b]). Emission factors are taken from the EMEP guidebook considering the national legislation where relevant.

Emission factors of the other industrial paint application from 1990 to 1995 are constant and derive from the 1999 EMEP/CORINAIR guidebook. The reduction of the emission factor from 1996 to 2004 is applied on the basis of information on different share of paints throughout the years provided by the national study PINTA. From 2010, the value of the 1999 Guidebook has been chosen considering the further reduction of the sector (in PINTA, the reduction for 2005 with respect to 1995 is equal to 37%, and for 2010 64%. Considering the default emission factor 250 g/kg of paint, the reduction is equal to 53%).

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 (EC, 1999)) 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 (EC, 2004).

Dry cleaning (3B2)

Concerning dry cleaning, activity data, equal to 30,000 machines, remain unchanged throughout the time series and the emission factor is calculated based on the allocation of machines to closed-circuit (CCM) and open-circuit (OCM). Different amounts of solvent are used in these machines and have different emission factors. The emission factors are calculated assuming that in 1990 the closed-circuit machines were 60%, in 1995 represented 90% and in 1999 up to 100%.

The average consumption of solvent per machine is equal to 258 kg/year for CCM and 763 kg/year for OCM, as derived from a national study by ENEA/USL-RMA (ENEA/USL-RMA, 1995). It is assumed that only perchlorethylene is used. These values are multiplied by the emission factors of the Guidebook EMEP, expressed as kg of solvent consumed (equal to 0.4 and 0.8 kg/kg of solvent, for CCM and OCM, respectively) and then the average annual emission factor was calculated based on the percentage distribution of closed and open circuit machines.

Chemical products, manufacture and processing (3C)

The category comprises emissions from the use of chemical products such as polyester, 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 [a] and [b]), whereas emission factors are from the EMEP/CORINAIR guidebook. For what concerns polyurethane, the relevant national industrial association has communicated that the phase out of CFC gases occurred in the second half of nineties and the blowing agent currently used is penthane.

As for polyvinylchloride (PVC), activity data and emission factors are supplied in the framework of the national PRTR. NMVOC emissions are entirely attributed to the phase of PVC production; no use of solvents occurs in the PVC processing. This information has been provided by the relevant industrial plant, EVC Italy, in 2001.

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.

As regard rubber processing, emission factors for the first years of nineties have been provided by the industrial association. The use of the Swedish emission factor from 1997 was justified in lack of other updated data.

For the glues manufacturing category, emission factors for 1990 are derived from the 1992 EMEP/CORINAIR guidebook. The trend of emission factor is estimated on the basis of the trend of the emission factor for consumption of glue (as indicated by the industrial association). From 1995 to 2004, the industrial association communicated data on consumption and solvent content by product. The reductions from 2000 are based on the assumptions of PINTA. From 2004 the emission factor has been assumed constant in lack of updated information. For previous years, values have been interpolated.

As regards leather tanning, emission factor for 1990 is from Legislative Decree 152/2006, equal to the maximum VOC content limit value (150 g/m2). For 2000 and 2003, emission factors have been calculated on the basis of emission figures derived by the national studies on the major leather tanning industries and statistical production.

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.

Emissions from domestic solvent use comprise emissions from the use of products for household and cleaning and for cosmetics which are derived as described in the following.

Activity data

Activity data are expressed as the sum, in tonnes, of household and cleaning products and cosmetics.

Household and cleaning products: data are communicated by the National Association of Detergents and Specialties for industry and home care (Assocasa, several years) either by personal communications or Association Reports and refer to the consumption of soaps and detergents and cleaning and maintenance products.

Cosmetics: data are the sum of cosmetics products in aerosol form and other cosmetics.

Figures of cosmetics in aerosol form are provided by the Italian Aerosol Association (AIA, several years [a] and [b]) and refer to the number of pieces of products sold for personal care (spray deodorants, hair styling foams and other hair care products, shaving foams, and other products). These figures are then converted in tonnes by means of the capacity of the different cosmetics containers.

Figures for other cosmetics products are derived by the Production Statistics Database (Prodcom) supplied by the National Institute of Statistics (ISTAT, several years [a] and [b]) by difference with the previous aerosol data.

Time series of cosmetics production is reconstructed by means of the annual production index, considering the year 2000 as the base year because this is the year where production national statistics and Prodcom data coincide. The next step is the calculation of apparent consumption taking into account import-export data derived by the National Association of Cosmetic Companies (UNIPRO, several years). Since these figures also include aerosol cosmetics, the amount of aerosol cosmetics is subtracted.

Final consumption is therefore estimated.

Emission factors

NMVOC emission factors are expressed in percentage of solvent contained in products.

Household and cleaning products: figures are communicated by the relevant industrial association, ASSOCASA, by personal communications. For leather, shoes, wood etc. and car maintenance products, figures are taken from BiPro Association. For insecticides and disinfestants, emission factors derive from national studies at local level.

Cosmetics: for aerosol cosmetics, the emission factor is communicated by the Italian Aerosol Association for the year 2004, and supposed constant from 1995. For other cosmetics, information from BiPro has been considered (EC report 'Screening study to identify reductions in VOC emissions due to the restrictions in the VOC content of products', year 2002 (EC, 2002)), and supposed constant from 1996.

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 [a] and [b]) 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 2011, for about 41% of total national NMVOC emissions, whereas in 1990 the weight out of the total was equal to 31%. PM and PAH emissions are also estimated in this sector but they account for less than 0.1%.

NMVOC emissions from the sector decreased from 1990 to 2011 of about 32 %, from 604 Gg in 1990 to 406 Gg in 2011, 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 2011, specifically, the reduction of emissions from paint application for domestic use, which dropped by 30% as compared 1990, is due to the implementation of the Italian Legislative Decree 161/2006.

Figure 5.2 shows emission trends from 1991 to 2011 with respect to 1990 by sub-sector.

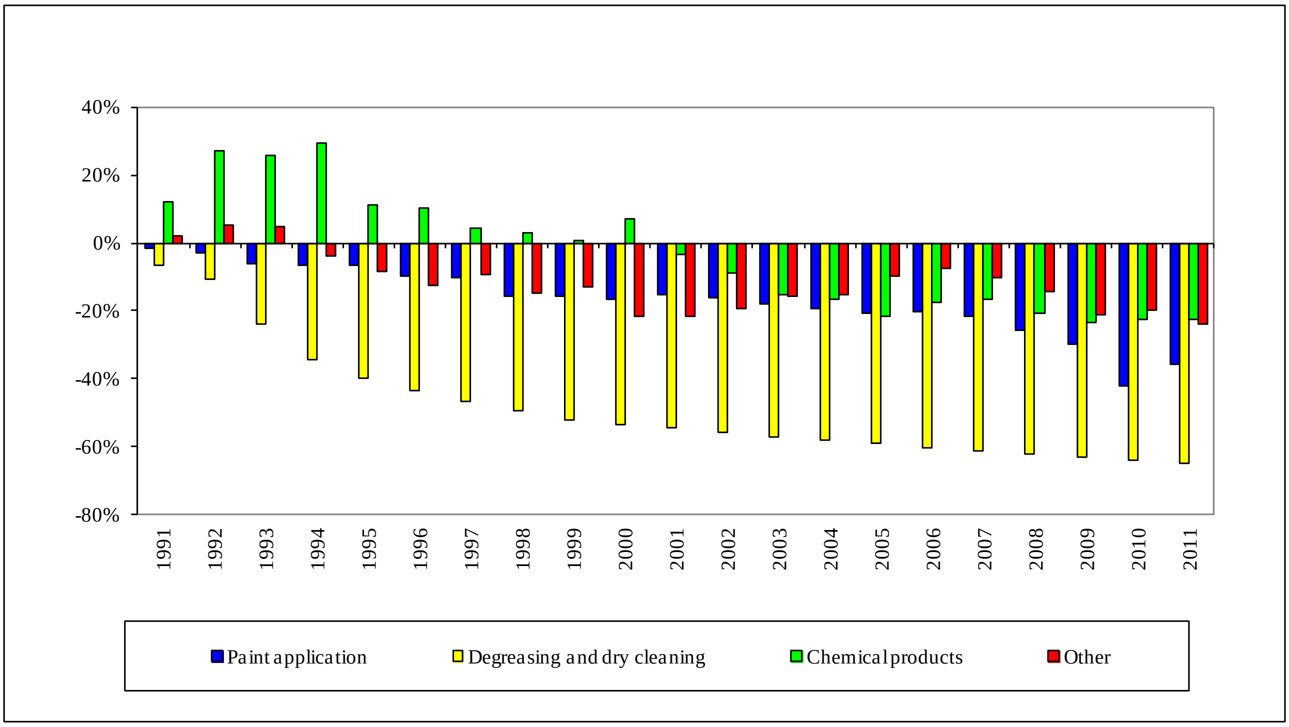

Figure 5.2 *Trend of NMVOC emissions from 1991 to 2011 as compared to 1990*

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 2011*

	3A1	3A2	3B1	3B2	3C	3D1	3D2	3D3
				%				
SO_x								
NO_x								
NH_3								
NMVOC	12.72	4.92	1.69	0.31	6.06	1.96	10.27	3.15
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 wood application and construction and building. 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 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	2011
Paint application											
Paint application : manufacture of automobiles	*vehicles*	2,865,857	2,521,355	2,770,104	1,766,930	1,947,856	2,011,788	1,693,200	1,337,573	1,310,425	1,228,020
Paint application : car repairing	*Mg paint*	22,250	17,850	24,276	23,475	24,422	25,417	23,184	19,320	18,545	17,724
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	168,685
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	420,000
Paint application : coil coating	*Mg paint*	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500
Paint application : boat building	*Mg paint*	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Paint application : wood	*Mg paint*	150,000	150,000	140,000	140,000	145,000	145,000	145,000	123,250	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	125,000
Degreasing, dry cleaning and electronics											
Metal degreasing	*Mg solvents*	52,758	32,775	25,895	22,237	21,569	20,922	20,295	19,686	19,095	18,522
Dry cleaning	*machines*	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Chemical products manufacturing or processing											
Polyester processing	*Mg product*	179,852	197,882	168,704	112,188	118,767	122,985	116,068	78,279	89,638	79,766
Polyvinylchloride processing	*Mg product*	617,600	575,600	405,285	348,497	316,296	318,225	296,993	77,559	0	0
Polyurethane processing	*Mg product*	145,700	230,633	350,187	175,278	201,400	210,148	196,585	196,585	196,585	196,585
Polystyrene foam processing (c)	*Mg product*	85,004	80,400	90,200	35,200	36,900	35,300	32,800	28,100	33,692	41,100
Rubber processing	*Mg product*	671,706	700,859	810,124	831,187	827,947	858,731	789,871	543,319	607,667	623,667
Pharmaceutical products manufacturing	*Mg product*	80,068	88,094	104,468	106,861	111,666	104,041	104,250	108,838	110,183	110,806
Paints manufacturing	*Mg product*	697,129	747,417	900,683	964,631	1,008,765	1,028,580	969,135	887,220	891,882	854,181
Inks manufacturing	*Mg product*	87,527	110,667	132,256	132,521	129,611	140,060	136,224	123,388	133,979	132,521
Glues manufacturing	*Mg product*	111,683	266,169	302,087	331,770	353,114	357,593	335,779	339,152	317,560	327,264
Asphalt blowing	*Mg product*	77,248	70,336	77,408	88,896	90,000	85,000	70,000	65,000	65,000	50,000
Textile finishing	*1000 m2*	1,332,679	1,301,105	1,173,047	987,705	1,024,070	1,044,012	899,727	722,589	831,236	757,241
Leather tanning	*1000 m2*	173,700	183,839	200,115	157,891	169,897	168,697	159,892	173,127	186,824	170,667
Other use of solvents and related activities											
Glass wool enduction	*Mg product*	105,029	119,120	139,421	129,958	153,254	158,264	136,768	68,228	115,923	133,467
Printing industry	*Mg ink*	73,754	91,667	100,690	111,550	111,550	111,550	111,550	111,550	111,550	111,550
Fat, edible and non edible oil extraction	*Mg product*	5,070,398	7,560,387	6,539,796	7,939,548	7,523,011	7,024,894	7,357,431	7,190,236	7,091,130	7,091,130
Application of glues and adhesives	*Mg product*	98,500	234,751	266,996	292,687	311,517	315,468	296,224	299,199	280,150	288,711
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	2,614,274	2,554,657
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	1,765,011

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

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Paint application											
Paint application : manufacture of automobiles	*g/vehicles*	8,676	6,296	4,833	4,065	3,959	3,857	2,782	2,983	2,854	2,817
Paint application : car repairing	*g/Mg paint*	700,000	700,000	605,500	605,500	605,500	520,141	502,999	574,749	497,810	585,176
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	255,000
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	86,400
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	10,000
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	340,000
Paint application : wood	*g/Mg paint*	446,500	425,000	406,300	390,750	377,250	377,250	377,250	377,250	377,250	377,250
Other industrial paint application	*g/Mg paint*	530,000	530,000	439,900	337,583	320,067	302,550	285,033	267,517	250,000	250,000
Degreasing, dry cleaning and electronics											
Metal degreasing	*g/Mg solvents*	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000	900,000
Dry cleaning	*g/machines*	306,000	154,000	103,000	103,000	103,000	103,000	103,000	103,000	103,000	103,000
Chemical products manufacturing or processing											
Polyester processing	*g/Mg product*	325	325	325	325	325	325	325	325	325	325
Polyvinylchloride processing	*g/Mg product*	0	0	0	0	0	0	0	0	0	0
Polyurethane processing	*g/Mg product*	120,000	110,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000
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	60,000
Rubber processing	*g/Mg product*	12,500	10,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Pharmaceutical products manufacturing	*g/Mg product*	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000
Paints manufacturing	*g/Mg product*	15,000	15,000	15,000	13,110	12,722	12,513	12,678	12,918	10,577	12,433
Inks manufacturing	*g/Mg product*	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Glues manufacturing	*g/Mg product*	20,000	5,041	3,603	2,806	2,806	2,806	2,806	2,806	2,806	2,806
Glues manufacturing	*g/Mg product*	544	544	544	544	544	544	544	544	544	544
Textile finishing	*g/1000 m2*	296	296	296	296	296	296	296	296	296	296
Leather tanning	*g/1000 m2*	150,000	150,000	125,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000
Other use of solvents and related activities											
Glass wool enduction	*g/Mg product*	800	800	800	800	800	800	800	800	800	800
Printing industry	*g/Mg ink*	234,649	228,190	184,332	174,227	174,227	174,227	174,227	174,227	174,227	174,227
Fat, edible and non edible oil extraction	*g/Mg product*	790	704	706	691	698	695	692	697	700	700
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	84,190
Domestic solvent use (other than paint application)(k)	*g/Mg product*	60,117	52,262	42,356	46,153	46,896	46,184	43,881	40,437	42,172	39,760
Vehicles dewaxing	*g/vehicles*	1,000	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.

Additional verifications of the emissions from the sector occurred last year, on account of the bilateral independent review between Italy and Spain and the revision of national estimates and projections in the context of the National emission ceilings Directive for the EU Member States and the Gothenburg Protocol of the Convention on Long-Range Transboundary Air Pollution (CLRTAP).

In the case of the bilateral review, national emissions from the solvent sector were revised by the Spanish team in October 2012.The analysis by category has not highlighted the need of major methodological revisions of the sector; an additional source of emissions has been added affecting only NMVOC emissions. A change of NMVOC emission factors for the last years in two chemical categories was the result of the other review process.

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 for 2010 is reported in Figure 5.3; methodologies are described in the relevant publication (ISPRA, 2009).

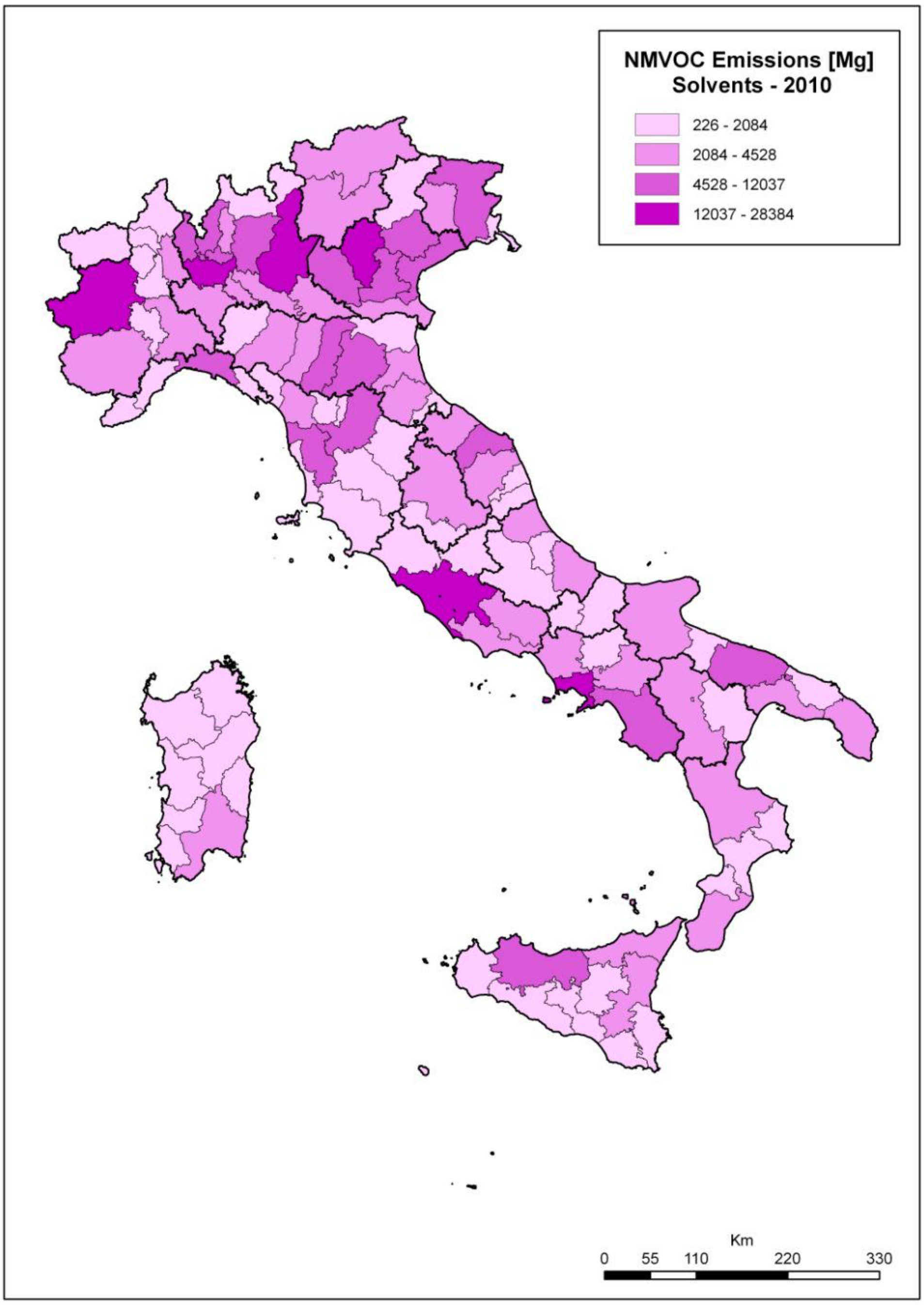

Figure 5.3 *NMVOC emissions from solvent and other product use in 2010 (t)*

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 modification involved the chemical products subsector with respect to NMVOC emissions, due to the update of emission factors for polyurethane processing. On the basis of the industrial association communication, the phase out of CFC gases occurred in the second half of nineties and the blowing agent currently used is penthane, which resulted in a strong reduction of emissions. In the same subsector, NMVOC emissions from asphalt bowling have been added for the whole time series. Recalculations are also observed in paint application, for NMVOC, due to the update of emission factors in paint application in wood from 2005 to 2010 and for car repairing in 2010. Minor recalculations occurred in other use of solvents, considering an updating of the activity data in fat, edible and non edible oil extraction and application of glues and adhesives for the whole time series.

Table 5.4 *Recalculations of NMVOC emissions between 2013 and 2012 submissions*

	NMVOC		
	3A. Paint application	3D. Other	3C. Chemical products
1990	-0.05%		0.05%
1991	-0.04%	0.07%	0.04%
1992	-0.04%	0.20%	0.04%
1993	-0.04%	-0.10%	0.04%
1994	-0.04%	-0.17%	0.04%
1995	-0.04%	0.05%	-2.57%
1996	-0.03%	-0.13%	-5.11%
1997	-0.06%	-0.26%	-7.87%
1998	-0.02%	-0.18%	-11.07%
1999	-0.03%	-0.07%	-14.32%
2000	-0.03%	-0.18%	-20.23%
2001	-0.02%	-0.65%	-17.03%
2002	-0.01%	-0.76%	-17.71%
2003		-0.95%	-17.89%
2004	-1.20%	-1.56%	-19.65%
2005	-0.68%	-0.02%	-16.84%
2006	-0.75%	1.49%	-18.22%
2007	0.06%	1.61%	-18.91%
2008	0.53%	0.86%	-18.60%
2009	1.69%	1.01%	-19.34%
2010	4.00%	-0.05%	-22.34%

5.6 Planned improvements

Specific developments 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 April 2013.

In 2011, key categories level were identified for NH_3 (4B1a, 4B1b, 4B2, 4B8, 4B9b, 4D1a), and for PM10 (4B9b) and for HCB (4G) emissions. In 1990 similar figures were obtained, however, for NH_3 emissions, 4B2 and 4B9b were not key categories. For the trend analysis, key categories were related to NH_3 emissions (4B1a, 4B1b, 4B2, 4B8, 4B9b, 4D1a), PM10 (4B9b) and HCB (4G).

In 2011, NH_3 emissions from the agriculture sector were 362 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 2011 shows a 21% 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 2011 is shown in Figure 6.1.

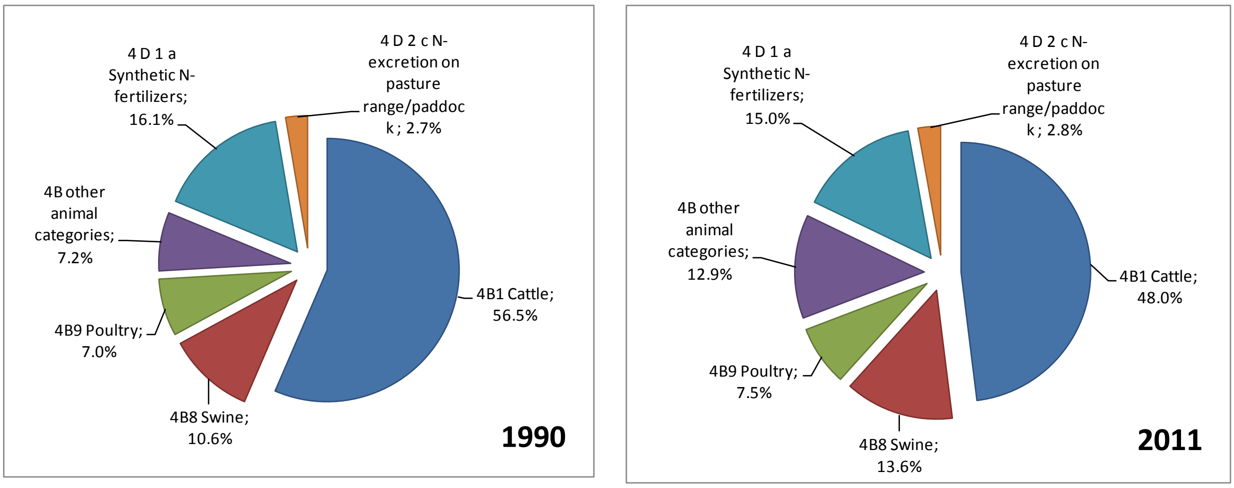

Figure 6.1 *Share of NH_3 emissions in the agriculture sector for 1990 and 2011*

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 the latest information available.

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

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

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
2011	1,754,981	4,142,544	354,402	7,942,641	959,915	373,327	50,966	7,602,093	18,467,042	200,718,160	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**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Ammonium sulphate	10%	50,762	61,059	36,698	27,855	30170.3	35,039	28,431	23,803	32,568	27,418
Calcium cyanamide	2%	3,310	507	3,003	2,357	2454.9	2,847	3,595	3,864	4,958	4,675
Nitrate (*)	2%	157,221	189,907	164,134	167,872	156,957	153,526	135,710	78,859	72,833	72,334
Urea	15%	291,581	321,196	329,496	317,814	338026.9	336,686	312,427	232,815	209,829	219,033
Other nitric nitrogen	2%	-	-	3,204	5,219	4882	3,749	3,952	3,671	3,332	3,479
Other ammoniacal nitrogen	2%	-	-	6,278	18,069	17497.2	17,063	15,620	13,018	12,412	12,993
Other amidic nitrogenous	15%	-	-	6,988	17,420	17037.8	19,470	20,634	16,101	15,366	17,663
Phosphate nitrogen	5%	112,237	99,468	77,916	69,758	70718.9	55,674	29,702	47,397	45,837	47,272
Potassium nitrogen	2%	3,937	2,876	5,291	12,289	13336.2	18,047	16,887	17,369	15,955	17,758
NPK nitrogen	2%	138,018	101,528	113,897	106,384	99965.3	83,694	63,712	56,191	64,462	65,444
Organic mineral	2%	444	20,960	38,688	34,809	34218.3	39,695	29,254	25,691	19,085	27,897
TOTAL		**757,509**	**797,500**	**785,593**	**779,846**	**785,265**	**765,490**	**659,922**	**518,778**	**496,637**	**515,966**

(*) includes ammonium 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 still 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; actually considering the default NO_X emission factors available on the Guidebook rough estimation of emissions lead to an amount considerably not comparable with the information collected at local level based also on air quality measurements. 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 emissions 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, 2013[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 2011*

Category	Weight *kg*	Housing	Grazing	TOTAL
		kg head^{-1} yr^{-1}		
Non-dairy cattle	378	48.18	1.27	**49.46**
Dairy cattle	603	110.20	5.80	**116.00**
Buffalo	525	92.05	2.75	**94.80**
Other swine (*)	85	12.92		**12.92**
Sow (*)	172	28.44		**28.44**
Sheep	48	1.62	14.58	**16.20**
Goats	47	1.62	14.58	**16.20**
Horses	520	20.00	30.00	**50.00**
Mules and asses	300	20.00	30.00	**50.00**
Poultry	1.7	0.52		**0.52**
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 2011*

Category	Housing	Storage	Land spreading	TOTAL
		kg NH_3 $head^{-1}$ yr^{-1}		
Non-dairy cattle	6.76	9.09	5.54	**21.39**
Dairy cattle	15.46	20.36	12.65	**48.47**
Buffalo	12.91	17.01	12.57	**42.49**
Other swine (*)	2.38	2.08	1.39	**5.86**
Sow (*)	4.87	4.64	3.10	**12.62**
Sheep	0.22		0.46	**0.68**
Goats	0.22		0.46	**0.68**
Horses	3.24		2.75	**5.99**
Mules and asses	3.24		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		0.34	**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 are 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, 2013[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 and 2011 and trend assessment. 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 3 kg in 2011 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 2011 the sector accounts for:

- 95% of national total NH_3 emissions;
- 21% of national total HCB emissions
- 12% of national total PM10 emissions; and
- 5% of national total PM2.5 emissions.

Moreover, the sector comprises 0.5% 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 2011, 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 13%, respectively. *Direct soil emissions (4D)*, specifically for the use of synthetic N-fertilisers (4D1a) represent 14% in 2011 of NH_3 emissions (16% in 1990).

Regarding PM10 emissions, the category *manure management (4B*) accounts for 10.6% in 2011 (6.6% 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 2.8% in 2011 (1.9% 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 2011*

	4B1a	4B1b	4B2	4B3	4B4	4B6	4B7	4B8	4B9a	4B9b	4B9d	4B13	4D1a	4D2c	4F	4G
								%								
SO_x																
NO_x															0.05	
NH_3	22.2	23.2	3.9	1.4	0.2	0.6	0.1	12.9	2.6	4.5	3.3	2.7	14.2	2.7		
NMVOC	0.01	0.03	0.002	0.004	0.0005	0.001	0.0002	0.02							0.1	
CO															0.5	
PM10	0.7	0.8	0.1	-	-	0.06	0.01	2.4	0.7	5.9					1.5	
PM2.5	0.5	0.7	0.1	-	-	0.05	0.007	0.5	0.1	0.9					1.8	
Pb																
Cd																
Hg																
PAH																
Dioxin																
HCB																20.7
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	2005	2006	2007	2008	2009	2010	2011
4 B 1 a Cattle Dairy	139	106	102	89	88	89	89	91	85	85
4 B 1 b Cattle Non-Dairy	119	117	110	95	90	96	94	92	88	89
4 B 2 Buffalo	4	6	8	9	10	12	13	14	16	15
4 B 3 Sheep	6	7	7	5	6	6	6	5	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	49	49	49	49	49	49	49
4 B 9 a Laying Hens	17	15	12	10	10	10	10	10	10	10
4 B 9 b Broilers	15	16	15	15	14	15	16	17	17	17
4 B 9 c Turkeys	-	-	-	-	-	-	-	-	-	-
4 B 9 d Other Poultry	11	14	13	13	13	13	14	13	13	13
4 B 13 Other (*)	9	10	10	12	11	12	11	10	10	10
4 D 1 a Synthetic N-fertilizers	73	80	79	77	81	80	72	56	52	54
4 D 2 c N-excretion on pasture range/paddock	12	13	13	10	10	10	10	10	10	10
TOTAL	**457**	**432**	**417**	**387**	**384**	**395**	**386**	**371**	**358**	**362**

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 2011total 4B NH_3 emissions have reduced by 20%. Cattle livestock decreased by 24% (from 7,752,152 to 5,897,525 heads). Dairy cattle and non-dairy cattle have decreased by 34% and 19%, 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 2011 by 9% and 16%, 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 1990-2011 emissions have reduced by 25% while the use of N-fertilizers by 32%. Between 2007/2008 and 2008/2009 N fertiliser distribution has decreased by 14% and 21%, respectively (see Table 6.2), while in 2010 and 2011 it remains on the 2009 levels. 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 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, 2013[d]; ISPRA, 2013[e]). The disaggregation of 2010 agricultural emissions has also been finalised and figures are available at the following web site: http://www.sinanet.isprambiente.it/it/inventaria/disaggregazione_prov2005/disagreggazione%202010/view. The disaggregation (NUTS3) of the NH_3 agricultural emissions is shown in Figure 6.2. In 2010, four regions contributed with more than 60% of agricultural NH_3 emissions: Lombardia, Veneto, Emilia Romagna and Piemonte.

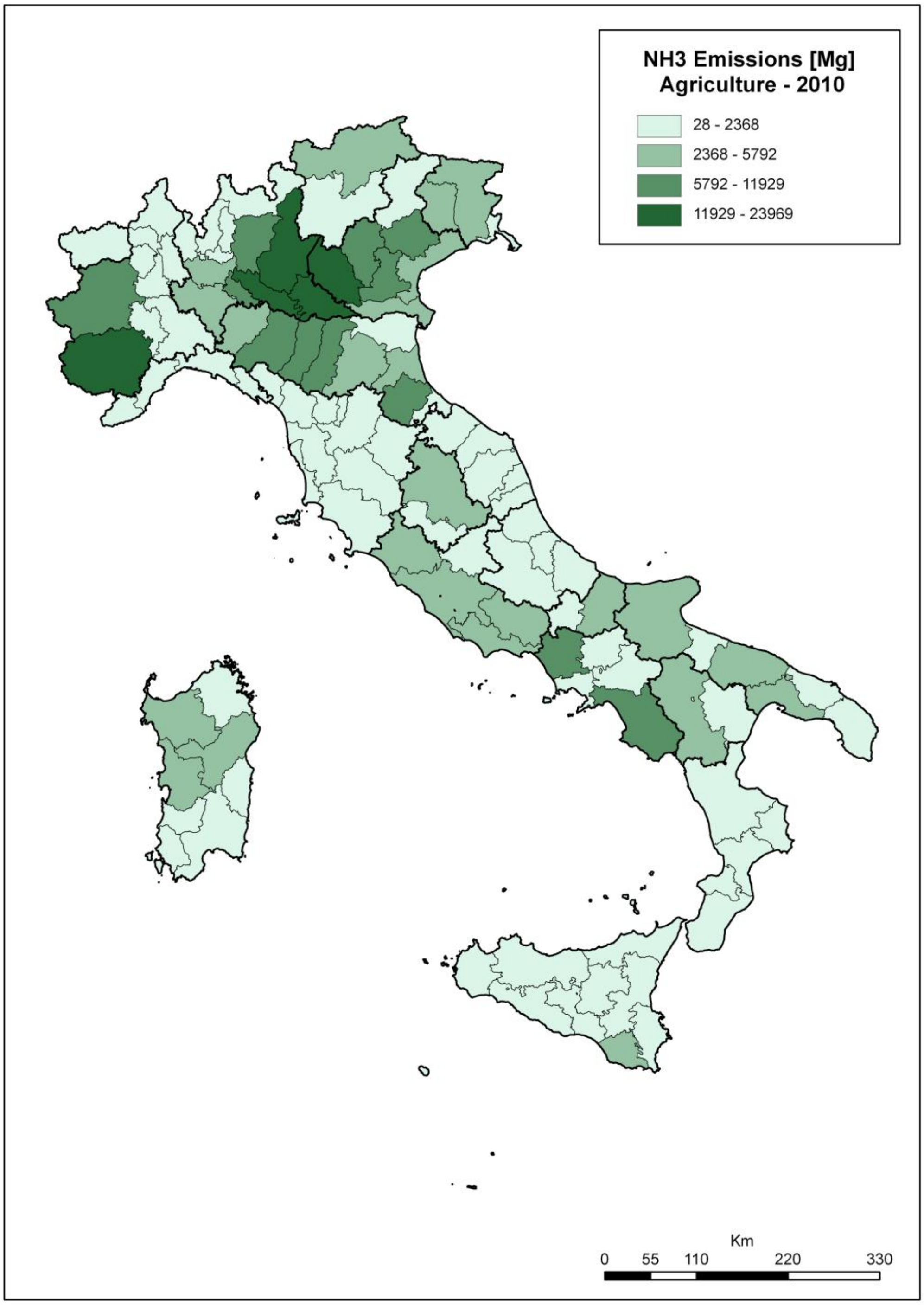

Figure 6.2 *NH_3 emissions from Agriculture in 2010 (t)*

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, 2013[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 2013, recalculations were implemented for the agricultural emission inventory. Fraction burned in rice fields from 1996 has been updated (from 0.5 to 0.6) on the basis of information received by the producer's association resulting in an increase of PM10, PM2.5, NO_X and NMVOC emissions of field burning of agriculture residual category. HCB emissions from the use of pesticides have been updated for 2009 and 2010 as a consequence of the update of activity data and resulted in the increase of HCB emissions for those years. Minor recalculation, for the whole time series, regarded non dairy cattle and buffaloes PM10 and PM2.5 emissions (4B1b and 4B2 category respectively) due to the update of the average weights used for the calculation of emission factors and sows NH3 emissions from 1998 due to the update of N-NH3 average storage and recovery emission factors; all these recalculations resulted in update less than 1% of the relevant categories.

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, 2013[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 in the next months. Information such as animal grazing period, animal housing, storage systems characteristics, and the use of manure/slurry for land application have been 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 03 09 02 05 09 02 08	Incineration of industrial wastes Flaring in oil refinery 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 2011, *small scale open burning* (6Ce) is a key category for what concerns PAH; *industrial waste incineration* (6Cb), due to waste water sludge incineration, is key category for HCB emissions.

In 1990, *industrial waste incineration* (6Cb) is key category for dioxins and HCB emissions whereas *municipal waste incineration* (6Cc) is key category for dioxins.

As regard the trend, *small scale open burning* (6Ce) is a key category for what concerns 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 source of different pollutants; for the main pollutants, in 2011, the sector accounts for:

- 29.6% in national total HCB emissions;
- 7.8% in national total PAH emissions.
- 3.4% in national total Dioxin emissions;

Moreover, the sector comprises 1.5% of total PM10 and PM2.5 emissions, 1.99% of CO, 2.3% of NH_3, 1.22% of NMVOC, and for what concerns priority heavy metals 1.48% of Cd, 1.22% of Hg and 1.11% 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, 2013 [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 is assumed that landfill gas composition is 50% VOC. The percentage by weight of CH4 compared to the total VOC emitted is 98.7%. The remaining 1.3% (NMVOC) consists of paraffinic, aromatic and halogenated hydrocarbons (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 VOC 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 (included in VOC, 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 lifecycle 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 2011, the non hazardous landfills in Italy disposed 15,644 kt of MSW and 3,469 kt of industrial wastes, as well as 318 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	2011
MSW production	22,231	25,780	28,959	31,664	32,511	32,542	32,467	32,110	32,479	32,731
MSW disposed in landfills for non hazardous waste	17,432	22,459	21,917	17,226	17,526	16,912	16,069	15,538	15,015	15,644
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	3,508	3,469
Sludge disposed in managed landfills for non hazardous waste	2,454	1,531	1,326	544	525	407	364	335	331	318
Total Waste to managed landfills for non hazardous waste	16,363	21,897	26,069	20,684	20,532	20,095	20,136	19,054	18,855	19,432
Total Waste to unmanaged landfills for non hazardous waste	6,351	5,071	0	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	19,054	18,855	19,432

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 2011, about 97% 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.

Since 2010, emission factors for urban waste incinerators have been updated on the basis of data provided by plants (ENEA-federAmbiente, 2012; De Stefanis P., 2012) concerning the annual stack flow, the amount of waste burned and the average concentrations of the pollutants at the stack.

Table 7.3 *Emission factors for waste incineration*

Air Pollutant	u.m	Municipal 1990-2009	Municipal Since 2010	Industrial	Clinical	Sludge	Oil
NO_x	*kg/t*	1.15	0.62	2	0.603624	3	2
CO	*kg/t*	0.07	0.07	0.56	0.07542	0.6	0.07542
NMVOC	*kg/t*	0.46046	0.46046	7.4	7.4	0.25116	7.4
SO_2	*kg/t*	0.39	0.02	1.28	0.02594	1.28	1.28
PM10	*g/t*	46	6.06	240	25.676	180	240
PM2.5	*g/t*	46	6.06	240	25.676	180	240
As	*g/t*	0.05	0.02	0.12	0.0042	0.5	0.12
Cu	*g/t*	1	0.001	1.2	0.564	10	1.2
Se	*g/t*	0.013	0.013	0.006	0.03736	-	0.006
Zn	*g/t*	0.017	0.017	12.6	-	10	12.6
Cd	*g/t*	0.25	0.01	0.8	0.001128	1.2	0.8
Cr	*g/t*	0.45	0.002	1.6	0.01168	3	1.6
Hg	*g/t*	0.15	0.033	0.8	0.03684	1.2	0.8
Ni	*g/t*	16.35	0.001	0.8	0.02504	3	0.8
Pb	*g/t*	1.35	1.04	24	0.0246	3	24
PAH	*g/t*	0.05	0.00054	0.48	0.00014126	0.6	0.48
PCB	*g/t*	0.005	0.00005	0.005	0.02	0.005	-
HCB	*g/t*	0.001	0.00002	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) and, since 2010 urban waste data, thanks to the abovementioned survey (ENEA-federAmbiente, 2012). 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 2011.

Table 7.4 *Dioxin emission factors for 1990 and 2011*

Waste Typology	u.m	1990	2011
Municipal	μg/t	115 - 1.6	0.1
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	2007	2008	2009	2010	2011
						Gg				
Total waste	1,656.2	2,149.1	3,061.7	4,964.2	5,066.4	6,010.7	6,065.1	6,387.5	6,974.6	7,382.9
with energy recovery	911.2	1,557.8	2,751.9	4,721.4	4,824.2	5,791.1	5,855.9	6,157.5	6,741.8	7,136.5
without energy recovery	745.0	591.3	309.8	242.8	242.2	219.6	209.2	230.0	232.8	246.4
Clinical waste (6Ca)	134.5	151.7	110.3	126.2	145.3	131.9	139.7	161.6	127.6	135.1
with energy recovery	25.3	41.1	76.7	105.7	119.0	104.1	106.1	107.6	73.7	78.0
without energy recovery	109.2	110.6	33.6	20.5	26.3	27.8	33.6	54.0	53.9	57.1
Industrial waste (6Cb)	496.1	560.7	626.5	1,618.1	1,651.7	2,571.4	2,544.3	2,363.2	2,478.1	2,623.1
with energy recovery	259.5	331.2	513.8	1,447.8	1,458.7	2,407.9	2,393.0	2,216.4	2,354.9	2,492.8
without energy recovery	236.6	229.6	112.6	170.4	193.0	163.5	151.2	146.8	123.2	130.4
Municipal waste (6Cc)	1,025.6	1,436.6	2,324.9	3,219.9	3,269.3	3,307.4	3,381.1	3,862.7	4,368.9	4,624.6
with energy recovery	626.4	1,185.5	2,161.4	3,168.0	3,246.5	3,279.1	3,356.8	3,833.5	4,313.2	4,565.7
without energy recovery	399.2	251.1	163.5	51.9	22.8	28.3	24.4	29.2	55.7	59.0

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, 2012), 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 87,871 in 2011. Moreover, it is practice to cremate also mortal remains: activity data have been supplied too by SEFIT, from 1999, whereas mortal remains from 1990 to 1998 have been reconstructed on the basis of an expert judgment (SEFIT, 2011).

In Table 7.6 time series of number of cremations, mortal remains, 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	2011
Cremations	5,809	15,436	30,167	48,196	53,013	58,554	63,611	71,898	77,379	87,871
Deaths	543,700	555,203	560,241	567,304	557,892	570,801	585,126	591,663	587,488	593,404
Mortal remains	1,000	1,750	1,779	9,880	10,101	12,824	15,165	15,819	18,899	23,353
% of cremation	1.07	2.78	5.38	8.50	9.50	10.26	10.87	12.15	13.17	14.81
Crematoria	ND	31	35	43	44	45	45	50	53	56

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 PAH (see Table 7.11). Moreover, Dioxins, TSP, PM10, PM2.5, CO, 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 (cereal, green crop, permanent cultivation) taking into account the amount of crop produced, from national statistics (ISTAT, several years [a], [b]; ISTAT, 2012 [a], [b]), the ratio of removable residue in the crop, the dry matter content of removable residue, the ratio of removable residue burned, the fraction of residues oxidised in burning, the carbon and nitrogen content of the residues. Most of these wastes refer especially to the prunes of olives and wine, because of the typical national cultivation. Activity data (agricultural production) used for estimating burning of agriculture residues are reported in Table 7.9. Emissions due to stubble burning, which are emissions only from the agriculture residues burned on field, are reported in the agriculture sector, under 4.F. Under the waste sector the burning of removable agriculture residues that are collected and could be managed in different ways (disposed in landfills, used to produce compost or used to produce energy) is reported. Different percentages of the removable agriculture residue burnt for different residues are assumed, varying from 10% to 90%, according to national and international literature. Moreover, these removable wastes are assumed to be all burned in open air (e.g. on field), taking in consideration the highest available CO, NMVOC, PM, PAH and dioxins emission factors as reported in the table above. The amount of biomass from pruning used for domestic heating is reported in the energy sector in the 1A4b category as biomass fuel.

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

Production	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
						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	6,849.9	6,641.8
Rye	20.8	19.8	10.3	7.9	8.6	9.0	10.8	12.2	13.9	14.4
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	950.9
Oats	298.4	301.3	317.9	429.2	394.9	361.1	356.1	314.4	288.9	297.1
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	1,555.9
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	9,752.4
Sorghum	114.2	214.8	215.2	184.9	221.4	193.2	224.6	243.4	275.6	299.9
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	7,054.7
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	3,168.3
Citrus Orchards	2,868.8	2,607.7	3,100.2	3,518.1	3,653.7	3,892.6	3,484.3	3,825.9	3,820.6	3,434.8
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	6,289.3
Carobs	29.2	44.4	38.1	31.7	26.1	32.8	31.2	30.0	25.3	44.7
Total	***35,441.0***	***39,474.0***	***41,384.5***	***43,340.0***	***41,600.5***	***40,831.2***	***42,401.5***	***39,120.5***	***39,012.0***	***39,504.2***

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 2011 (from 363,319 tons to 8,857,122 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, 2013 [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-NH_3+NO_X emissions is 20% (IPCC, 1997), whereas 16% is emitted as N-NH_3 and 4% as N-NO_X.

Table 7.10 *Sludge spreading activity data and parameters, 1990 – 2011*

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	5.2	5,071
1991	3,428,000	411,360	102,840	5.2	5,313
1992	3,155,825	378,699	94,675	5.2	4,891
1993	2,883,649	360,155	90,039	5.2	4,652
1994	2,660,337	510,022	127,505	5.2	6,587
1995	2,437,024	630,046	157,512	5.2	8,137
1996	2,563,404	698,019	174,505	5.2	9,015
1997	2,843,644	870,987	217,747	5.2	11,249
1998	3,532,924	777,256	194,314	5.3	10,292
1999	3,598,156	860,095	215,024	5.2	11,104
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	1,145,852	286,463	3.9	11,241
2011	3,716,578	1,185,811	296,453	4.0	11,858

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 2011. 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

In addition, dioxins emissions from municipal and industrial waste are key categories at trend assessment. In particular, from 1990 dioxins emissions from waste incineration have decreased by nearly 90% as a consequence of the introduction of more stringent limits of these emissions for incineration plants (Figure 7.2 and Figure 7.5).

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 2011 (Figure 7.1, Figure 7.2, Figure 7.3 and Figure 7.4).

It is important to point out that the waste incineration sector is the major source of HCB emissions (30% of the national total), in particular the waste water sludge incineration, 3.12 Kg in 2011, which shows a decrease of 67.2% 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.

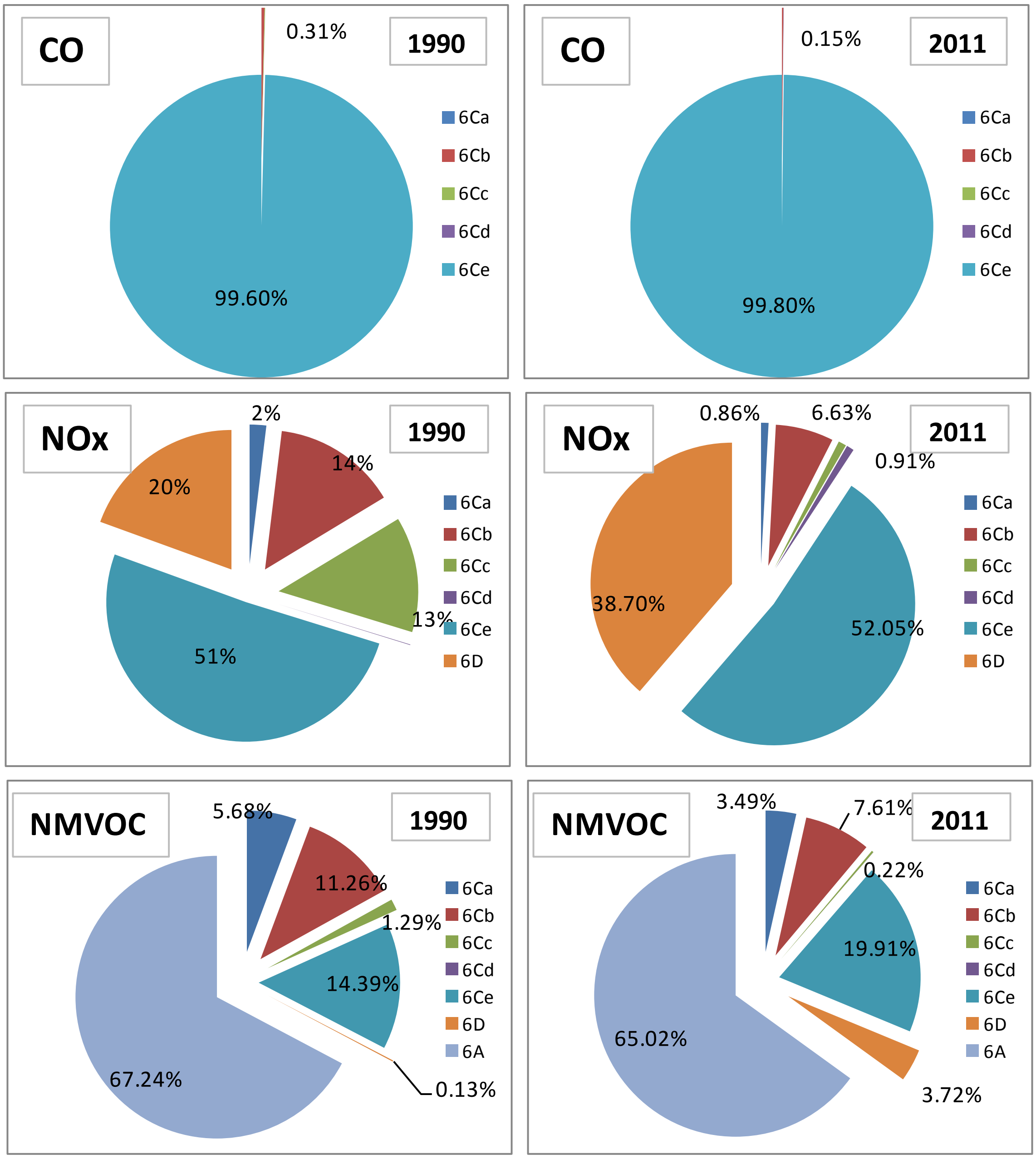

Figure 7.1 *Contribution of CO, NO_X and NMVOC sub-category emissions to waste sector total emissions*

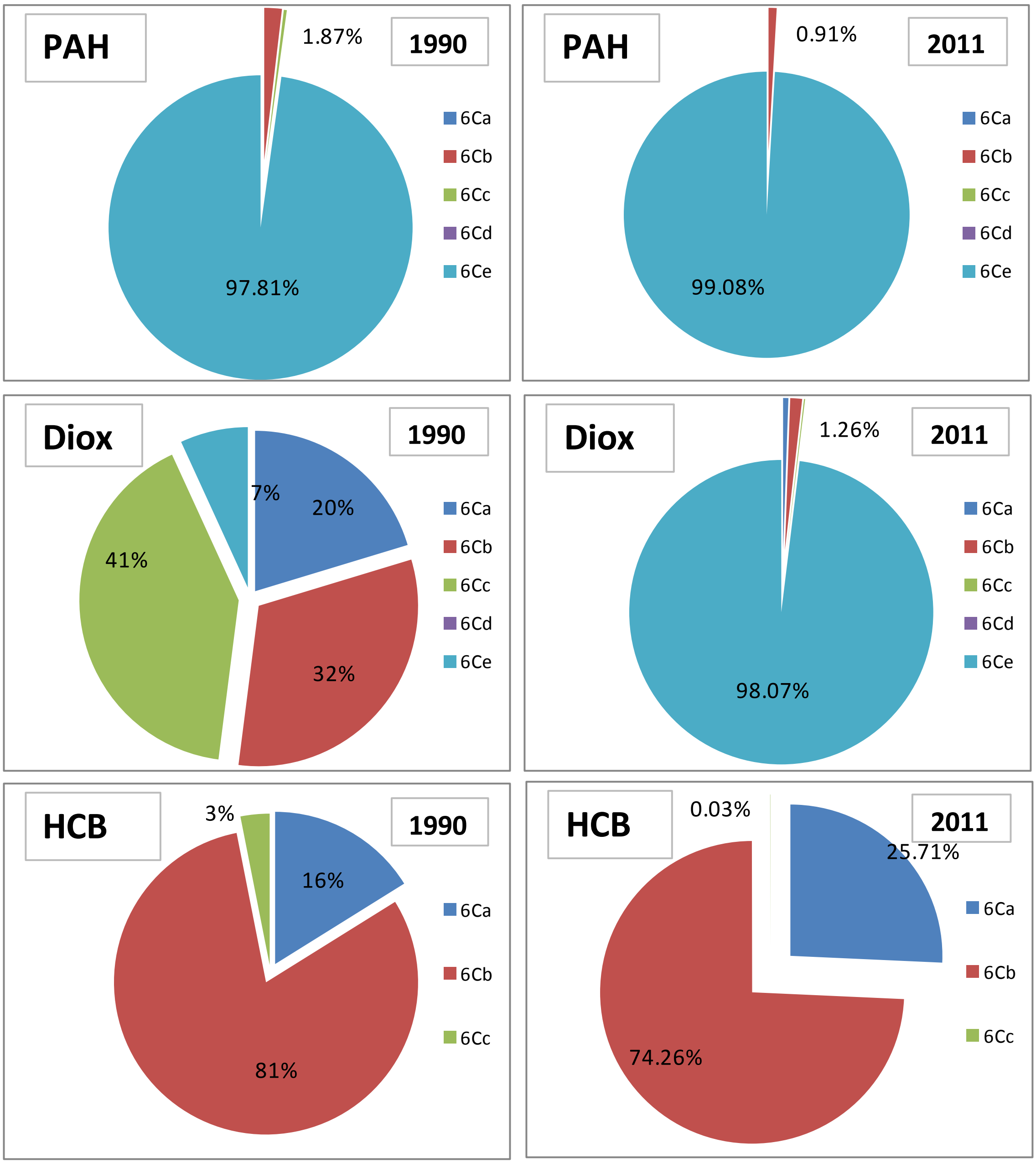

Figure 7.2 *Contribution of POPs Annex III sub-category emissions to waste sector total emissions*

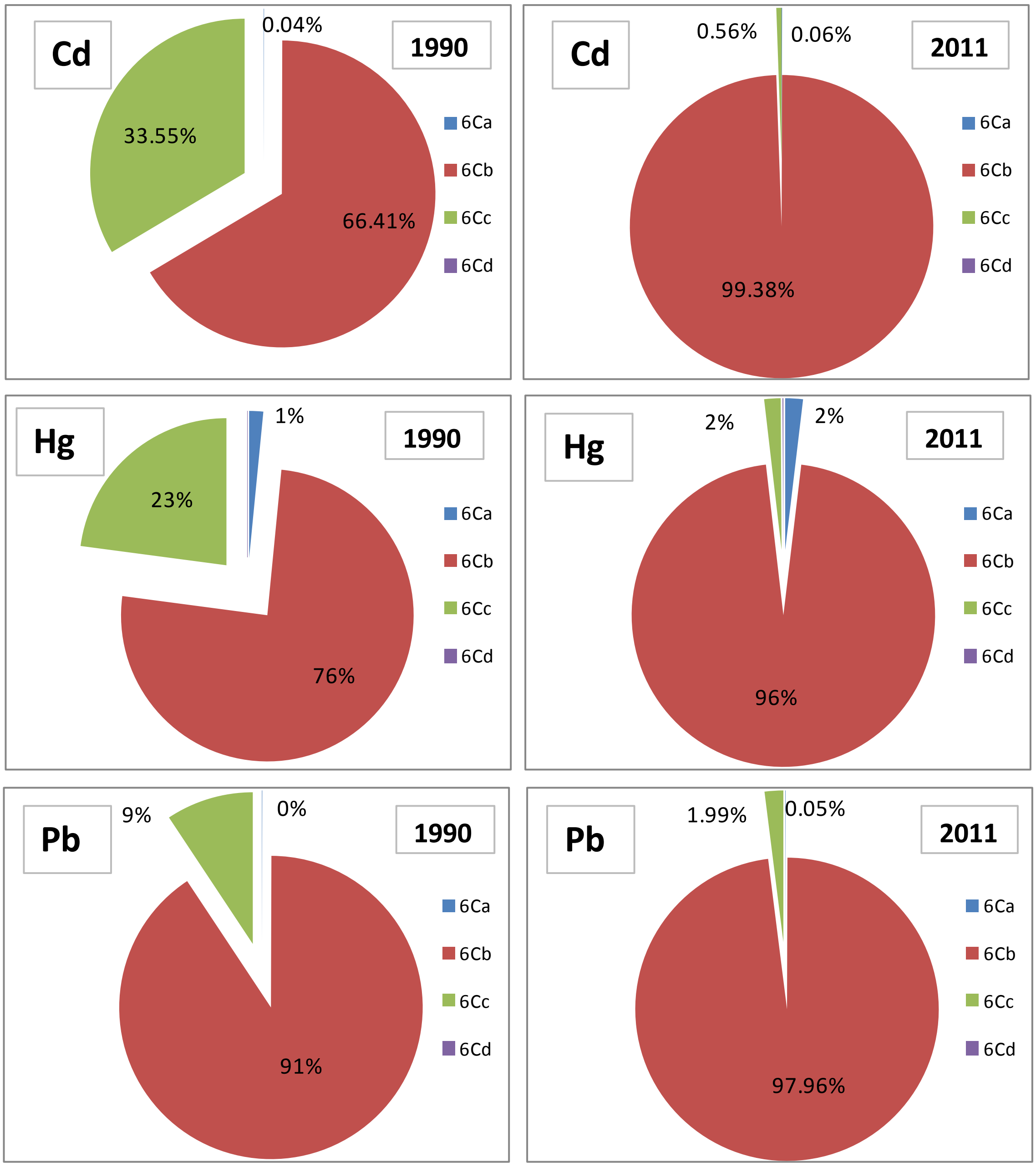

Figure 7.3 *Contribution of priority heavy metals sub-category emissions to waste sector total emissions*

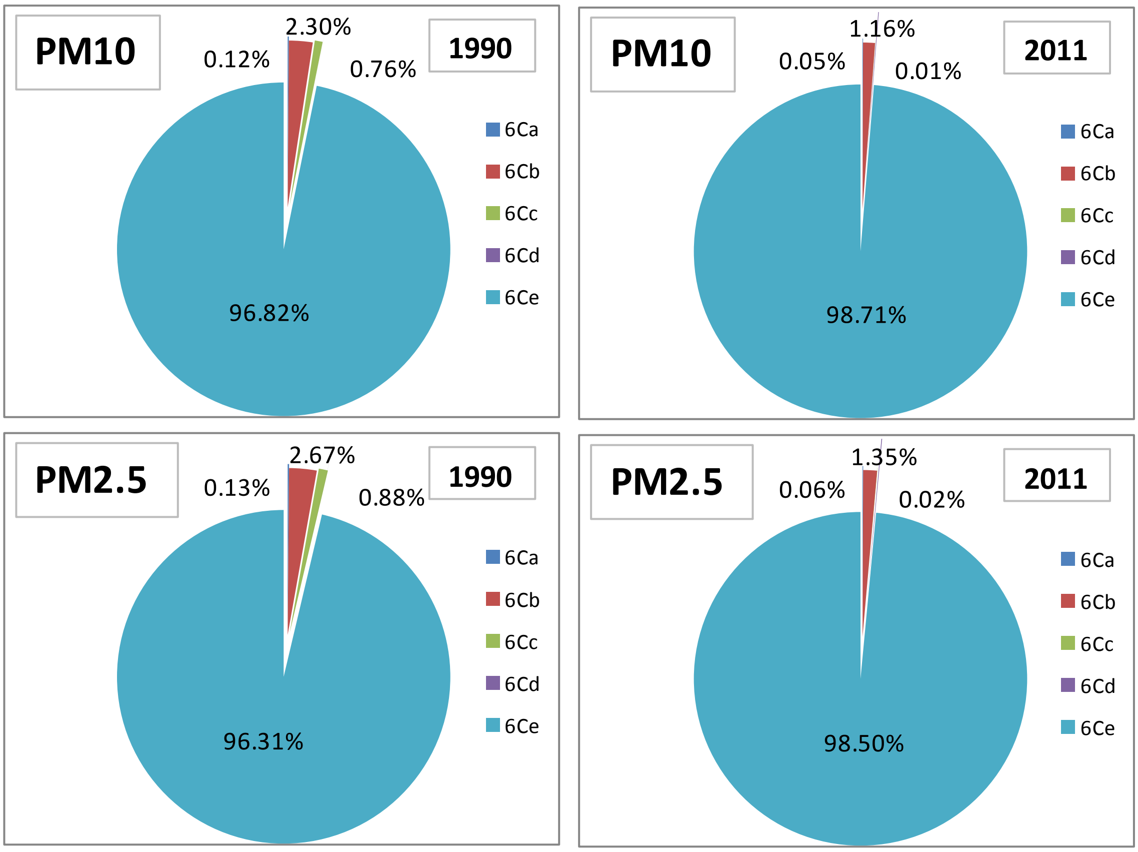

Figure 7.4 *Contribution of PM10 and PM2.5 sub-category emissions to waste sector total emissions*

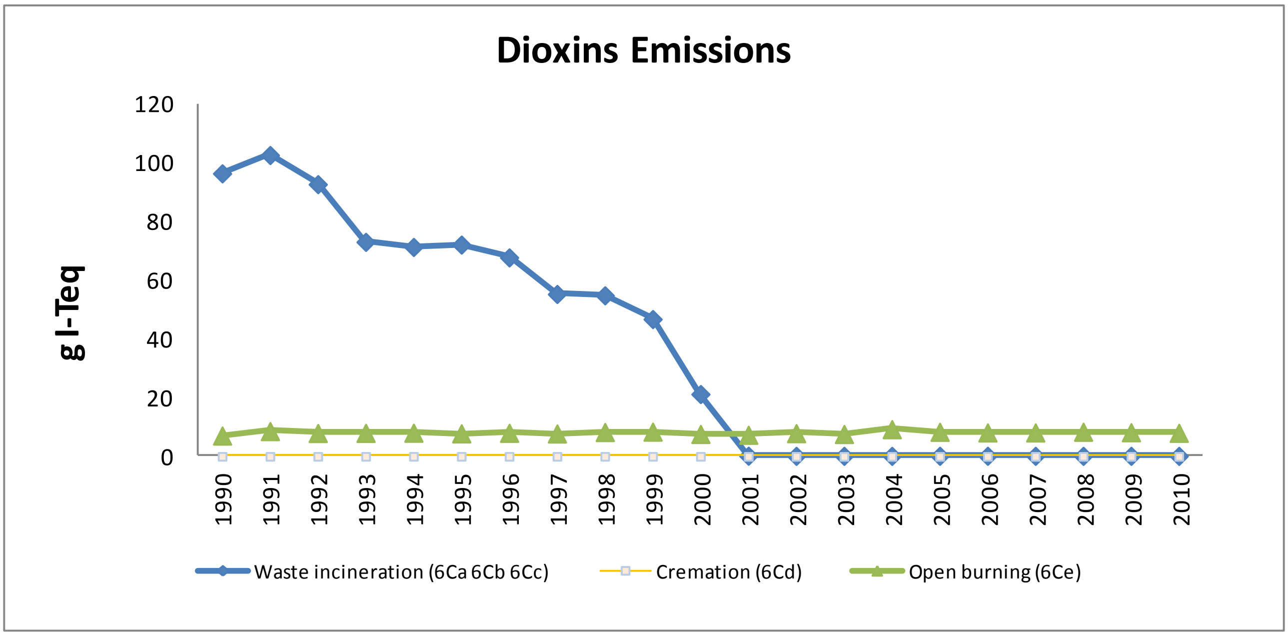

Figure 7.5 *Time series of dioxin emissions of the waste sector by category (g I-Teq)*

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	2011
Solid waste disposal (6A)										
NMVOC (Gg)	9.567	9.978	11.514	9.731	9.315	8.902	8.382	8.302	8.007	7.861
NH_3 (Gg)	7.757	8.090	9.335	7.889	7.552	7.218	6.796	6.731	6.492	6.373
Waste incineration (6C)										
CO (Gg)	42.56	48.82	47.18	52.58	50.63	50.60	52.56	50.90	49.35	49.03
NO_x (Gg)	2.76	2.89	2.42	2.64	2.61	2.56	2.56	2.57	2.47	2.47
NMVOC (Gg)	4.64	4.84	3.33	3.87	3.91	3.70	3.76	3.94	3.71	3.78
SO_x (Gg)	0.48	0.42	0.24	0.28	0.30	0.27	0.26	0.25	0.24	0.23
PM10 (Gg)	2.42	2.65	2.55	2.80	2.74	2.73	2.80	2.75	2.68	2.67
PM2.5 (Gg)	2.08	2.29	2.19	2.41	2.35	2.34	2.41	2.36	2.30	2.30
PAH (t)	6.22	6.85	6.61	7.26	7.09	7.07	7.27	7.12	6.95	6.92
Dioxins (g I-Teq))	103.55	80.01	28.85	8.54	8.33	8.31	8.54	8.39	8.17	8.15
HCB (kg)	12.86	13.96	9.86	8.26	13.53	13.60	12.68	4.02	3.98	4.22
PCB (kg)	5.36	4.61	2.05	1.52	1.61	1.51	1.55	1.96	1.70	1.80
As (t)	0.06	0.05	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
Cd (t)	0.30	0.26	0.14	0.16	0.17	0.15	0.14	0.13	0.10	0.11
Cr (t)	0.59	0.51	0.28	0.32	0.36	0.31	0.29	0.26	0.21	0.22
Cu (t)	0.93	0.79	0.48	0.41	0.50	0.47	0.44	0.29	0.23	0.24
Hg (t)	0.26	0.24	0.12	0.15	0.17	0.15	0.14	0.13	0.11	0.11
Ni (t)	6.76	4.34	2.80	1.02	0.59	0.65	0.57	0.61	0.11	0.12
Pb (t)	5.78	5.37	2.56	3.85	4.14	3.43	3.18	3.46	2.91	3.08
Se (t)	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zn (t)	2.93	2.84	1.38	2.12	2.37	2.00	1.85	1.85	1.55	1.64
Compost production (6D)										
NMVOC (Gg)	0.018	0.040	0.168	0.346	0.369	0.380	0.364	0.364	0.425	0.450
Sludge spreading (6D)										
NO_x	0.667	1.069	1.440	1.166	1.022	1.092	1.162	1.494	1.477	1.558
NH_3	0.994	1.600	2.207	1.888	1.685	1.793	1.890	2.380	2.385	2.516

7.4 Recalculations

Recalculations in the sector have been done because the quantity of waste disposed in landfill has been updated since 2009 (ISPRA, several years) producing a recalculation for 2010.

As regards incineration, a revision concerned all pollutants on the basis of the update of data on incineration plants with or without energy recovery since 2007. 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.

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.

2010 emissions from urban waste incinerators have been recalculated because of the update of emission factors on the basis of data provided by plants (ENEA-federAmbiente, 2012; De Stefanis P., 2012) concerning the annual stack flow, the amount of waste burned and the average concentrations of the pollutants at the stack.

Recalculations in PAH, Dioxins, TSP, PM_{10}, $PM_{2.5}$, CO, NMVOC and NO_X emissions occurred for the whole time series because of the updating of open burning activity data as a consequence of a reallocation of biomass pruning used for domestic heating, and relevant emissions, in the energy sector in the 1A4b biomass fuel subcategory.

Finally, negligible recalculations occurred in “Other waste – 6D” due to the 2009 compost activity data update.

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 the next 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 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 2011 have been submitted.

The percentage difference between the time series reported in the 2012 submission and the series reported this year (2013 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 2010 show a decrease for all pollutants except SO_X and NH_3 where an increase is observed.

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) taking into account the update of activity data time series, pruning biomass combustion has been moved from the waste to the energy sector for the years 1990-2009 and the update of NMVOC, PAH and PM emission factors for the whole time series. In addition for 2010, emission factors of waste incineration with energy recovery have been revised at plant level, especially for HMs and POPs. Recalculations involved all the pollutants and resulted for the whole time series in a strong decrease of PM10, PM2.5, PAH and NMVOC emission levels, which is mostly the decrease observed for these pollutants at national level and reported in Table 8.1.

In the *energy* sector a further revision of the emission estimates regarded the road transport sector. Specifically, the upgraded version of COPERT model, version 10.0 (EMISIA SA, 2012), has been applied to calculate emissions of all pollutants for the whole period 1990-2010. The new version of the model introduces important elements such as a new subsector classification of passenger cars, updated emission factors of Euro 5 and Euro 6 diesel passenger cars, updated emissions for mopeds, updated methane for gasoline passenger cars.

Regarding the *navigation* category, the composition of the fleet of gasoline fuelled recreational craft has been updated from 2005 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 2010, 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 2010, NMVOC emissions from road paving, for 2010, and roof covering, from 2007 to 2010.

For the *solvent* sector the main modification involved category 3C with respect to NMVOC emissions, due to the update of emission factors for polyurethane processing which have been reduced considering the information provided by the industrial association on the phase out of CFC gases in the second half of nineties. In the same subsector, NMVOC emissions from asphalt bowling have been added for the whole time series. Recalculations are also observed in paint application, due to the update of emission factors in paint application in wood from 2005 to 2010 and for car repairing in 2010. Minor recalculations occurred in other use of solvents, considering an updating of some activity data.

Recalculations were implemented for the *agriculture* sector. Specifically, the fraction burned in rice fields from 1996 has been updated on the basis of new information received by the producer’s association resulting in an increase of PM10, PM2.5, NO_X and NMVOC emissions of the field burning of agriculture residual category. An increase of HCB emissions from the use of pesticide for 2009 and 2010 was due to the update of activity data. Minor recalculations, for the whole time series, regarded PM10 and PM2.5 emissions from non dairy cattle and buffaloes (4B1b and 4B2 category respectively) due to the update of the relevant average weights and NH3 emissions from sows, from 1998, due to the update of N-NH3 average storage and recovery emission factors.

In the *waste* sector, a revision concerned all pollutants on the basis of the update of data on incineration plants with or without energy recovery from 2007. Recalculations in PAH, Dioxins, TSP, PM10, PM2.5, CO, NMVOC and NO_X emissions occurred for the whole time series because of the updating of open burning activity data as a consequence of a reallocation of biomass pruning used for domestic heating, and relevant emissions, in the energy sector. Other recalculations occurred for the update of activity data for the last two years and emission factors for 2010 for urban waste incinerators; these recalculations accounts for most the changes observed in Table 8.1 for HCB, PCB, Dioxins and HMs.

Table 8.1 *Recalculation between 2012 and 2013 submissions*

	SO_X	NO_X	NH_3	NMVOC	CO	PM10	PM2.5	Pb	Hg	Cd	DIOX	PAH	HCB	PCB
						%								
1980	0.3	-0.1	0.0	-7.5	-5.6									
1981	0.3	-0.1	0.0	-7.4	-5.7									
1982	0.2	-0.1	0.0	-7.4	-5.6									
1983	0.2	-0.1	0.0	-7.2	-5.7									
1984	0.2	-0.1	0.0	-7.2	-5.6									
1985	0.2	-0.1	0.0	-7.0	-5.6									
1986	0.2	-0.1	0.0	-5.5	-5.7									
1987	0.2	-0.0	0.0	-6.0	-5.6									
1988	0.2	0.0	0.0	-5.7	-5.7									
1989	0.2	0.1	0.0	-5.9	-5.6									
1990	0.3	0.4	0.0	-4.6	-1.8	-2.3	-2.3	0.0	0.1	0.3	-1.7	-27.4	0.3	2.8
1991	0.3	0.0	0.1	-4.5	-0.2	-1.0	-0.5	0.0	0.1	0.6	-3.0	-38.9	0.5	2.6
1992	0.3	0.3	0.1	-4.7	-1.6	-2.3	-2.1	0.1	0.1	0.5	-2.6	-38.3	0.5	2.4
1993	0.3	0.2	0.0	-5.6	-1.2	-1.8	-1.4	0.1	0.1	0.6	-2.9	-37.3	0.5	2.9
1994	0.4	0.3	-0.0	-5.9	-2.8	-3.1	-3.0	0.1	0.1	0.5	-2.8	-38.4	0.5	2.6
1995	0.4	0.2	-0.1	-6.5	-1.1	-2.6	-2.4	0.1	0.1	0.6	-2.9	-38.4	0.5	3.0
1996	0.5	0.3	-0.1	-7.1	-0.8	-2.9	-2.8	0.1	0.1	0.5	-2.7	-38.1	0.4	2.9
1997	0.5	0.2	-0.1	-7.4	-2.8	-3.5	-3.4	0.1	0.1	0.6	-3.2	-40.6	0.5	2.9
1998	0.6	0.4	-0.2	-7.1	-2.2	-3.9	-4.0	0.1	0.1	0.5	-3.0	-40.5	0.5	3.4
1999	0.5	0.6	-0.0	-6.4	-3.3	-4.5	-4.6	0.1	0.2	0.7	-3.9	-46.3	1.0	3.3
2000	0.4	0.3	0.1	-6.1	-3.1	-4.8	-4.9	0.1	0.1	0.5	-3.4	-44.2	0.8	3.5
2001	0.3	0.4	0.0	-5.2	-3.4	-6.6	-7.1	0.2	0.1	0.5	-5.5	-51.1	0.5	3.2
2002	0.5	0.4	0.1	-6.4	-5.5	-11.0	-12.4	0.3	0.1	0.3	-7.7	-60.4	0.3	2.8
2003	0.6	0.2	0.0	-4.9	-5.8	-12.2	-13.9	0.2	0.1	0.2	-8.1	-61.8	0.2	2.7
2004	0.7	0.0	0.0	-6.7	-5.9	-13.9	-15.7	0.3	0.1	0.3	-9.9	-68.0	0.4	2.7
2005	0.7	0.1	0.1	-5.1	-5.4	-13.9	-15.8	0.2	0.1	0.2	-8.8	-61.2	0.4	2.7
2006	0.5	-0.0	0.1	-5.0	-6.4	-16.1	-18.6	0.2	0.0	0.2	-8.7	-62.9	0.2	2.4
2007	0.3	-0.9	0.2	-7.4	-9.1	-21.6	-25.3	0.0	0.1	-0.0	-9.1	-71.6	0.0	2.2
2008	0.3	-0.5	0.2	-7.1	-8.9	-22.9	-26.9	0.0	0.1	-0.0	-9.8	-76.2	-0.0	2.2
2009	0.2	0.8	0.1	-7.0	-10.0	-26.6	-31.2	-1.8	-2.0	-2.3	-13.7	-105.6	-47.5	2.9
2010	2.2	-1.5	0.1	-7.7	-7.7	-27.3	-32.1	-4.2	-9.9	-20.2	-14.8	-86.3	-72.9	-8.8

8.2 Planned improvements

Specific improvements are specified in the 2013 QA/QC plan (ISPRA, 2013[c]); they can be summarized as follows.

For the *energy* and *industrial processes* sectors, a major progress regards 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, and for POPs emissions the use of the results of a national research in the potential update of emission factors and methodologies. 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 the landfill gas combustion in landfills flaring and emissions from the exceeding biogas flared at wastewater treatment plants are under investigation.

The EMEP/EEA Guidebook 2009 chapters (EMEP/EEA, 2009) will continue to be considered and latest methodologies and update emission factors will be applied in the next year submission of the inventory with a focus to PAH, dioxin and heavy metals estimates in order to improve the accuracy and reduce the uncertainty.

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 2020 and 2030. Actually, this model was 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 National Communication under the UN Convention on Climate Change 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.

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.

In May 2012 the review of the Gothenburg Protocol ended, and the European Commission addressed the review of the thematic strategy on air pollution (TSAP), which is still ongoing. Other documentation on the review processes and on emission scenarios in Italy can be found in D'Elia and Peschi (2013).

Moreover in 2013, the Italian Government adopted a new National Strategy on Energy, which has relevant impacts on emission projections.

In this context, different emission scenarios have been produced at national level, whose projections, regarding PM2.5, SO_2, NO_X, NMVOC and NH_3, cover the years from 2005 till 2030 and have been harmonized with the national emission inventory at 2005 and 2010.

All the different scenarios foreseen a reduction for all air pollutants but PM2.5, compared to 2005 emission levels, and at the moment it is not clear if Italy will respect all the ceilings set out in the Gothenburg Protocol for 2020. Anyhow insights are still in progress and the situation may change with the update of the emission projections.

In Table 9.1 emissions reduction calculated for the two last available projections (the national projections used in TSAP review process and the latest calculated on the national energy strategy) are reported in comparison with the Gothenburg Protocol ceilings.

Table 9.1 *Comparison between emission reductions in 2020 for two different national emission scenarios and Gothenburg Protocol ceilings.*

National emission levels			
	National energy strategy	TSAP	GP Targets
SO2	-48%	-45%	-35%
NOx	-34%	-33%	-40%
PM2.5	15%	5%	-10%
VOC	-33%	-31%	-35%
NH3	-8%	-8%	-5%

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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