INVENTORY OF EMISSIONS IN SPAIN
1990-2008

SUBMISSION TO THE SECRETARIAT OF THE GENEVA CONVENTION AND EMEP PROGRAMME

Strategic Environmental Information Unit

General Directorate for Environmental Quality and Assessment

Secretariat of State for Climate Change

Ministry of the Environment and Rural and Marine Affairs

September 2010

CONTENTS

1.- EXECUTIVE SUMMARY

Chapter updated in July 2010.

1.1.- Presentation

This document is the 2010 edition of the emissions inventory report submitted by Spain to the Secretariat of the Geneva Convention on Long Range Transboundary Air Pollution and the associated EMEP Program (CLRTAP-EMEP), in accordance with the 2010 CLRTAP-EMEP work plan.

The nomenclature used for this inventory is the Nomenclature for Reporting (NFR). In this inventory edition, the format used to present the emissions estimates, and at least in part for the activity variables, corresponds with the structure of the tables in Annex IV (Templates for Reporting) of the UNECE document, as of January 29th, 2009, entitled "ECE/EB.AIR/97"[1]. As for the report proper of the emissions inventory, the IIR, in short, for its English acronym "Informative Inventory Report", its structure follows the specifications of Annex VI "Recommended structure for IIR" in the said ECE/EB.AIR/97 document.

With regard to the inventoried substances reported in i) the inventory tables and ii) the IIR report, their list is shown below, with the pollutants grouped by homogeneous blocks. The list of substances retained for the IIR focuses on the pollutants most relevant for the Geneva Convention and its Protocols, although its coverage is less than that of the pollutants list in the emission inventory tables, with the aim of not extending further the IIR, whose extension, even with this provision, results in a voluminous document.

- **Main pollutants** (for both the inventory tables and the IIR)**:**
    - Nitrous oxides "NO_X", in mass of NO_2
    - Non-methane volatile organic compounds "NMVOC".
    - Sulphur oxides "SO_X", in mass of SO_2.
    - Ammonia "NH_3".
    - Carbon monoxide "CO"[2].

1 Document EMEP ECE/EB.AIR/97 may be accessed on the website of the EMEP Centre on Emission Inventories and Projections' (CEIP). At http://www.ceip.at/fileadmin/inhalte/emep/reporting_2009/Rep_Guidelines_ECE_EB_AIR_97_e.pdf . Reporting guidelines and questionnaire specifications for the 2010 inventory are available at http://www.ceip.at/reporting-instructions/reporting-programme-2010/.

2 Report forms include CO under a separate column entitled "Other."

- **Particulate matter** (for both the inventory tables and the IIR):
  - $PM_{2.5}$, particulate matter less than 2.5 microns in diameter.
  - PM_{10}, particulate matter less than 10 microns in diameter.
  - TSP, total suspended particulates.
- **Heavy metals:**
  - Priority metals (for both the inventory tables and the IIR): Lead (Pb), Cadmium (Cd) and Mercury (Hg).
  - Other metals (for the IIR): Arsenic (As), Chrome (Cr), Copper (Cu), Nickel (Ni), Selenium (Se) and Zinc (Zn).
- **Persistent organic compounds (POPs)**:
  - Hexachlorocyclohexane (HCH), (for the IIR)
  - Dioxins and furanes (DIOX), (for both the inventory tables and the IIR)
  - Polycyclic aromatic hydrocarbons (PAH), (for both the inventory tables and the IIR)
  - Hexachlorobenzene (HCB), (for the IIR)
  - Pentachlorophenol (PCP), (for the IIR)

This edition of the updated inventories, reviewing as appropriate the estimates given in the previous edition for the years 1980-2007, extends that time series to the year 2008[3]. The revision of the estimates, where made, for certain entries in the inventory was motivated by different factors including: the revision of statistics and base data, changes in estimation methodologies (selection of methods, factors and algorithms) as a consequence of improvements in the knowledge of emissions generating processes, and finally the correction of errors detected. The information about the inventory tables included in this 2010 edition incorporates the contents indicated in Table 1.1 below.

[3] The following substances were reported during the 1980-1989 sub-period: SO_x, NO_x, NMVOC, CO and NH_3, and disaggregation was employed in the 11 groups of the first version of the NFR nomenclature (groups equivalent to those of the SNAP nomenclature of 1990), since the information on this sub-period is not available in a disaggregated form by activities in the current SNAP nomenclature, which would make it possible to update such information to the current NFR version.

Table 1.1.- Contents of the inventory information sent in 2010 to the Secretariat of the of the Geneva Convention and the EMEP Programme

The table numbering corresponds to those in Annex IV “Templates for Reporting” in the UNECE document entitled “ECE/EB.AIR/97” dated January 27th, 2009, and, unless otherwise indicated, the years covered are those in the period 1990-2008.

Annex IV-Table 1

Contains information on:

4 main pollutants (NO_x, NMVOC; SO_x, NH_3) for the years 1990-2008
Particulates in suspension ($PM_{2.5}$; PM_{10}; TSP) for the years 2000-2008 (not for the previous years)
Others (CO) for the years 1990-2008
Priority heavy metals (Pb, Cd and Hg) for the years 1990-2008
Other heavy metals (As, Cr, Cu, Ni, Se, Zn) for the years 1990-2008

Persistent organic compounds (DIOX, total HAP, HCB y HCH) for the years 1990-2008It does not contain information for PCB, although the corresponding labels have been included.

Annex IV-Table 2A and Annex IV-Table 2B

Contain information for the years 2010, 2015 and 2020. These tables have only been completed in the corresponding Excel file for 2008.

Annex IV-Table 3A and Annex IV-Table 3B

Contain information on the same pollutants listed in the *“Annex IV-Table 1”* sheet with breakdown by the cells in the EMEP grid.

It is important to point out that the geographical coverage of the *“Annex IV-Table 1”*, *“Annex IV-Table 2A"* and *“Annex IV-Table 2B”* sheets (for both the historic data and projected data) corresponds to the total of Spain’s national territory. On the other hand, *“Annex IV-Table 3A"* and *“Annex IV-Table 3B”* only cover the part of Spanish territory that intersects with the EMEP area (thus excluding the Canary Islands, Ceuta and Melilla).

1.2.- Most relevant features of the inventory and its main variations with respect to the previous edition

1.2.1.- New inventory presentation structure

The 2010 edition conforms to the new structure of the Reporting Guidelines contained in the ECE/EB.AIR/97 document and its corresponding annexes, both with regard to the inventory tables, as per Annex IV “Templates for Reporting” in the said ECE/EB.AIR/97 document, and also the inventory report itself (IIR), as per Annex VI “Recommended structure for the IIR” in the said ECE/EB.AIR/97 document.

1.2.2.- Trends and homogeneity of the series over time

In the analysis of the emissions series, the inventory working group has identified “atypical values” in certain years that do not seem to correspond to any regular pattern. In these cases, the potential causes of the “anomalies” have been investigated and, in most cases, it has been found that the root cause lay in a similar pattern in the activity variable, which in turn was mostly confirmed with the data in the original source for that activity variable.

As for the homogeneity of the series over time, it should be noted that, whenever recalculations were carried out in each new edition of the inventory for any activity*pollutant cross-tab, not only is the year directly affected revised but the change made is projected to the whole of the time series to ensure the homogeneity of the entire series. In this sense, mention must also be made of the fact that, for the 5 main pollutants (NO_X, NMVOC, SO_X, NH_3 and CO), the series is updated and revised in each edition for the whole of the period inventoried, i.e. since 1980.

The most relevant specific situations regarding trends and the “atypical values” in the series are commented in due course in chapter 3 “Explanation of trends” and in the subsequent sectorial chapters from Chapter 4 “Energy” to Chapter 10 “Other”.

1.2.3.- Completeness

The base inventory in SNAP format is compiled for the activity*pollutant cross-tabs of the SNAP nomenclature, extended with additional columns for particulates (in their various classes $PM_{2.5}$; PM_{10} and TSP).

With respect to completeness, the greatest effort has been made to identify the activity variables and parameters needed as feedstock for the emission calculation procedures through the application of the corresponding algorithms (and in most cases of the available emission factors).

In general, it is felt that the target of completeness has been reached quite closely for the majority of the activity*pollutant cross-tabs in the inventory. In any case, the tables in the inventory have been assigned “NE” and “IE” labels to reflect, respectively, those situations in which it has not been possible to effect the estimation (for reasons mostly attributable to the lack of information on emission factors), “NE”; or where the estimation has been included in a different cell (i.e. for another activity) in the inventory table, “IE”.

The detailed information on the shortcomings with regard to completeness, reflected by means of the NE and IE labels, is given in the respective sectorial chapters from Chapter 4 “Energy” to Chapter 10 “Other”.

1.2.4.- Improvement priorities

For each new edition of the inventory, a list of improvement priorities is drawn up. The detailed information on these improvement plans concerns both the horizontal aspects of the inventory system as well as the sectorial aspects dealt with in the respective chapters from Chapter 4 “Energy” to Chapter 10 “Other”. The following improvement plans can be cited here by way of a concise summary:

a) Harmonization of the Inventory with other emissions tracking instruments.

   Integration into the inventory of the base information and the certified emissions of the facilities subject to the emission rights trading regime.

b) Adaptation of the variation over time of certain emission factors (and associated activity variables) to the penetration of environmentally more efficient technologies.

As the most relevant examples, we cite here those of: i) Stationary engines and their NO_X factors; ii) Use of solvents and other products and their NMVOC emission factors; Mobile machinery engines (for agriculture and other uses) and the main pollutant factors and particulates.

c) Progression to more advanced emission estimation methodologies.

As the most relevant examples, we cite here those of: i) Development of a national methodology for estimating emissions from traffic and air and maritime transportii) Development of a national methodology for the estimation of emissions from agriculture and animal husbandry.

d) Quantitative estimation of uncertainty and methodology improvements in the identification of key categories.

With regard to uncertainty analysis, a quantitative diagnosis based on the Tier 1 approach is planned; the Tier 2 approach is applied to the analysis of key categories based on references contained in the EMEP/EEA 2009 guidebook.

e) Systematic review of emission factors based on the EMEP/EEA 2009 guidebook.

Emissions factors based on the EMEP/CORINAIR 2007 guidebook (or previous versions) are being reviewed in accordance with new information provided by the EMEP/EEA 2009 guidebook; this process should be completed in the next two inventory editions.

2.- INTRODUCTION

Chapter updated in June 2010

2.1.- National Inventory Background

2.1.1.- General presentation

The Inventory is based on the most extensive cross-tab structure of activities and pollutants, in accordance with the SNAP nomenclature from EMEP/CORINAIR, extended with the corresponding columns for particulate matter diametric classes ($PM_{2,5}$, PM_{10} and TSP) discussed below, so that its projections comply with the specified formats for the presentation of the results. In addition, these formatting specifications may at times impose certain conventions on the definitions and ways of calculating emissions which differ in their approach from the most general base structure used for the Inventory, due to the application of the requirements specified for each format.

In addition to the basic SNAP nomenclature for the Inventory, the "Common Reporting Format" (CRF) and “Nomenclature for Reports” (NFR) are used.

The “Common Reporting Format” (CRF) is the method of reporting to the various international bodies on greenhouse gases emissions. These include particularly the Commission of the European Union and the Secretariat General of the United Nations Framework Convention on Climate Change (UNFCCC). In these two cases the inventory is presented following the guidelines for reports specified in the document FCCC/SBSTA/2006/9[1] and in the update document titled “Annotated outline of the National Inventory Report including reporting elements under the Kyoto Protocol[2]”, both by the UNFCCC. The tables in the inventory are presented in electronic format using the software enabled for this purpose (CRF Reporter, version 3.3.22) by the UNFCCC in order to comply with the Common Reporting Format (CRF), and the inventory also includes specific tables for informing the Kyoto Protocol.

The “Nomenclature for Reporting” is the nomenclature adopted to report on emissions to the various international bodies in the EMEP Programme of the United Nations Geneva Convention on Long-Range Transboundary Air Pollution. These bodies include the EMEP Programme, the Secretariat of the Convention, and the Commission of the European Union for questions involving compliance with Directive 2001/81/CE on National Emission Ceilings.

---

1 http://unfccc.int/resource/docs/2006/sbsta/eng/09.pdf

2 http://unfccc.int/files/national_reports/annex_i_ghg_inventories/reporting_requirements/application/pdf/annotated_nir_outline.pdf

For this present report, the NFR nomenclature, the emissions presentation format, and part of the presentation format for the activity variables all comply with the tables structure in section D of Annex IV of the UNECE Reporting Guidelines, as they appear in the "ECE/EB.AIR/97" document (27 January 2009), and whose NFR format specifications can be seen on the following web page of the Centre for Emissions Inventories and Projections (CEIP) of the EMEP programme: http://www.ceip.at/reporting-instructions/reporting-programme-2010/

The national emissions inventory, in its basic SNAP format, is compiled on a spatial scale that covers the various hierarchy levels of the nomenclature of territorial units (NUTS) of the European Commission Statistical Office (EUROSTAT). The NUTS nomenclature includes the following four levels:

- Level 0: Spain
- Level 1: 7 large geographical regions (North-West, North-East, Madrid, Centre, East, South, Canary Islands).
- Level 2: 19 autonomous communities, including the autonomous cities of Ceuta and Melilla.
- Level 3: 52 provinces including Ceuta and Melilla.

The use of administrative units is perhaps the most convenient form of geographical breakdown in the Inventory, both in terms of the input of basic data and from the standpoint of using the results to make environmental policy decisions. In fact, a large part of the information on socio-economic variables, and most particularly in the case of Area Sources, is only available at one level in the hierarchy of administrative units (province, autonomous community, region and state, in the case of Spain), and most environmental policy decisions are made with reference to these administrative units.

The Inventory also specifies what are known as Large Point Sources (LPS), which will be expanded further on. The co-ordinates of the geographical location of these LPS are given and they are thus automatically included within the corresponding NUTS hierarchy.

During the drafting of this Inventory, top priority has been given to achieving representative, complete, consistent and transparent results for the Spanish territory as a whole.

2.1.2.- Geographical scope differentiated according to presentation formats in the Inventory

i) Inventory for the entire national territory.

The inventory for the entire national territory comprises: i) the Spanish part of the Iberian mainland, the Balearic Islands, the Canary Islands, and the cities of Ceuta and Melilla (and their dependent territories) on the western Mediterranean coast of North Africa.

ii) Inventory for the EMEP grid.

The Inventory for the EMEP grid excludes from the national territory: the Canary Islands and the cities of Ceuta and Melilla (and their dependent territories) on the western Mediterranean coast of North Africa. Therefore the Inventory for the EMEP grid comprises the Spanish part of the Iberian mainland and the Balearic Islands.

iii) Inventory for the National Emissions Ceilings Directive.

The Inventory for the National Emissions Ceilings Directive excludes the Canary Islands from the national territory. Thus the Inventory for the National Emissions Ceilings Directive comprises the Spanish part of the Iberian mainland, the Balearic Islands and the cities of Ceuta and Melilla (and their dependent territories) on the western Mediterranean coast of North Africa.

2.1.3.- Activity scope differentiated according to presentation formats in the Inventory

i) National total for the entire territory and for the EMEP grid.

The Inventory for the entire territory and for the EMEP grid includes all SNAP activities with their corresponding NFR associated code; and excludes, in the air traffic category, cruising phases (both domestic and international segments) and the international segment of maritime traffic. Complementary to these exclusions, it should be noted that the air traffic category does include the LTO component of both domestic and international segments.

ii) Inventory for the National Emissions Ceilings Directive.

The Inventory for the National Emissions Ceilings Directive, according to article 2 “Scope of application” of this Directive, excludes: a) the international segment of maritime traffic; b) the cruising phase component of international air traffic (but only the part corresponding to the cruising phase); c) the segment of domestic air traffic (but only the part corresponding to the cruising phase). Complementary to these exclusions, it should be noted that the air traffic category does include the LTO component of both national and international segments.

2.1.4.- Synthesis of emissions estimation results differentiated according to presentation formats in the Inventory

The following tables show the synthesis of emissions estimation results differentiated according to the presentation formats in the Inventory. Specifically, Table 2.1.1 shows the emissions for the entire national territory according to current NFR nomenclature, and Table 2.1.2 shows the emissions for the part of the national territory which intersects the EMEP grid.

Table 2.1.1.- Emissions. National total

Year	NO_X (Gg)	NMVOC (Gg)	SO_X (Gg)	NH_3 (Gg)	CO (Gg)	$PM_{2,5}$ (Gg)	PM_{10} (Gg)	PST (Gg)	Pb (Mg)	Cd (Mg)	Hg (Mg)	DIOX (g-I Teq)	PAH (Mg)
1990	1.340,9	1.036,1	2.176,2	317,7	3.654,1				2.788,4	26,8	14,6	185,0	321,3
1991	1.381,8	1.053,7	2.176,0	313,7	3.723,7				1.879,1	26,0	15,2	191,0	322,7
1992	1.412,1	1.067,3	2.128,7	310,5	3.740,7				1.265,4	24,5	16,4	199,9	313,5
1993	1.380,2	990,8	2.004,9	295,2	3.558,2				1.154,7	22,0	14,9	196,7	317,6
1994	1.396,5	1.007,1	1.952,8	316,7	3.441,3				1.144,1	23,1	14,8	190,5	313,1
1995	1.379,3	975,1	1.791,4	310,6	3.165,4				966,6	23,2	14,7	164,6	306,9
1996	1.326,8	1.004,1	1.563,5	339,1	3.195,9				947,9	21,2	13,4	163,7	317,5
1997	1.340,5	1.017,0	1.740,6	341,0	3.089,8				883,5	21,1	11,5	136,5	334,1
1998	1.322,1	1.048,9	1.586,6	359,1	2.985,2				818,4	21,3	12,1	138,0	314,8
1999	1.372,7	1.041,1	1.601,9	369,1	2.817,8				758,4	21,5	13,0	144,1	303,4
2000	1.394,4	1.017,9	1.462,7	380,1	2.674,7	126,5	170,5	231,3	626,2	20,3	12,6	149,7	274,3
2001	1.365,5	998,4	1.438,9	381,3	2.608,6	127,2	170,9	230,9	408,6	20,4	12,7	144,3	258,9
2002	1.407,6	921,6	1.541,5	378,0	2.379,8	129,0	174,5	236,6	274,8	21,0	13,3	144,7	226,5
2003	1.401,5	932,6	1.277,4	392,2	2.453,3	129,9	173,5	233,4	271,0	19,5	12,1	149,7	280,2
2004	1.446,8	920,9	1.320,6	385,7	2.311,6	130,3	174,0	233,7	266,8	18,9	12,1	152,6	254,4
2005	1.434,2	885,1	1.271,9	367,2	2.125,6	131,4	173,2	230,2	273,5	18,5	11,9	152,0	223,6
2006	1.401,9	873,1	1.170,5	377,8	2.113,3	130,2	171,1	226,8	275,9	18,3	11,2	159,0	249,6
2007	1.416,2	863,5	1.170,4	388,4	2.100,6	133,8	174,9	232,0	275,2	15,3	10,3	163,5	257,5
2008	1.237,4	815,6	530,0	358,4	1.995,5	124,7	159,8	211,5	269,5	14,9	9,4	160,3	256,3

Table 2.1.2.- Emissions. National total – Inventory for the EMEP grid

Year	NO_X (Gg)	COVNM (Gg)	SO_X (Gg)	NH_3 (Gg)	CO (Gg)	$PM_{2,5}$ (Gg)	PM_{10} (Gg)	PST (Gg)	Pb (Mg)	Cd (Mg)	Hg (Mg)	DIOX (g-I Teq)	HAP (Mg)
1990	1.276,9	1.002,1	2.092,4	315,5	3.571,3				2.689,4	25,7	13,4	180,9	317,7
1991	1.317,0	1.021,3	2.098,1	311,7	3.639,3				1.815,7	24,9	14,0	187,0	317,5
1992	1.348,0	1.034,7	2.057,2	308,5	3.654,6				1.225,2	23,3	15,2	195,4	308,3
1993	1.314,4	959,1	1.934,0	293,2	3.481,1				1.119,5	20,9	13,6	192,5	312,3
1994	1.312,4	974,4	1.880,3	314,6	3.358,5				1.108,1	21,9	13,6	186,1	307,8
1995	1.299,7	943,3	1.730,1	308,6	3.088,8				935,4	22,0	13,5	161,5	301,7
1996	1.234,1	967,5	1.515,1	336,8	3.101,5				907,5	19,9	12,1	160,0	312,1
1997	1.263,7	980,2	1.703,2	338,7	3.005,6				844,8	19,7	10,1	133,1	329,1
1998	1.244,9	1.011,6	1.549,6	357,0	2.903,8				783,2	19,9	10,7	134,6	310,3
1999	1.278,5	1.000,7	1.559,6	366,9	2.725,9				717,3	20,0	11,4	140,5	299,2
2000	1.301,7	979,2	1.419,2	377,2	2.594,6	121,7	165,0	225,0	595,4	18,8	11,0	147,1	272,0
2001	1.271,5	959,7	1.393,7	378,3	2.532,1	122,1	165,2	224,4	392,5	18,8	11,1	141,7	258,1
2002	1.311,2	886,4	1.499,8	375,1	2.310,0	123,7	168,6	230,1	270,0	19,4	11,8	142,4	225,7
2003	1.299,9	898,7	1.232,1	389,3	2.394,1	124,5	167,5	226,7	265,7	17,7	10,2	147,4	279,4
2004	1.347,3	887,0	1.276,4	382,8	2.257,4	124,8	167,9	226,8	261,3	17,0	10,3	150,4	253,5
2005	1.335,3	852,2	1.232,0	364,4	2.077,0	126,0	167,1	223,4	268,3	16,8	10,2	149,8	222,7
2006	1.297,4	841,8	1.128,9	375,1	2.074,4	125,0	165,2	220,3	271,3	16,7	9,6	156,8	248,7
2007	1.303,6	832,6	1.120,9	385,7	2.065,6	128,1	168,6	225,0	270,7	13,7	8,7	161,1	256,7
2008	1.123,2	785,7	475,7	355,8	1.963,6	118,9	153,2	204,0	264,9	13,3	7,8	157,9	255,5

2.2.- Description of institutional, legal and procedural arrangements

2.2.1.- Institutional, legal and procedural arrangements adopted to prepare the Inventory

2.2.1.1.- National authority for the inventory system and regulatory framework

Spain has enacted the legal framework necessary for the deployment of the required institutional, legal, and procedural arrangements, in order to be able to comply with the functions designed to guarantee that the principles of good practice are followed in compiling the inventories (transparency, consistency, comparability, thoroughness and accuracy), and to this end has assigned the corresponding resources for the correct performance of all these functions.

The Directorate-General for Environmental Quality and Assessment (DGCEA) of the Ministry for the Environment, Rural and Marine Affairs (MARM) is the National Authority for the Air Pollutant Emissions Inventory System in accordance with Ministerial Order MAM/1444/2006 dated May 9th. The DGCEA contains the Strategic Environmental Information Unit (UIAE), the body charged with the execution of the inventory and processing the information collected from the various sources. Moreover, Article 27.4 of the Air Quality and Environmental Protection Act law 34/2007 dated November 15th, , establishes the Spanish System for Information, Monitoring and Prevention of Air Pollution (SEIVP) and, in relation to this, specifies that for the preparation and periodic updating on the inventory, the Government will develop a regulatory framework for the Spanish Inventory System (SEI) in accordance with current international guidelines. With regards the operational institutional aspect, it is worth highlighting within the regulatory framework, the agreement of the Government's Delegate Committee for Economic Affairs on February 8th, 2007 (ACDGAE-2007) which establishes:

i) the mechanisms for obtaining information for the application in Spain of the National Air Pollutant Inventory and

ii) the time periods and procedures for preparing the Inventory and the Projections for Air Pollutants.

The following procedure is used to approve the inventory: the proposal for the National Air Pollutant Inventory prepared by the DGCEA is sent by the Minister for the Environment and Rural and Marine Affairs to the Government's Delegated Committee for Economic Affairs for approval.

Air pollutant emissions inventories are considered to be statistics for State purposes and as such, in accordance with article 149.1.31 of the Spanish Constitution, are performed on the basis of the exclusive responsibility of the State for the preparation of statistics for State purposes. The regulatory frame of reference is provided by the Spanish Public Statistical Function Act (Law 12/1989 date May 9th) and by the 2009-2012 National Statistical Plan, approved by Royal Decree 1663/2008 dated October 17th. The section on environment and sustainable development of the 2009-2012 National Statistical Plan

includes, with statistical operation number 5713, the “Air Pollutant Emissions Inventory”[3]. The inclusion of the air pollutants emissions inventory entails the following statistical operation: the obligation to provide the information required for its compilation, with the protection of statistical secrecy and guarantee of its continuity within the framework of the National Statistical Plan.

With regard to data collection, the aforesaid Law 12/1989 establishes two different regimes for the regulation of statistics, depending on whether data are required in a compulsory manner or individuals are free to provide information voluntarily. Since they form part of the National Statistical Plan and their preparation represents an obligation for the Spanish State, among other reasons in order to comply with its international commitments – and particularly those affecting the European Union–, emissions inventories fall into the first of these two regimes, i.e., the submission of data by individuals is compulsory.

The Ministerial Departments and public bodies with competences in sectors entailing activities that generate (or that may generate) emissions of pollutants into the atmosphere are requested by the DGCEA to provide the information necessary for compiling the inventory, also referring to the abovementioned ACDGAE-2007 as regulatory support. As a procedure to guarantee greater precision in the channels for collecting institutional information, the DGCEA convened (on April 15th, 2009) the representatives of the Ministerial Departments in order to designate those responsible in the Focal Points who would assume the responsibility in each department for processing the information required for the SEI. To assist them in this task, the DGCEA provided the representatives from the different departments with the corresponding section of the Guide to Institutional Information Requirements (Institutional_Requirements_Guide) specifying the type of data to be requested from the different Departments and bodies, so as to incorporate the pertinent procedures into their respective Statistical Plans in order to have this information available. This Institutional_Requirements_Guide is updated on a regular basis (at least once a year), particularly when there are changes in the methodology for compiling the Inventory or in the levels of detail required for updating the time series for the data, in order to guarantee the Inventory’s consistency over time.

2.2.1.2.- Institutional arrangements

While the existence of a body assuming overall responsibility for the inventory is indispensable, it is evident that, given the high number and complexity of the tasks involved in preparing the inventory, the participation of numerous different offices is also essential to its planning, development and approval.

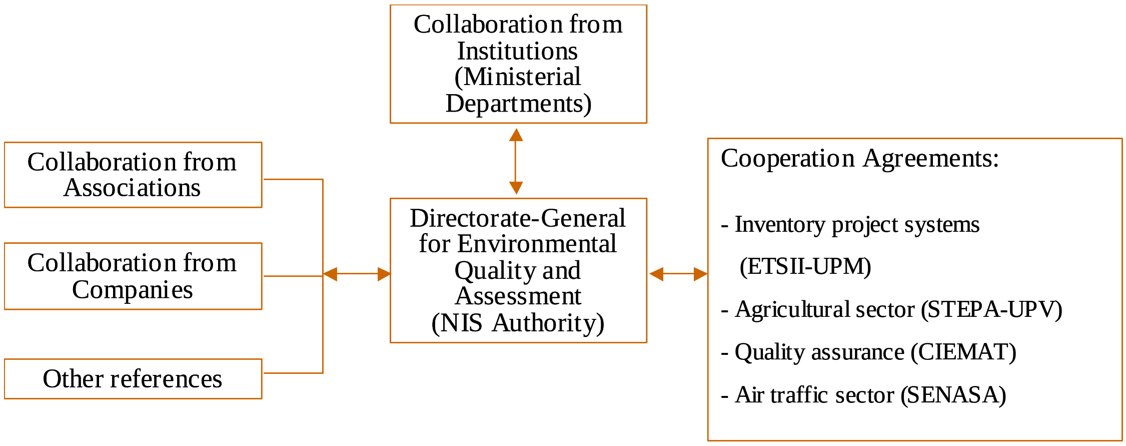
The DGCEA is the National Authority for the National Air Pollutant Emissions Inventory System (Ministerial Order MAM/1444/2006). To carry out its functions the DGCEA relies on the Technical Assistance division of the AED-NDS-TWOBE temporary association of

[3] The National Statistical Plan is updated every four years. The previous plan, which covered the period 2005-2008, also included the Air Pollutant Emissions Inventory with its corresponding statistical operation number.

companies[4] which provides technical support in the tasks of materially carrying out and overseeing the general development of the inventory, with AED (Análisis Estadístico de Datos, S.A.) playing a key role in this Technical Assistance.

To support the development and implementation of the SEI, the DGCEA has also established cooperation agreements with various organisations, principally research institutes and university departments, including: ETSII-UPM[5] for the system of Inventoried projections; STEPA-UPV[6] for the agricultural sector, CIEMAT[7] for quality assurance procedures, and particularly in the energy sector [8], SENASA[9] for the development of a model of air traffic and associated emissions. Figure 2.2.1 shows the coordination chart for the resources enabled by the DGCEA for the SEI.

[10]***Figure 2.2.1.- Coordination of resources by the DGCEA for the SEI***



Furthermore working groups have been set up with different bodies in the various thematic contexts. See Figure 2.2.2 for the most significant working groups and forums, which include the following:

- Agriculture (GT-INV-AG) and Livestock (GT-INV-GAN), to address specific aspects of these two sub-sectors and which is composed of representatives from the Ministry of

---

4 AED (Análisis Estadístico de Datos, S.A.), NDS (Net Design Studio, S.L.) and TWOBE (Estudio Internacional Twobe, S.L.)

5 Technical School of Industrial Engineering – Madrid Polytechnic University

6 Systems and Technology of Animal Production – Valencia Polytechnic University

7 Research Centre for Energy, Environment and Technology

8 Collaboration agreement with CIEMAT for the years 2007 and 2008.

9 Airworthiness and Aeronautical Security Studies and Services Company.

10 Collaboration agreement with the CIEMAT effective in 2007 and 2008.

the Environment and in collaboration with experts in the field from STEPA-UPV, ETSIAgr-UPM[11], and TRAGSA[12].

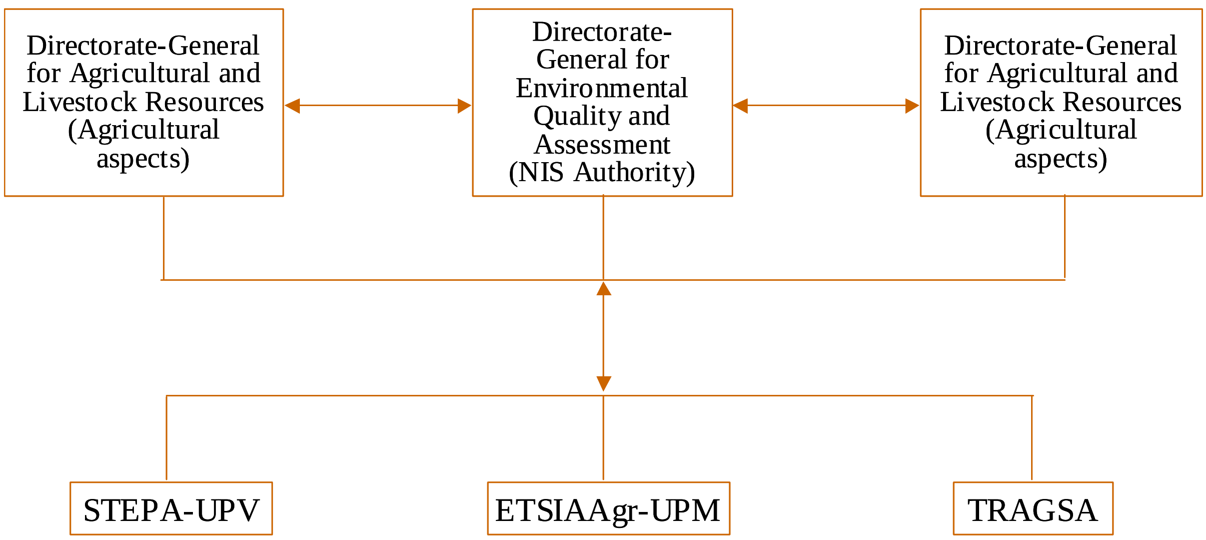
- Land Use and Climate Change (GT-USCC) for the improvement of estimations in the equivalent sector in the CRF (Land Use, Land Use Change and Forestry) with the co-operation of the MARM, the Ministry of Public Works, and experts from CEAM[13].

- Co-ordination of technical aspects with the Autonomous Regions regarding methodological elements and base information for the inventories.

- The forum created in 2008 to verify disaggregation by the Autonomous Regions in the National Inventory and which holds sector-wide meetings (to deal with specific subjects in a particular sector) as well as bilateral meetings (to deal with subjects relating to a specific Region). These meetings are attended by the Inventory team as well as by representatives from the Inventories area of the Regional Governments.

Figure 2.2.2.-Working groups and forums

Interministerial working groups for "Agriculture (GT-INV-AG)-Livestock (GT-INV-GAN)"

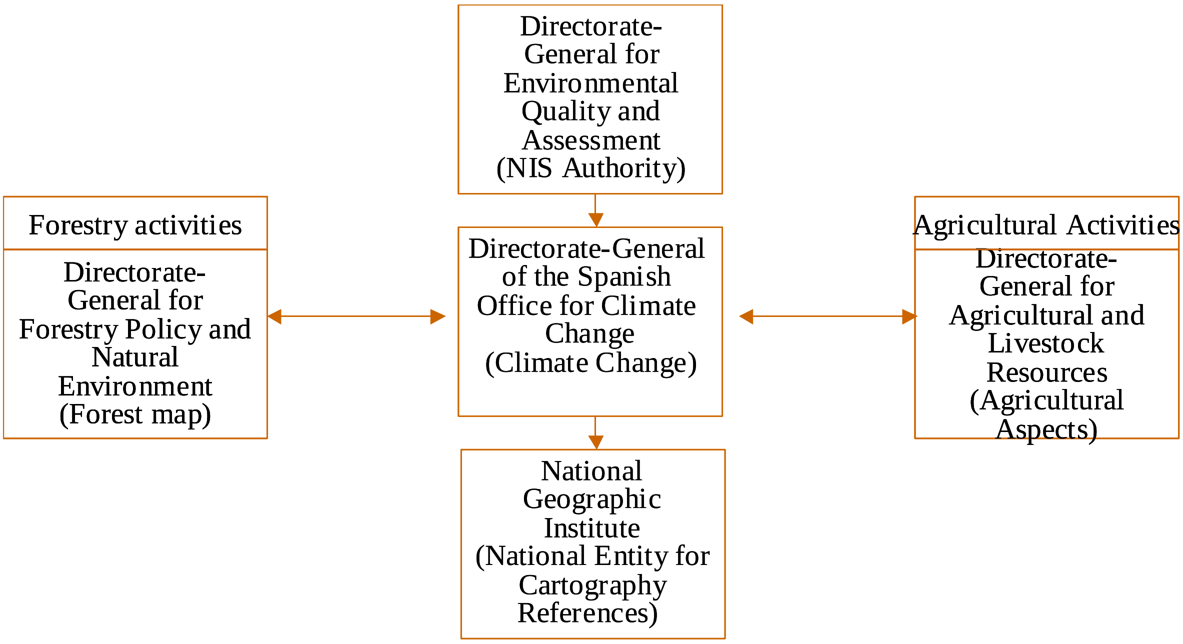


[11] Technical School of Agriculture in the Madrid Polytechnic University

[12] Empresa de Transformación Agraria, S.A.

[13] Centre of Environmental Studies for the Mediterranean.

Interministerial working groups for “Changes in land use”



Working group for harmonisation of Autonomous Community inventories with the National Inventory

Forum for the verification of the disaggregation by the Autonomous Communities of the National Inventory vs. the Autonomous Inventories

With reference to the participation of ministerial departments, and in accordance with section 2.2.1.1 regarding the classification of responsibilities into focal points within the ministerial departments and autonomous bodies, the information necessary for the emissions inventory in the Spanish Inventory System (SEI) is compiled using the necessary information systems (for activity variables, methods, etc.) and focal points, as shown in Figure 2.2.3 below. Chart 2.2.1 includes the main contents of the coverage by theme corresponding to the blocks of ministerial departments and autonomous bodies included in Figure 2.2.3.

Figure 2.2.3.-Participation of ministerial departments in the SEI

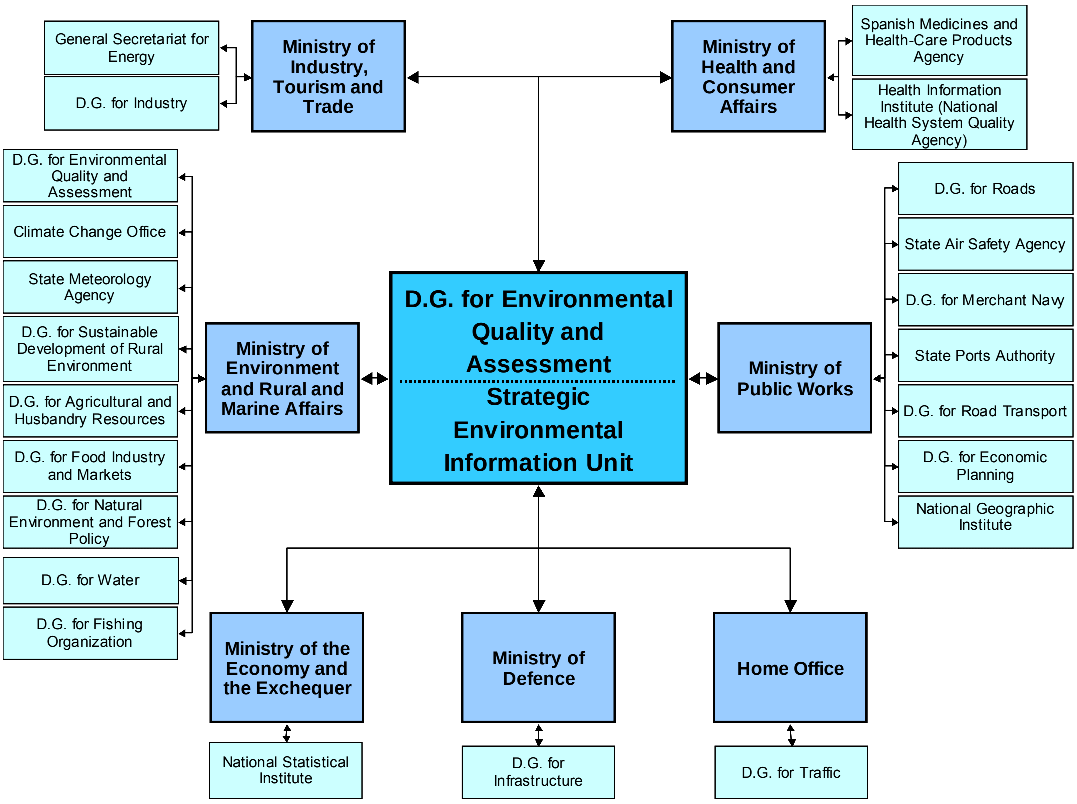


Chart 2.2.1.- Information required from the focal points

Ministry	Department	Information required
Ministry of Defence	D.G. for Infrastructure	- Fuel consumption in military tactical equipment
Home Office	D.G. for Traffic	- Vehicle fleet - Registration and de-registration of vehicles in the fleet - Characteristics of registered vehicles (propulsion system, ...)
Ministry of Public Works	D.G. for Roads	- Distances travelled by vehicles (broken down by institution responsible for the road) - Map of roads. - Kilometres of roads by type of surface, slopes and other road infrastructure data
	State Air Safety Agency	- Statistics on movements of civil aircraft - Activity variables and other relevant information for the MECETA model
	D.G. for Merchant Navy and State Ports Authority	- Statistics on movements of vessels, lengths of stay and port entry and departure times - National / international shipping traffic - Register of vessels - Cartographic information on routes - Supply of fuel for national and international traffic
	D.G. for Economic Planning D.G. for Road Transport	- Permanent survey on haulage of goods by road - Other statistics on road transport
	National Geographic Institute	- BCN200 cartographic digital database and frontier limits - EMEP grid cell surface co-efficient (province) - CORINE-LAND COVER 1990, 2000, 2006 - Land occupancy in Spain (SIOSE) - Cartographic uses for LULUCF

Chart 2.2.1.- Information required from contact points (Continued)

Ministry	Department	Information required
Ministry of Defence	D.G. for Infrastructure	- Fuel consumption in military tactical equipment
Ministry of Health and Consumer Affairs	Spanish Medicines and Health-Care Products Agency	- Nitrous oxide (N_2O) used in anaesthesia
	Health Information Institute (National Health System Quality Agency)	- Operating hospital beds
Ministry of the Economy and the Exchequer	National Statistical Institute	- Population, historical series and forecasts - Industrial survey of companies and products - Industrial production index - National accounts - Survey of energy consumption - Socio-economic indicators
Ministry of Industry, Trade and Tourism	General Secretariat for Energy	- IEA and Eurostat international questionnaires: · Heat and electricity · Natural gas · Oil-based products · Coals · Renewable energies and waste - Energy in Spain - Other energy-related statistics - Alternative Energy Development Institute (IDEA): Co-generation and biomass
	D.G. for Industry	- Non-ferrous metalwork - Ferrous metalwork - Construction materials - Sundry industries - Other chemical industries - Textile industry
Ministry of the Environment, and Rural and Marine Affairs.	D.G. for Environmental Assessment and Quality	- Waste treatment Generation/destination balance of waste Directories of facilities and statistics on waste and treatment: Managed landfills (with/without biogas recovery) Incinerators of municipal waste Incinerators of industrial waste Incinerators of other waste Municipal and animal waste composting plants Biomethanization facilities Waste-derived fuel production facilities
	D.G. for the Climate Change Office	- Information on the accounting of Kyoto units - Information on the national register - Information on Article 3, paragraph 14 of the Kyoto Protocol
	State Meteorology Agency	- Weather and climate information: · Temperature (air and land) · Rainfall and evapotranspiration · Wind · Sunshine, cloud cover, and solar irradiation · Electrical discharges · META, SYNOP, CLIMATOLOGY and TEMP reports · Climate maps

Chart 2.2.1.- Information required from contact points (Continued)

Ministry	Department	Information required
Ministry of Defence	D.G. for Infrastructure	- Fuel consumption in military tactical equipment
Ministry of the Environment, and Rural and Marine Affairs (Continued).	D.G. for Sustainable Development of Rural Settings D.G. for Agricultural and Husbandry Resources Technical General Secretariat	- Statistics on forestation and farmland - Farmland management practices (herbaceous and woody crops) for the Kyoto Protocol - Statistics on surface areas, production and yield for farm crops (ESYRCE) - Map of crops and uses - Consumption of synthetic fertilizers - Consumption of halocarbons and SF_6 - Generation/destination balance and composition of WWTP sludge - Fleet and statistics on self-propelled mobile farm machinery - Food and Agriculture Statistical Yearbook - Censuses/Surveys of cattle breeding assets - Statistics on husbandry production (milk, meat, etc.)
	D.G. for Food Industry and Markets	- Diet (protein content) - Directory and statistics for the food processing industry - Raw materials, products and water treatments
	D.G. for Natural Environment and Forest Policy.	- Forestry map (MFE 50 and MFE 25) for land use and land use changes on hillsides - National Forestry Inventories (IFN2 and IFN3) - Forestry Management Practices for the Kyoto Protocol - Database of forestry repopulation - Statistical and cartographic applications for the estimation of GHG flows in forestry activities
	D.G. for Water	- Database, directory and statistics on urban WWTPs - Database, directory and statistics on industrial WWTPs
	D.G. for Fishing Organization	- Database on fishing fleet for use in connection with the inventory - Statistics on the operational fishing fleet

2.2.2.- Overview of the inventory's planning

The Directorate-General for Environmental Quality and Assessment (DGCEA), as the National Authority for the SEI, and with the UIAE as its operational unit, designs and directs the planning tasks for the inventory, of which some of the most important are described below:

1) Identification of priority activities for the improvement of the inventory, based on the identification of key categories and the availability of resources, and programming objectives for achieving this improvement.

2) Maintenance and revision plan for the rest of the activities in the inventory which are not considered to have such a high priority.

3) Assignment of human/material resources and the identification of responsibilities in order to carry out the activities considered in points 1) and 2) above.

4) Establishment of a monitoring plan (time periods, results, analysis of deviations and corrective actions) for the activities in point 3) above.

These tasks will be undertaken between January and February each year, and the decisions in the plan shall be documented for the new edition of the Inventory. Technical Assistance collaborates in these tasks with the UIAE to prepare the Inventory, and all the

relevant information provided in the previous period by the institutions cooperating with the SEI is collected, also taking into account the results of quality control activities, reports from the review teams, and where necessary, quality assurance and verification reports.

2.2.3.- Overview of the preparation and management of the inventory

The Directorate-General for Environmental Quality and Assessment (DGCEA), as the National Authority of the SEI, and with the UIAE as its operational unit, designs and directs the tasks of preparation and management, specifically using the Technical Assistance resources for the Inventory, and the collaboration of the different organisations mentioned above in the section regarding institutional arrangements.

Although the process of preparation of the inventory is described in greater detail in section 2.3 below, the following stages are individually highlighted in this overview due to their particular importance:

1) The procedure begins with the analysis of the key categories identified in the previous edition of the inventory and which constitute the starting point for assigning the priorities for improving the inventory and for maintaining the remaining activities.

   A diagnosis is made of the key categories which appear as priorities in the development plan for the new inventory in order to achieve the best implementation of the estimation method of the emissions to be applied, taking into account the time period for attaining the specified objectives and the assignment of the available resources.

2) The second stage in the process is the choice of methods for estimating the emissions. This stage includes the initial selection of a category not previously considered, as well as the revision of the selected methods for those categories where a methodological change is proposed.

3) The third stage in the process is to collect the necessary information for applying the selected methods according to the activity (activity parameters and variables, algorithms and emission factors, measured or estimated emissions).

4) The fourth stage of the procedure is processing the data. This phase involves integrating the base data with the methods for estimating emissions in order to apply the procedures for calculating these emissions.

5) The fifth stage of the process is the preparation of reports and results tables for air pollutant emissions required by a variety of forums to which the SEI reports, in order to find the best balance between accuracy and precision on the one hand, and available resources on the other, in accordance with the established format, content and time periods.

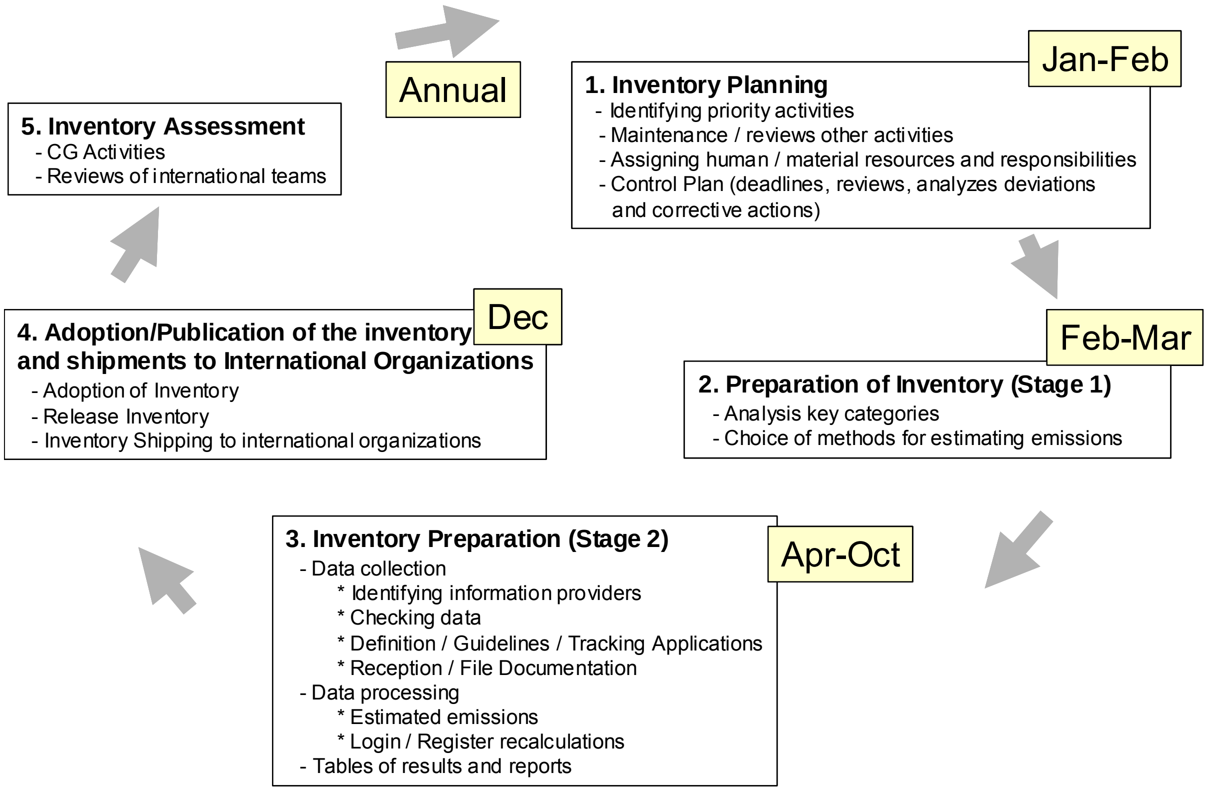
6) Finally the inventory is submitted for approval, as established in the Agreement of the Government's Delegate Committee for Economic Affairs. Once the inventory has been

approved, the reports and information –in the presentation required for each case– are published and sent to the international bodies through the national focal points.

The prospective calendar for the development of these stages is as follows: i) February and March (stages 1 and 2), April to October (stages 3 to 5), December (stage 6).

Figure 2.2.4 below shows the annual cycle of planning and preparation activities for the inventory.

Figure 2.2.4.- Diagram of the annual cycle of activities for the inventory.



2.3.- Preparation of the Inventory

The national emissions inventory is conceived as a single inventory that can be presented in a variety of output formats. One of these formats corresponds to the presentation of air pollutant emissions for the Secretariat of the Convention on Long-Range Transboundary Air Pollution and the EMEP programme.

The inventory drafting process takes place over the course of a series of stages which include: identification of key categories, selection of methods, compilation of data, information processing, results presentation and uncertainty analysis, and inventory validation. These stages are described in the subsections below.

2.3.1.- Identification of key categories

The primary objective in this stage is to establish the relative priority of the source and sink categories based on their contribution to the emissions and absorptions for the whole Inventory. An ulterior objective is to assist in optimising resource allocation to improve the accuracy and precision of the Inventory, by identifying and prioritising efforts to improve the estimation of categories, designated *key categories*[14]; focusing on the Inventory's absolute level or estimated emissions trends, weighting –when possible– this level or trend by the emission's uncertainty estimation for the corresponding category.

Section 2.5 of this chapter below gives specific details on this process and the results of identifying key categories.

2.3.2.- Selection of methods for estimating emissions

The objective of this phase is to select which estimation methods will be employed in the Inventory for each source and sink category. This stage includes the initial selection of a category not previously considered, as well as the selection of the revised method for any categories where a methodological change is introduced in an existing method. The factors to be considered in this process include: the preliminary feasibility analysis on all the available methodologies (availability of required information, effective practicability of the estimation algorithms), and the cost-effective analysis of the required resources (development, implementation and maintenance resources), and the benefits, in terms of forecast and accuracy, associated to this methodology-category for the entire Inventory.

Selection method criteria

The method for estimating emissions depends on the nature of the activity considered, and in this aspect, particularly whether or not it is considered a key category and on the availability of the basic information. The method selected is in each case geared to determining the most exact and accurate results of the emissions from each activity studied, following a progressive improvement plan over time up to increasingly advanced tiers.

The choice of method is made largely following the decision tree chart proposed for the different activities in the corresponding sections of the EMEP/CORINAIR 2007 Guidebook and the EMEP/EEA 2009 Guidebook. These guidebooks have been complemented with regards specific information on algorithms and emission factors by the following general reference sources: the EPA's AP-42 Guide, other secondary resource references, and of course the country's own methodologies (country-specific advanced tiers), which are given greater priority than those in the general references, and which are highlighted in thematic chapters 4 to 10 of this report.

[14] IPCC Good Practices Guidance 2000 defines a key category if it (emission source or sink) can exert a major influence on the Inventory's global estimation, whether by absolute value or series trend.

Types of methods

The selection of methodology conforms to some of the following types of established classification methods.

I) Methods based on observed emission data

a. Continuous measurement

b. Measurements at regular intervals

II) Methods based on calculation procedures

a. Balance of materials

b. Modelling/correlation

c. Emission factors

Review of methodologies

The methodologies are examined, focusing on the methodologies associated with major categories as the main targets for improved approaches (tier advance). For non-key categories a rotating examination is established such that on a tri-annual basis they are all subjected to an analysis of their potential for improvements in the methodology.

2.3.3.- Data compilation

The objective of this phase is the compilation of required data on activity parameters and variables, algorithm information and emission factors, and where necessary on measured or estimated emissions; and, in general, pertinent information on the selected methods for each activity.

The starting point for the compilation of activity data is:

- The nomenclature for activities and pollutants and the selection of the method of emission estimation.
- The identification of bodies or information sources related with each nomenclature activity.

A content form covering activity variables and parameters, and possibly specifications of the methods used for estimating emissions, will be associated with each body providing information.

The information compilation process involves the following steps:

- Identification of the information providers for each activity.

- Verification and revision if necessary of contact information.
- Definition of requests.
- Sending and follow-up of requests.
- Receipt of requested information.

The EFDI auxiliary database is used to monitor these activities. The EFDI database follows the whole process from the sending to the receipt of requests for each edition of the Inventory, ensuring its traceability.

Identification of the information providers

The first step involves updating the data obtained in previous editions of the Inventory from the providers of the information classified by SNAP group. The different institutions with competence in the area of each activity are requested to report on any incorporations, cancellations or modifications which have occurred during the year in the organisations, companies, plants, etc. which belong to or are associated with each institution.

Data verification

Once the list of information providers has been obtained, the contact data is verified by telephone follow-up, in order to confirm the contact data (contact person/s, e-mail address, postal address) of the information providers for the Inventory.

The information on contact data is entered into the auxiliary database *Status of the Documentary Sources of the Inventory* (EFDI). This database contains the history of the data, as well as a record and comments on any modifications in the companies, associations and public bodies. All information corresponding to previous editions of the Inventory is always maintained in order to guarantee constant control, which is the underlying principle of the data collection system.

Definition of requests

Once the list of Inventory information providers and their details have been updated, an analysis is made of the documentation which should be requested from each information provider (questionnaire to be completed, special publication).

For the providers who have collaborated in a previous edition of the Inventory, the requests for information that were sent in that edition are revised and the pertinent modifications are made in each case. For new information providers, the information to be requested is analysed, and a new form is designed if the content of the information to be requested does not fall into any of the already existing types of form.

The request for information generally consists of a letter (requesting the providers' cooperation and explaining the content of the letter), and one or several annexes (questionnaire to be completed, data collection tables) usually in EXCEL or WORD file

format. In other cases the letter itself (with no annexes) contains the request for the data or publications by the organisation to whom the information request is addressed.

Sending and follow-up of requests

Once the institutions and the information to be requested from each one have been identified, the information requests are processed.

These requests are sent to the contact persons identified at the contact data verification stage, in duplicate: once by post (the request letter is sent signed by the director of the DGCEA, to certify the official nature of the request) and by e-mail (the letter is sent together with the annexes for the requested information, which allows greater agility and efficiency in preparing the response by the recipient of the request, as well as in its subsequent processing in the DGCEA).

The EFDI database records a list of the information requested from each organisation, sending date and deadline for the receipt of the reply, by SNAP activity and for each edition of the Inventory.

The status of the requests is continually monitored by the EFDI database, and where necessary an alert system issues reminders if certain dates are exceeded. Finally the processing of the requests is completed, and they are labelled either “concluded” or “pending”, whichever the case.

In the case that the time period indicated in the request letter for the receipt of a response has elapsed, and no information has been received from the provider, a process is initiated by telephone and e-mail to contact the provider with a reminder of the need to supply this information, underlining the obligatory nature of the request (deriving from the consideration of the inventory as a statistical operation) and the need to return the duly completed request form in the shortest possible time.

Receipt of requests

A formal external examination is made of the responses received in order to detect any omissions or deficiencies; if this is the case they are recycled back into the request emission system in order to correct these defects. The information is then formally received and the organisations that have provided an acknowledgement of receipt are notified, and informed that a preliminary validation of the data provided will be made and subsequently completed with tests to be carried out at the data processing stage. Alternatively, for the organisations that have not provided the requested information within the specified time period, a notification will be included in the current edition regarding the lack of information for processing.

The EFDI database records the whole process from the sending to the receipt of requests for each edition of the Inventory in order to ensure its traceability.

Archiving the documentation

All documentation generated throughout the inventory is collected together in a register which records the operations carried out and the results obtained. This register is stored in electronic or hard copy format in such a way as to prevent its manipulation, deterioration or loss.

A standardised procedure is followed that includes:

- Organisation and circulation of documentation as it is generated by the project.
- Classification and maintenance of documents containing substantive information in a structured archive.
- Description of documentation, contents and key words to facilitate consultation at a later date.
- Physical installation that ensures easy recovery and preservation.

The file thus comprises base data and associated documentation, based on the relationships between SNAP categories, organisations and documents, grouped together to form chronological series of documents. It also includes the different reports sent and the inventory's own database.

For practical motives regarding work organisation and for safekeeping, the SEI database, along with the most important complementary data, are maintained in the Directorate-General for Environmental Quality and Assessment (Ministry of Environment and Rural and Marine Affairs) for the preparation of the Inventory.

The aim of this entire information management system is to comply with the goals of information protection and to provide fast and accurate access to the data.

2.3.4.- Data processing

The objective of this phase is the development, implementation and maintenance of the emissions estimation algorithms in compliance with the methods chosen and the information on the activity variables and parameters, and other procedural specifications included in the compilation of data.

This phase incorporates the integration of the base data with the emission estimation methods in order to apply the calculation procedures for these emissions.

The activity data, the emission factors and calculation procedures are implemented in the ORACLE database of the Inventory which is responsible for managing the data processing and generating emission estimations. However, there are previous calculation

procedures determined in modules outside the database and that are predominantly supported by spreadsheets and auxiliary databases[15].

This phase also incorporates data processing involving new approaches in methodologies and new calculations.

A combination of approaches is used to process the information: both bottom-up (from the detailed level to the aggregate level) and top-down (from the aggregate level to the detailed level). In general, the bottom-up approach uses, whenever available, information verified at the most disaggregated levels of the hierarchies by sector of the nomenclature for potentially pollutant-emitting activities that are the basis of the inventory (SNAP nomenclature) and territorial activities (NUTS nomenclature of EUROSTAT). On the basis of this initial information, estimates for the higher levels can then be obtained by successive aggregation until the maximum level is reached.

This first approach is used for large point sources and a good number of area sources (for example, emissions from mining industries, agricultural crops and livestock). The second approach, the top-down approach, is used for the remaining area sources.

Database: information content

The information base obtained from the providers is illustrated and stored in the Inventory's ORACLE database using the following procedures:

- Expansion, where necessary, of the relational model with the representation of the new sets of data received.

- Verification and integration of data into the database.

    - Application of the internal consistency criteria for the data in each data block. Missing information is identified, anomalous data highlighted (erroneous or suspected error), and communication is established with the provider in order to obtain the missing information and to analyse the anomalous data and correct any errors.

    - Consistency criteria are applied for the sets of data supplied by the different providers. Potentially incompatible data aggregates are identified and communicated to the providers in order to resolve apparent contradictions.

    - Integration of the validated information into the database.

[15] In the practical application the most frequently used are EXCEL spreadsheets and ACCESS databases.

Database: calculation algorithms

The algorithms for emission estimations are represented in the Inventory's ORACLE database as references and procedures that refer to variables, parameters, and emission factors chosen during the phase of selection and development of methods.

Emissions estimation

Before the final estimation of emissions, a preliminary estimation of annual emissions by sectors and sub-sectors of activity and substance (gas) category is prepared. The inter-annual variation rates between the contributions of these prior estimations by sector/sub-sector throughout all the years in the inventoried period are compared with the total emissions of each substance and for each sector/sub-sector, in order to detect any possible anomalies.

If any anomalies are detected, their cause is investigated, and any errors identified are resolved.

Once these errors have been resolved, a final emissions estimation is prepared according to the different activity nomenclatures and in all the presentation formats required by the Inventory: base format SNAP, CRF Format, NFR Format.

Identification and recording of new calculations

During the method selection phase in the Inventory's preparatory process, the methodology used in the previous edition of the Inventory is revised. This revision may lead to a new approach in the methodology used for some of the activities in the Inventory. These new approaches in the methodologies may involve the need for new calculations that could affect all or part of the time series. In addition, the database update (new available information or correction of errors) may also give rise to new calculations.

Chapter 11 of the IIR "New calculations and improvements" describes the new calculations applied in the national inventory of emissions and its planned improvements. This chapter examines the following themes:

- Explanation and justification of recalculations.
- Implications for emission levels.
- Implications for emission trends.
- Improvements planned for the Inventory (analysis by affected categories).

2.3.5.- Preparation of results tables and reports

The objective of this phase is to prepare the reports and results tables for air pollutant emissions required by the various forums to which the SEI reports, in order to find the best

balance between accuracy and precision on the one hand, and available resources on the other, in accordance with the format, content and deadline criteria.

Each type of report generated is correctly recorded and filed according to its particular specifications.

The reports and results tables generated are described below:

A) Report to Geneva Convention (CLRTAP) and EMEP programme

- Annual report to the United Nations Economic Commission for Europe. EMEP programme
  - Anthropogenic emissions pollutants SO_X, NO_X, NMVOC, NH_3, CO, heavy metals, particulate matter and persistent pollutants. Breakdown by point sources and desegregation by EMEP grid
  - EMEP/CORINAIR methodology
  - Presentation of data in NFR tables

B) Report for National Emissions Ceiling Directive

- Annual communication to the European Union Commission
  - Anthropogenic emissions of SO_X, NO_X, NMVOC and NH_3
  - EMEP/CORINAIR methodology
  - Data presentation of NFR (Nomenclature for Reporting) tables with sector-based and territorial specifications.

C) Report on greenhouse gas emissions

- Annual report to the European Union Commission
- Annual report to the Secretariat of the Framework Convention on Climate Change

These reports contain:

- Anthropogenic emission of CO_2, CH_4, N_2O, HFC, PFC and SF_6 (year x-2). Provisional data for CO, SO_2, NO_X y COVNM (year x-2 and definitive x-3). Emissions and absorptions for land uses and land use changes (year x-2)

  IPCC base methodology
- Data presentation CRF (Common Reporting Format) + NIR (National Inventory Report)

This phase involves monitoring the database interfaces with the presentation forms of the tables and reports, and verifying the variations arising from any methodological revisions and new recalculations effected in successive editions of the Inventory.

2.3.6.- Inventory approval

The Inventory is approved according to the procedure established in ACDGEE-2007 previously mentioned in section 2.2.1.1. The proposal for the National Air Pollutant Inventory prepared by the DGCEA is sent by the Minister for the Environment and Rural and Marine Affairs to the Government's Delegated Committee for Economic Affairs.

Once the Inventory on air pollutant emissions has been approved, together with its reports and data in the required presentation formats, they are published and sent to international bodies by means of the respective countries' focal points for the secretariats of the various relevant international conventions, as occurs for the European Commission through Spain's Permanent Representation before the European Union.

2.4.- General methodology

This section describes the methodology followed for preparing the national inventory and its specific presentation for submitting emissions estimations for the Geneva Convention (CLRTAP) and the EMEP programme.

2.4.1.- Coverage of activities and pollutants

The basic structure for compiling the inventory with regard to the cross-referencing of potential emission activities and pollutants is the SNAP-97 nomenclature, extended with the columns corresponding to particulate matter broken down by diametric classes ($PM_{2.5}$, PM_{10} and TSP). The presentation format for the emissions, and part of the activity variables, corresponds to the table structures given in section D of Annex IV of the document entitled "ECE/EB.AIR/97" of UNECE (January 27th 2009).

2.4.2.- Coverage and spatial resolution

Administrative division:

The base national emissions inventory is compiled on a scale of spatial disaggregation that covers the various hierarchy levels of the nomenclature of territorial units NUTS of the European Commission Statistical Office (EUROSTAT). The territorial classification includes the 4 following levels:

- Level 0: Spain
- Level 1: 7 large geographic regions (North-West, North-East, Madrid, Centre, East, South, Canary Islands).

- Level 2: 19 autonomous communities, including the autonomous cities of Ceuta and Melilla.
- Level 3: 52 provinces including Ceuta and Melilla.

In any case, maximum priority has been given to ensuring that the national inventory is representative, complete, consistent and transparent for the whole of the Spanish national territory.

The Inventory also specifies what are known as Large Point Sources (LPS), which will be expanded further on. The co-ordinates of the geographical location of these LPS are given and they are thus automatically included within the corresponding NUTS hierarchy.

The use of administrative units is perhaps the most convenient form of geographical breakdown in the Inventory, both in terms of the capture of basic data and from the standpoint of using the results to make environmental policy decisions. In fact, a large part of the information on socio-economic variables, and most particularly in the case of Area Sources, is only available at certain levels in the hierarchy of administrative units (province, autonomous community, region and state, in the case of Spain), and most environmental policy decisions are made with reference to these administrative units.

Regular geographic division: EMEP/OECD grids:

In order to satisfy the requirements of the EMEP Programme, base Inventory information has been presented on what is known as the EMEP grid (EMEP/OECD), which is a regular 50x50 km grid obtained by polar stereographic projection[16], with activities broken down according to NFR (Nomenclature for Reporting) nomenclature. It should be noted that the coverage of this grid does not include the Canary Islands; while Ceuta and Melilla are not considered within the EMEP Programme.

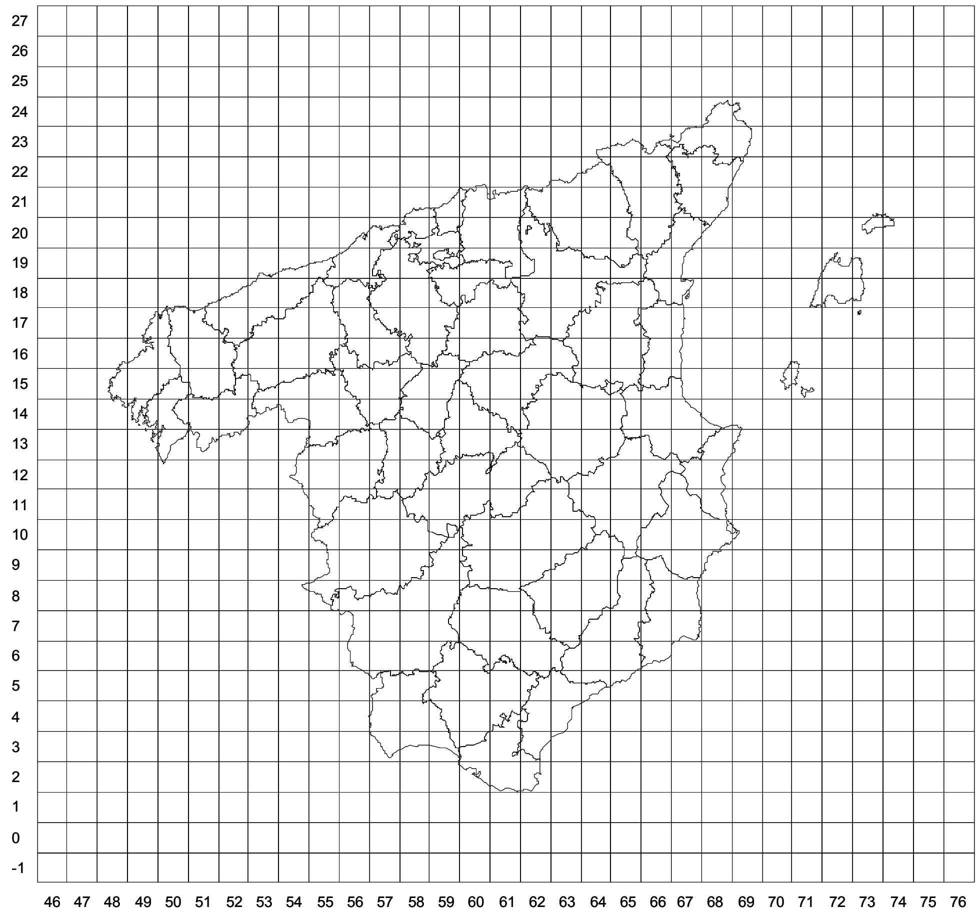
For the Inventory, initially based on administrative units, the Inventory work team has transposed the results to the EMEP grid ensuring consistency with the corresponding projections.

Figure 2.4.1 shows the superimposition of the EMEP grid on the part of Spain covered. The values shown on the horizontal and vertical axes correspond to the numerical references used for the grid cells.

---

[16] Specifications can be consulted in Schedule V of the document entitled “ECE/EB.AIR/97”.

Figure 2.4.1.- Superimposition of the EMEP grid on the national territory



Localisation of Large Point Sources (LPS):

LPS localisation is specified by means of geographic co-ordinates and their corresponding projections on UTM and stereographic plans. This specification makes it possible to locate each point source inside both the corresponding unit of administrative division and also the cell corresponding to the EMEP grid, and thus allows the contribution of the emissions from the point sources to be attributed to their geographic unit of reference. The geographical information fields are given below:

- Geographical co-ordinates:
    - Latitude (degrees, minutes, seconds). Precision 30 m.
    - Longitude (degrees, minutes, seconds). Precision 20 m.
- UTM co-ordinates:
    - Time zone

· X metres. Precision 1 m.

· Y metres. Precision 1 m.

- Stereographic co-ordinates:

· X metres. Precision 1 m.

· Y metres. Precision 1 m.

- Elevation of stack emissions:

Emissions for large point sources will be segmented into sections according to stack elevation Z (with precision 1 m.):

· Z_1: with Z< 45 m

· Z_2: with 45 m <= Z < 100 m

· Z_3: with 100 <= Z < 150 m

· Z_4: with 150 <= Z < 200 m

· Z_5: with 200 m <= Z

2.4.3.- Types of emission sources: point and area sources

Two basic classes of emission sources have been distinguished in accordance with the EMEP/CORINAIR methodology: point sources and area sources.

Area sources

Area sources generally comprise various emitting units (primary sector activities such as agriculture and extraction, industrial plants, commercial and residential centres and sites, natural spaces) which, as a result of their limited individual significance or due to the way their basic data are represented (breakdown by territorial units), must be dealt with on an aggregate basis for a particular geographical area. As explained above, area sources have been considered in the national base inventory at the NUTS 3 level, and the EMEP grid information has been extrapolated in order to complete the inventory in NFR format.

It should be pointed out here that, by applying the Inventory's principle of spatial consistency, whenever there are point sources superimposed on what are strictly area sources for a particular activity in the Inventory within a NUTS 3 area (province) or within a cell on the EMEP grid, the value of the activity variable (and the emissions) must be verified at the entire NUTS 3 level to ensure it is the aggregation of the values corresponding to the sum of the point sources and those of the area sources also located within the aforementioned NUTS.

Large point sources

Point sources are those stationary sources which, due to their significance for the Inventory, must be treated individually. For the exact location of these point sources, their geographic coordinates are provided together with complementary information to enable identification of the most significant variables in the processes generating pollutants and their emission conditions. This information on large point sources is shown in Table 2.4.1 below.

Table 2.4.1.- Data structure for Large Point Sources

- Identification of the organisation (institution/company)
- Identification of the plant or activity centre
- General information on the activity centre or plant
- Description and physical parameters, including three-dimensional co-ordinates, of the emission points: stacks
- Physical-chemical variables on the flow of gases emitted by the stack: volume, temperature, pressure, oxygen, humidity, etc.
- List of units emitting into the different stacks
- Description of the characteristics of the emitting units
- Consumption and characteristics of the fuels used
- Emissions abatement techniques applied to emitting units or stacks
- Emissions per emitting unit
- Stack emissions
- Diffuse emissions
- Total emissions from the plant or activity centre

Table 2.4.2 below presents the criteria used to identify LPS as they appeared in Table I A of the document entitled “ECE/EB.AIR/80, Air Pollution Studies series, No. 15”, based on the sector corresponding to the plant, on the relevant substances emitted and on the capacity of the facilities. The Table is completed with a final column reporting the proposal made in the national inventory with regard to whether or not the emission source listed in the rows of this Table is considered as an LPS. It should be noted that this concept of LPS has not as yet been adapted to the specifications in the “ECE/EB.AIR/97” document, as the implementation of the verification procedure is still pending in the emissions inventory regarding which LPSs, according to the definitions in the “ECE/EB.AIR/80” guidelines for previous reports, are to be associated with the corresponding emissions thresholds for each substance in the E-PRTR regulation. The correspondence between the old and new criteria for LPS identification will be included in the next edition of the inventory.

Table 2.4.2.- Monitoring of EMEP criteria for identifying Large Point Sources

	EMEP CRITERIA											INVENTORY APPROACH	
	POLLUTANT										THRESHOLD	LPS	COMMENTS
PROCESS	NO_X	SO_2	NH_3	NMVOC	CO	HM	PCDD/F	PAH	HCB	TSP	CAPACITY	(1)	
Combustion plants	X	X			X	X	X			X	300 MW	X	Convention thermal power plants
Waste incineration plants					X	X	X	X	X		50 t waste per day	P	Excluding small installations
Thermal metallurgical processes	X	X			X	X	X		X	X	All primary processes	X	Integrated iron and steel plants and alumina and aluminium production
Aluminium production								X			All	P	
Cement production	X	X				X				X	All	S	
Refineries	X	X		X	X	X	X	X		X	All	P	
Coke and anode production					X			X			All	X	Coke from integral metallurgy Total coverage for anode production
Sulphuric acid production	X	X									All	P	Including facilities for the abatement of SO_2 emissions in non-ferrous metal industries or of any other kind.
Ammonia and nitric acid production	X		X								All	X	Nitric acid production.
Chemical production processes							X		X		All	S	
Airports (2)	X			X	X							P	Threshold: 100,000 landing and take-off cycles (LTO) per year. Traffic at altitudes of more than 3,000 feet are not included in the LTO cycle.
Vehicle painting units				X							10^5 vehicles per year	P	
Use of chlorinated fuels in furnaces							X		X		All	S	
Wood processing facilities (3)				X				X				S	
All stationary sources	(X)	(X)		(X)						(X)	500 t NO_X or SO_2 or NMVOC or TSP emitted per year	X	SO_2 or NO_X or VOC emissions exceed 1,000 tonnes per year (or 300 kt per year for CO_2 emissions)

(1) P: LPS; S: Area source; X: Both considerations.
(2) Airports: Includes only emissions from aircraft.
(3) LPS if its contribution to total PAH emissions is significant.

It should be noted that if a plant acquires the consideration of Large Point Source for a particular pollutant, this consideration is extended to all of the pollutants and information is therefore given on the emissions with respect to all pollutants considered.

In the case of the national base inventory, in addition to those shown in the Table above, plants in other sectors have also been considered as Large Point Sources when their contribution to the emissions of certain pollutants in the Inventory is highly significant. These sectors include the following:

- Paper pulp: the EMEP/CORINAIR methodology identifies paper plants producing over 100,000 tons of pulp per year (9% dry material prepared for use and shipment) as an LPS.
- Any site where the emissions are vented using stacks greater than or equal to 100 metres in height (of relevance for EMEP)[17].

2.4.4.- Approaches for preparing the inventory

A combination of bottom-up and top-down approaches has been used for preparing the Inventory.

In general, the bottom-up approach has been used whenever verified data were available at the most disaggregated levels of the sector-based (SNAP/NFR) and territorial hierarchies (NUTS). On the basis of these initial data, successive aggregation has been used to obtain the estimates for the upper levels up to the maximum possible aggregation level

The top-down approach has been adopted in cases where the above approach was not feasible due to the non-existence of data with maximum disaggregation, their non-availability, or the high cost of processing due to the large number of data items to be handled. In these situations, the procedure for completing the Inventory was complemented with procedures for distributing the estimated emissions to the levels of greatest disaggregation by using the most appropriate subrogated variables for each type of activity.

In general terms, the first approach (bottom-up) has been used for the Large Point Sources and in a good number of the Area Sources, and the second approach (top-down) for the remainder of these sources.

Nevertheless, it should be noted that one or the other approach was not exclusively applied, and that, particularly during the Inventory's verification phase, the examination of the bottom-up results has been filtered using consistency tests deriving from the top-down approach, and vice-versa.

[17] Point sources with stacks over 100 metres high have been identified for those sectors from which information is received via individualised questionnaire from each plant. It may be possible that for future inventory editions, additional focuses with stacks over 100 metres high will be identified.

2.4.5.- Emissions estimation methodology

General description of the estimation methods:

The emissions estimation method depends on the nature of the activity being considered and the availability of basic data.

The choice of method has been aimed at obtaining the most exact and accurate result for the emissions in each activity examined. Based on the availability of information on the emissions themselves, the estimation methods applied in the preparation of this Inventory can be classified into two major categories:

I) Methods based on observed emission data.

These methods are based on direct observation of the variable of interest, i.e. the emission itself, and the following types can be distinguished between these methods:

a) **Continuous measurement.**

b) **Measurement at regular intervals.**

In this Inventory, methods based on direct observation have mainly been used in connection with the Large Point Sources –excluding airports– as their environmental importance and the size of the activity involved mean that this kind of measured data is frequently available. This information is collected from the plants themselves through questionnaires.

Specifically, direct measurement has been used for the determination of:

- SO_X: in thermal power plants, oil refineries, sulphuric acid plants (in part: in some plants and in certain years), paper pulp plants (in part: in some plants and in certain years) and in urban and industrial waste incineration plants.

- NO_X: in thermal power plants, oil refineries (in part: in some plants and in certain years), nitric acid plants (in part: in some plants and in certain years), paper pulp plants (in part: in some plants and in certain years) and in urban waste incineration plants (in part: in some plants and in certain years) and in industrial waste incineration plants.

- NMVOC: in vehicle painting lines and industrial waste incineration plants.

- NH_3 nitric acid manufacturing plants and urban waste incineration plants (in part in both: in some plants and in certain years).

- TSP: in thermal power plants (covering the vast majority of plants), oil refineries (limited coverage of plants), integral iron and steelworks (for all centres but with limited coverage of stack facilities), urban waste incinerators, paper pulp (limited coverage of plants) and aluminium production (limited coverage of plants).

- Other pollutants in all those point sources for which it has been possible to collect direct data. This is the case in:

  Coal-fired thermal power plants (1995-1998) for cadmium, mercury and lead.

  Urban waste incinerators, mainly with respect to heavy metals and dioxins.

  Industrial waste incinerators, mainly with respect to heavy metals and dioxins.

  Cement (clinker) production between 2005-2008 for the following substances: SO_x, NO_x, NMVOC, CO, As, Cd, Cr, Cu, Hg, Ni, Pb, Zn, TSP and DIOX.

  Chlorine production (years 1998-2008) for mercury emissions.

II) Methods based on calculation procedures

This category can once more be subdivided into procedures based on:

a) **Simple balance of materials.**

This method has been applied for the estimation of sulphur dioxide in combustion facilities where information is available regarding the amount of sulphur present in the various fuels used and the retention coefficients for ash and specific parts of the combustion facilities. In installations with de-sulphurisation units where information was available on emission abatement techniques, the estimation of potential emissions has been corrected, where necessary, with a reduction coefficient. This procedure was also used to estimate lead emissions and other heavy metals in internal combustion engines in vehicles for road transport and mobile machinery.

b) **Complete balance.**

This method comprises the determination of all inputs and outputs of different chemical elements (using data on the types of process and facilities as well as the amounts of materials and the elements in their composition), although it was not in fact possible to apply it effectively in the estimation due to its complexity. In any case it has been retained as a reference method for validating atypical estimates.

c) **Methods based on functional statistical models: Modelling-correlation.**

This method is based on the results of earlier works into the estimation of functional relationships or correlations between certain physical and chemical variables and emissions from certain activities. It has the advantage of providing specific relationships and making it possible to estimate the emissions as if there were continuous monitoring of the activity. Specifically, it has been applied to estimate emissions from group 1A3b Road transport, 4B Manure management

and 4D Agricultural soils when functional ratios adjusted by regression analysis were available.

d) **Methods based on emission factors: activity factors and variables.**

This method has been the most generally used in preparing the Inventory and has always been considered as the back-up option, only applied when no other more precise option was available to estimate the emissions for an activity. These default emission factors, given by unit of socio-economic variable, constitute subrogated information on plants or activities that can be assimilated to those for which estimations are required in this inventory.

2.4.5.1.- Consideration of the effect of abatement techniques

One point of great importance for the correct application of the estimation methods based on algorithms is the consideration of the efficacy of the abatement which is assumed in the functional relationships and in the emission factors used in this group of methodologies. For this purpose, the appropriate corrections were applied, in terms of the data available for each activity in the Inventory, to the value of the functional relationship or to the emission factors in order to adapt them to the degree of application of emission abatement techniques in the various emitting activities included in the Inventory. The following examples, among others, can be given as important illustrations of this criterion:

- Heavy metal emission factors at coal-fired thermal power plants depending on whether or not they use gas desulphurisation techniques in addition to particulate control techniques (please refer to Table 31, Chapter B111, EMEP/CORINAIR Guidebook).
- NO_X emission factors in the processing furnaces of oil refineries when they use low NO_X-emission burners (please refer to section 3.5, Chapter B-136, EMEP/CORINAIR Guidebook).
- SO_2 emission factors at primary zinc and copper production plants when there is an associated sulphuric acid production plant capable of reducing the emissions from the first plants by between 90% and 99%. Furthermore, in SO_2 emissions at the refineries, the number of sulphur recovery phases in Claus plants has been taken into account so as to select the most representative factor in those cases where no direct estimation was available for the emissions provided by the plants themselves.
- For heavy metal and dioxin, emission factors depending on the abatement techniques as specified in the EMEP/CORINAIR Guidebook (chapter B921), for those cases in which direct measurements have not been provided by the waste incineration plants themselves.
- For PM_{10} and $PM_{2,5}$ particulate, emission factors in LPS that, in addition to TSP emissions, report the implementation of particulate abatement techniques in their facilities (including especially dry electrostatic precipitators, whose effectiveness exceeds 99% reduction). The possible existence of control measures has been used to evaluate the appropriate level of abatement and its comparison with the four abatement levels indicated by the CEPMEIP, for each unit, and this parameter determines the emission factor assigned.

- Emission factors for conventional pollutants (SO_x, NO_X, NMVOC and CO), heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn) and particles (TSP) in the manufacture of cement (clinker) according to the estimated rate of penetration of emission control techniques in the sector in the sub-periods 1990-2000, 2001-2004 and 2005-2008.

- Emission factors for mercury in the manufacture of chlorine according to the estimated rate of penetration of emission control techniques in the sector and the implementation of less polluting processes during the 1998-2008 sub-period.

2.4.6.- Sources of information on emission factors and estimation algorithms

The following list contains the main data sources and the institutions consulted in collating the default emission factors or estimation algorithms used in the Inventory.

a) European Environment Agency (EEA) and the European Topic Centre on Air and Climate Change; and the EMEP programme:

- EMEP/CORINAIR Atmospheric Emission Inventory Guidebook, 3rd ed., 2001 (Guidebook, 5th update, December 2007 and intermediate updates between 2001 and 2007). Version available on the web page http://www.eea.europa.eu/publications/EMEPCORINAIR5.

- EMEP/EEA 2009 Guidebook, which is the update as far as 2009 of the previous versions of the EMEP/CORINAIR Guidebook, and which is available on the following website: http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009. Specifically, the COPERT IV methodology from this guidebook referring to the estimation algorithm for road traffic emissions.

- Web page of the European Topic Centre on Air and Climate Change http://air-climate.eionet.eu.int.

- CORINAIR Manual (1992). “Default Emission Factors Handbook”. Second Edition. Published by CITEPA for DG-XI of the European Commission.

b) Task Force on Emission Inventories and CEPE-EMEP Projections:

- Web page of the CEPE Task Force on Emissions Inventories and Projections (TFEIP), http://www.tfeip-secretariat.org.

- Web pages of the different working groups in the joint EMEP/CORINAIR programme.

c) EMEP and other programmes with a European scope:

- EMEP programme web page: http://www.emep.int) and the web page of the Centre for Emissions, Inventories and Projections (CEIP) (http://www.ceip.at/).

- Coordinated Programme on Particulate Matter Emissions Inventories, Projections and Guidance (CEPMEIP) web page: (http://www.air.sk/tno/cepmeip/)

- UNECE-CLRTAP. “Draft BAT Background Document. Task Force on the Assessment of Abatement Options/Techniques for Volatile Organic Compounds. French-German Institute for Environmental Research”. University of Karlsruhe. 1997.

d) OSPARCOM-HELCOM-CEPE

- PARCOM-ATMOS. “Emission Factors Manual. PARCOM-ATMOS. Emission factors for air pollutants”. P.F.J. van der Most and C. Veldt, eds., TNO Environmental and Energy Research, TNO Rept. 92-235, Apeldoorn, the Netherlands. 1992

- TNO-MEP - R 95/247. Technical Paper to the OSPARCOM-HELCOM UNECE Emission Inventory of Heavy Metals and Persistent Organic Pollutants.

- State of the Art Report of the Task Force on Heavy Metals Emissions. 2nd edition. Prague. 1995.

- Experiences with the Heavy Metals Inventory in Slovakia. Task Force of Emission Inventory. Oxford. 1996.

- Atmospheric Emission Inventory Guidelines for Persistent Organic Pollutants (POPs). External Affairs Canada and Czech and Slovak Republics. Prague, 1995.

- TOCOEN Project: “Compilation of Emission Factors for Persistent Organic Pollutants. A case Study of Emission Estimates in the Czech and Slovak Republics”. Prague, 1993.

e) Intergovernmental Panel on Climate Change (IPCC)

The guideline in the methodology prepared by the IPCC is of great interest regarding transverse methodological aspects (not linked solely to greenhouse gases) to be considered in preparing the inventory, such as: application of the principles, development of quality control and quality assurance procedures, criteria for selecting estimation methodologies; uncertainty quantification methods.

- The web site of the Intergovernmental Panel on Climate Change is: http://www.ipcc.ch.

  With regard to the preparation of inventories according to the IPCC methodology, the following basic references must be mentioned:

  - Revised 1996 IPCC Guidelines.
  - IPPC 2000 Guidance on Good Practice and Uncertainty Management in National Greenhouse Gas Inventories.
  - IPCC 2003 LULUCF Good Practice Guidance

- IPCC 2006 Guidance for National Greenhouse Gas Inventories.

- These reference sources and their attendant technical issues can be consulted on the web page http://www.ipcc-nggip.iges.or.jp, maintained by the Institute for Global Environmental Strategies (IGES) which runs the Technical Support Office for the IPCC Programme.

f) European Office of the IPPC: Institute for Prospective Technological Studies (IPTS) of Seville:

- The European Office of the IPPC (http://eippcb.jrc.es) has been developing in the IPTS an assessment of the different activity sectors subject to Directive 96/61/EC regarding integrated pollution prevention and control (IPPC). These sector-wide studies contain information on the processes used and the outlook for best available technologies (BAT) to allow a comparative examination of the evolution of their associated emission factors.

g) Sector-wide guides on technical improvements available in Spain:

These guides, developed by the Directorate-General for Environmental Quality and Assessment of the MARM in partnership with the various activity sectors, provide useful information for the inventory on the processes and techniques applied, current emission levels and available technical improvements, and are considered references to be consulted in order to complete the information to be submitted to the Spanish Pollutant Emission Register (PRTR-Spain, http://www.prtr-es.es/) according to the Integrated Pollution Prevention and Control Directive (IPPC).

h) U.S. Environmental Protection Agency (EPA)

- Compilation of Air Pollutant Emission Factors (AP-42). 5th edition.

  Air Chief also has a web page at the following address: http://www.epa.gov/ttn/chief/.

- Other web pages of interest are:
  - http://www.epa.gov/oar/oaqps/
  - http://www.epa.gov/ttn/uatw/

i) Interprofessional Technical Centre for the Study of Air Pollution (CITEPA)

- Etude sur les méthodes d'evaluation des quantités émises de particules fines (PM10 et inférieures) primaires et secundaires pour tous les secteurs d'activité en vue des inventaires. Final report. July, 2002.

j) International Institute for Applied Systems Analysis (IIASA)

- IIASA develops the RAINS model within the Long Range Transboundary Air Pollution Programme. The RAINS model and its information on emission factors can be consulted on the web page http://www.iiasa.ac.at/rains/index.html.

- "Modelling Particulate Emissions in Europe, A Framework to Estimate Reduction Potential and Control Cost". Z. Klimont, J. Cofala, I. Bertok, M. Amann, C. Heyes and F. Gyarfas. 2002.

k) Studies conducted within the framework of the European Commission

- Specific studies for other machinery and mobile sources (excluding road transport) Published by A.Andrias, Z.Samaras & K.H. Zierock.

  Notes on the Assessment of the Emissions of 'Off-Road' Mobile Machinery in the European Community. February 1993.

  The estimation of the Emissions of 'Other Mobile Sources and Machinery'. Subparts 'Off-Road Vehicles and Machines', 'Railways' and 'Inland Waterways' in the European Union. Final report (September, 1994.)

  Guidebook on the Estimation of the Emissions of 'Other Mobile Sources and Machinery'. Subparts 'Off-Road Vehicles and Machines', 'Railways' and 'Inland Waterways' (SNAPs 0801, 0802, 0803). September, 2004.

2.4.7.- Reference to information on regulated processes (PRTR, RENADE and LCPD)

It has not yet been possible to perform a systematic verification of the data from the three main references for basic information on regulated processes –PRTR, CO_2 Emissions Trading (RENADE Register) and the Large Combustion Plant Directive (LCPD)– essentially due to the fact that the first two mentioned do not provide the necessary basic information at the level of the central administration responsible for the inventory (DGCEA), whereas for the LCPD information, the harmonisation of the information systems is pending between the Ministry of Industry, Tourism and Trade (MITYC) which maintains these records, and the aforesaid DGCEA.

Some very important administrative steps have recently been taken to channel the relevant CO_2 Emissions Trading information (RENADE Register), both with respect to the basic information and to the results of the CO_2 emissions estimations, so that it is accessible to the central administration and, in particular, to the DGCEA responsible for the Inventory. Thus it is expected that future editions will be able to offer information which is harmonised with that of the Inventory. A similar harmonisation procedure is expected to be implemented for LCPD with the MITYC. Nonetheless, with regard to PRTR, there are still major difficulties for the short-term harmonisation of the information deriving from this register with that of the Inventory.

2.4.8.- General reference to information sources on activity variables: censuses, statistics, etc.

The most important references to censuses and statistical yearbooks are related to the following subjects and variables:

- Population:
  - Censuses of population and housing (every ten years, with the most recent in 2001)
  - Update of the municipal register of local inhabitants (official annual series of population figures)
- Energy:
  - National energy balance (International Energy Agency and EUROSTAT)
- Industry:
  - Industrial survey of companies and products (INE, annual)
- Agriculture:
  - Statistical Yearbook (Ministry of the Environment and Rural and Marine Affairs; annual)
  - Bulletins (Monthly Statistical Bulletin from Ministry of the Environment and Rural and Marine Affairs)
- Transport:
  - Transport and Communications Yearbook (Ministry of Public Works)
  - Statistical yearbook of vehicle fleets (DGT)

More specific information on censuses and statistical sources is provided in the sector-specific chapters 4 to 10 of this report.

2.5.- Analysis of key categories

In order to improve the precision and accuracy of the emission inventory estimations, it is necessary to consolidate the quality assurance and control procedures on the activities which could be considered key or high-priority from the perspective of their contribution to the uncertainty of the inventory estimations.

With regard to the methodological references, the IPCC 2000 Good Practice Guidance document, considered in this analysis as a basic methodological source for the Emissions Inventory for any type of inventoried substance, defines a category as key if it can exert a significant influence on the estimation of either the level or the trend of the inventory as a whole.

From an operational perspective, this guide establishes two levels or approaches (Tiers) to identify key sources. The first approach, Tier 1, determines the influence, either by level *(Level Assessment)* or trend *(Trend Assessment)*, that an emission source can exert on

the uncertainty of the global inventory estimation, but without requiring the use of more formal procedures of uncertainty analysis. The second approach, Tier 2, uses a similar procedure but is based on the availability of prior information deriving from a formal uncertainty analysis.

This chapter shows the determination of the key emissions categories applying a Tier 1 approach. This determination is given for the main pollutants (NO_X, NMVOC, SO_X, NH_3, CO), particulate matter ($PM_{2,5}$, PM_{10}, TSP), priority metals (Pb, Cd, Hg) and persistent organic pollutants (DIOX and PAH). When using Tier 1, it is necessary to distinguish whether a source is identified as key due to either its level or its trend, or both. For *level* identification, a threshold is first defined (usually 95%) for the cumulative distribution function of the emissions according to the activities in the Inventory, once these have been sorted into descending order of contribution to the Inventory. All activities included in the cumulative distribution function can be considered within that threshold to account for approximately 90% of the overall inventory uncertainty. For identification of *trend*, Tier 1 also specifies a threshold of 95% but defined in this case with regard to the contribution of the activities to the trend metrics[18].

Apart from the classification of a category, where appropriate, as a key source in quantitative terms with regard to its level and/or trend as expressed in the preceding tables, qualitative assessments are in some cases also of interest for those source activities deserving attention for other possible motives as potentially exerting a significant influence on the inventory's overall estimates. The reasons given in the IPCC 2000 Good Practice Guidance for the qualitative assessment of a category as a key source include the following: actions, whether planned or under way, to control and reduce emissions; any relevant changes experienced during the period considered; showing evidence originating major uncertainty; showing unexpectedly high or low emissions; and being subject to major methodological changes in the emission estimations. This is the case, among others, for the following categories:

- Activities involving the use of solvents and other products, where the estimation of NMVOC emissions has in general been carried out by using default emission factors that have remained fixed for the period 1990-2008 and which therefore may not correctly reflect the unit reduction of emissions due to the penetration of emission abatement technologies.

---

[18] The respective metrics for the level and trend are calculated by the following formulae

(1) $L_{x,t} = E_{x,t} / E_t$

(2) $T_{x,t} = L_{x,t} * \left| (E_{x,t} - E_{x,0}) / E_{x,t} - (E_t - E_0) / E_t \right|$

where:

$L_{x,t}$ is the level assessment for category *x* in year *t*

$T_{x,t}$ is the trend assessment for category *x* in year *t*

$E_{x,t}$ and $E_{x,0}$ are the emission estimations for category *x* in year *t* and *0*, respectively

0 is the base year (i.e. 1990 for main pollutants, metals and persistent organic pollutants; and 2000 for particulate matter)

- Fuel consumptions allocated to the national and international segments of air and maritime traffic, which require subsequent verification and whose revision may give rise to a significant re-estimation of the emissions from these air and maritime traffic segments. A major new methodological revision is also in progress for both these activities.

- Fuel consumptions and emission factors for NO_x, NMVOC, CO and particulate matter allocated to the activities related to the use of agricultural and industrial mobile machinery and fishing that may be subject to verification and whose revision may give rise to a significant re-estimation of the emissions in these activities.

- In agriculture, the livestock sector, due to a review currently under way into the methodology and the basic activity parameters, which is expected to involve changes associated mainly with emission factors and to a lesser degree with activity variables (particularly in the segmentation of the number of animals by age, production use, etc.).

- Activity variables and emission factors considered in the burning of forestry wastes which must also be verified.

Once the approach of the analysis is presented, the results obtained in the identification of key categories by pollutant are shown in Tables 2.5.1. and 2.5.2 for level in the initial year (1990 for main pollutants, metals and persistent organic pollutants; and 2000 for particulate matter) and final year (2008); and in Table 2.5.3 for trend in 2008. Table 2.5.4 shows a summary of the results, based on qualitative criteria, for the whole of the period.

The structure of Table 2.5.1 and 2.5.2 contains the following fields: i) code and description of the key category; ii) substance for which this category is key; iii) emissions in the category*substance cross-tab; iv) contribution to the inventory level (as a percentage); v) accumulated contribution (up to that category in the table) to the inventory level. With regards the description of the rows, the list of activities is given in descending order by their contribution to the inventory emissions and, after this list, the “SUBTOTAL” row, which combines the data for all the categories shown in the previous list; and finally the “TOTAL EMISSIONS” row, which groups the rest of the sources emitting the pollutant in question together with those in the preceding SUBTOTAL.

The structure of Table 2.5.3 contains the following fields: i) code and description of the key category; ii) substance for which this category is key; iii) emissions in the category*substance cross-tab for the base year; iii) emissions in the category*substance cross-tab for the reference year, in this case, the end year in the period inventoried; iv) assessment of the trend associated with the category*substance cross-tab; v) contribution to the inventory trend (as a percentage); v) accumulated contribution (up to that category in the table) to the inventory trend. With regards the description of the rows, the list of activities is given in descending order by their contribution to the inventory trend and, after this list, the “SUBTOTAL” row which combines the data for all the categories shown in the previous list; and finally the “TOTAL EMISSIONS” row grouping the rest of the sources emitting the pollutant in question together with those in the preceding SUBTOTAL.

Finally, the structure of Table 2.5.4 contains the following fields: i) code and description of the categories considered; ii) substance; iii) identifier (YES or blank) of whether the

category is (YES) or is not (blank) key for the pollutant in question; iv) identifier of whether or not it is a key category for the level of the pollutant; v) identifier of whether or not it is a key category for the trend of the pollutant; vi) years in the period inventoried during which the category has been identified as a key category for the level of the substance (blank if it was not considered key for this criterion); and vii) years in the period inventoried during which the category has been identified as a key category for the trend of the substance (blank if it was not considered key for this criterion). In this regard, it should be mentioned that a category will be classified as key for the level (or the trend) of a pollutant if it is identified as key in the inventory according to the criterion for any year in the period analysed. The “Key Source Category” column shows which categories are key for the pollutant under at least one of the two quantitative criteria.

Table 2.5.1.- Contribution to level by activity - 1990

Pollutant: NO_X

NFR CATEGORIES		Pollutant	Emissions ($Gg\ NO_2$)	Level valuation	Accumulated total
1 A 3 b i	Road transport - Passenger cars	NO_X	338,769	0,253	0,253
1 A 3 b iii	Road transport - Heavy duty vehicles	NO_X	250,134	0,187	0,439
1 A 1 a	Public electricity and heat production	NO_X	228,321	0,170	0,609
1 A 2	Manufacturing industries and construction - Stationary + Mobile machinery	NO_X	224,409	0,167	0,777
1 A 4 c i+1 A 4 c ii	Agriculture / Forestry / Fishing - Stationary + Other vehicles and mobile machinery	NO_X	94,052	0,070	0,847
1A 4 c iii	National fishing	NO_X	42,231	0,031	0,878
1 A 3 d ii	National maritime traffic	NO_X	33,703	0,025	0,904
1 A 1 b	Oil refineries	NO_X	23,609	0,018	0,921
1 A 3 b ii	Road transport - Light duty vehicles	NO_X	22,029	0,016	0,938
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	NO_X	19,147	0,014	0,952
	SUBTOTAL	NO_X	1.276,403	0,952	
	TOTAL EMISSIONS	NO_X	1.340,948		

Pollutant: NMVOC

NFR CATEGORIES		Pollutant	Emissions (Gg)	Level valuation	Accumulated total
1 A 3 b i	Road transport - Passenger cars	NMVOC	192,722	0,186	0,186
3 A	Paint application	NMVOC	172,460	0,166	0,352
3 D	Other uses of solvents and other products	NMVOC	113,482	0,110	0,462
1 A 3 b v	Road transport - Petrol evaporation	NMVOC	87,934	0,085	0,547
3 C	Manufacture and processing of chemical products	NMVOC	67,710	0,065	0,612
1 A 3 b iv	Road transport - Mopeds and Motorcycles	NMVOC	61,985	0,060	0,672
4 F	Field burning of agricultural wastes	NMVOC	57,886	0,056	0,728
3 B	Degreasing and dry cleaning	NMVOC	41,988	0,041	0,768
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	NMVOC	41,262	0,040	0,808
1 B 2 a v	Distribution of oil products	NMVOC	33,211	0,032	0,840
2 D	Other industries	NMVOC	32,296	0,031	0,871
1 B 2 a i + 1 B 2 a iv	Exploration / Production / Transport / Refining / Storage of petroleum	NMVOC	23,631	0,023	0,894
1 A 2	Manufacturing industries and construction - Stationary + Mobile machinery	NMVOC	17,057	0,016	0,911
1 A 4 c i+1 A 4 c ii	Agriculture / Forestry / Fishing - Stationary + Other vehicles and mobile machinery	NMVOC	16,182	0,016	0,926
1 A 3 b iii	Road transport - Heavy duty vehicles	NMVOC	14,583	0,014	0,940
2 A 6	Road paving with asphalt	NMVOC	11,670	0,011	0,952
	SUBTOTAL	NMVOC	986,059	0,952	
	TOTAL EMISSIONS	NMVOC	1.036,107		

Table 2.5.1.- Contribution to level by activity – 1990 (Continued)

Pollutant: SO_X

NFR CATEGORIES		Pollutant	Emissions (Gg SO_2)	Level valuation	Accumulated total
1 A 1 a	Public electricity and heat production	SO_X	1.459,010	0,670	0,670
1 A 2 f	Other manufacturing and construction industries - Stationary + Mobile machinery	SO_X	136,798	0,063	0,733
1 A 1 b	Oil refineries	SO_X	134,403	0,062	0,795
1 A 3 b	Road transport	SO_X	54,277	0,025	0,820
1 A 2 c	Chemical industry	SO_X	53,295	0,024	0,844
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	SO_X	40,591	0,019	0,863
1 B 2 a iv	Refining / Storage of petroleum	SO_X	40,267	0,019	0,882
1 A 2 d	Paper pulp, paper and printing industry	SO_X	38,618	0,018	0,899
1 A 2 e	Food processing, beverages and tobacco	SO_X	38,287	0,018	0,917
1 A 3 c + 1 A 3 d + 1 A 3 e	Other transport	SO_X	37,306	0,017	0,934
1 A 2 b	Non-ferrous iron and steelworks	SO_X	35,506	0,016	0,950
	SUBTOTAL	SO_X	2.068,359	0,950	
	TOTAL EMISSIONS	SO_X	2.176,246		

Pollutant: NH_3

NFR CATEGORIES		Pollutant	Emissions (Gg)	Level valuation	Accumulated total
4 D	Agricultural soils	NH_3	200,495	0,631	0,631
4 B	Manure management	NH_3	93,137	0,293	0,924
2 B	Chemical industry	NH_3	15,460	0,049	0,973
	SUBTOTAL	NH_3	309,091	0,973	
	TOTAL EMISSIONS	NH_3	317,698		

Pollutant: CO

NFR CATEGORIES		Pollutant	Emissions (Gg)	Level valuation	Accumulated total
1 A 3 b i	Road transport - Passenger cars	CO	1.844,588	0,505	0,505
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	CO	523,860	0,143	0,648
4 F	Field burning of agricultural wastes	CO	412,731	0,113	0,761
2 C	Metallurgical production	CO	289,671	0,079	0,840
1 A 3 b iv	Road transport - Mopeds and Motorcycles	CO	162,743	0,045	0,885
1 A 2 f	Other manufacturing and construction industries - Stationary + Mobile machinery	CO	100,361	0,027	0,912
1 A 2 a	Iron and steel	CO	96,678	0,026	0,939
1 A 3 b iii	Road transport - Heavy duty vehicles	CO	52,616	0,014	0,953
	SUBTOTAL	CO	3.483,249	0,953	
	TOTAL EMISSIONS	CO	3.654,081		

Table 2.5.1.- Contribution to level by activity – 1990 (Continued)

Pollutant: Pb

NFR CATEGORIES		Pollutant	Emissions (Mg)	Level valuation	Accumulated total
1A3	Transport	Pb	2.576,134	0,924	0,924
1A2	Manufacturing and construction industries	Pb	147,984	0,053	0,977
	SUBTOTAL	Pb	2.724,119	0,977	
	TOTAL EMISSIONS	Pb	2.788,359		

Pollutant: Cd

NFR CATEGORIES		Pollutant	Emissions (Mg)	Level valuation	Accumulated total
1A2	Manufacturing and construction industries	Cd	19,789	0,739	0,739
1A1	Energy industries	Cd	4,040	0,151	0,890
2C	Metallurgical production	Cd	2,280	0,085	0,975
SUBTOTAL		Cd	26,109	0,975	
	TOTAL EMISSIONS	Cd	26,782		

Pollutant: Hg

NFR CATEGORIES		Pollutant	Emissions (Mg)	Level valuation	Accumulated total
1A1	Energy industries	Hg	6,087	0,418	0,418
1A2	Manufacturing and construction industries	Hg	2,825	0,194	0,612
2B	Chemical industry	Hg	1,880	0,129	0,741
6A	Landfill deposit	Hg	1,490	0,102	0,843
2C	Metallurgical production	Hg	1,263	0,087	0,930
6C	Waste incineration	Hg	0,771	0,053	0,983
	SUBTOTAL	Hg	14,315	0,983	
	TOTAL EMISSIONS	Hg	14,568		

Pollutant: DIOX

NFR CATEGORIES		Pollutant	Emissions (g)	Level valuation	Accumulated total
1A2	Manufacturing and construction industries	DIOX	51,140	0,276	0,276
1A4	Other sectors	DIOX	38,102	0,206	0,482
6A	Landfill deposit	DIOX	24,829	0,134	0,617
1A1	Energy industries	DIOX	22,907	0,124	0,740
6C	Waste incineration	DIOX	15,068	0,081	0,822
2C	Metallurgical production	DIOX	14,686	0,079	0,901
4F	Field burning of agricultural wastes	DIOX	12,068	0,065	0,966
	SUBTOTAL	DIOX	178,799	0,966	178,799
	TOTAL EMISSIONS	DIOX	185,004		185,004

Table 2.5.1.- Contribution to level by activity – 1990 (Continued)

Pollutant: PAH

NFR CATEGORIES		Pollutant	Emissions (Mg)	Level valuation	Accumulated total
4F	Field burning of agricultural wastes	PAH	199,839	0,622	0,622
2C	Metallurgical production	PAH	48,644	0,151	0,773
1A2	Manufacturing and construction industries	PAH	43,740	0,136	0,910
1A4	Other sectors	PAH	22,034	0,069	0,978
	SUBTOTAL	PAH	314,257	0,978	314,257
	TOTAL EMISSIONS	PAH	321,251		321,251

Pollutant: $PM_{2.5}$

NFR CATEGORIES		Pollutant	Emissions (Gg)	Level valuation	Accumulated total
1A4	Manufacturing and construction industries	$PM_{2.5}$	49,058	0,388	0,388
1A3	Transport	$PM_{2.5}$	32,502	0,257	0,645
1A2	Manufacturing and construction industries	$PM_{2.5}$	21,181	0,167	0,812
1A1	Energy industries	$PM_{2.5}$	15,422	0,122	0,934
4B	Manure management	$PM_{2.5}$	3,525	0,028	0,962
	SUBTOTAL	$PM_{2.5}$	121,687	0,962	
	TOTAL EMISSIONS	$PM_{2.5}$	126,525		

Pollutant: PM_{10}

NFR CATEGORIES		Pollutant	Emissions (Gg)	Level valuation	Accumulated total
1A4	Manufacturing and construction industries	PM_{10}	50,557	0,297	0,297
1A3	Transport	PM_{10}	36,364	0,213	0,510
1A1	Energy industries	PM_{10}	29,149	0,171	0,681
1A2	Manufacturing and construction industries	PM_{10}	25,397	0,149	0,830
4B	Manure management	PM_{10}	17,602	0,103	0,933
2C	Metallurgical production	PM_{10}	6,136	0,036	0,969
	SUBTOTAL	PM_{10}	165,204	0,969	
	TOTAL EMISSIONS	PM_{10}	170,487		

Table 2.5.1.- Contribution to level by activity – 2000 (Continued)

Pollutant: TSP

NFR CATEGORIES		Pollutant	Emissions (Gg)	Level valuation	Accumulated total
1A4	Manufacturing and construction industries	TSP	52,270	0,226	0,226
1A1	Energy industries	TSP	42,158	0,182	0,408
1A3	Transport	TSP	41,676	0,180	0,588
1A2	Manufacturing and construction industries	TSP	31,673	0,137	0,725
4B	Manure management	TSP	29,789	0,129	0,854
4D	Agricultural soils	TSP	18,929	0,082	0,936
2C	Metallurgical production	TSP	7,494	0,032	0,968
	SUBTOTAL	TSP	223,990	0,968	
	TOTAL EMISSIONS	TSP	231,328		

Pollutant: NO_X

NFR CATEGORIES		Pollutant	Emissions (Gg NO_2)	Level valuation	Accumulated total
1 A 2	Manufacturing industries and construction - Stationary + Mobile machinery	NO_X	262,996	0,213	0,213
1 A 3 b iii	Road transport - Heavy duty vehicles	NO_X	227,479	0,184	0,396
1 A 1 a	Public electricity and heat production	NO_X	205,635	0,166	0,563
1 A 3 b i	Road transport - Passenger cars	NO_X	173,441	0,140	0,703
1 A 4 c i+1 A 4 c ii	Agriculture / Forestry / Fishing - Stationary + Other vehicles and mobile machinery	NO_X	136,163	0,110	0,813
1 A 3 d ii	National maritime traffic	NO_X	72,363	0,058	0,871
1 A 3 b ii	Road transport - Light duty vehicles	NO_X	30,366	0,025	0,896
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	NO_X	27,725	0,022	0,918
1A 4 c iii	National fishing	NO_X	24,058	0,019	0,938
1 A 1 b	Oil refineries	NO_X	22,128	0,018	0,956
	SUBTOTAL	NO_X	1.182,355	0,956	
	TOTAL EMISSIONS	NO_X	1.237,357		

Table 2.5.2.- Contribution to level by activity - 2008

Pollutant: NMVOC

NFR CATEGORIES		Pollutant	Emissions (Gg)	Level valuation	Accumulated total
3 A	Paint application	NMVOC	172,448	0,211	0,211
3 D	Other uses of solvents and other products	NMVOC	166,707	0,204	0,416
3 C	Manufacture and processing of chemical products	NMVOC	100,600	0,123	0,539
4 F	Field burning of agricultural wastes	NMVOC	51,679	0,063	0,603
2 D	Other industries	NMVOC	45,871	0,056	0,659
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	NMVOC	40,027	0,049	0,708
1B 2 a i+1 B 2 a iv	Exploration / Production / Transport / Refining / Storage of petroleum	NMVOC	26,653	0,033	0,741
1 B 2 a v	Distribution of oil products	NMVOC	26,507	0,032	0,773
1 A 2	Manufacturing industries and construction - Stationary + Mobile machinery	NMVOC	26,321	0,032	0,805
3 B	Degreasing and dry cleaning	NMVOC	26,063	0,032	0,837
6 D	Other waste treatments and elimination	NMVOC	21,739	0,027	0,864
1 A 4 c i+1 A 4 c ii	Agriculture / Forestry / Fishing - Stationary + Other vehicles and mobile machinery	NMVOC	20,330	0,025	0,889
1 A 3 b i	Road transport - Passenger cars	NMVOC	20,270	0,025	0,914
1 A 3 b v	Road transport - Petrol evaporation	NMVOC	20,127	0,025	0,938
2 B	Chemical industry	NMVOC	11,946	0,015	0,953
	SUBTOTAL	NMVOC	777,285	0,953	
	TOTAL EMISSIONS	NMVOC	815,604		

Pollutant: SO_X

NFR CATEGORIES		Pollutant	Emissions (Gg SO_2)	Level valuation	Accumulated total
1 A 1 a	Public electricity and heat production	SO_X	187,899	0,354	0,354
1A3c +1A3d +1A3e	Other transport	SO_X	68,940	0,130	0,485
1 A 2 f	Other manufacturing and construction industries - Stationary + Mobile machinery	SO_X	66,382	0,125	0,610
1 A 1 b	Oil refineries	SO_X	47,322	0,089	0,699
1 A 2 a	Iron and steel	SO_X	28,242	0,053	0,752
1 A 1 c	Transformation of solid fuels and other energy industries	SO_X	21,920	0,041	0,794
1 B 2 a iv	Refining / Storage of petroleum	SO_X	20,421	0,039	0,832
1 A 2 b	Non-ferrous iron and steelworks	SO_X	17,067	0,032	0,864
1 A 2 c	Chemical industry	SO_X	15,556	0,029	0,894
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	SO_X	13,844	0,026	0,920
1 A 2 b	Food processing, beverages and tobacco	SO_X	6,247	0,012	0,932
1 A 2 c	Paper pulp, paper and printing industry	SO_X	6,217	0,012	0,943
1 A 4 c i+1 A 4 c ii	Agriculture / Forestry / Fishing - Stationary + Other vehicles and mobile machinery	SO_X	5,927	0,011	0,955
	SUBTOTAL	SO_X	505,985	0,955	
	TOTAL EMISSIONS	SO_X	530,043		

Table 2.5.2.- Contribution to level by activity – 2008 (Continued)

Pollutant: NH_3

NFR CATEGORIES		Pollutant	Emissions (Gg)	Level valuation	Accumulated total
4 D	Agricultural soils	NH_3	207,765	0,580	0,580
4 B	Manure management	NH_3	120,510	0,336	0,916
2 B	Chemical industry	NH_3	11,589	0,032	0,948
6	Waste treatment and elimination	NH_3	8,084	0,023	0,971
	SUBTOTAL	NH_3	347,949	0,971	
	TOTAL EMISSIONS	NH_3	358,398		

Pollutant: CO

NFR CATEGORIES		Pollutant	Emissions (Gg)	Level valuation	Accumulated total
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	CO	489,841	0,245	0,245
2 C	Metallurgical production	CO	421,866	0,211	0,457
4 F	Field burning of agricultural wastes	CO	368,474	0,185	0,642
1 A 3 b i	Road transport - Passenger cars	CO	219,011	0,110	0,751
1 A 2 f	Other manufacturing and construction industries - Stationary + Mobile machinery	CO	125,088	0,063	0,814
1 A 2 a	Iron and steel	CO	93,548	0,047	0,861
1 A 3 b iv	Road transport - Mopeds and Motorcycles	CO	74,974	0,038	0,898
1 A 2 - 1A2a - 1A2f	Manufacturing and construction industries - Other	CO	46,445	0,023	0,922
1 A 4 c i+1 A 4 c ii	Agriculture / Forestry / Fishing - Stationary + Other vehicles and mobile machinery	CO	45,984	0,023	0,945
1 A 3 b iii	Road transport - Heavy duty vehicles	CO	41,908	0,021	0,966
	SUBTOTAL	CO	1.927,138	0,966	
	TOTAL EMISSIONS	CO	1.995,502		

Pollutant: $PM_{2.5}$

NFR CATEGORIES		Pollutant	Emissions (Gg)	Level valuation	Accumulated total
1A4	Manufacturing and construction industries	$PM_{2.5}$	53,175	0,426	0,426
1A3	Transport	$PM_{2.5}$	29,839	0,239	0,665
1A2	Manufacturing and construction industries	$PM_{2.5}$	24,671	0,198	0,863
1A1	Energy industries	$PM_{2.5}$	8,245	0,066	0,929
4B	Manure management	$PM_{2.5}$	3,775	0,030	0,960
	SUBTOTAL	$PM_{2.5}$	119,704	0,960	
	TOTAL EMISSIONS	$PM_{2.5}$	124,746		

Table 2.5.2.- Contribution to level by activity – 2008 (Continued)

Pollutant: PM_{10}

NFR CATEGORIES		Pollutant	Emissions (Gg)	Level valuation	Accumulated total
1A4	Manufacturing and construction industries	PM_{10}	54,582	0,342	0,342
1A3	Transport	PM_{10}	34,426	0,215	0,557
1A2	Manufacturing and construction industries	PM_{10}	28,452	0,178	0,735
4B	Manure management	PM_{10}	19,106	0,120	0,855
1A1	Energy industries	PM_{10}	11,789	0,074	0,929
2C	Metallurgical production	PM_{10}	7,165	0,045	0,973
	SUBTOTAL	PM_{10}	155,519	0,973	
	TOTAL EMISSIONS	PM_{10}	159,768		

Pollutant: TSP

NFR CATEGORIES		Pollutant	Emissions (Gg)	Level valuation	Accumulated total
1A4	Manufacturing and construction industries	TSP	56,266	0,266	0,266
1A3	Transport	TSP	40,750	0,193	0,459
1A2	Manufacturing and construction industries	TSP	36,097	0,171	0,629
4B	Manure management	TSP	32,512	0,154	0,783
4D	Agricultural soils	TSP	16,463	0,078	0,861
1A1	Energy industries	TSP	14,962	0,071	0,932
2C	Metallurgical production	TSP	8,615	0,041	0,973
	SUBTOTAL	TSP	205,665	0,973	
	TOTAL EMISSIONS	TSP	211,465		

Pollutant: Pb

NFR CATEGORIES		Pollutant	Emissions (Mg)	Level valuation	Accumulated total
1A2	Manufacturing and construction industries	Pb	153,822	0,571	0,571
2C	Metallurgical production	Pb	82,851	0,307	0,878
1A3	Transport	Pb	24,751	0,092	0,970
	SUBTOTAL	Pb	261,423	0,970	
	TOTAL EMISSIONS	Pb	269,507		

Pollutant: Cd

NFR CATEGORIES		Pollutant	Emissions (Mg)	Level valuation	Accumulated total
1A2	Manufacturing and construction industries	Cd	6,110	0,410	0,410
2C	Metallurgical production	Cd	4,385	0,295	0,705
1A1	Energy industries	Cd	3,784	0,254	0,959
	SUBTOTAL	Cd	14,280	0,959	
	TOTAL EMISSIONS	Cd	14,887		

Table 2.5.2.- Contribution to level by activity – 2008 (Continued)

Pollutant: Hg

NFR CATEGORIES		Pollutant	Emissions (Mg)	Level valuation	Accumulated total
1A1	Energy industries	Hg	4,698	0,500	0,500
2C	Metallurgical production	Hg	2,468	0,263	0,763
1A2	Manufacturing and construction industries	Hg	1,555	0,166	0,928
2B	Chemical industry	Hg	0,394	0,042	0,970
	SUBTOTAL	Hg	9,115	0,970	
	TOTAL EMISSIONS	Hg	9,393		

Pollutant: DIOX

NFR CATEGORIES		Pollutant	Emissions (g)	Level valuation	Accumulated total
1A2	Manufacturing and construction industries	DIOX	77,306	0,482	0,482
1A4	Other sectors	DIOX	31,288	0,195	0,677
2C	Metallurgical production	DIOX	28,990	0,181	0,858
1A3	Transport	DIOX	8,158	0,051	0,909
4F	Field burning of agricultural wastes	DIOX	7,390	0,046	0,955
	SUBTOTAL	DIOX	153,132	0,955	
	TOTAL EMISSIONS	DIOX	160,330		

Pollutant: PAH

NFR CATEGORIES		Pollutant	Emissions (Mg)	Level valuation	Accumulated total
4F	Field burning of agricultural wastes	PAH	122,383	0,477	0,477
1A2	Manufacturing and construction industries	PAH	52,851	0,206	0,684
2C	Metallurgical production	PAH	48,461	0,189	0,873
1A4	Other sectors	PAH	19,823	0,077	0,950
	SUBTOTAL	PAH	243,518	0,950	
	TOTAL EMISSIONS	PAH	256,310		

Table 2.5.3.- Contribution to trend by activity - 2008

Pollutant: NO_X

NFR CATEGORIES		Pollutant	1990 emission ($Gg NO_2$)	2008 emission ($Gg NO_2$)	Trend valuation	Contribution to the trend	Accumulated total
1 A 3 b i	Road transport - Passenger cars	NO_X	338,769	173,441	0,122	0,393	0,393
1 A 2	Manufacturing industries and construction - Stationary + Mobile machinery	NO_X	224,409	262,996	0,049	0,158	0,551
1 A 4 c i + 1 A 4 c ii	Agriculture / Forestry / Fishing - Stationary + Other vehicles and mobile machinery	NO_X	94,052	136,163	0,043	0,140	0,691
1 A 3 d ii	National maritime traffic	NO_X	33,703	72,363	0,036	0,117	0,807
1A 4 c iii	National fishing	NO_X	42,231	24,058	0,013	0,042	0,850
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	NO_X	19,147	27,725	0,009	0,028	0,878
1 A 3 b ii	Road transport - Light duty vehicles	NO_X	22,029	30,366	0,009	0,028	0,906
1 A 3 a	Civil Aviation (LTO)	NO_X	3,119	9,511	0,006	0,019	0,925
4 F	Field burning of agricultural wastes	NO_X	14,609	7,778	0,005	0,016	0,941
1 A 1 a	Public electricity and heat production	NO_X	228,321	205,635	0,004	0,014	0,955
	SUBTOTAL	NO_X	1.020,388	950,036	0,296	0,955	
	TOTAL EMISSIONS	NO_X	1.340,948	1.237,357	0,310		

Pollutant: NMVOC

NFR CATEGORIES		Pollutant	1990 emission ($Gg NO_2$)	2008 emission ($Gg NO_2$)	Trend valuation	Contribution to the trend	Accumulated total
1 A 3 b i	Road transport - Passenger cars	NMVOC	183,756	53,312	0,128	0,205	0,205
3 D	Other uses of solvents and other products	NMVOC	113,482	168,922	0,083	0,133	0,474
1 A 3 b v	Road transport - Petrol evaporation	NMVOC	130,357	42,317	0,086	0,137	0,342
3 C	Manufacture and processing of chemical products	NMVOC	67,710	104,325	0,054	0,086	0,656
3 A	Paint application	NMVOC	172,460	193,383	0,051	0,081	0,737
1 A 3 b iv	Road transport - Mopeds and Motorcycles	NMVOC	67,079	8,718	0,060	0,095	0,570
2 D	Other industries	NMVOC	32,296	49,401	0,025	0,040	0,819
6 D	Other waste treatments and elimination	NMVOC	8,338	21,845	0,017	0,028	0,886
1 A 2	Manufacturing industries and construction - Stationary + Mobile machinery	NMVOC	17,248	37,066	0,026	0,042	0,778
2 A 6	Road paving with asphalt	NMVOC	11,670	0,003	0,012	0,019	0,926
1 B 2 a i + 1 B 2 a iv	Exploration / Production / Transport / Refining / Storage of petroleum	NMVOC	23,141	25,774	0,007	0,011	0,948
1 A 4 c i + 1 A 4 c ii	Agriculture / Forestry / Fishing - Stationary + Other vehicles and mobile machinery	NMVOC	16,181	20,167	0,007	0,011	0,937
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	NMVOC	23,699	41,486	0,025	0,040	0,858
3 B	Degreasing and dry cleaning	NMVOC	41,988	26,073	0,013	0,020	0,906
	SUBTOTAL	NMVOC	923,499	800,402	0,599	0,957	
	TOTAL EMISSIONS	NMVOC	1.094,842	958,058	0,626		

Table 2.5.3.- Contribution to trend by activity – 2008 (Continued)

Pollutant: SO_X

NFR CATEGORIES		Pollutant	1990 emission (Gg SO_2)	2008 emission (Gg SO_2)	Trend valuation	Contribution to the trend	Accumulated total
1 A 1 a	Public electricity and heat production	SO_X	1.459,010	187,899	1,297	0,449	0,449
1A3 c + 1A3 d + 1A3 e	Other transport	SO_X	37,306	68,940	0,464	0,160	0,609
1 A 2 f	Other manufacturing industries and construction - Stationary + Mobile machinery	SO_X	136,798	66,382	0,256	0,089	0,697
1 A 2 a	Iron and steel	SO_X	33,844	28,242	0,155	0,054	0,751
1 A 1 c	Transformation of solid fuels and other energy industries	SO_X	10,599	21,920	0,150	0,052	0,803
1 A 1 b	Oil refineries	SO_X	134,403	47,322	0,113	0,039	0,842
1 A 3 b	Road transport	SO_X	54,277	2,317	0,084	0,029	0,871
1 B 2 a iv	Refining / Storage of petroleum	SO_X	40,267	20,421	0,082	0,028	0,900
1 A 2 b	Non-ferrous iron and steelworks	SO_X	35,506	17,067	0,065	0,023	0,922
2 C	Metallurgical production	SO_X	4,271	5,862	0,037	0,013	0,935
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	SO_X	40,591	13,844	0,031	0,011	0,946
1 A 2 d	Paper pulp, paper and printing industry	SO_X	38,618	6,217	0,025	0,009	0,954
	SUBTOTAL	SO_X	2.025,490	486,433	2,759	0,954	
	TOTAL EMISSIONS	SO_X	2.176,246	530,043	2,892		

Pollutant: NH_3

NFR CATEGORIES		Pollutant	1990 emission (Gg)	2008 emission (Gg)	Trend valuation	Contribution to the trend	Accumulated total
4 D	Agricultural soils	NH_3	200,495	207,765	0,046	0,361	0,361
4 B	Manure management	NH_3	93,137	120,510	0,038	0,303	0,663
2 B	Chemical industry	NH_3	15,460	11,589	0,014	0,115	0,778
6	Waste treatment and elimination	NH_3	2,123	8,084	0,014	0,111	0,889
1	Energy processing	NH_3	0,822	5,320	0,011	0,086	0,975
	SUBTOTAL	NH_3	312,036	353,268	0,123	0,975	
	TOTAL EMISSIONS	NH_3	317,698	358,398	0,126		

Pollutant: CO

NFR CATEGORIES		Pollutant	1990 emission (Gg)	2008 emission (Gg)	Trend valuation	Contribution to the trend	Accumulated total
1 A 3 b i	Road transport - Passenger cars	CO	1.844,588	219,011	0,723	0,483	0,483
2 C	Metallurgical production	CO	289,671	421,866	0,242	0,162	0,645
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	CO	523,860	489,841	0,187	0,125	0,769
4 F	Field burning of agricultural wastes	CO	412,731	368,474	0,131	0,088	0,857
1 A 2 f	Other manufacturing industries and construction - Stationary + Mobile machinery	CO	100,361	125,088	0,064	0,043	0,900
1 A 2 a	Iron and steel	CO	96,678	93,548	0,037	0,025	0,925
1 A 2 - 1 A 2 a - 1 A 2 f	Manufacturing and construction industries - Other	CO	28,457	46,445	0,028	0,019	0,944
1 A 4 c i + 1 A 4 c ii	Agriculture / Forestry / Fishing - Stationary + Other vehicles and mobile machinery	CO	44,292	45,984	0,020	0,013	0,957
	SUBTOTAL	CO	3.340,638	1.810,257	1,434	0,957	
	TOTAL EMISSIONS	CO	3.654,081	1.995,502	1,498		

Table 2.5.3.- Contribution to trend by activity – 2008 (Continued)

Pollutant: $PM_{2.5}$

NFR CATEGORIES		Pollutant	1990 emission (Gg)	2008 emission (Gg)	Trend valuation	Contribution to the trend	Accumulated total
1A1	Energy industries	PM2_5	15,422	8,245	0,057	0,368	0,368
1A4	Other sectors	PM2_5	49,058	53,175	0,039	0,254	0,622
1A2	Manufacturing and construction industries	PM2_5	21,181	24,671	0,031	0,200	0,822
1A3	Transport	PM2_5	32,502	29,839	0,018	0,117	0,939
2C	Metallurgical production	PM2_5	3,028	3,547	0,005	0,030	0,968
		SUBTOTAL	121,191	119,476	0,149	0,968	
		TOTAL EMISSIONS	126,525	124,746	0,154		

Pollutant: PM_{10}

NFR CATEGORIES		Pollutant	1990 emission (Gg)	2008 emission (Gg)	Trend valuation	Contribution to the trend	Accumulated total
1A1	Energy industries	PM10	29,149	11,789	0,104	0,478	0,478
1A4	Other sectors	PM10	50,557	54,582	0,048	0,222	0,700
1A2	Manufacturing and construction industries	PM10	25,397	28,452	0,031	0,143	0,843
4B	Manure management	PM10	17,602	19,106	0,017	0,080	0,923
2C	Metallurgical production	PM10	6,136	7,165	0,009	0,044	0,967
		SUBTOTAL	128,840	121,093	0,210	0,967	
		TOTAL EMISSIONS	170,487	159,768	0,217		

Pollutant: TSP

NFR CATEGORIES		Pollutant	1990 emission (Gg)	2008 emission (Gg)	Trend valuation	Contribution to the trend	Accumulated total
1A1	Energy industries	TSP	42,158	14,962	0,122	0,465	0,465
1A4	Other sectors	TSP	52,270	56,266	0,044	0,167	0,633
1A2	Manufacturing and construction industries	TSP	31,673	36,097	0,037	0,141	0,773
4B	Manure management	TSP	29,789	32,512	0,027	0,104	0,878
1A3	Transport	TSP	41,676	40,750	0,014	0,052	0,930
2C	Metallurgical production	TSP	7,494	8,615	0,009	0,035	0,965
		SUBTOTAL	205,061	189,202	0,253	0,965	
		TOTAL EMISSIONS	231,328	211,465	0,262		

Table 2.5.3.- Contribution to trend by activity – 2008 (Continued)

Pollutant: Pb

NFR CATEGORIES		Pollutant	1990 emission (Gg)	2008 emission (Gg)	Trend valuation	Contribution to the trend	Accumulated total
1A3	Transport	Pb	2.576,134	24,751	8,609	0,500	0,500
1A2	Manufacturing and construction industries	Pb	147,984	153,822	5,356	0,311	0,810
2C	Metallurgical production	Pb	44,503	82,851	3,015	0,175	0,985
		SUBTOTAL	2.768,622	261,423	16,980	0,985	
		TOTAL EMISSIONS	2.788,359	269,507	17,233		

Pollutant: Cd

NFR CATEGORIES		Pollutant	1990 emission (Gg)	2008 emission (Gg)	Trend valuation	Contribution to the trend	Accumulated total
1A2	Manufacturing and construction industries	Cd	19,789	6,110	0,591	0,494	0,494
2C	Metallurgical production	Cd	2,280	4,385	0,377	0,315	0,808
1A1	Energy industries	Cd	4,040	3,784	0,186	0,155	0,964
		SUBTOTAL	26,109	14,280	1,154	0,964	
		TOTAL EMISSIONS	26,782	14,887	1,197		

Pollutant: Hg

NFR CATEGORIES		Pollutant	1990 emission (Gg)	2008 emission (Gg)	Trend valuation	Contribution to the trend	Accumulated total
2C	Metallurgical production	Hg	1,263	2,468	0,273	0,338	0,338
6A	Landfill deposit	Hg	1,490	0,082	0,145	0,179	0,517
2B	Chemical industry	Hg	1,880	0,394	0,135	0,167	0,684
1A1	Energy industries	Hg	6,087	4,698	0,128	0,158	0,841
1A2	Manufacturing and construction industries	Hg	0,771	0,048	0,074	0,092	0,933
6C	Waste incineration	Hg	2,825	1,555	0,044	0,054	0,987
		SUBTOTAL	14,315	9,246	0,799	0,987	
		TOTAL EMISSIONS	14,568	9,393	0,809		

Pollutant: DIOX

NFR CATEGORIES		Pollutant	1990 emission (Gg)	2008 emission (Gg)	Trend valuation	Contribution to the trend	Accumulated total
1A2	Manufacturing and construction industries	DIOX	51,140	77,306	0,237	0,317	0,317
6A	Landfill deposit	DIOX	24,829	1,375	0,145	0,194	0,511
1A1	Energy industries	DIOX	22,907	2,679	0,124	0,165	0,676
2C	Metallurgical production	DIOX	14,686	28,990	0,117	0,156	0,832
6C	Waste incineration	DIOX	15,068	3,144	0,071	0,095	0,927
4F	Field burning of agricultural wastes	DIOX	12,068	7,390	0,022	0,029	0,957
		SUBTOTAL	140,698	120,884	0,716	0,957	
		TOTAL EMISSIONS	185,004	160,330	0,749		

Table 2.5.3.- Contribution to trend by activity – 2008 (Continued)

Pollutant: PAH

NFR CATEGORIES		Pollutant	1990 emission (Gg)	2008 emission (Gg)	Trend valuation	Contribution to the trend	Accumulated total
4F	Field burning of agricultural wastes	PAH	199,839	122,383	0,181	0,498	0,498
1A2	Manufacturing and construction industries	PAH	43,740	52,851	0,088	0,241	0,739
2C	Metallurgical production	PAH	48,644	48,461	0,047	0,130	0,868
1A3	Transport	PAH	5,173	11,473	0,036	0,099	0,967
		SUBTOTAL	297,396	235,167	0,352	0,967	
		TOTAL EMISSIONS	321,251	256,310	0,364		

Table 2.5.4. - Summary of the activities' contribution to the inventory

Pollutant: NO_X

NFR CATEGORIES		Pollutant	Key source category	Criterion		Level comments	Trend comments
				Level	Trend		
ENERGY							
1 A 1 a	Public electricity and heat production	NO_X	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1 A 1 b	Oil refineries	NO_X	YES	YES	YES	Level in 1990-2008	Trend in 1991, 1994-1996, 1998
1 A 1 c	Transformation of solid fuels and other energy industries	NO_X	YES		YES		Trend in 1991
1 A 2	Manufacturing industries and construction - Stationary + Mobile machinery	NO_X	YES	YES	YES	Level in 1990-2008	Trend in 1991-1998, 2001-2008
1 A 3 a	Civil Aviation (LTO)	NO_X	YES		YES		Trend in 1996-1999, 2006-2008
1 A 3 b i	Road transport - Passenger cars	NO_X	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1 A 3 b ii	Road transport - Light duty vehicles	NO_X	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1 A 3 b iii	Road transport - Heavy duty vehicles	NO_X	YES	YES	YES	Level in 1990-2008	Trend in 1991-2001, 2004-2005
1 A 3 b - 1A3bi - 1A3bii - 1A3biii	Road transport - Others	NO_X					
1 A 3 c + 1 A 3 e	Other transport	NO_X					
1 A 3 d ii	National maritime traffic	NO_X	YES	YES	YES	Level in 1990-2008	Trend in 1991-1994, 1996-2008
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	NO_X	YES	YES	YES	Level in 1990-2008	Trend in 1991, 1996-2008
1 A 4 c i + 1 A 4 c ii	Agriculture / Forestry / Fishing - Stationary + Other vehicles and mobile machinery	NO_X	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1A 4 c iii	National fishing	NO_X	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1 A 5	Others, stationary and mobile	NO_X					
1B	Fugitive emissions	NO_X	YES		YES		Trend in 1991-1992, 1994-1995
INDUSTRIAL PROCESSES							
2	Industrial processes	NO_X	YES		YES		Trend in 1991-2003, 2005
USE OF SOLVENTS AND OTHER PRODUCTS							
3	Use of solvents and other products	NO_X					
AGRICULTURE							
4 F	Field burning of agricultural wastes	NO_X	YES		YES		Trend in 1991-1995, 1999-2008
4 - 4 F	Agriculture - Others	NO_X	YES		YES		Trend in 1992-1995
WASTE							
6 A	Landfill deposit	NO_X					
6 C	Waste incineration	NO_X					
6 D + 6 B	Waste treatment and elimination - Others	NO_X					
OTHERS							
7	Others	NO_X					

Table 2.5.4.- Summary of the activities' contribution to the inventory (Continued)

Pollutant: NMVOC

NFR CATEGORIES		Pollutant	Key source category	Criterion		Level comments	Trend comments
				Level	Trend		
ENERGY							
1 A 1	Energy industries	NMVOC	YES	YES		Level in 2007	
1 A 2	Manufacturing industries and construction - Stationary + Mobile machinery	NMVOC	YES	YES	YES	Level in 1990-2008	Trend in 1994, 2001-2008
1 A 3 a	Civil Aviation (LTO)	NMVOC					
1 A 3 b i	Road transport - Passenger cars	NMVOC	YES	YES	YES	Level in 1990-2008	Trend in 1991-1993, 1995-2008
1 A 3 b ii	Road transport - Light duty vehicles	NMVOC					
1 A 3 b iii	Road transport - Heavy duty vehicles	NMVOC	YES	YES	YES	Level in 1990-1998	Trend in 1994-1996
1 A 3 b iv	Road transport - Mopeds and Motorcycles	NMVOC	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1 A 3 b v	Road transport - Petrol evaporation	NMVOC	YES	YES	YES	Level in 1990-2006	Trend in 1991-1992, 1994-2008
1 A 3 b vi + 1 A 3 b vii	Road transport - Others	NMVOC					
1 A 3 c + 1 A 3 d + 1 A 3 e	Other transport	NMVOC					
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	NMVOC	YES	YES	YES	Level in 1990-2008	Trend in 1992-1993, 2005-2008
1 A 4 c i + 1 A 4 c ii	Agriculture / Forestry / Fishing - Stationary + Other vehicles and mobile machinery	NMVOC	YES	YES	YES	Level in 1990-2008	Trend in 2004-2008
1A 4 c iii	National fishing	NMVOC					
1 A 5	Others, stationary and mobile	NMVOC					
1B1	Fugitive emissions from solid fuels	NMVOC					
1 B 2 a i + 1 B 2 a iv	Exploration / Production / Transport / Refining / Storage of petroleum	NMVOC	YES	YES	YES	Level in 1990-2008	Trend in 1994-2000, 2002-2008
1 B 2 a v	Distribution of oil products	NMVOC	YES	YES	YES	Level in 1990-2008	Trend in 1991, 1993-1997
1 B 2 b + 1 B 2 c	Fugitive emissions from natural gas, venting and flaring	NMVOC	YES		YES		Trend in 1991-1996, 1998, 2002
INDUSTRIAL PROCESSES							
2 A 6	Road paving with asphalt	NMVOC	YES	YES	YES	Level in 1990	Trend in 1991-2008
2 A - 2 A 6	Mineral products - Others	NMVOC					
2 B	Chemical industry	NMVOC	YES	YES	YES	Level in 1991-2008	Trend in 1993-2004
2 C	Metallurgical production	NMVOC					
2 D	Other industries	NMVOC	YES	YES	YES	Level in 1990-2008	Trend in 1991-1994, 1996-2008

Table 2.5.4.- Summary of the activities' contribution to the inventory (Continued)

Pollutant: NMVOC							
NFR CATEGORIES		Pollutant	Key source category	Criterion		Level comments	Trend comments
USE OF SOLVENTS AND OTHER PRODUCTS							
3 A	Paint application	NMVOC	YES	YES	YES	Level in 1990-2008	Trend in 1991-1995, 1997-2008
3 B	Degreasing and dry cleaning	NMVOC	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
3 C	Manufacture and processing of chemical products	NMVOC	YES	YES	YES	Level in 1990-2008	Trend in 1992-2008
3 D	Other uses of solvents and other products	NMVOC	YES	YES	YES	Level in 1990-2008	Trend in 1991-1993, 1995-2008
AGRICULTURE							
4 D	Agricultural soils	NMVOC					
4 F	Field burning of agricultural wastes	NMVOC	YES	YES	YES	Level in 1990-2008	Trend in 1991-1994, 1996-1997, 1999, 2002-2003, 2005
4 - 4 D - 4 F	Agriculture - Others	NMVOC					
WASTE							
6 A	Landfill deposit	NMVOC	YES		YES		Trend in 1991-1993, 1995-2003
6 B	Wastewater processing	NMVOC					
6 C	Waste incineration	NMVOC					
6 D	Other waste treatments and elimination	NMVOC	YES	YES	YES	Level in 1999-2008	Trend in 1991-2008
OTHERS							
7	Others	NMVOC					

Table 2.5.4.- Summary of the activities' contribution to the inventory (Continued)

Pollutant: SO_X

NFR CATEGORIES		Pollutant	Key source category	Criterion		Level comments	Trend comments
				Level	Trend		
	ENERGY						
1 A 1 a	Public electricity and heat production	SO_X	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1 A 1 b	Oil refineries	SO_X	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1 A 1 c	Transformation of solid fuels and other energy industries	SO_X	YES	YES	YES	Level in 1999-2008	Trend in 1991-1992, 1995-2008
1 A 2 a	Iron and steel	SO_X	YES	YES	YES	Level in 1991-1998, 2001, 2008	Trend in 1991-1992, 1997, 1999-2008
1 A 2 b	Non-ferrous iron and steelworks	SO_X	YES	YES	YES	Level in 1990, 1997-2008	Trend in 1991-1999, 2004, 2008
1 A 2 c	Chemical industry	SO_X	YES	YES	YES	Level in 1990-2002, 2008	Trend in 1991-1992, 1994-1995, 1997, 1999-2007
1 A 2 d	Paper pulp, paper and printing industry	SO_X	YES	YES	YES	Level in 1990-1997, 1999-2002, 2008	Trend in 1991-1993, 1996-2008
1 A 2 e	Food processing, beverages and tobacco	SO_X	YES	YES	YES	Level in 1990-2002, 2008	Trend in 1993-2007
1 A 2 f	Other manufacturing industries and construction - Stationary + Mobile machinery	SO_X	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1 A 3 a	Civil Aviation (LTO)	SO_X					
1 A 3 b	Road transport	SO_X	YES	YES	YES	Level in 1990-1999, 2003-2004	Trend in 1991-2008
1 A 3 c + 1 A 3 d + 1 A 3 e	Other transport	SO_X	YES	YES	YES	Level in 1990-2008	Trend in 1993-1996, 1999-2008
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	SO_X	YES	YES	YES	Level in 1990-2008	Trend in 1991-1992, 1994-2003, 2008
1 A 4 c i + 1 A 4 c ii	Agriculture / Forestry / Fishing - Stationary + Other vehicles and mobile machinery	SO_X	YES	YES		Level in 2003, 2006-2008	
1A 4 c iii	National fishing	SO_X					
1 A 5	Others, stationary and mobile	SO_X					
1B1	Fugitive emissions from solid fuels	SO_X					
1 B 2 a iv	Refining / Storage of petroleum	SO_X	YES	YES	YES	Level in 1990-2008	Trend in 1991-2001, 2003, 2006, 2008
1 B 2 c	Venting and flaring	SO_X	YES	YES	YES	Level in 1994-1996, 1998, 2000, 2003-2005	Trend in 1991-1994, 1996, 1998, 2000, 2002, 2006-2007
1 B 2 - 1 B 2 a iv - 1 B 2 c	Fugitive emissions from oil and natural gas - Others	SO_X					
	INDUSTRIAL PROCESSES						
2 B	Chemical industry	SO_X					
2 C	Metallurgical production	SO_X	YES		YES		Trend in 1998, 2000-2008
2 - 2 B - 2 C	Industrial processes - Other	SO_X					

Table 2.5.4.- Summary of the activities' contribution to the inventory (Continued)

Pollutant: SO_X

NFR CATEGORIES		Pollutant	Key source category	Criterion		Level comments	Trend comments
				Level	Trend		
USE OF SOLVENTS AND OTHER PRODUCTS							
3	Use of solvents and other products	SO_X					
AGRICULTURE							
4	Agriculture	SO_X					
WASTE							
6	Waste treatment and elimination	SO_X					
OTHERS							
7	Others	SO_X					

Pollutant: NH_3

NFR CATEGORIES		Pollutant	Key source category	Criterion		Level comments	Trend comments
				Level	Trend		
ENERGY							
1	Energy processing	NH_3	YES	YES	YES	Level in 2004	Trend in 1994-2008
INDUSTRIAL PROCESSES							
2 B	Chemical industry	NH_3	YES	YES	YES	Level in 2004	Trend in 1994-2008
2 - 2 B	Industrial processes - Other	NH_3	YES	YES	YES	Level in 2004	Trend in 1994-2008
USE OF SOLVENTS AND OTHER PRODUCTS							
3	Use of solvents and other products	NH_3					
AGRICULTURE							
4 B	Manure management	NH_3	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
4 D	Agricultural soils	NH_3	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
4 - 4 B - 4 D	Agriculture - Others	NH_3	YES		YES		Trend in 1991, 1999-2000, 2002, 2005
WASTE							
6	Waste treatment and elimination	NH_3	YES	YES	YES	Level in 2006, 2008	Trend in 1991-1993, 2000-2008
OTHERS							
7	Others	NH_3					

Table 2.5.4.- Summary of the activities' contribution to the inventory (Continued)

Pollutant: CO

NFR CATEGORIES		Pollutant	Key source category	Criterion: Level	Criterion: Trend	Level comments	Trend comments
	ENERGY						
1 A 1	Energy industries	CO	YES		YES		Trend in 1994-1995
1 A 2 - 1 A 2 a - 1 A 2 f	Manufacturing and construction industries - Others	CO	YES	YES	YES	Level in 2000-2008	Trend in 1993, 1995, 1997-2008
1 A 2 a	Iron and steel	CO	YES	YES	YES	Level in 1990-2008	Trend in 1992-1994, 1996-1998, 2000-2008
1 A 2 f	Manufacturing and construction industries - stationary + mobile machinery	CO	YES	YES	YES	Level in 1990-2008	Trend in 1991-1994, 1999-2008
1 A 3 a	Civil Aviation (LTO)	CO					
1 A 3 b i	Road transport - Passenger cars	CO	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1 A 3 b ii	Road transport – Light duty vehicles	CO	YES	YES		Level in 1994-1995	
1 A 3 b iii	Road transport - Heavy duty vehicles	CO	YES	YES	YES	Level in 1990-2008	Trend in 1991-2007
1 A 3 b iv	Road transport – Mopeds and Motorcycles	CO	YES	YES	YES	Level in 1990-2008	Trend in 1991-2003
1 A 3 b v + 1 A 3 b vi + 1 A 3 b vii	Road transport - Others	CO					
1A3 c + 1A3 d + 1A3 e	Other transport	CO					
1 A 4 a + 1 A 4 b	Commercial / Institutional / Residential	CO	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1 A 4 c i + 1 A 4 c ii	Agriculture / Forestry / Fishing - Stationary + Other vehicles and mobile machinery	CO	YES	YES	YES	Level in 1998-1999, 2005-2008	Trend in 1991-1993, 2008
1A 4 c iii	National fishing	CO					
1 A 5	Other, stationary and mobile	CO					
1B	Fugitive emissions	CO					
	INDUSTRIAL PROCESSES						
2 C	Metallurgical production	CO	YES	YES	YES	Level in 1990-2008	Trend in 1991-1992, 1994-2008
2 - 2 C	Industrial processes - Others	CO	YES		YES		Trend in 1991
	USE OF SOLVENTS AND OTHER PRODUCTS						
3	Use of solvents and other products	CO					
	AGRICULTURE						
4 F	Field burning of agricultural wastes	CO	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
4 - 4 F	Agriculture - Others	CO					
	WASTE						
6 A	Landfill deposit	CO	YES		YES		Trend in 1991-1993, 1996
6 B	Wastewater processing	CO					
6 C	Waste incineration	CO					
6 D	Other waste treatments and elimination	CO					
	OTHERS						
7	Others	CO					

Table 2.5.4.- Summary of the activities' contribution to the inventory (Continued)

Pollutant: $PM_{2.5}$

NFR CATEGORIES		Pollutant	Key source category	Criterion		Trend comments	Trend comments
				Level	Trend		
ENERGY							
1 A 1	Energy industries	PM2,5	YES	YES	YES	Level in 2000-2008	Trend in 2001-2008
1 A 2	Manufacturing and construction industries	PM2,5	YES	YES	YES	Level in 2000-2008	Trend in 2001-2008
1 A 3	Transport	PM2,5	YES	YES	YES	Level in 2000-2008	Trend in 2001-2008
1 A 4	Other sectors	PM2,5	YES	YES	YES	Level in 2000-2008	Trend in 2001-2008
1 A 5	Other activities	PM2,5					
1 B	Fugitive emissions from fuels	PM2,5	YES		YES		Trend in 2002
INDUSTRIAL PROCESSES							
2 A	Mineral products	PM2,5					
2 B	Chemical industry	PM2,5					
2 C	Metallurgical production	PM2,5	YES		YES		Trend in 2001-2008
2 D	Other industries	PM2,5					
2 E	POP production	PM2,5					
2 G	Others	PM2,5					
USE OF SOLVENTS AND OTHER PRODUCTS							
3 A	Paint application	PM2,5					
3 B	Degreasing and dry cleaning	PM2,5					
3 C	Manufacture and processing of chemical products	PM2,5					
3 D	Others	PM2,5					
AGRICULTURE							
4 B	Manure management	PM2,5	YES	YES	YES	Level in 2000-2008	Trend in 2001
4 D	Agricultural soils	PM2,5					
4 F	Field burning of agricultural wastes	PM2,5					
4 G	Others	PM2,5					
WASTE							
6 A	Landfill deposit	PM2,5					
6 B	Wastewater processing	PM2,5					
6 C	Waste incineration	PM2,5					
6 D	Other waste treatments and elimination	PM2,5					
OTHERS							
7	Others	PM2,5					

Table 2.5.4.- Summary of the activities' contribution to the inventory (Continued)

Pollutant: PM_{10}							
NFR CATEGORIES		Pollutant	Key source category	Criterion		Level comments	Trend comments
				Level	Trend		
ENERGY							
1 A 1	Energy industries	PM10	YES	YES	YES	Level in 2000-2008	Trend in 2001-2008
1 A 2	Manufacturing and construction industries	PM10	YES	YES	YES	Level in 2000-2008	Trend in 2001-2008
1 A 3	Transport	PM10	YES	YES	YES	Level in 2000-2008	Trend in 2001-2006
1 A 4	Other sectors	PM10	YES	YES	YES	Level in 2000-2008	Trend in 2001-2008
1 A 5	Other activities	PM10					
1 B	Fugitive emissions from fuels	PM10	YES		YES		Trend in 2002-2005, 2007
INDUSTRIAL PROCESSES							
2 A	Mineral products	PM10					
2 B	Chemical industry	PM10					
2 C	Metallurgical production	PM10	YES	YES	YES	Level in 2000-2008	Trend in 2001-2008
2 D	Other industries	PM10					
2 E	POP production	PM10					
2 G	Others	PM10					
USE OF SOLVENTS AND OTHER PRODUCTS							
3 A	Paint application	PM10					
3 B	Degreasing and dry cleaning	PM10					
3 C	Manufacture and processing of chemical products	PM10					
3 D	Others	PM10					
AGRICULTURE							
4 B	Manure management	PM10	YES	YES	YES	Level in 2000-2008	Trend in 2001-2008
4 D	Agricultural soils	PM10					
4 F	Field burning of agricultural wastes	PM10					
4 G	Others	PM10					
WASTE							
6 A	Landfill deposit	PM10					
6 B	Wastewater processing	PM10					
6 C	Waste incineration	PM10					
6 D	Other waste treatments and elimination	PM10					
OTHERS							
7	Others	PM10					

Table 2.5.4.- Summary of the activities' contribution to the inventory (Continued)

Pollutant: TSP

NFR CATEGORIES		Pollutant	Key source category	Criterion		Level comments	Trend comments
				Level	Trend		
	ENERGY						
1 A 1	Energy industries	TSP	YES	YES	YES	Level in 2000-2008	Trend in 2001, 2003-2008
1 A 2	Manufacturing and construction industries	TSP	YES	YES	YES	Level in 2000-2008	Trend in 2001-2008
1 A 3	Transport	TSP	YES	YES	YES	Level in 2000-2008	Trend in 2001-2002, 2005-2008
1 A 4	Other sectors	TSP	YES	YES	YES	Level in 2000-2008	Trend in 2001-2008
1 A 5	Other activities	TSP					
1 B	Fugitive emissions from fuels	TSP	YES		YES		Trend in 2002-2005
	INDUSTRIAL PROCESSES						
2 A	Mineral products	TSP					
2 B	Chemical industry	TSP					
2 C	Metallurgical production	TSP	YES	YES	YES	Level in 2000-2008	Trend in 2001-2008
2 D	Other industries	TSP					
2 E	POP production	TSP					
2 G	Others	TSP					
	USE OF SOLVENTS AND OTHER PRODUCTS						
3 A	Paint application	TSP					
3 B	Degreasing and dry cleaning	TSP					
3 C	Manufacture and processing of chemical products	TSP					
3 D	Others	TSP					
	AGRICULTURE						
4 B	Manure management	TSP	YES	YES	YES	Level in 2000-2008	Trend in 2001-2008
4 D	Agricultural soils	TSP	YES	YES	YES	Level in 2000-2008	Trend in 2001-2007
4 F	Field burning of agricultural wastes	TSP					
4 G	Others	TSP					
	WASTE						
6 A	Landfill deposit	TSP					
6 B	Wastewater processing	TSP					
6 C	Waste incineration	TSP					
6 D	Other waste treatments and elimination	TSP					
	OTHERS						
7	Others	TSP					

Table 2.5.4.- Summary of the activities' contribution to the inventory (Continued)

Pollutant: Pb

NFR CATEGORIES		Pollutant	Key source category	Criterion		Level comments	Trend comments
				Level	Trend		
ENERGY							
1 A 1	Energy industries	Pb	YES		YES		Trend in 1991-1995
1 A 2	Manufacturing and construction industries	Pb	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1 A 3	Transport	Pb	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1 A 4	Other sectors	Pb					
1 A 5	Other activities	Pb					
1 B	Fugitive emissions from fuels	Pb					
INDUSTRIAL PROCESSES							
2 A	Mineral products	Pb					
2 B	Chemical industry	Pb					
2 C	Metallurgical production	Pb	YES	YES	YES	Level in 1992-2008	Trend in 1991-2008
2 D	Other industries	Pb					
2 E	POP production	Pb					
2 G	Others	Pb					
USE OF SOLVENTS AND OTHER PRODUCTS							
3 A	Paint application	Pb					
3 B	Degreasing and dry cleaning	Pb					
3 C	Manufacture and processing of chemical products	Pb					
3 D	Others	Pb					
AGRICULTURE							
4 B	Manure management	Pb					
4 D	Agricultural soils	Pb					
4 F	Field burning of agricultural wastes	Pb					
4 G	Others	Pb					
WASTE							
6 A	Landfill deposit	Pb					
6 B	Wastewater processing	Pb					
6 C	Waste incineration	Pb					
6 D	Other waste treatments and elimination	Pb					
OTHERS							
7	Others	Pb					

Table 2.5.4.- Summary of the activities' contribution to the inventory (Continued)

Pollutant: Cd								
NFR CATEGORIES		Pollutant	Key source category	Criterion		Level comments	Trend comments
				Level	Trend		
ENERGY							
1 A 1	Energy industries	Cd	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1 A 2	Manufacturing and construction industries	Cd	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1 A 3	Transport	Cd	YES		YES		Trend in 1993, 1996, 1998
1 A 4	Other sectors	Cd	YES		YES		Trend in 1991-1992, 1994-1995, 1997
1 A 5	Other activities	Cd					
1 B	Fugitive emissions from fuels	Cd					
INDUSTRIAL PROCESSES							
2 A	Mineral products	Cd					
2 B	Chemical industry	Cd					
2 C	Metallurgical production	Cd	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
2 D	Other industries	Cd					
2 E	POP production	Cd					
2 G	Others	Cd					
USE OF SOLVENTS AND OTHER PRODUCTS							
3 A	Paint application	Cd					
3 B	Degreasing and dry cleaning	Cd					
3 C	Manufacture and processing of chemical products	Cd					
3 D	Others	Cd					
AGRICULTURE							
4 B	Manure management	Cd					
4 D	Agricultural soils	Cd					
4 F	Field burning of agricultural wastes	Cd					
4 G	Others	Cd					
WASTE							
6 A	Landfill deposit	Cd					
6 B	Wastewater processing	Cd					
6 C	Waste incineration	Cd					
6 D	Other waste treatments and elimination	Cd					
OTHERS							
7	Others	Cd					

Table 2.5.4.- Summary of the activities' contribution to the inventory (Continued)

Pollutant: Hg

NFR CATEGORIES		Pollutant	Key source category	Criterion		Level comments	Trend comments
				Level	Trend		
ENERGY							
1 A 1	Energy industries	Hg	YES	YES	YES	Level in 1990-2008	Trend in 1991-2008
1 A 2	Manufacturing and construction industries	Hg	YES	YES	YES	Level in 1990-2008	Trend in 1991-1996, 1999-2002, 2005, 2007-2008
1 A 3	Transport	Hg					
1 A 4	Other sectors	Hg	YES		YES		Trend in 1991
1 A 5	Other activities	Hg					
1 B	Fugitive emissions from fuels	Hg					
INDUSTRIAL PROCESSES							
2 A	Mineral products	Hg					
2 B	Chemical industry	Hg	YES	YES	YES	Level in 1990-2008	Trend in 1991-1994, 1997-2008
2 C	Metallurgical production	Hg	YES	YES	YES	Level in 1990-2008	Trend in 1992, 1994-2008
2 D	Other industries	Hg					
2 E	POP production	Hg					
2 G	Others	Hg					
USE OF SOLVENTS AND OTHER PRODUCTS							
3 A	Paint application	Hg					
3 B	Degreasing and dry cleaning	Hg					
3 C	Manufacture and processing of chemical products	Hg					
3 D	Others	Hg					
AGRICULTURE							
4 B	Manure management	Hg					
4 D	Agricultural soils	Hg					
4 F	Field burning of agricultural wastes	Hg					
4 G	Others	Hg					
WASTE							
6 A	Landfill deposit	Hg	YES	YES	YES	Level in 1990-1999	Trend in 1991-2008
6 B	Wastewater processing	Hg					
6 C	Waste incineration	Hg	YES	YES	YES	Level in 1990-1994	Trend in 1991-2008
6 D	Other waste treatments and elimination	Hg					
OTHERS							
7	Others	Hg					

Table 2.5.4.- Summary of the activities' contribution to the inventory (Continued)

Pollutant: DIOX

NFR CATEGORIES		Pollutant	Key source category	Criterion		Level comments	Trend comments
				Level	Trend		
ENERGY							
1 A 1	Energy industries	DIOX	YES	YES	YES	Level in 1990-2001, 2004-2007	Trend in 1991-2008
1 A 2	Manufacturing and construction industries	DIOX	YES	YES	YES	Level in 1990-2008	Trend in 1991-1995, 1997-2008
1 A 3	Transport	DIOX	YES	YES	YES	Level in 1997-2008	Trend in 1994, 1996, 1999, 2001-2004, 2007
1 A 4	Other sectors	DIOX	YES	YES	YES	Level in 1990-2008	Trend in 1993-1995, 1997-1999
1 A 5	Other activities	DIOX					
1 B	Fugitive emissions from fuels	DIOX					
INDUSTRIAL PROCESSES							
2 A	Mineral products	DIOX					
2 B	Chemical industry	DIOX					
2 C	Metallurgical production	DIOX	YES	YES	YES	Level in 1990-2008	Trend in 1991-1992, 1994-2008
2 D	Other industries	DIOX					
2 E	POP production	DIOX					
2 G	Others	DIOX					
USE OF SOLVENTS AND OTHER PRODUCTS							
3 A	Paint application	DIOX					
3 B	Degreasing and dry cleaning	DIOX					
3 C	Manufacture and processing of chemical products	DIOX					
3 D	Others	DIOX					
AGRICULTURE							
4 B	Manure management	DIOX					
4 D	Agricultural soils	DIOX					
4 F	Field burning of agricultural wastes	DIOX	YES	YES	YES	Level in 1990-2008	Trend in 1992-1993, 1996-1998, 2002, 2005-2008
4 G	Others	DIOX					
WASTE							
6 A	Landfill deposit	DIOX	YES	YES	YES	Level in 1990-1999	Trend in 1991-2008
6 B	Wastewater processing	DIOX					
6 C	Waste incineration	DIOX	YES	YES	YES	Level in 1990-1996, 2000-2003	Trend in 1991-2008
6 D	Other waste treatments and elimination	DIOX					
OTHERS							
7	Others	DIOX					

Table 2.5.4.- Summary of the activities' contribution to the inventory (Continued)

Pollutant: PAH

NFR CATEGORIES		Pollutant	Key source category	Criterion		Level comments	Trend comments
				Level	Trend		
ENERGY							
1 A 1	Energy industries	PAH	YES		YES		Trend in 1993-1994, 1998
1 A 2	Manufacturing and construction industries	PAH	YES	YES	YES	Level in 1990-2008	Trend in 1991-1995, 1997, 1999-2008
1 A 3	Transport	PAH	YES	YES	YES	Level in 2005-2007	Trend in 1991-2008
1 A 4	Other sectors	PAH	YES	YES	YES	Level in 1990-2008	Trend in 1991-1992, 1995-1999, 2002, 2005
1 A 5	Other activities	PAH					
1 B	Fugitive emissions from fuels	PAH	YES		YES		Trend in 1995-1996, 1998-1999
INDUSTRIAL PROCESSES							
2 A	Mineral products	PAH					
2 B	Chemical industry	PAH					
2 C	Metallurgical production	PAH	YES	YES	YES	Level in 1990-2008	Trend in 1991-1998, 2000-2008
2 D	Other industries	PAH					
2 E	POP production	PAH					
2 G	Others	PAH					
USE OF SOLVENTS AND OTHER PRODUCTS							
3 A	Paint application	PAH					
3 B	Degreasing and dry cleaning	PAH					
3 C	Manufacture and processing of chemical products	PAH					
3 D	Others	PAH					
AGRICULTURE							
4 B	Manure management	PAH					
4 D	Agricultural soils	PAH					
4 F	Field burning of agricultural wastes	PAH	YES	YES	YES	Level in 1990-2008	Trend in 1991-1997, 1999-2008
4 G	Others	PAH					
WASTE							
6 A	Landfill deposit	PAH					
6 B	Wastewater processing	PAH					
6 C	Waste incineration	PAH					
6 D	Other waste treatments and elimination	PAH					
OTHERS							
7	Others	PAH					

2.6.- Information on the quality assurance and quality control plan

2.6.1.- Approach

The quality assurance and quality control plan focuses on following the generally-accepted principles of good practice to ensure that the Inventory meets the following requirements: timely presentation, completeness (with respect to activities and pollutants covered), consistency (transversal and in time series), comparability (with other inventories), accuracy and precision, transparency, and ongoing improvements.

The quality assurance and quality control plan is an essential part of the system for quality assurance and quality control (QA/QC) and verification activities. It lists the verification and QA/QC activities and the composition of the team assigned to carry them out, and indicates the allocation of responsibilities to its members. The quality assurance and control plan is conceived as an internal document for organising verification and QA/QC activities in order to ensure the Inventory's ongoing improvement and that the Inventory is able to meet its objectives. The plan is thus conceived as an active element, which initially serves as a reference point for specifications for the next edition of the Inventory, and is periodically reviewed at least once a year to ensure it includes all the changes occurring in activities and inventory processes detected by the inventory's working group, as well as the recommendations of external review teams. This periodic revision of the quality assurance and quality control plan to adapt it to recommended procedural changes is an important element in ensuring the plan's contribution to the ongoing improvement of the QA/QC system. The quality assurance and quality control plan affects all stages of the inventory's development.

2.6.2.- Objectives

An essential element of the quality assurance and quality control plan is the establishment of its objectives with regard to the Inventory's quality. These objectives, which relate to the basic principles in drafting the inventory, must be established in a realistic manner and be suitable to the ultimate objective, namely the improvement of the quality of the Inventory. The establishment of the objectives facilitates evaluation of the inventory when a review is conducted. The objectives established in the quality assurance and control plan for the Spanish inventory are described below:

a) Compliance with deadlines for the availability and distribution of the Inventory

A timeline of individual tasks has been developed to achieve this objective. Checkpoints have been established for the times when the different preparation stages are undertaken. The satisfactory completion of the deadlines for these stages constitutes the best control for the overall completion of the inventory to guarantee its availability within the time period. In addition, in the case that the deadline for a partial stage is exceeded, a warning signal is generated in order to be able to make up the delay in subsequent stages.

One factor subject to special supervision is timely completion of the stage dealing with the collecting the answers to the requests sent to information providers.

b) Completeness

This principle refers to the objective of achieving an Inventory which is as complete as possible with the inclusion of emissions estimated for all activity*pollutant cross-tabs producing emissions, complemented by the appropriate label (NO = not occurring; NA = not applicable; IE = Inappropriate activity estimate; CE = Confidential and NE = not estimated) for cases in which an affirmative estimate is not given (emission or absorption).

To bring this principle into operation, an exhaustive analysis is done of the Inventory's basic SNAP nomenclature (which corresponds to the nomenclatures used in the rest of the Inventory formats) of all the activity*pollutant cross-tabs for which references for emission estimations are provided, and with reference to these methods, an analysis is made and the basic data necessary for the application of selected estimation method is collected.

c) Consistency (transversal and time series)

The objective of transversal consistency refers to the use of the same variable or parameter in all the Inventory categories that share it. This objective is ensured by introducing this variable or parameter into the database a single time and ensuring general access to it by any algorithms or procedural modules requiring its use.

The objective of time series consistency refers to the assurance of a homogeneous pattern over time of the variables indexed in time, in an effort to avoid erroneous patterns. This objective is achieved by: i) quality control of primary data, and ii) atypical control to identify possible false patterns with incorrect values. The operational control of this objective is executed with QC over the variables entered and methods for detecting atypical elements in time series.

d) Comparability

The completion of this objective, wich attempts to attain the highest standard of Inventory comparability with inventories developed for other countries and geographic areas and potentially, in the longer term, with different time periods, is addressed with the systematic use of definitions for generally used terms and nomenclature for activities and pollutants maintained over time. To comply with these requirements the Spanish Inventory uses definitions and nomenclatures (and any corresponding associated elements) in the SNAP base and in NFR (air pollution substances) and CRF formats (greenhouse gases).

e) Accuracy and precision

The term accuracy calls for achieving an unbiased estimator (not deviating upward or downward) with respect to the central value of the emissions estimation; whereas precision calls for reaching the minimal uncertainty (confidence interval close to the central value with a particular degree of probability, conventionally 95%). This twofold objective is obtained by means of analysis and revision, as necessary, of the methods used in specific key categories which, because they are clearly susceptible to improvement in their methodological approach (progressing to more advanced tiers), are considered priority; and additionally of a sample

selection of non-key categories. The recommendations from the bodies in charge of quality control procedures are used as needed for this improvement plan.

f) Transparency

The objective of transparency aims to guarantee the reproducibility of the Inventory results by external teams from the base data and documentation of the estimation algorithms. To this end the base report in the Inventory's SNAP format: Vol. 2 "Analysis by SNAP activities" provides: a description of the processes generating the emissions, the activity variables used and their sources, the algorithms and emission factors used, and the actual emissions estimated. Additionally, the information on the final activity variables, emission algorithms/factors, and emissions estimations can be consulted in the Inventory's ORACLE database.

g) Inventory improvement

All the above objectives lead to this ultimate aim of improvement of the Inventory, and thus all the quality assurance and control elements mentioned also contribute to this final goal.

2.6.3.- Responsible body

The Directorate-General for Environmental Quality and Assessment (DGCEA) of the Ministry of Environment and Rural and Marine Affairs, as the Single National Authority of the National Inventory System for Pollutant Emissions into the Atmosphere (Ministerial Order MAM/1444/2006) is the body responsible for the Inventory's quality assurance and control system, and has the support of specific technical assistance for undertaking the tasks required by this system; and this support is clearly assigned a series of responsibilities and tasks and provided with specific qualified personnel dedicated to implementing the quality assurance and control system.

The main responsibilities of the quality assurance and control plan are:

- To coordinate QA/QC activities for the national Inventory.
- To collect and reference the internal procedures for QA/QC used by the information providers and other organisations which cooperate with the SEI.
- To ensure the development and application of the QA/QC plan.

The coordination of resources by DGCEA as required for the implementation of the National Inventory System (NIS), including coordinating the contribution of the different bodies participating in the QA/QC plan, is shown in section of this document dealing with Institutional and Legal Arrangements.

2.6.4.-Quality control of the development stages of the Inventory

Selection of the methods for estimating emissions

The EFDI database containing the documentation used for the preparation of the Inventory also includes the documentary references on the methodologies used in each of its editions. In addition, a record of the references used to estimate the emissions can be consulted for each of the activities considered by the Inventory in the "National Inventory base report" in SNAP format: Vol. 2. "Analysis by SNAP activities" which is prepared with each Inventory edition. This serial publication allows access to historical information on methodologies employed in successive editions of the Inventory.

Data compilation

a) Quality controls

This phase of the project involves the following QC procedures relating to Level 1 Quality Control activities.

Completeness check

Verification of providers' contact information

Follow-up of requests

Verification of the integrity of the base documentation received

Data processing

a) Quality controls (level 1)

This phase of the project involves the following QC procedures relating to general quality control activities (level 1).

Verification of transcription errors in data input

Verification that the estimation algorithms operate correctly

Verification of correctness of the units in which variables and parameters are expressed

Verification of the integrity of the database structure

Verification of the consistency of information shared by different sources

Verification of data flow correction in the various stages of the process

Verification of methodological changes or of data requiring recalculation

Verification of the homogeneity of the time series

Verification of homogeneity in transversal cross-section

Comparison with estimations from the previous year

b) Quality control by type of source (level 2)

These controls cover specific data types used in the estimation methods for individual sources, especially:

- Main categories (key sources) of sources and sinks
- Categories that have undergone methodological revisions.
- Categories that employ advanced estimation methods.

Although some of these controls may be shared by various sources, others are sector-specific. For this reason they are generally specified by sectors.

The following controls (ranges and evolution indices) are particularly worth noting:

- On the product/input ratios(or their reverse)
  - In the transformation of energy
  - In industrial combustion
  - In industrial processes (without combustion)
  - In agricultural or livestock production
  - In the generation and processing of wastes
- On the composition of materials/fuels:
  - Material/products:

    Physical-chemical properties: density (liquids), carbonate contents, VOC contents
  - Fuels:

    Physical-chemical properties: molar gas composition, dry carbon base composition, petroleum product composition, carbon contents, heating value

    Evolution of fuel mix (relative price dependency)

    Balance of materials, especially of carbon in industrial processes.

Preparation of results tables and reports

a) Quality controls

Each chapter is verified by means of a reading by a person other than the technical expert responsible for it; and the outgoing copy is checked to ensure it conforms to the original plan.

2.6.5.- Quality assurance system

The Inventory's quality assurance is conducted through an objective revision by personnel unconnected to the team preparing the Inventory, in order to evaluate its quality and its compliance with the proposed quality control specifications, at the same time using this stage to identify any areas for improvement, as part of the ongoing process for the optimisation of the Inventory.

The programme is mainly enacted through the following channels:

- Institutes/technical experts specifically employed for quality revision, focusing on the main source categories or those that have undergone alterations in data or estimation methods.

- Systematic commissions to specialist institutes to perform quality assurance work on specific activities or substances in the Inventory relating to the corporate purpose of these institutions.

- In addition, in-depth revisions by experts participating in inventory organisations in similar countries, reference work groups for the main source categories or the Secretariats or Panels of the Conventions or Protocols in question.

Particularly worth noting in this section is the "Quality Assurance Programme of the National Inventory of Air Pollutant Emissions" which was commissioned from CIEMAT (Research Centre for Energy, Environment and Technology). This work on the quality assurance (GC) of the inventory was carried out by CIEMAT between 2007 and 2008[19].

2.6.6.- Confidentiality handling

The air pollutant emission inventories are considered to be statistics for State purposes under statistical operation 5713 of the 2009-2012 Statistical Plan and, as such, in accordance with article 149.1.31 of the Spanish Constitution, they are performed on the basis of the exclusive responsibility of the State for the preparation of statistics for State purposes. The regulatory frame of reference is provided by the Spanish Public Statistical Function Act (Law 12/1989 of 9 May) and by the 2009-2012 National Statistical Plan, approved by Royal Decree 1663/2008 of 17 October. In this context, the information

[19] The report on CIEMAT's work can be consulted in the SEI archive.

requested for the inventory follows the rules of statistical secrecy in accordance with the provisions of the 2009-2012 National Statistical Plan.

As a general criterion, emissions data in the SEI are not considered to be confidential. However the data on socioeconomic variables containing information belonging to the companies or plants which have provided base information for the preparation of the Inventory are considered to be confidential, provided this information has not been made public or authorised by those responsible in the company for their publication in the Inventory. Data on emission factors are also considered to be confidential whenever it is possible to infer data on activity variables at the company or plant level by using these emissions factors and the information on emissions. The activity variables or emission factors which are subject to confidentiality restrictions are identified with label "C".

The numeric criterion for the maintenance of confidentiality requires this confidentiality to be maintained if there is a number of less than 3 economic agents for any item in the inventory (activity variable, general socio-economic data, technological data, etc.).

The list of categories in the Inventory –cross-referenced with the emitted substances– which are considered confidential are revised annually based on the variation in the number of economic agents which are considered for an item in the Inventory in each edition.

On an annual basis, the economic agents providing information of a confidential nature for the Inventory are asked by means of a specific form whether they wish to lift the confidentiality restrictions on the information that they consider sensitive.

2.7.- General uncertainty evaluation

The uncertainty assessment in the Inventory uses two different approaches: a) a qualitative approach, extending to all the activities of the basic SNAP nomenclature and all pollutants; and b) a quantitative approach referring to the gases with direct potential to contribute to the greenhouse effect on all the emission activities in the CRF-IPCC nomenclature[20].

The qualitative approach has been used for this report in the NFR format, and its assessment procedures are described in general terms below.

[20] The quantitative approach, following the Tier 1 approach of the IPCC 2000 Guidelines, is explained in Annex 7 "Uncertainty Assessment" of the Spain Greenhouse Gas Emissions Inventory Report (NIR). The NIR is available at: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/2761.php

2.7.1.- Quality label allocation criteria

The allocation of quality labels to the emissions estimates is based on the labels associated with the Inventory's basic data (activity variables and emission factors) classified from A (the most precise) to E (the least precise), and are described below in Table 2.7.1 [21]

[21] See Table 3.2 "Rating definitions" in Chapter 5 "Uncertainties" in part A "General Guidance Chapters" of the EMEP/EEA 2009 Guidebook.

Table 2.7.1 - Classification of data quality labels

ACTIVITY VARIABLES

LABEL	MEANING	TYPICAL UNCERTAINTY RANGE
A	Very precise value specifically known	10% to 30%
B	Precise specific value	20% to 60%
C	Approximate value, but sufficiently well-estimated as to be considered representatively correct	50% to 200%
D	Approximate value, with good representation of the order of magnitude	100% to 300%
E	Only an approximate value, representing only a possible order of magnitude	Order of magnitude (scale factor 0.1 to 10)

EMISSION FACTORS

LABEL	MEANING	TYPICAL UNCERTAINTY RANGE
A	Data based on a large number of tests using analytical techniques and considered representative of the entire population	10% to 30%
B	Data based on a large number of tests using analytical techniques and considered representative of a large percentage of the population	20% to 60%
C	Data based on a small number of tests using analytical techniques and considered reasonably representative of the entire population	50% to 200%
D	Data based on a single test using analytical techniques or in a certain number of references based on engineering calculations	100% to 300%
E	Data based on engineering calculations provided in a reference; data based on an engineering-related opinion; data sets for which no documentation is provided. In general, these may not be representative of the entire population	Order of magnitude (scale factor 0.1 to 10)

Using the data on the quality labels for the activity variables and the emission factors, the emissions quality labels can be derived in accordance with the composition system “DATA ATTRIBUTE RATING SYSTEM”, specified in Table 2.7.2. below. This composition system has been adopted by the Inventory Working Party as it is considered to be the most appropriate for the context of the Spanish Inventory.

Table 2.7.2. - System adopted for the composition of the emissions quality label: “DATA ATTRIBUTE RATING SYSTEM”

Labels of the activity variables and emission factor	Label of the emissions variable	Labels of the activity variables and emission factor	Label of the emissions variable
E-E	E	C-C	C
E-D	E	D-A	D
E-C	E	C-B	C
D-D	D	C-A	C
E-B	E	B-B	B
E-A	E	B-A	B
D-C	D	A-A	A
D-B	D		

2.7.2.- Quality label allocation procedure

In the present edition of the Inventory, the qualitative diagnosis of uncertainty has been made by classifying the emission factors and the activity variables with quality labels. The allocation of a particular quality label from the range of options A-E was established by applying the following criteria:

FOR THE EMISSIONS:

The typification of the quality of the emissions is based on the classification, using the same categories (A-E), of the activity variables and the estimation methods (mostly emission factors), and on a composition method using the hypothesis of the independence of the quality level (label) in both data inputs (activity variables and emission factors). Specifically, obtaining the label for the cross-tab between SNAP group and pollutant has been considered as a weighted average (taking the emissions as the weighting factor and assuming correspondence between the ordinal ranking A-B-C-D-E and the cardinal series 1-2-3-4-5 in order to apply the weighting algorithm numerically and assign, after calculating the weighting, its numerical value, rounded wherever necessary, to the corresponding letter in the ordinal series) of the labels allocated to the emissions of each of the individualised and point sources, as well as area sources contributing to the SNAP-pollutant cross-tab under consideration. This composition procedure is similar to the “Data Attribute Rating System” referred to in Table 2.7.2 above.

FOR THE EMISSIONS FACTORS:

The following general criteria have been applied initially for the allocation of quality labels to emission factors:

"A" for those derived from measured observations (SO_2 and NO_x) and for those based on materials balance (CO_2) in combustion processes.

"B" for those derived from the methods for balance of materials, basically SO_2, Pb and CO_2, if they have not been classified with a better quality label as described in the previous paragraph.

“B”, “C” and “D” for those based on default emission factors in highly anthropogenic sectors (SNAP groups 1 to 9) if these have not been classified with a better label as described in the previous paragraphs.

“C”, “D” and “E” for those based on emission factors and on correlation functions with agriculture and livestock sectors and natural sectors (SNAP groups 10 and 11) if these have not been classified with a better label as described in the previous paragraphs.

The above general criteria have been allocated the label codes indicated in the main methodological sources of the Inventory: EMEP/CORINAIR Guidebook (first to third editions with their successive updates), EMEP/EEA 2009 Guidebook, CORINAIR Manual (1992), and the IPCC 1996 Guidelines and the IPCC Guidelines from 2000, 2003 and 2006, whenever these contained explicit information. The corresponding emission factor quality labels, with their reference sources, are provided within each of the emission-producing activities in the

SNAP nomenclature listed in volume 2 of the Inventory Report in its basic SNAP format, whenever that specific information was available.

FOR THE ACTIVITY VARIABLES

The following general principles have been applied for the allocation of quality labels to the activity variables:

"A" for the data collected from the questionnaires sent by Large Point Sources, as well as the data from the Population Censuses (e.g. Population Census) and the Statistical Yearbooks on Registration (e.g. Registration of Motor Vehicles).

"B" for sector-based statistics based on questionnaires sent to activity centres (a large part of the statistics produced by the Technical Secretariat-General of the Ministry of Industry, Tourism and Trade).

“B”, “C” and “D” for the “Inferred” Statistical Yearbooks (e.g. statistics in the Agricultural Statistical Yearbook from the MARM).

“C”, “D” and “E” for the diagnoses based on expert opinions.

In general, whenever it has been necessary to resort to secondary information, i.e. for geographical or disaggregation by sector using subrogated variables, the quality label given to the disaggregated information has been assigned the quality level immediately below the one attributed to the primary aggregated variable.

2.7.3.- Quality labels allocated to the emissions estimates.

Table 2.7.3 shows the quality labels associated to the estimated emissions in each SNAP group and each of the pollutants in the three blocks. These labels have been derived using the procedure described in section 2.7.2. The information in the Table can be considered representative for the whole of the period in the inventory.

Table 2.7.3.- Mean quality levels (labels) of emissions

GROUP	ACIDIFIERS, OZONE PRECURSORS AND GREENHOUSE GASES										
	SO_2	NO_X	NMVOC	CH_4	CO	CO_2	N_2O	NH_3	SF_6	HFC	PFC
1	A	B	C	C	B	A	D				
2	B	C	E	E	E	A	D				
3	C	C	D	D	D	B	D				
4	B	C	D	D	D	B	C	E		C	C
5			D	D		B					
6			D				A	D	C	C	C
7	A	D	D	D	D	A	D	D			
8	B	C	C	C	C	B	E	E			
9	C	D	D	B	E	D	D	D			
10	D	D	E	C	D		D	D			
11	D	D	E	D	D		E	E			
MEAN	B	C	E	C	D	B	D	D	C	C	C

Table 2.7.3.- Mean quality levels (labels) of emissions (Continued)

GROUP	HEAVY METALS									PARTICULATE MATTER		
	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn	$PM_{2.5}$	PM_{10}	TSP
1	D	D	D	D	D	D	D	D	D	C	C	B
2	D	D	D	D	D	D	D	D	D	E	E	D
3	D	D	D	D	D	D	D	D	D	D	D	C
4	D	D	D	C	C	C	D	C	D	D	D	C
5										D	D	C
6												
7		E	E	E		E	A	D	E	C	C	B
8	D	D	D	D	D	D	C	D	D	C	C	B
9	D	D	D	D	D	D	D	D	D	D	D	C
10										E	E	D
11												
MEAN	D	D	D	D	D	D	B	D	E			

GROUP	PERSISTENT ORGANIC POLLUTANTS									
	HCH	PCP	HCB	TCM	TRI	PER	TCB	TCE	DIOX	PAH
1									D	D
2									E	E
3									E	D
4		D	D	E		E			D	D
5										
6					E	C		E		E
7									E	E
8			E						E	E
9		D	D						B	D
10	E		E						E	E
11										D
MEAN	E	D	E	E	E	C		E	D	D

2.8.- General completeness evaluation

In this section we provide an explanation of the reason that in some activity*pollutant cross-tabs in the inventory tables, it has not been possible to estimate the corresponding emissions figures in this edition of the inventory. There are various reasons for this, and particularly the following: no information was available on the activity variables, the emission factor associated to a definite activity variable was not available, and even including a certain lack of specificity in the application of the emissions estimation algorithm and its required parameters.

When it was not possible to estimate the emissions and it is nonetheless considered that the process does generate emissions for the activity*pollutant cross-tab considered, a “not estimated” (NE) label has been entered in the corresponding cell. When an emissions estimation that should have been allocated to a certain cell has been allocated to another cell, a notation key of “estimated elsewhere” (IE) is entered in the cell. The most important cases, by sector, are described below for this allocation of NE or IE labels.

2.8.1.- Energy

2.8.1.1.- Sources not estimated (NE)

Depending on the criteria adopted for assigning an “NE” label to a category*pollutant cross-tab in the CLRTAP-EMEP (NFR) format inventory, the following types can be distinguished:

a) Activity data (essentially, fuel consumption) not available

- Recreational craft (partially category 1A5b) are allocated a “NE” label as there is no base information available for estimating the associated consumption rates. The inclusion of this new activity in the Inventory is presumed to be insignificant in terms of emission[22].

b) Emission factors not available in the methodological guidelines consulted

- NH_3 emissions for stationary combustion. In view of the considerations set out in the EMEP/CORINAIR Guide Book (chapters B-111 and B-112), NH_3 emissions in stationary combustion are of scant relevance in the total inventory levels and are associated with the incorporation of certain secondary NO_X abatement measures, but the existence of these is not recorded in the information supplied by the plants treated in the inventory as point sources, and is presumably of null or very scant implementation in the combustion facilities –generally low power– in the rest of the sectors. The only information available on measured emissions of this pollutant was in coke furnaces, coal gasification plants and MSW incinerators with energy recovery.

- Emissions of major metals (Pb, Hg) in air traffic at airports (categories 1A3a). Emissions have not been calculated for these metals as the mean specifications of the fuels used in aviation (kerosene jet fuel, gasoline jet fuel and aviation gasoline) were not available broken down into their metal composition. This is estimated to be a negligible source of emissions or of scant relevance for both metals[23,24].

- Emissions of NMVOC and metals in coal mining and manipulation (category 1B1a). In view of the considerable uncertainty declared by the EMEP/CORINAIR Guidebook with regard to the composition of firedamp gas, it has been decided to analyse the representativeness of the concentrations of the default NMVOC compounds proposed to characterise domestic mining and coals, without incorporating the estimation of this pollutant into the present edition, although it is assumed to involve emissions of very little significance in the inventory as a whole. Regarding metals, no studies are available on possible traces of metals

[22] Although using a conservative criterion it was initially assumed that the activity of recreational crafts was not estimated in the Inventory, it seems likely that this consumption has been estimated in the whole of national navigation, and it is currently being investigated whether the corresponding label should be “IE” instead of “NE”.

[23] The consumption of aviation gasoline, with higher lead content than gasoline due to the additional incorporation of lead to increase the number of octanes (comment in the EMEP/CORINAIR Guidebook) is marginal and limited to small piston-driven aircraft, in comparison with the consumption of kerosene jet fuel.

[24] For forthcoming editions of the inventory, it is intended to change the methodology for estimating consumption and the emissions of the main pollutants in air traffic, which might represent changes in the estimated consumption rates for these categories (LTO operations) and alter –presumably to a minor degree– the appraisal of its importance.

contained in the coal or in the adjacent strata and that are emitted in the mining processes or in the subsequent manipulation of the coal in gaseous or particulate state. For other pollutants not estimated in this category, such as CO or SO_X, the levels of emission estimated are nil or insignificant.

- SO_X emissions due to fugitive emissions of crude oil (category 1B2ai), petroleum-derived products (1B2av) and natural gas (category 1B2b) or natural gas venting (partially, 1B2c). As no information is available on traces of sulphur originally contained in the hydrocarbons or subsequently incorporated into them in the treatment phase (in the case of the addition of sulphur to natural gas for odorisation purposes), it has not been possible to estimate the potential SO_X emissions in non-combustive processes. This emission source is presumed to be of very low importance to the Inventory as a whole.

- Other category*pollutant cross-tabs such as: i) emissions of metals and NH_3 in venting or flaring of oil and gas (category 1B2c); ii) emissions of DIOX due to fugitive emissions (categories 1B2); iii) emissions of metals (Pb, Hg) and DIOX in railway traffic (category 1A3c) or mobile machinery (categories 1A4cii, 1A2fii); iv) emissions of metals (Pb, Cd, Hg) in other modes of transport (category 1A3e); and v) emissions of NH_3 and DIOX in air traffic (categories 1A3a), have not been estimated, as the emission factors do not appear in the reference sources consulted. None of these categories is considered likely to constitute a relevant emission source for the aforesaid pollutants.

It should be pointed out that other activities potentially producing emissions that have not been estimated, and whose items are identified with the label NO/NE in the NFR format, were: i) international marine navigation (category 1A3di(ii)); ii) other fugitive emissions from solid fuels (category 1B1c); and iii) production of geothermal energy, peat, or extraction of another energy source not included in the prior categories of 1B (category 1B3), since they are either not significant or do not take place in Spain.

2.8.1.2.- Sources included elsewhere (IE)

As indicated in the chapter on the energy sector (please refer to section 4.3.9), the categories associated with mobile sources in the services (1A4aii) and residential sectors (1A4bii) appear with an "IE" label in the CLRTAP-EMEP inventory format (NFR), as their emissions are essentially included within the categories related to the stationary sources of their respective sector[25]. In a similar context, according to confirmation from the national bodies assigned to complete the questionnaires to be sent to the international bodies to prepare the energy balances, the consumption rates allocated to military activities (fixed and mobile facilities) are counted –although not distinguished– in the national energy balances

[25] Since the reference source chosen for the activity variable does not distinguish consumption for each sector by source type (stationary or mobile), and no additional information was available in the inventory to break it down, and judging that in both sectors consumption from stationary sources was clearly predominant, it was decided to associate total consumption with these sources, estimating the resulting emissions with factors corresponding to stationary facilities.

used in the Inventory, and thus their emissions were estimated for the Inventory within the categories to which the items of consumption are associated[26].

Among the activity*pollutant cross-tabs in the energy sector whose emissions are reflected in other categories, it is worth noting the potential emissions of priority metals (Cd, Hg, Pb) from fugitive emissions when the coke furnace door is opened (category 1B1b), estimated overall for the process as a whole within the category on combustion (1A1c)[27].

Finally, for PAH emissions, it has only been possible to estimate the aggregate of the emissions of this pollutant, without the breakdown of each of its component types. The cells corresponding to each of the types have therefore been attributed an "IE" label, and the emission figure has been included in the column corresponding to the total (column marked "Total 1-4"). This was intended to indicate that the emissions of each of the types of PAH are estimated in the total for this pollutant.

2.8.2.- Industrial processes

2.8.2.1.- Sources not estimated (NE)

An initial cause for the absence of emissions estimations ("NE" label) was the lack of accuracy in the specifications of the estimation algorithm and the inputs it requires. These include particularly the activities for the storage, handling and transport of mineral products (category 2A7c), chemical products (2B5b) and metallic products (2C5f); construction and demolition activity (2A7b); or the processing of timber (2D3).

In all these activities, in the opinion of the inventory working group, it is difficult to understand in the specifications of the EMEP/CORINAIR Guide Book, first of all the estimation algorithm itself, and, secondly, the specificity of the activity variables and parameters that have to be included in the algorithm for the emissions estimation.

Moreover, an "NE" label has also been assigned to those cross-tabs of category*pollutant for which emission factors were not available, in order to allow the emissions to be estimated. In some of these cases there is uncertainty regarding the potential emission of certain pollutants in some activities (for example, emissions of the main pollutants in most of the activities in category 2A Mineral products), whereas in others, such as metal production activities (production of copper, lead, nickel, zinc), there is a potential

---

26 As it was impossible to dissociate the items in the balance for consumption for military activities, and to avoid double counting in the emission levels, it was decided not to produce a complementary estimation of the historic consumption in these activities. Based on the information provided by the Ministry of Defence regarding the consumption of tactical military equipment for 2008, the differentiated treatment in these items is presumed to be of minor importance for the emission levels of the Inventory.

27 The reference guide used (EMEP/CORINAIR Guidebook) proposes generic factors for metals without distinguishing them by sub-process (combustion and/or opening-loading-extinguishing), and it is not possible to identify the kind of emission source type (combustion and/or fugitive emissions) for these substances.

risk of double counting the emissions, as these activities are associated to the part corresponding to combustion within category 1A2b, and it is not clear which part of the production process should be included in the industrial processes sector (excluding combustion).

2.8.2.2.- Sources included elsewhere (IE)

For PAH emissions it was only possible to estimate the aggregate of the emissions of this pollutant, without the breakdown of each of its component types. The cells corresponding to each of the types have therefore been attributed an “IE” label, and the emission figure has been included in the column corresponding to the total (column marked “Total 1-4”). This was intended to indicate that the emissions of each of the types of PAH are estimated in the total for this pollutant.

2.8.3.- Use of solvents and other products

2.8.3.1.- Sources not estimated (NE)

It was not possible to use verified emission factors for particulate matter ($PM_{2.5}$, PM_{10} and TSP) for the various activities considered in the categories in this sector, so for these pollutants an “NE” label has been attributed in cases where it is thought that there might be potential emissions.

It should also be mentioned that, for category 3C (Chemicals), it has only been possible to estimate the emissions of NMVOC, as no emission factors were available to allow the estimation of other pollutants potentially emitted in the activities in this category.

2.8.3.2.- Sources included elsewhere (IE)

For PAH emissions it was only possible to estimate the aggregate of the emissions of this pollutant, without the breakdown of each of its component types. The cells corresponding to each of the types have therefore been attributed an “IE” label, and the emission figure has been included in the column corresponding to the total (column marked “Total 1-4”). This was intended to indicate that the emissions of each of the types of PAH are estimated in the total for this pollutant.

2.8.4.- Agriculture

2.8.4.1.- Sources not estimated (NE)

An “NE” label has been attributed for those category*pollutant cross-tabs in which:

i) no verified emission factors were available to allow the emissions estimation

ii) no verified values were available for the activity variable

The first case affects the emissions of NMVOC in the Manure Management activity (4B), the emissions of NH_3 due to goats and the emissions of particulate matter from sheep, goats and poultry; as well as the emissions of $PM_{2.5}$ for Croplands (4D) and particulate matter for Residue Burning (4F). The second case occurs in Manure Management (4B) for the following species of animal: buffalo, turkey and other animals.

It is important to point out, as explained in detail in chapter 7 Agriculture, that emissions have not been considered from activities 4D2a, 4D2b and 4D2c, therefore their label is “NA” for all pollutants. However, activity 4G has considered only those activities using pesticides and limestone, which only produce emissions of HCH and HCB (until 2002) so the label is “NA” for the rest of the pollutants.

2.8.4.2.- Sources included elsewhere (IE)

For PAH emissions due to Residue Burning (4F), it was only possible to estimate the aggregate of the emissions of this pollutant, without the breakdown of each of its component types. The cells corresponding to each of the types have therefore been attributed an “IE” label, and the emission figure has been included in the column corresponding to the total (column marked “Total 1-4”). This was intended to indicate that the emissions of each of the types of PAH are estimated in the total for this pollutant.

2.8.5.- Waste

2.8.5.1.- Sources not estimated (NE)

An “NE” label has been attributed in those category*pollutant cross-tabs for which emission factors were not available to allow the emissions estimation. This is the situation of Wastewater processing (6B), where there is considered to be a potential emission of certain pollutants such as NMVOC. It is also the case of NH_3 in Landfill deposit (6A) and in Hospital waste incineration (6Ca). Nor has it been possible to use verified emission factors for NH_3 and particulate matter ($PM_{2.5,}$ PM_{10} and TSP) for Incineration of WWTP sludge (6Ce).

In the case of incineration of MSW, the emissions from this activity since 2003 come entirely from facilities that have been carrying out energy recovery, and these emissions are thus calculated in the chapter corresponding to energy and therefore an “NE”[28] label has been assigned to the waste sector.

Finally, for the case of the Other treatments (6D) category, it was only possible to calculate the pollutants for which information is available on emission factors and an “NE” label has been assigned to those pollutants for which it is believed that there could be a potential emission.

---

[28] This “NE” label should in fact be reported as “NA”, and will be corrected in the next edition of the inventory.

2.8.5.2.- Sources included elsewhere (IE)

For PAH emissions it was only possible to estimate the aggregate of the emissions of this pollutant, without the breakdown of each of its component types. The cells corresponding to each of the types have therefore been attributed an “IE” label, and the emission figure has been included in the column corresponding to the total (column marked “Total 1-4”). This was intended to indicate that the emissions of each of the types of PAH are estimated in the total for this pollutant.

3.- EXPLANATION OF KEY TRENDS

Chapter updated in July 2010.

This chapter presents a summary of the results of estimating the inventory emissions for the following substances: i) main pollutants (NO_X, NMVOC, SO_X, NH_3 and CO); ii) particulates ($PM_{2.5}$, PM_{10} and TSP); iii) priority metals (Pb, Cd and Hg); and iv) persistent organic pollutants (DIOX and PAH), over the period 1990-2008 and with regard to the whole of Spain, and not only the part of its territory that intersects with the EMEP grid.

The presentation deals first, in heading 3.1, with a general description for the substances indicated, followed, in heading 3.2, by a more detailed analysis by substance and activity category generating the emissions.

3.1.- Aggregate analysis

Tables 3.1.1.a, 3.1.1.b and 3.1.1.c respectively show the change in emissions in absolute terms, their annual change rate, taking 1990 as base 100 (2000 for particulate matter), and the five-yearly rolling index, also taking the emissions in 1990 as base 100 (2000 for particulate matter). To illustrate the course of the emissions graphically, Figures 3.1.1.a to 3.1.1.d show the representation of the annual change indices for these pollutants.

Table 3.1.1.a.- Absolute values

Year	NO_X (Gg)	NMVOC (Gg)	SO_X (Gg)	NH_3 (Gg)	CO (Gg)	$PM_{2,5}$ (Gg)	PM_{10} (Gg)	TSP (Gg)	Pb (Mg)	Cd (Mg)	Hg (Mg)	DIOX (g-I Teq)	PAH (Mg)
1990	1,340.9	1,036.1	2,176.2	317.7	3,654.1				2,788.4	26.8	14.6	185.0	321.3
1991	1,381.8	1,053.7	2,176.0	313.7	3,723.7				1,879.1	26.0	15.2	191.0	322.7
1992	1,412.1	1,067.3	2,128.7	310.5	3,740.7				1,265.4	24.5	16.4	199.9	313.5
1993	1,380.2	990.8	2,004.9	295.2	3,558.2				1,154.7	22.0	14.9	196.7	317.6
1994	1,396.5	1,007.1	1,952.8	316.7	3,441.3				1,144.1	23.1	14.8	190.5	313.1
1995	1,379.3	975.1	1,791.4	310.6	3,165.4				966.6	23.2	14.7	164.6	306.9
1996	1,326.8	1,004.1	1,563.5	339.1	3,195.9				947.9	21.2	13.4	163.7	317.5
1997	1,340.5	1,017.0	1,740.6	341.0	3,089.8				883.5	21.1	11.5	136.5	334.1
1998	1,322.1	1,048.9	1,586.6	359.1	2,985.2				818.4	21.3	12.1	138.0	314.8
1999	1,372.7	1,041.1	1,601.9	369.1	2,817.8				758.4	21.5	13.0	144.1	303.4
2000	1,394.4	1,017.9	1,462.7	380.1	2,674.7	126.5	170.5	231.3	626.2	20.3	12.6	149.7	274.3
2001	1,365.5	998.4	1,438.9	381.3	2,608.6	127.2	170.9	230.9	408.6	20.4	12.7	144.3	258.9
2002	1,407.6	921.6	1,541.5	378.0	2,379.8	129.0	174.5	236.6	274.8	21.0	13.3	144.7	226.5
2003	1,401.5	932.6	1,277.4	392.2	2,453.3	129.9	173.5	233.4	271.0	19.5	12.1	149.7	280.2
2004	1,446.8	920.9	1,320.6	385.7	2,311.6	130.3	174.0	233.7	266.8	18.9	12.1	152.6	254.4
2005	1,434.2	885.1	1,271.9	367.2	2,125.6	131.4	173.2	230.2	273.5	18.5	11.9	152.0	223.6
2006	1,401.9	873.1	1,170.5	377.8	2,113.3	130.2	171.1	226.8	275.9	18.3	11.2	159.0	249.6
2007	1,416.2	863.5	1,170.4	388.4	2,100.6	133.8	174.9	232.0	275.2	15.3	10.3	163.5	257.5
2008	1,237.4	815.6	530.0	358.4	1,995.5	124.7	159.8	211.5	269.5	14.9	9.4	160.3	256.3

Table 3.1.1.b.- Annual index (with 1990 as base 100; 2000 for particulate matter)

Year	NO_X (Gg)	NMVOC (Gg)	SO_X (Gg)	NH_3 (Gg)	CO (Gg)	$PM_{2,5}$ (Gg)	PM_{10} (Gg)	TSP (Gg)	Pb (Mg)	Cd (Mg)	Hg (Mg)	DIOX (g-I Teq)	PAH (Mg)
1990	100.00	100.00	100.00	100.00	100.00				100.00	100.00	100.00	100.00	100.00
1991	103.04	101.70	99.99	98.76	101.91				67.39	96.91	104.18	103.23	100.45
1992	105.30	103.01	97.81	97.72	102.37				45.38	91.44	112.76	108.07	97.59
1993	102.93	95.63	92.13	92.93	97.38				41.41	82.23	102.05	106.31	98.85
1994	104.14	97.20	89.73	99.68	94.18				41.03	86.35	101.89	102.95	97.46
1995	102.86	94.11	82.32	97.77	86.63				34.67	86.64	100.87	88.95	95.53
1996	98.95	96.91	71.85	106.75	87.46				34.00	79.09	91.98	88.48	98.82
1997	99.97	98.15	79.98	107.33	84.56				31.69	78.63	78.77	73.78	104.00
1998	98.60	101.23	72.90	113.04	81.70				29.35	79.63	82.86	74.57	98.00
1999	102.37	100.48	73.61	116.19	77.11				27.20	80.42	88.96	77.90	94.43
2000	103.98	98.24	67.21	119.63	73.20	100.00	100.00	100.00	22.46	75.97	86.55	80.93	85.37
2001	101.83	96.36	66.12	120.03	71.39	100.52	100.27	99.81	14.65	76.18	87.16	78.01	80.60
2002	104.97	88.95	70.83	118.98	65.13	101.94	102.33	102.30	9.85	78.26	91.35	78.21	70.52
2003	104.51	90.01	58.70	123.45	67.14	102.70	101.77	100.88	9.72	72.70	82.93	80.89	87.23
2004	107.90	88.88	60.68	121.39	63.26	103.00	102.07	101.02	9.57	70.40	82.73	82.49	79.18
2005	106.95	85.42	58.45	115.60	58.17	103.87	101.58	99.50	9.81	69.02	81.62	82.16	69.60
2006	104.55	84.27	53.78	118.90	57.83	102.92	100.33	98.04	9.90	68.26	76.66	85.97	77.69
2007	105.61	83.34	53.78	122.27	57.49	105.75	102.59	100.29	9.87	57.21	70.40	88.38	80.15
2008	92.27	78.72	24.36	112.81	54.61	98.59	93.71	91.41	9.67	55.59	64.48	86.66	79.78

Table 3.1.1.c.- Mean five-yearly index (with 1990 as base 100; 2000 for particulate matter)

Five-year Period	NO_X (Gg)	NMVOC (Gg)	SO_X (Gg)	NH_3 (Gg)	CO (Gg)	$PM_{2,5}$ (Gg)	PM_{10} (Gg)	TSP (Gg)	Pb (Mg)	Cd (Mg)	Hg (Mg)	DIOX (g-I Teq)	PAH (Mg)
1990-1994	103.08	99.51	95.93	97.82	99.17				59.04	91.39	104.18	104.11	98.87
1991-1995	103.65	98.33	92.40	97.37	96.49				45.98	88.71	104.35	101.90	97.98
1992-1996	102.84	97.37	86.77	98.97	93.60				39.30	85.15	101.91	98.95	97.65
1993-1997	101.77	96.40	83.20	100.89	90.04				36.56	82.59	95.11	92.10	98.93
1994-1998	100.90	97.52	79.36	104.91	86.90				34.15	82.07	91.27	85.75	98.76
1995-1999	100.55	98.18	76.13	108.22	83.49				31.38	80.88	88.69	80.74	98.16
1996-2000	100.77	99.00	73.11	112.59	80.81				28.94	78.75	85.82	79.13	96.13
1997-2001	101.35	98.89	71.97	115.24	77.59				25.07	78.16	84.86	77.04	92.48
1998-2002	102.35	97.05	70.13	117.57	73.70				20.70	78.09	87.37	77.92	85.78
1999-2003	103.53	94.81	67.29	119.66	70.79				16.78	76.71	87.39	79.19	83.63
2000-2004	104.64	92.49	64.71	120.70	68.02	101.63	101.29	100.80	13.25	74.70	86.14	80.10	80.58
2001-2005	105.23	89.92	62.95	119.89	65.02	102.41	101.60	100.70	10.72	73.31	85.16	80.35	77.43
2002-2006	105.78	87.51	60.49	119.66	62.31	102.89	101.62	100.35	9.77	71.73	83.06	81.94	76.84
2003-2007	105.91	86.38	57.08	120.32	60.78	103.65	101.67	99.95	9.77	67.52	78.87	83.98	78.77
2004-2008	103.46	84.12	50.21	118.19	58.27	102.83	100.06	98.05	9.76	64.09	75.18	85.13	77.28

Figure 3.1.1.a.- Emissions evolution index (Main pollutants)

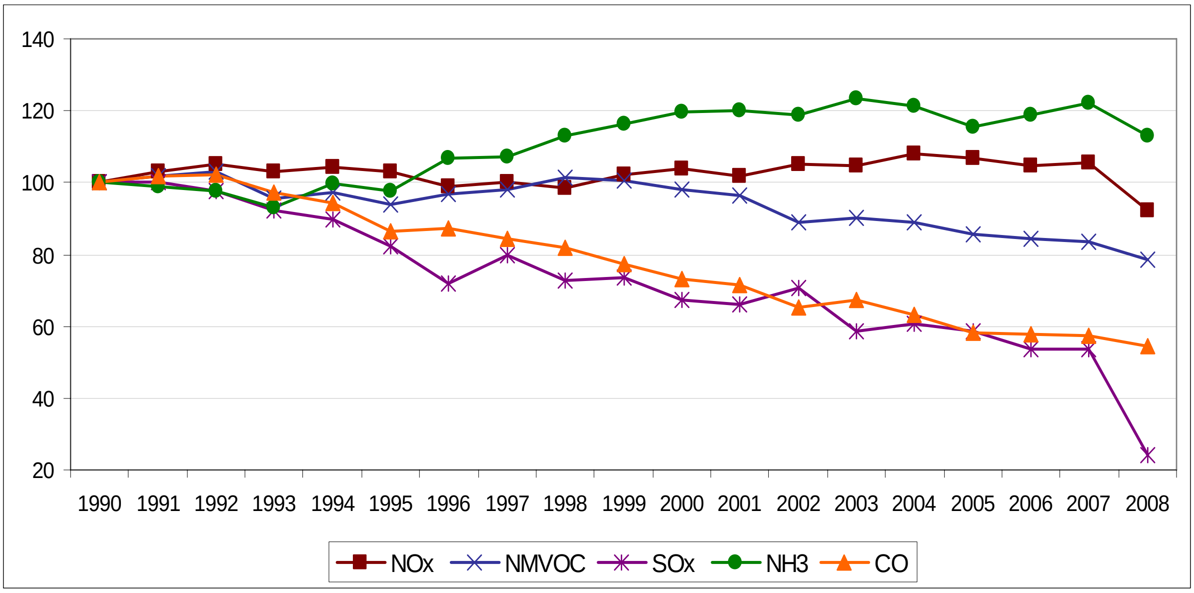


Figure 3.1.1.b.- Emissions evolution index (Particulate matter)

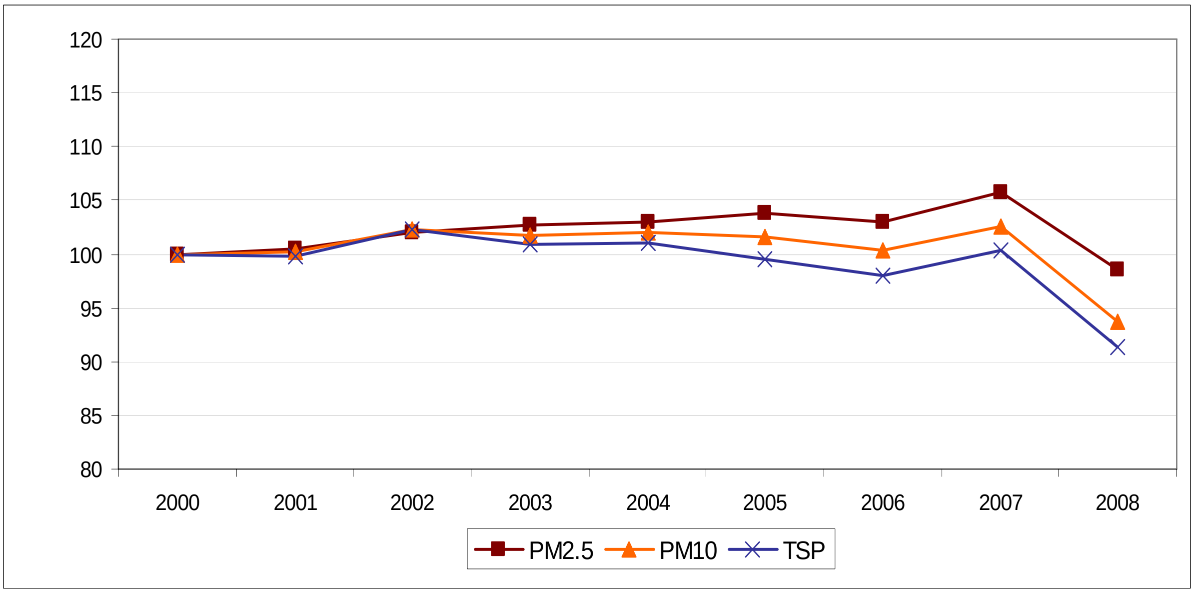


Figure 3.1.1.c.- Emissions evolution index (Priority metals)

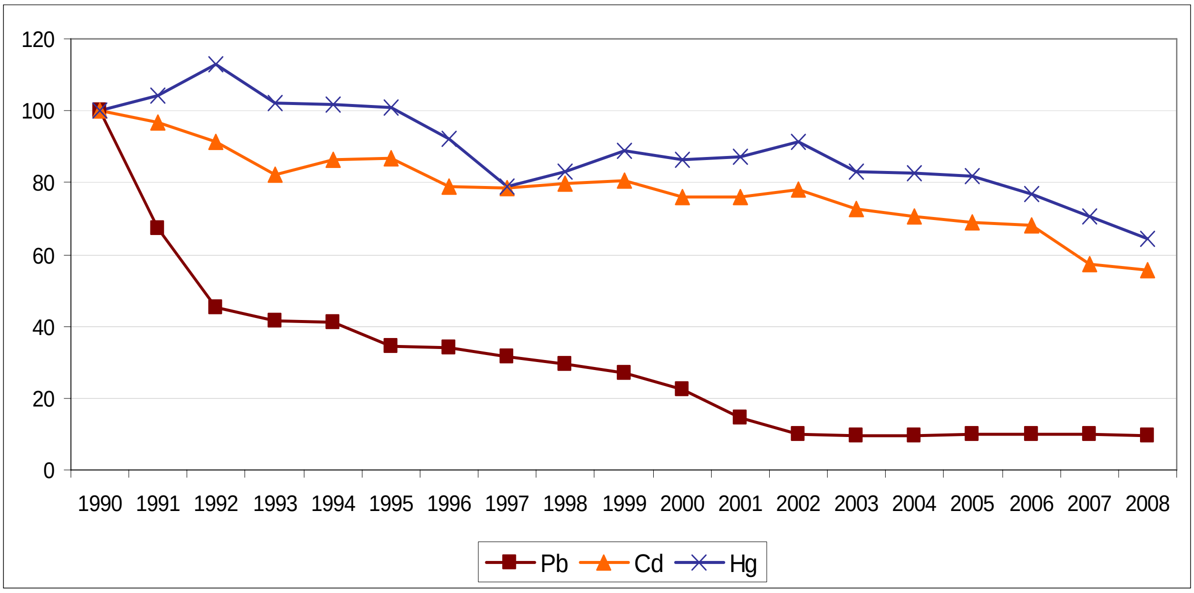
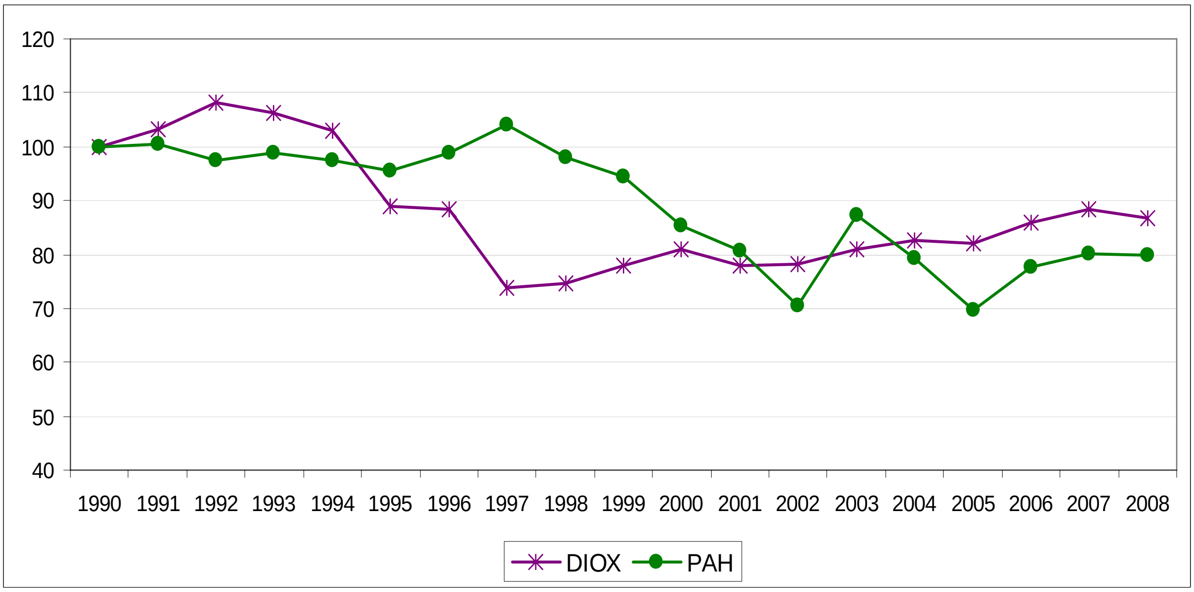


Figure 3.1.1.d.- Emissions evolution index (Persistent organic pollutants)



By referring to Table 3.1.1.b and its illustration in Figure 3.1.1.a, we can see a distinct behaviour for each substance. NH_3 evolution was characterized in 2008 by a 12.8% increase rate with respect to 1990; on the other hand, NO_X remained stable in global terms while growing slightly, except for 2008, when a significant decrease is observed, dropping by 7.7% with respect to the rate in 1990; conversely, NMVOC are characterized by a relatively stable evolution until 2000, followed by a sustained decrease that results in a 21.3% drop between 1990 and 2008, whereas CO and SO_X also fall, particularly in 1990-2008 (by 45.4% and 75.6%, respectively), even though the most significant drop in the case of SO_X occurred in

2008.These time profiles are confirmed in Table 3.1.1.c showing the five-yearly rolling index, which smoothes the erratic changes identified in annual series as it is a mean of the corresponding five-year period.

As for the particulate matter in their three classes (please refer to Table 3.1.1.b and Figure 3.1.1.b), the change indices are practically identical in the period 2000-2002, and from this latter year on a gradual albeit moderate divergence can be seen, with a dispersion range of approximately 5 percentage points in 2007, the dispersion range between the different diametric classes stood at 5 percentage points in 2007, reaching 7 points by 2008 (with respect to 2000); with index values, by diameter class, in 2008 of 98.6 for $PM_{2.5}$, 93.7 for PM_{10} and 91.4 for TSP. On the other hand, due to the small year-to-year variability in the three series, with the exception of one significant drop in 2008, the values of the five-yearly rolling index in Table 3.1.1.c strengthen further the already stable profile of the series.

For heavy metals (please refer to Table 3.1.1.b and Figure 3.1.1.c), a distinction must be drawn between the clearly downward trend in the emissions of Pb, with a very marked slope in the period 1990-1992, a gentler albeit clear slope in the period 1992-2002, and practically stable from this latter year on, finishing in 2008 at a level of 9.7% up on 1990. On the other hand, for Cd and Hg, after an initial period from 1990 to 1997 with differences between both pollutants, there is a relatively parallel progression for both with an overall moderately downward trend that accumulates falls between 1990 and 2008 in the order of 44.4% for Cd and 35.5% for Hg.

Finally, dioxins and PAH (please refer to Table 3.1.1.b and Figure 3.1.1.d) are the substances that, within the block of pollutants analyzed, show the greatest irregularity, framed within an overall decline. In the specific case of dioxins, the bulk of this fall is in the period 1990-1997, and from then on there is moderate growth that places the index in 2008 at 86.7 with respect to 1990. In the meantime, the PAH are characterized by a more erratic behaviour although within an overall trend that is more uniformly declining, with the index in 2008 at 79.8 with respect to 1990.

3.2.- Analysis by substance and activity category

This sub-heading presents the emissions information for each of the substances analyzed broken down by activity categories.

3.2.1.- Nitrogen Oxides

NO_X emissions were stable, slightly growing until 2007 and recording a significant decrease in 2008, mainly due to the weight of combustion in the energy, manufacturing and construction sectors, as well as by transport (essentially road transport), and in a more secondary position, by the other combustion activities. In absolute terms, this evolution is shown in Table 3.2.1.1, and in terms of the contribution of each category in Table 3.2.1.2.

Figure 3.2.1.1 graphically illustrates the variation in the activities' contribution to the emissions of this pollutant between the start year and the last year of the period inventoried (1990 and 2007). As can be seen, the changes in the contributions are moderate, except in categories 1.A.1 (industrial combustion in the energy sector), which dropped significantly in

2008, and 1.A.2 (combustion in manufacturing and construction industries), where the overall increase over four percentage points is offset by the drop of almost seven points in category 1.A.3 (transport) and by smaller changes in the other sectors.

***Table 3.2.1.1.- NO_X emissions** (Gg of NO_2)*

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	257.1	265.6	278.5	273.0	285.5	303.1	264.2	311.3	286.1	322.4
1.A.2 Manufacturing Industries and Construction	224.4	224.4	204.8	195.6	203.9	217.6	198.3	213.4	219.1	229.5
1.A.3 Transport	654.1	688.8	728.1	710.7	704.5	656.3	656.8	607.8	605.4	605.9
1.A.4 Other Sectors	155.4	157.9	158.2	158.5	160.0	162.1	163.3	164.6	168.6	172.2
1.B Fugitive Emissions from Fuels	6.7	5.8	5.1	8.1	5.7	5.2	5.7	5.0	5.0	4.8
2. Industrial Processes	13.0	10.0	9.0	7.5	8.2	8.4	8.3	8.7	8.6	8.8
3. Solvent and Other Product Use										
4. Agriculture	28.7	27.8	26.6	25.1	26.9	25.6	29.3	29.0	28.5	28.4
6. Waste	1.4	1.5	1.7	1.6	1.4	0.7	0.5	0.4	0.4	0.4
TOTAL	**1,340.9**	**1,381.7**	**1,412.0**	**1,380.0**	**1,396.2**	**1,379.0**	**1,326.4**	**1,340.0**	**1,321.8**	**1,372.4**

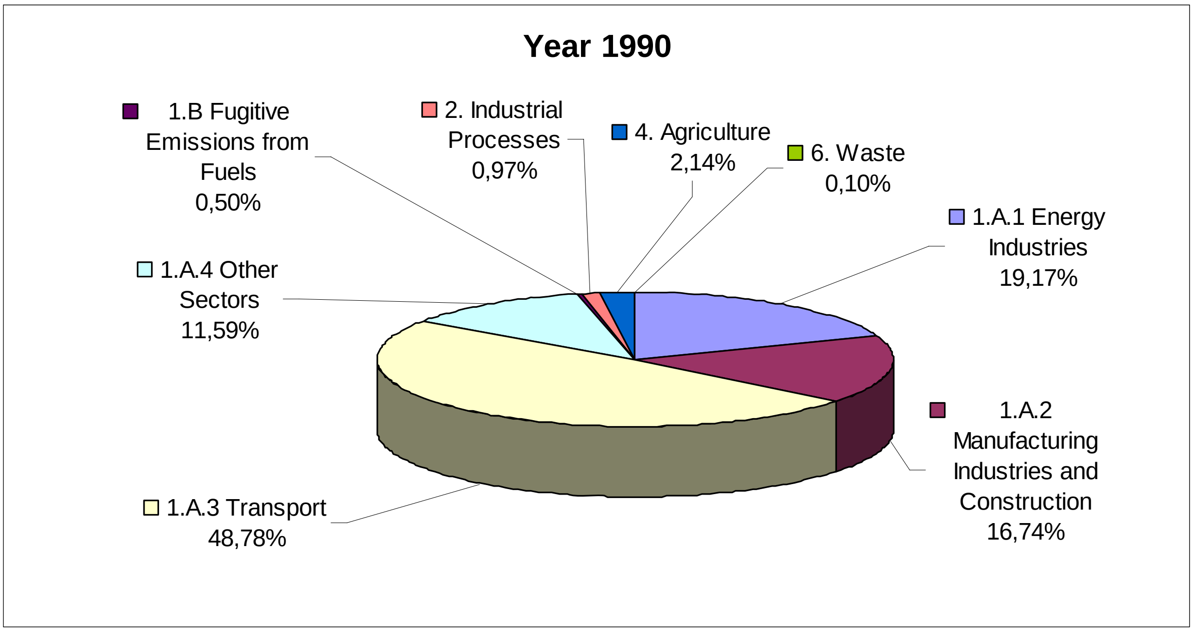
CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	342.5	311.9	355.2	330.9	355.5	358.5	330.7	343.0	233.4
1.A.2 Manufacturing Industries and Construction	234.8	246.4	253.9	267.8	276.0	273.0	280.1	277.8	263.0
1.A.3 Transport	603.9	593.8	585.4	583.3	595.9	585.8	571.7	574.0	520.2
1.A.4 Other Sectors	171.9	174.4	177.5	179.0	182.5	183.9	184.4	186.0	187.9
1.B Fugitive Emissions from Fuels	5.0	5.3	5.5	5.2	5.6	5.0	5.2	5.1	5.1
2. Industrial Processes	8.8	8.9	8.5	8.5	8.0	8.1	8.0	8.0	7.8
3. Solvent and Other Product Use									
4. Agriculture	26.7	23.9	20.7	25.8	22.5	19.0	21.2	21.7	19.4
6. Waste	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2
TOTAL	**1,394.0**	**1,364.9**	**1,407.0**	**1,400.8**	**1,446.3**	**1,433.6**	**1,401.6**	**1,415.9**	**1,237.1**

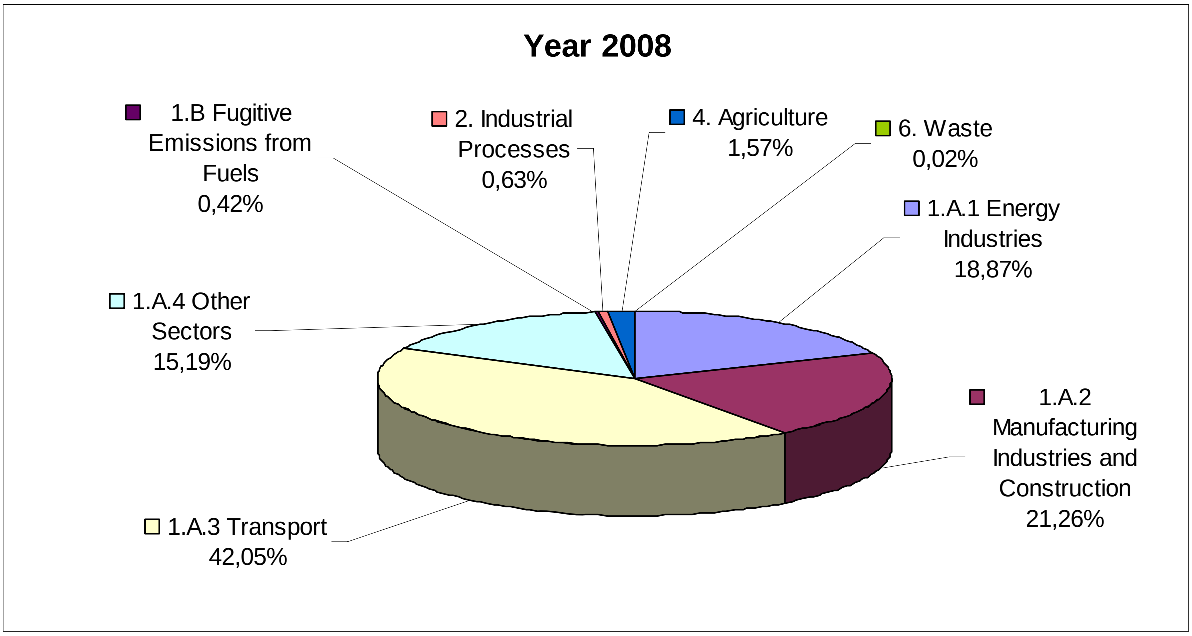
Table 3.2.1.2.- Contribution by categories to NO_X emissions

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	19.17	19.22	19.73	19.78	20.45	21.98	19.92	23.23	21.64	23.49
1.A.2 Manufacturing Industries and Construction	16.74	16.24	14.50	14.17	14.61	15.78	14.95	15.92	16.58	16.72
1.A.3 Transport	48.78	49.85	51.56	51.50	50.46	47.59	49.52	45.36	45.80	44.15
1.A.4 Other Sectors	11.59	11.43	11.21	11.49	11.46	11.75	12.31	12.28	12.76	12.55
1.B Fugitive Emissions from Fuels	0.50	0.42	0.36	0.59	0.41	0.37	0.43	0.37	0.38	0.35
2. Industrial Processes	0.97	0.72	0.64	0.54	0.59	0.61	0.63	0.65	0.65	0.64
3. Solvent and Other Product Use										
4. Agriculture	2.14	2.01	1.89	1.82	1.93	1.86	2.21	2.16	2.16	2.07
6. Waste	0.10	0.11	0.12	0.11	0.10	0.05	0.04	0.03	0.03	0.03
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	24.57	22.85	25.25	23.62	24.58	25.00	23.60	24.23	18.87
1.A.2 Manufacturing Industries and Construction	16.84	18.05	18.04	19.12	19.09	19.04	19.99	19.62	21.26
1.A.3 Transport	43.32	43.51	41.61	41.64	41.20	40.86	40.79	40.54	42.05
1.A.4 Other Sectors	12.33	12.77	12.62	12.78	12.62	12.83	13.16	13.14	15.19
1.B Fugitive Emissions from Fuels	0.36	0.39	0.39	0.37	0.39	0.35	0.37	0.36	0.42
2. Industrial Processes	0.63	0.65	0.60	0.61	0.55	0.57	0.57	0.57	0.63
3. Solvent and Other Product Use									
4. Agriculture	1.92	1.75	1.47	1.84	1.56	1.33	1.51	1.53	1.57
6. Waste	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 3.2.1.1.- Contribution by categories to NO_X emissions





3.2.2.- Non-Methane Volatile Organic Compounds

NMVOC emissions show relative overall stability until 2000, after which there is a downward trend. The aggregate balance is basically the result of the combination of a downward trend in category 1.A.3 (transport) and an upward trend in category 3 (solvent and other product use). It should be noted that the NMVOC emissions from crop leaf biomass are not included in category 4 (agriculture) as they are not felt to be anthropogenic. In absolute

terms, the changes are shown in Table 3.2.2.1, and, in terms of the contribution by each category, in Table 3.2.2.2.

Figure 3.2.2.1 graphically illustrates the variation in the activities' contribution to the emissions of this pollutant between the start year and the last year of the period inventoried (1990 and 2008). As can be seen, the changes in the absolute emissions of the dominant categories are reflected in the contributions to the total NMVOC emissions for each category.

Table 3.2.2.1.- NMVOC emissions (Gg)

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	9.1	9.2	9.5	8.7	8.1	8.1	7.5	7.7	8.1	8.8
1.A.2 Manufacturing Industries and Construction	17.1	17.4	16.5	15.6	14.8	16.0	15.1	16.2	17.2	18.8
1.A.3 Transport	363.4	381.5	409.9	375.0	375.5	338.7	340.0	314.7	307.2	278.6
1.A.4 Other Sectors	58.8	58.8	58.5	57.9	58.2	58.0	57.9	58.6	58.8	59.0
1.B Fugitive Emissions from Fuels	63.5	63.1	67.1	67.3	71.3	71.5	70.7	70.2	74.4	77.2
2. Industrial Processes	56.9	51.4	49.4	43.5	49.5	46.7	49.8	56.4	58.3	57.8
3. Solvent and Other Product Use	395.6	395.3	380.0	343.1	352.7	364.4	387.6	410.9	451.1	471.7
4. Agriculture	57.9	60.7	57.8	60.0	58.2	55.9	60.0	66.5	58.2	52.4
6. Waste	13.8	16.3	18.7	19.7	18.8	15.9	15.5	15.7	15.6	16.9
TOTAL	**1,036.1**	**1,053.7**	**1,067.3**	**990.8**	**1,007.1**	**975.1**	**1,004.1**	**1,017.0**	**1,048.9**	**1,041.1**

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	9.0	8.9	9.6	9.2	9.8	10.2	9.9	9.9	8.2
1.A.2 Manufacturing Industries and Construction	20.1	21.7	22.7	24.7	26.0	27.1	27.7	27.8	26.3
1.A.3 Transport	239.8	222.4	153.0	139.5	118.4	99.7	85.2	75.2	61.6
1.A.4 Other Sectors	58.6	58.7	59.3	59.6	59.9	60.4	61.1	60.8	61.1
1.B Fugitive Emissions from Fuels	70.2	70.9	69.5	66.8	66.8	66.6	60.3	58.5	58.6
2. Industrial Processes	61.3	63.9	66.1	59.7	65.5	61.6	66.3	65.6	60.2
3. Solvent and Other Product Use	486.7	476.7	478.2	487.6	501.0	500.4	490.6	491.7	465.8
4. Agriculture	54.4	56.5	43.0	64.8	53.1	39.3	50.4	51.7	51.7
6. Waste	17.8	18.6	20.2	20.7	20.5	19.9	21.5	22.2	22.1
TOTAL	**1,017.9**	**998.4**	**921.6**	**932.6**	**920.9**	**885.1**	**873.1**	**863.4**	**815.6**

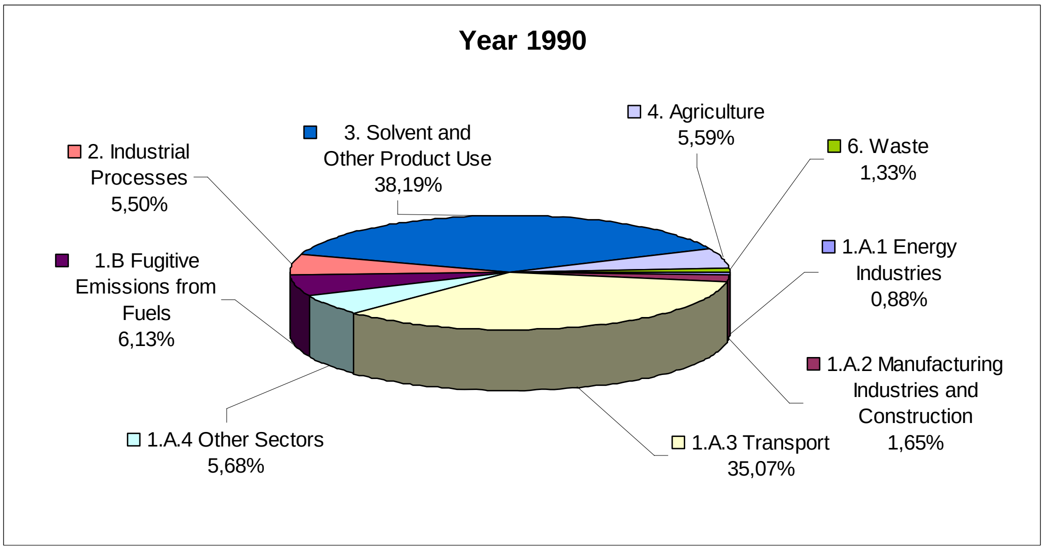
Table 3.2.2.2.- Contribution by categories to NMVOC emissions

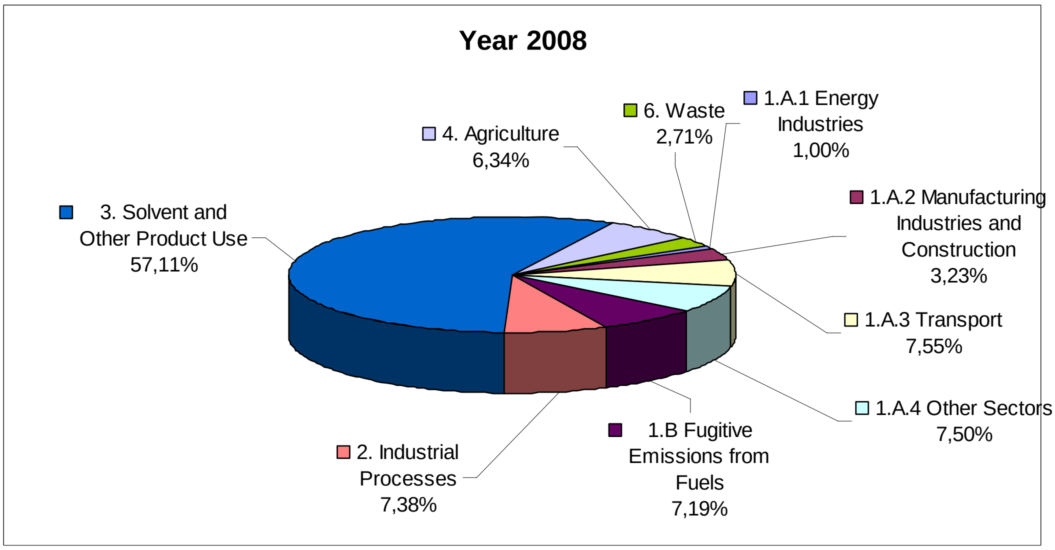
CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	0.88	0.87	0.89	0.88	0.80	0.83	0.75	0.76	0.77	0.84
1.A.2 Manufacturing Industries and Construction	1.65	1.65	1.55	1.57	1.47	1.64	1.50	1.60	1.64	1.80
1.A.3 Transport	35.07	36.21	38.40	37.85	37.29	34.73	33.86	30.94	29.29	26.76
1.A.4 Other Sectors	5.68	5.58	5.48	5.84	5.78	5.95	5.77	5.76	5.61	5.66
1.B Fugitive Emissions from Fuels	6.13	5.98	6.29	6.79	7.08	7.33	7.04	6.91	7.09	7.41
2. Industrial Processes	5.50	4.88	4.63	4.39	4.92	4.79	4.96	5.55	5.56	5.55
3. Solvent and Other Product Use	38.19	37.52	35.60	34.63	35.02	37.37	38.61	40.41	43.01	45.31
4. Agriculture	5.59	5.76	5.42	6.05	5.78	5.73	5.97	6.53	5.55	5.04
6. Waste	1.33	1.55	1.75	1.99	1.87	1.63	1.55	1.54	1.49	1.62
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 3.2.2.2.- Contribution by categories to NMVOC emissions *(Continued)*

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	0.88	0.89	1.04	0.99	1.06	1.15	1.14	1.15	1.00
1.A.2 Manufacturing Industries and Construction	1.98	2.18	2.47	2.65	2.82	3.06	3.17	3.22	3.23
1.A.3 Transport	23.56	22.28	16.60	14.96	12.86	11.27	9.75	8.71	7.55
1.A.4 Other Sectors	5.76	5.88	6.44	6.39	6.50	6.82	7.00	7.04	7.50
1.B Fugitive Emissions from Fuels	6.90	7.11	7.54	7.16	7.26	7.52	6.91	6.78	7.19
2. Industrial Processes	6.02	6.40	7.17	6.41	7.11	6.96	7.60	7.60	7.38
3. Solvent and Other Product Use	47.81	47.75	51.89	52.28	54.40	56.53	56.20	56.95	57.11
4. Agriculture	5.34	5.66	4.66	6.95	5.76	4.44	5.78	5.99	6.34
6. Waste	1.75	1.86	2.19	2.22	2.22	2.25	2.47	2.57	2.71
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 3.2.2.1.- Contribution by categories to NMVOC emissions





3.2.3.- Sulphur Oxides

The decrease in SO_X emissions is clearly determined by the fall in emissions due to combustion in energy sector industries, whose emissions represent between 48.5% (2008) and 79.7% (2005) of the whole emissions for this gas. It is worth mentioning the sharp fall in emissions during 2008 due to decreased activity at coal-fired power plants. Among the remaining categories, it is worth noting those for combustion in manufacturing and construction industries, transport, fugitive fuel emissions and the rest of the combustion activities. In absolute terms, this change is shown in Table 3.2.3.1, and in terms of the contribution by each category in Table 3.2.3.2.

Figure 3.2.3.1 graphically illustrates the variation in the activities' contribution to the emissions of this pollutant between the start year and the last year of the period inventoried (1990 and 2008). As can be seen, the changes in the contributions are moderate until 2007, although these changes do not necessarily correspond in trend (increase or decrease) with those occurring in the absolute emission values of the categories considered. However, sector weighting in 2008 is obviously conditioned by the significant drop in coal-fired power plant emissions, which results in the energy sector going from 77.3% in 2007 down to 48.5% in 2008, while the remaining sectors registered increased emissions.

Table 3.2.3.1.- SO_X emissions (Gg of SO_2)

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	1,604.0	1,592.2	1,575.8	1,430.0	1,344.6	1,199.9	1,085.5	1,248.4	1,131.6	1,178.6
1.A.2 Manufacturing Industries and Construction	336.3	344.7	306.3	309.6	343.1	345.5	250.4	301.6	257.3	231.6
1.A.3 Transport	91.8	95.0	98.6	102.9	111.0	88.3	88.0	51.5	50.3	58.0
1.A.4 Other Sectors	59.3	63.0	69.3	56.6	60.6	64.2	53.5	55.8	55.3	57.9
1.B Fugitive Emissions from Fuels	64.7	62.0	58.5	85.7	74.0	75.2	69.0	64.6	73.7	57.8
2. Industrial Processes	14.4	13.2	14.3	14.1	13.9	13.5	12.0	13.4	13.6	13.5
3. Solvent and Other Product Use										
4. Agriculture	4.4	4.6	4.4	4.6	4.4	4.3	4.6	5.1	4.4	4.0
6. Waste	1.2	1.3	1.5	1.4	1.2	0.6	0.5	0.3	0.3	0.3
TOTAL	**2,176.2**	**2,176.0**	**2,128.7**	**2,004.9**	**1,952.8**	**1,791.4**	**1,563.5**	**1,740.6**	**1,586.6**	**1,601.8**

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	1,090.8	1,051.6	1,175.4	986.4	1,040.5	1,013.2	914.7	905.2	257.1
1.A.2 Manufacturing Industries and Construction	191.8	212.1	192.2	127.9	117.4	108.7	110.3	115.4	139.7
1.A.3 Transport	53.0	57.9	60.2	62.8	64.5	55.6	61.0	71.5	72.0
1.A.4 Other Sectors	54.0	53.7	54.2	41.3	40.2	38.6	34.5	33.2	20.6
1.B Fugitive Emissions from Fuels	55.4	46.0	43.3	41.7	41.8	40.2	33.4	28.5	24.7
2. Industrial Processes	13.2	13.0	12.5	12.0	12.0	12.4	12.6	12.5	11.8
3. Solvent and Other Product Use									
4. Agriculture	4.1	4.3	3.3	4.9	4.0	3.0	3.8	3.9	3.9
6. Waste	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2
TOTAL	**1,462.7**	**1,438.9**	**1,541.4**	**1,277.4**	**1,320.6**	**1,271.9**	**1,170.5**	**1,170.4**	**530.0**

Table 3.2.3.2.- Contribution by categories to SO_X emissions

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	73.71	73.17	74.03	71.33	68.86	66.98	69.43	71.72	71.32	73.58
1.A.2 Manufacturing Industries and Construction	15.46	15.84	14.39	15.44	17.57	19.29	16.02	17.33	16.22	14.46
1.A.3 Transport	4.22	4.37	4.63	5.13	5.68	4.93	5.63	2.96	3.17	3.62
1.A.4 Other Sectors	2.73	2.89	3.26	2.82	3.10	3.58	3.42	3.20	3.48	3.62
1.B Fugitive Emissions from Fuels	2.97	2.85	2.75	4.28	3.79	4.20	4.41	3.71	4.64	3.61
2. Industrial Processes	0.66	0.61	0.67	0.70	0.71	0.76	0.77	0.77	0.86	0.85
3. Solvent and Other Product Use										
4. Agriculture	0.20	0.21	0.21	0.23	0.23	0.24	0.29	0.29	0.28	0.25
6. Waste	0.06	0.06	0.07	0.07	0.06	0.03	0.03	0.02	0.02	0.02
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	74.57	73.09	76.25	77.22	78.79	79.66	78.15	77.34	48.51
1.A.2 Manufacturing Industries and Construction	13.11	14.74	12.47	10.02	8.89	8.54	9.43	9.86	26.36
1.A.3 Transport	3.63	4.03	3.91	4.92	4.88	4.37	5.21	6.11	13.58
1.A.4 Other Sectors	3.69	3.73	3.52	3.23	3.04	3.04	2.95	2.84	3.89
1.B Fugitive Emissions from Fuels	3.79	3.20	2.81	3.26	3.16	3.16	2.85	2.44	4.67
2. Industrial Processes	0.90	0.90	0.81	0.94	0.91	0.98	1.08	1.06	2.22
3. Solvent and Other Product Use									
4. Agriculture	0.28	0.30	0.21	0.39	0.31	0.24	0.33	0.34	0.74
6. Waste	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.03
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 3.2.3.1.- Contribution by categories to SO_X emissions

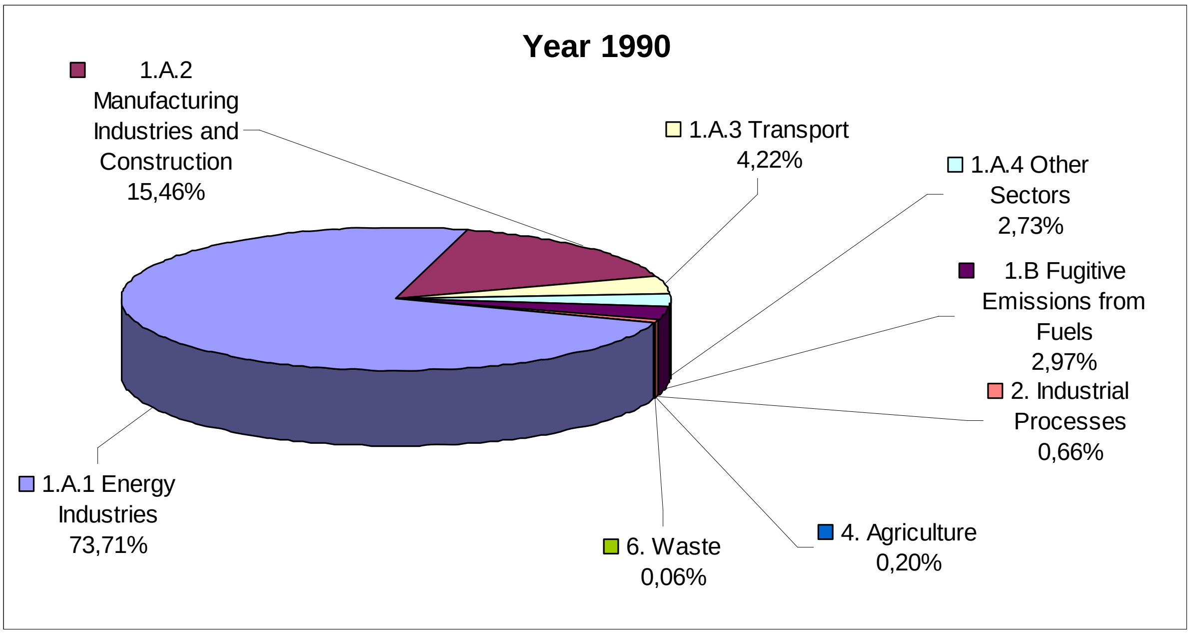
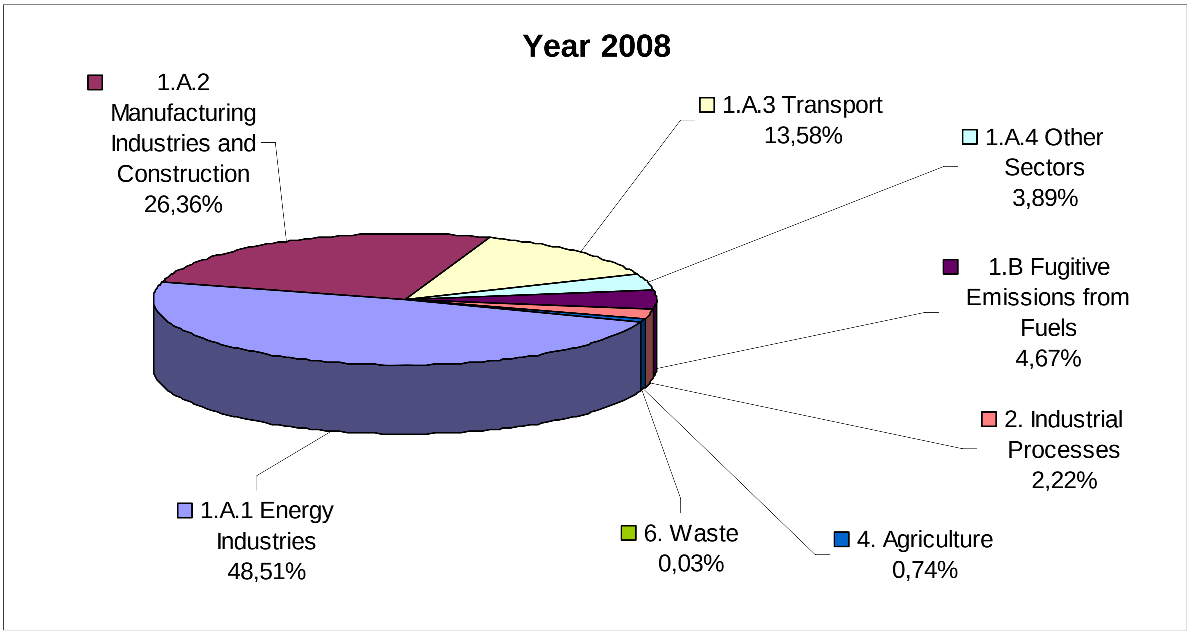


Figure 3.2.3.1.- Contribution by categories to SO_X emissions *(Continued)*



3.2.4.- Ammonia

The agricultural sector represents in the order of 93% (range between 92.2% and 95.4%) of ammonia emissions, therefore any change in this sector decisive for the variation of the emissions in the period analyzed. Among the other categories, the most noteworthy of the emissions produced in industrial processes, and to a lesser extent in transport and waste treatment and disposal. In absolute terms, this change is shown in Table 3.2.4.1, and in terms of the contribution of each category in Table 3.2.4.2.

Figure 3.2.4.1 graphically illustrates the change experienced in these categories' contribution to the emissions of this pollutant between the start year and the last year of the period inventoried (1990 and 2008). As can be seen, the changes in the contributions are moderate, although these changes do not necessarily correspond in trend (increase or decrease) with those occurring in the absolute emission values of the categories considered.

Table 3.2.4.1.- NH_3 Emissions *(Gg)*

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
1.A.2 Manufacturing Industries and Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.A.3 Transport	0.4	0.4	0.4	0.8	1.6	2.2	3.0	3.8	4.8	5.9
1.A.4 Other Sectors	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.B Fugitive Emissions from Fuels	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
2. Industrial Processes	16.2	16.0	13.5	11.2	14.7	15.0	16.4	17.5	18.3	18.7
3. Solvent and Other Product Use										
4. Agriculture	298.6	295.4	295.0	281.6	298.4	291.4	317.4	316.7	333.1	341.4
6. Waste	2.1	1.6	1.2	1.3	1.5	1.7	2.0	2.5	2.5	2.8
TOTAL	**317.7**	**313.7**	**310.5**	**295.2**	**316.7**	**310.6**	**339.1**	**341.0**	**359.1**	**369.1**

Table 3.2.4.1.- NH_3 Emissions (Gg) (Continued)

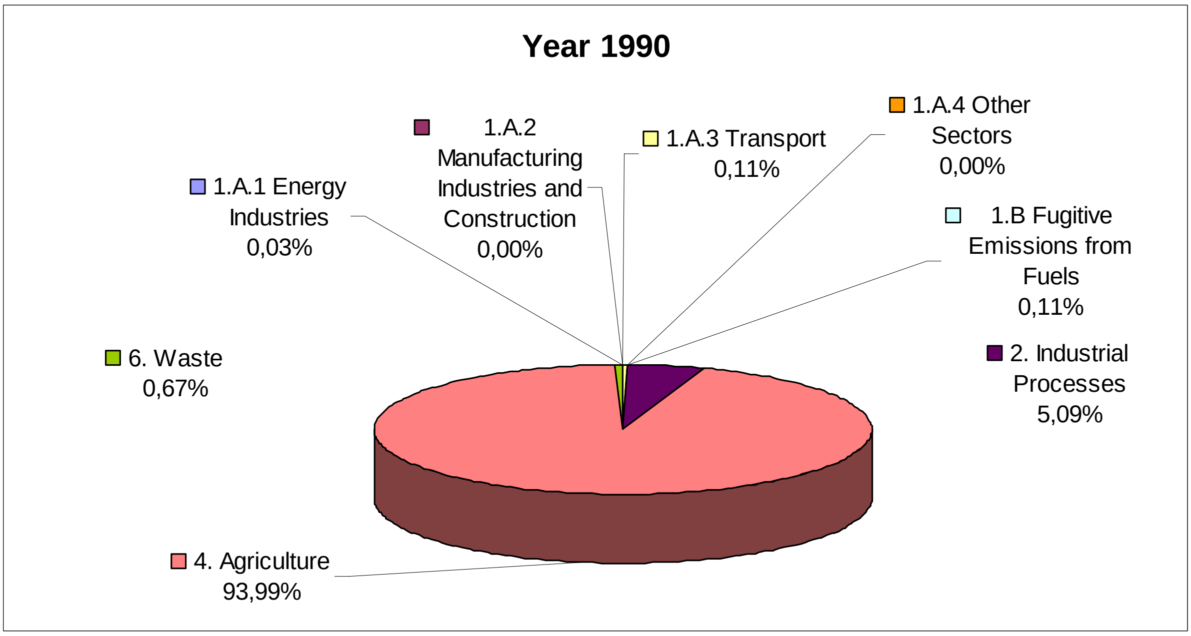
CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
1.A.2 Manufacturing Industries and Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.A.3 Transport	6.3	6.5	7.7	7.4	7.2	6.9	6.3	5.8	4.9
1.A.4 Other Sectors	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.B Fugitive Emissions from Fuels	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
2. Industrial Processes	15.8	15.1	15.3	15.5	14.7	14.5	13.8	15.1	12.3
3. Solvent and Other Product Use									
4. Agriculture	354.0	355.4	349.6	363.4	356.8	338.6	350.0	359.5	332.7
6. Waste	3.5	3.9	4.9	5.5	6.5	6.8	7.2	7.7	8.1
TOTAL	**380.1**	**381.3**	**378.0**	**392.2**	**385.7**	**367.2**	**377.8**	**388.4**	**358.4**

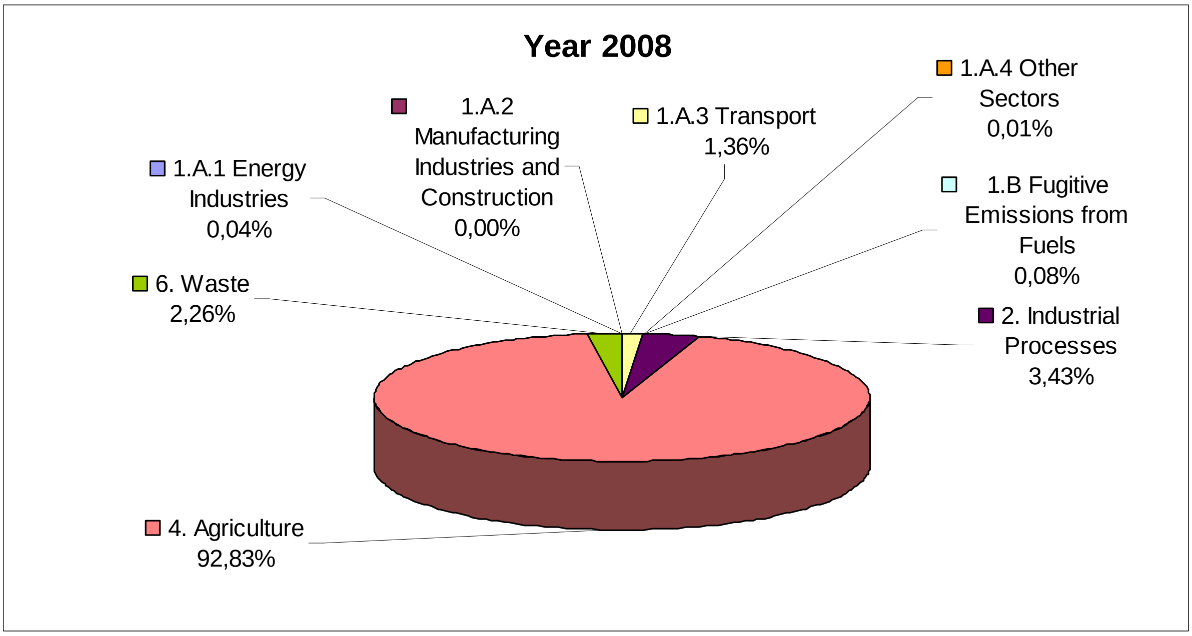
Table 3.2.4.2.- Contribution by categories to NH_3 emissions

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.02
1.A.2 Manufacturing Industries and Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3 Transport	0.11	0.12	0.13	0.27	0.51	0.71	0.90	1.13	1.34	1.60
1.A.4 Other Sectors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B Fugitive Emissions from Fuels	0.11	0.11	0.11	0.12	0.11	0.09	0.08	0.09	0.08	0.07
2. Industrial Processes	5.09	5.09	4.34	3.78	4.65	4.82	4.82	5.13	5.10	5.06
3. Solvent and Other Product Use										
4. Agriculture	93.99	94.14	95.00	95.37	94.24	93.80	93.59	92.89	92.74	92.48
6. Waste	0.67	0.50	0.39	0.44	0.46	0.56	0.58	0.73	0.70	0.76
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	0.03	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.04
1.A.2 Manufacturing Industries and Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3 Transport	1.66	1.70	2.04	1.89	1.86	1.87	1.66	1.49	1.36
1.A.4 Other Sectors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
1.B Fugitive Emissions from Fuels	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
2. Industrial Processes	4.17	3.95	4.05	3.95	3.81	3.95	3.66	3.88	3.43
3. Solvent and Other Product Use									
4. Agriculture	93.13	93.20	92.49	92.66	92.52	92.21	92.67	92.55	92.83
6. Waste	0.92	1.03	1.31	1.40	1.69	1.86	1.90	1.97	2.26
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 3.2.4.1.- Contribution by categories to NH_3 emissions





3.2.5.- Carbon Monoxide

The downward trend in CO emissions is basically determined by the similar behaviour of this gas's emissions in activity category 1.A.3 corresponding to transport, where it is the dominant category with a contribution throughout the period inventoried ranging from 18.3% (2008) and 60.1% (1992). In the other categories, the most significant are combustion in other sectors (category 1.A.4), industrial processes, agriculture and combustion in

manufacturing and construction industries. The variation is shown in Tables 3.2.5.1 and 3.2.5.2.

Figure 3.2.5.3 graphically illustrates the change experienced in these categories' contribution to the emissions of this pollutant between the start year and the last year of the period inventoried (1990 and 2008). As can be seen, the main change is in the transport category, with a fall of almost 39% between 1990 and 2008. The rest of the categories show general increases in their contributions, determined by the decline in the dominant category, with those occurring in the categories of "combustion in other sectors" and "industrial processes" being the most outstanding, and, to a lesser extent, in combustion at manufacturing plants and construction and in agriculture.

***Table 3.2.5.1.- CO emissions** (Gg)*

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	18.5	18.7	19.2	20.1	24.0	25.9	22.4	19.1	18.5	20.1
1.A.2 Manufacturing Industries and Construction	225.5	226.5	200.9	194.6	198.8	205.1	195.8	182.6	172.9	211.1
1.A.3 Transport	2,109.0	2,160.9	2,247.5	2,042.6	1,922.8	1,691.3	1,719.5	1,543.7	1,485.6	1,333.1
1.A.4 Other Sectors	569.5	574.5	573.8	559.9	553.4	540.5	538.1	539.8	538.4	534.3
1.B Fugitive Emissions from Fuels	3.5	3.4	3.3	3.6	3.3	2.8	2.8	3.0	3.1	2.8
2. Industrial Processes	298.1	286.2	259.6	286.6	304.8	292.9	283.9	322.7	347.3	338.2
3. Solvent and Other Product Use										
4. Agriculture	412.7	432.6	412.4	427.5	415.0	398.5	427.5	473.8	414.8	373.9
6. Waste	17.2	20.9	24.0	23.2	19.2	8.4	6.0	5.0	4.6	4.3
TOTAL	**3,654.1**	**3,723.7**	**3,740.7**	**3,558.2**	**3,441.3**	**3,165.4**	**3,195.9**	**3,089.7**	**2,985.2**	**2,817.8**

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	21.8	20.7	23.5	24.4	26.7	29.5	27.2	27.7	24.3
1.A.2 Manufacturing Industries and Construction	229.9	238.8	245.3	250.8	262.6	261.1	266.6	282.4	265.1
1.A.3 Transport	1,140.6	1,041.1	892.8	798.4	697.8	601.8	509.6	450.2	365.1
1.A.4 Other Sectors	526.8	527.1	529.6	532.8	534.1	535.6	536.2	535.9	536.6
1.B Fugitive Emissions from Fuels	3.1	3.0	3.0	3.1	3.3	3.2	3.2	3.1	3.1
2. Industrial Processes	361.5	372.1	376.7	378.9	406.5	412.2	408.8	430.7	431.0
3. Solvent and Other Product Use									
4. Agriculture	387.7	402.6	306.4	462.2	378.4	280.1	359.6	368.5	368.5
6. Waste	3.4	3.2	2.5	2.8	2.0	2.1	2.0	1.9	1.9
TOTAL	**2,674.7**	**2,608.5**	**2,379.8**	**2,453.2**	**2,311.6**	**2,125.6**	**2,113.2**	**2,100.6**	**1,995.5**

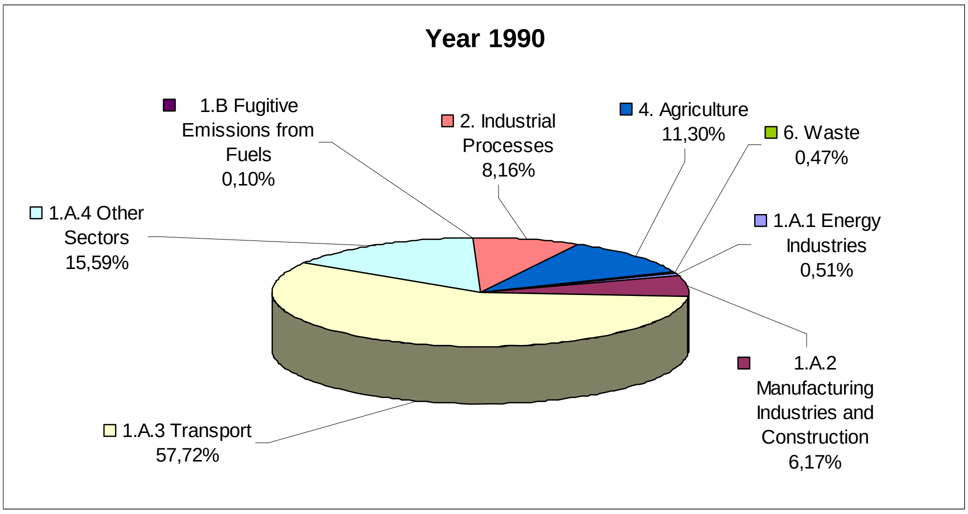
Table 3.2.5.2.- Contribution by categories to CO emissions

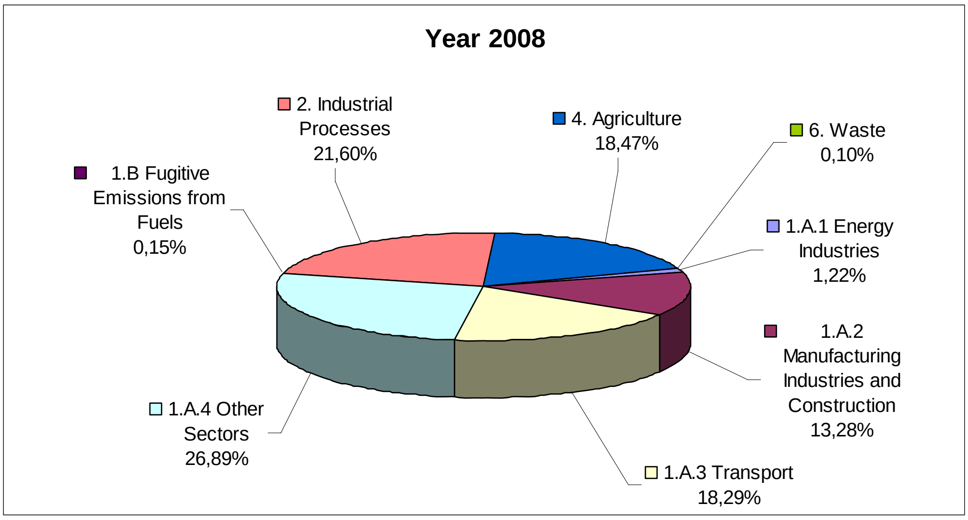
CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	0.51	0.50	0.51	0.57	0.70	0.82	0.70	0.62	0.62	0.71
1.A.2 Manufacturing Industries and Construction	6.17	6.08	5.37	5.47	5.78	6.48	6.13	5.91	5.79	7.49
1.A.3 Transport	57.72	58.03	60.08	57.41	55.87	53.43	53.80	49.96	49.76	47.31
1.A.4 Other Sectors	15.59	15.43	15.34	15.74	16.08	17.08	16.84	17.47	18.04	18.96
1.B Fugitive Emissions from Fuels	0.10	0.09	0.09	0.10	0.09	0.09	0.09	0.10	0.10	0.10
2. Industrial Processes	8.16	7.69	6.94	8.06	8.86	9.25	8.88	10.44	11.64	12.00
3. Solvent and Other Product Use										
4. Agriculture	11.30	11.62	11.02	12.01	12.06	12.59	13.38	15.33	13.90	13.27
6. Waste	0.47	0.56	0.64	0.65	0.56	0.27	0.19	0.16	0.15	0.15
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 3.2.5.2.- Contribution by categories to CO emissions (Continued)

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	0.81	0.79	0.99	0.99	1.16	1.39	1.29	1.32	1.22
1.A.2 Manufacturing Industries and Construction	8.59	9.16	10.31	10.22	11.36	12.28	12.62	13.45	13.28
1.A.3 Transport	42.64	39.91	37.52	32.54	30.19	28.31	24.11	21.43	18.29
1.A.4 Other Sectors	19.69	20.21	22.26	21.72	23.11	25.20	25.37	25.51	26.89
1.B Fugitive Emissions from Fuels	0.12	0.12	0.13	0.13	0.14	0.15	0.15	0.15	0.15
2. Industrial Processes	13.51	14.26	15.83	15.45	17.59	19.39	19.34	20.51	21.60
3. Solvent and Other Product Use									
4. Agriculture	14.49	15.43	12.87	18.84	16.37	13.18	17.02	17.54	18.47
6. Waste	0.13	0.12	0.10	0.11	0.09	0.10	0.09	0.09	0.10
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 3.2.5.3.- Contribution by categories to CO emissions





3.2.6.- Particulate matter with diameter less than 2.5 microns ($PM_{2.5}$)

The variation in the $PM_{2.5}$ emissions reflects a high degree of stability, except for the significant drop in 2008, with the emissions concentrated in combustion activities. Within combustion, in absolute terms it is possible to see until 2007 a moderate increase in emissions in all categories except for industries in the energy sector; meanwhile, there was a significant drop in the sector during 2008 due to decreased activity at coal-fired power plants, and slight falls in manufacturing plants, combustion and transport due to a general decrease in economic activity. In the entire series, levels achieved in 2008 stood 1.4% below those of 2000. The changes are shown in absolute terms in Table 3.2.6.1, and in terms of the contribution of each category in Table 3.2.6.2.

Figure 3.2.6.1 graphically illustrates the change experienced in these activities' contribution to the emissions of this pollutant between the start year and the last year of the period analyzed (2000-2008). As can be seen, the changes in the categories' contributions are not very noteworthy, with maintenance in general of the percentage structure between 2000 and 2008, decreasing in the energy and transport sector, while industrial combustion and combustion in other sectors increased.

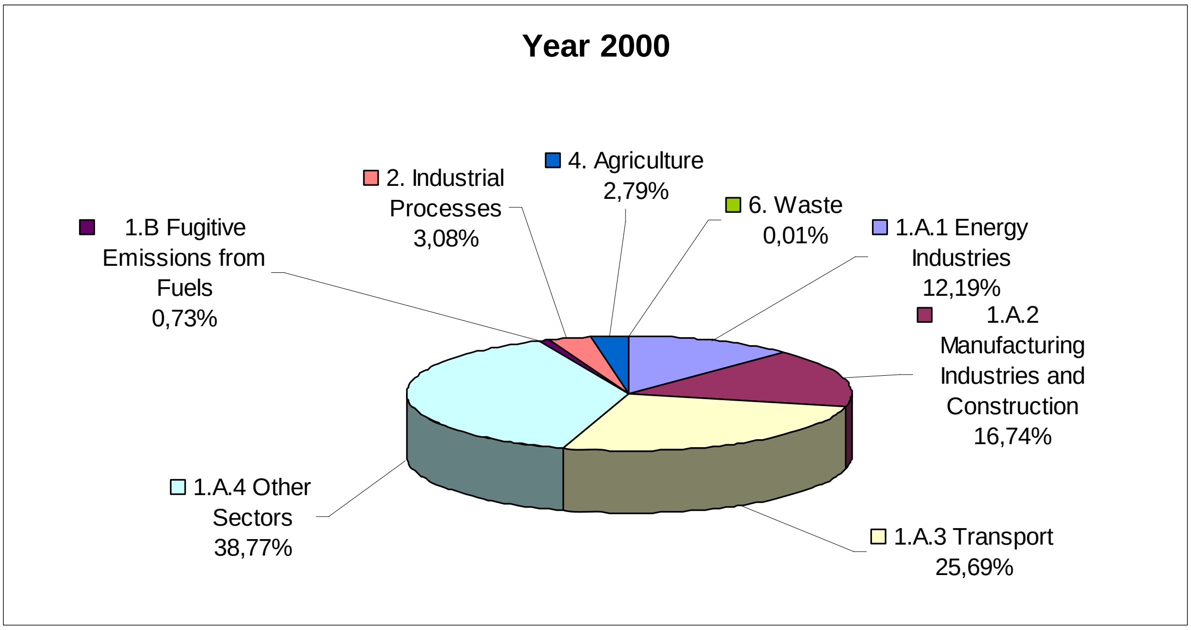
***Table 3.2.6.1.- $PM_{2.5}$ emissions** (Gg)*

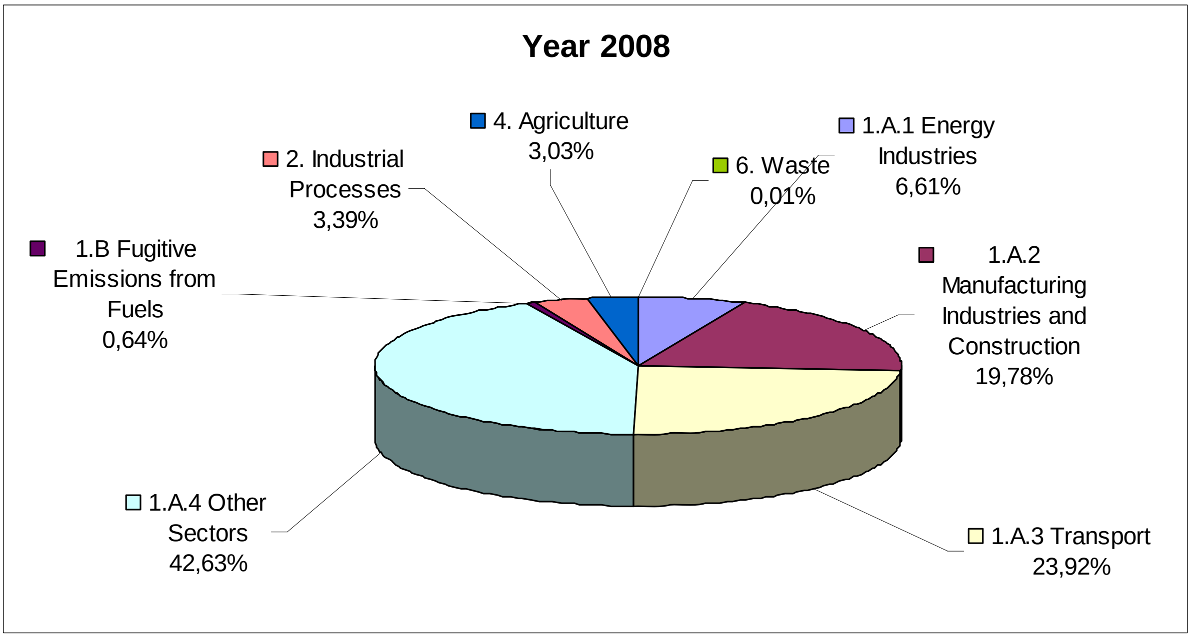
CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	15.4	14.0	15.1	14.2	14.0	14.9	12.7	13.8	8.2
1.A.2 Manufacturing Industries and Construction	21.2	21.9	22.8	23.9	24.1	24.3	24.9	26.1	24.7
1.A.3 Transport	32.5	32.9	31.8	32.2	31.8	31.6	31.3	32.2	29.8
1.A.4 Other Sectors	49.1	49.9	50.6	50.8	51.4	51.7	52.2	52.6	53.2
1.B Fugitive Emissions from Fuels	0.9	0.9	0.9	0.8	0.9	0.8	0.9	0.8	0.8
2. Industrial Processes	3.9	4.0	4.1	4.4	4.3	4.3	4.4	4.4	4.2
3. Solvent and Other Product Use									
4. Agriculture	3.5	3.7	3.7	3.7	3.8	3.8	3.8	3.9	3.8
6. Waste	0.0	0.01	0.02	0.02	0.01	0.02	0.01	0.02	0.02
TOTAL	**126.5**	**127.2**	**129.0**	**129.9**	**130.3**	**131.4**	**130.2**	**133.8**	**124.7**

Table 3.2.6.2.- Contribution by categories to $PM_{2.5}$ emissions

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	12.19	11.03	11.74	10.96	10.77	11.36	9.75	10.34	6.61
1.A.2 Manufacturing Industries and Construction	16.74	17.19	17.64	18.37	18.46	18.46	19.14	19.49	19.78
1.A.3 Transport	25.69	25.84	24.68	24.76	24.39	24.02	24.06	24.04	23.92
1.A.4 Other Sectors	38.77	39.24	39.24	39.06	39.46	39.37	40.05	39.30	42.63
1.B Fugitive Emissions from Fuels	0.73	0.68	0.67	0.62	0.67	0.63	0.67	0.63	0.64
2. Industrial Processes	3.08	3.12	3.18	3.35	3.31	3.27	3.42	3.29	3.39
3. Solvent and Other Product Use									
4. Agriculture	2.79	2.89	2.85	2.87	2.92	2.87	2.90	2.91	3.03
6. Waste	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 3.2.6.1.- Contribution by categories to $PM_{2.5}$ emissions





3.2.7.- Particulate Matter with diameter less than 10 microns (PM_{10})

The variation in the PM_{10} emissions reflects a high degree of stability, except for the significant drop in 2008, with the emissions concentrated in the activities of combustion and agriculture. Within combustion, for industries in the energy sector, even though it is not the dominant category in absolute terms, it is possible to see the greatest absolute and relative reduction in emissions (a fall of 46.5% in 2008 with respect to 2000), as the other sectors

show a slightly upward trend. The changes are shown in absolute terms in Table 3.2.7.1, and in terms of the contribution of each category in Table 3.2.7.2.

Figure 3.2.7.1 graphically illustrates the change experienced in these activities' contribution to the emissions of this pollutant between the start year and the last year of the period analyzed (2000-2008). As can be seen, the changes in the share of categories are small, except for that of combustion in the energy sector, which goes from 17.1% in 2000 down to 7.4% in 2008, countered by the opposite (upward) trend in the remaining combustion categories.

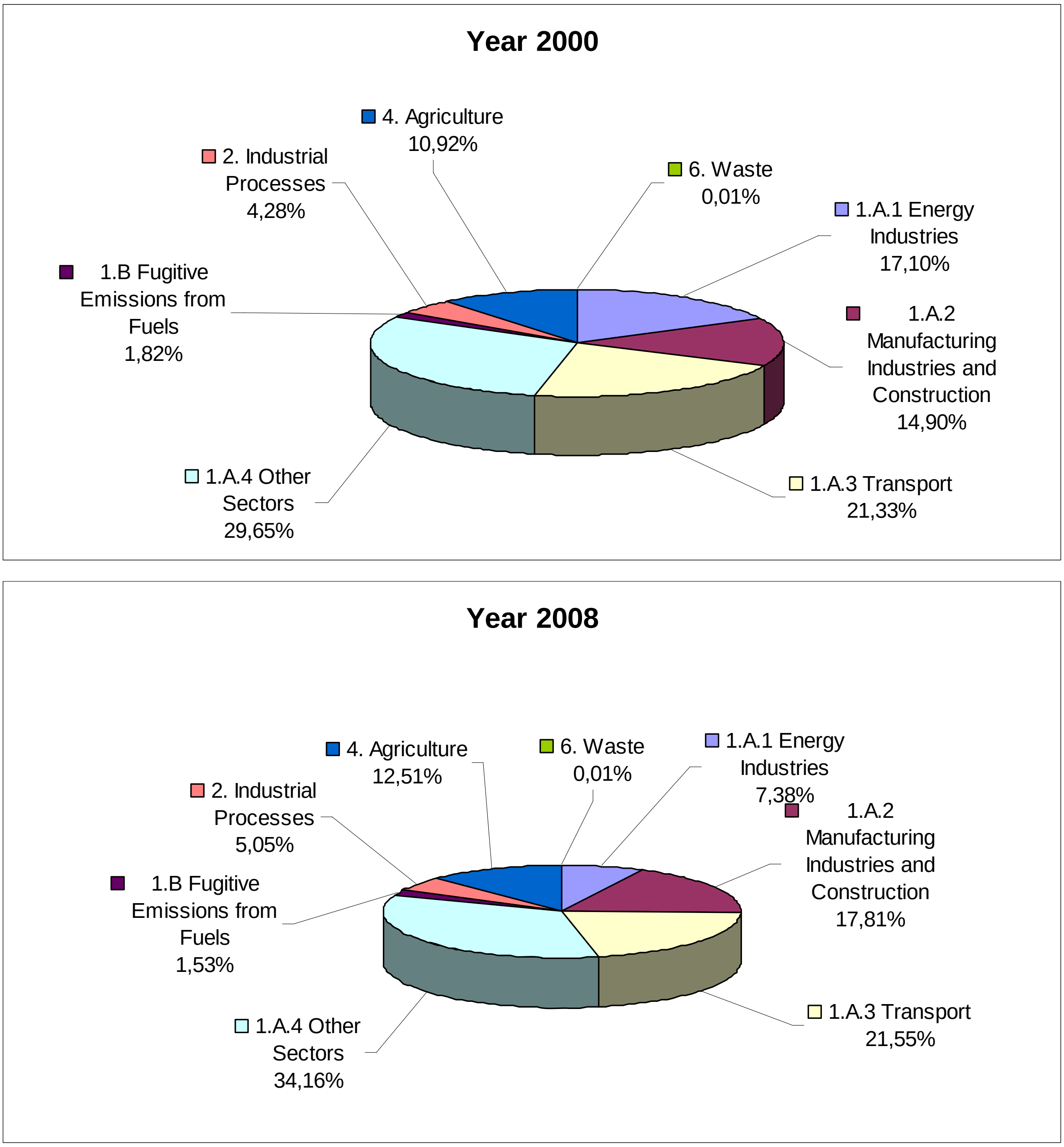
***Table 3.2.7.1.- PM_{10} emissions** (Gg)*

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	29.1	26.4	29.4	26.3	26.1	25.6	21.9	22.6	11.8
1.A.2 Manufacturing Industries and Construction	25.4	26.4	27.0	27.9	27.9	27.6	28.4	29.8	28.5
1.A.3 Transport	36.4	36.9	36.0	36.6	36.2	36.1	36.0	37.0	34.4
1.A.4 Other Sectors	50.6	51.4	52.1	52.3	52.9	53.2	53.6	54.0	54.6
1.B Fugitive Emissions from Fuels	3.1	2.9	2.9	2.7	2.8	2.7	2.8	2.6	2.4
2. Industrial Processes	7.3	7.5	7.7	8.3	8.2	8.2	8.5	8.4	8.1
3. Solvent and Other Product Use									
4. Agriculture	18.6	19.4	19.2	19.5	20.0	19.9	19.9	20.5	20.0
6. Waste	0.0	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
TOTAL	**170.5**	**170.9**	**174.5**	**173.5**	**174.0**	**173.2**	**171.1**	**174.9**	**159.8**

Table 3.2.7.2.- Contribution by categories to PM_{10} emissions

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	17.10	15.44	16.87	15.14	14.99	14.76	12.78	12.89	7.38
1.A.2 Manufacturing Industries and Construction	14.90	15.46	15.48	16.08	16.02	15.94	16.59	17.02	17.81
1.A.3 Transport	21.33	21.59	20.64	21.09	20.77	20.85	21.06	21.17	21.55
1.A.4 Other Sectors	29.65	30.06	29.87	30.15	30.41	30.73	31.32	30.87	34.16
1.B Fugitive Emissions from Fuels	1.82	1.72	1.68	1.57	1.62	1.53	1.66	1.51	1.53
2. Industrial Processes	4.28	4.37	4.44	4.76	4.70	4.72	4.95	4.78	5.05
3. Solvent and Other Product Use									
4. Agriculture	10.92	11.35	11.01	11.22	11.48	11.46	11.62	11.75	12.51
6. Waste	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 3.2.7.1.- Contribution by categories to PM_{10} emissions



3.2.8.- Total Suspended Particulate Matter (TSP)

The variation in the TSP emissions reflects a high degree of stability, exception of the sharp decline is recorded in 2008, with the emissions concentrated in the activities of combustion and agriculture. Within combustion, for industries in the energy sector, even though it is not the dominant category in absolute values, it is possible to see the greatest absolute and relative reduction in emissions (a fall of 64.5% in 2008 with respect to 2000), as

the other sectors show a slightly upward trend. The changes are shown in absolute terms in Table 3.2.8.1, and, and in terms of the contribution of each category in Table 3.2.8.2.

Figure 3.2.8.1 graphically illustrates the change experienced in these activities' contribution to the emissions of this pollutant between the start year and the last year of the period analyzed (2000-2008). As can be seen, the changes in the categories' contributions are minor, with a noteworthy decrease in combustion among industries in the energy sector, which went from a share of 18.2% in 2000 to 7.1% in 2008.

Combining the observations of the three diameter classes of particulates ($PM_{2.5}$, PM_{10} and TSP) it can be said that combustion in industries in the energy sector is the cause of the divergence over time of the emissions of these three pollutants, as shown in Figure 3.1.1.b. Furthermore, this trend may be explained by the greater efficiency gradually achieved over time in the reduction of particles with greater relative grading, combined with a decrease in coal consumption at thermal plants (particularly in 2008).

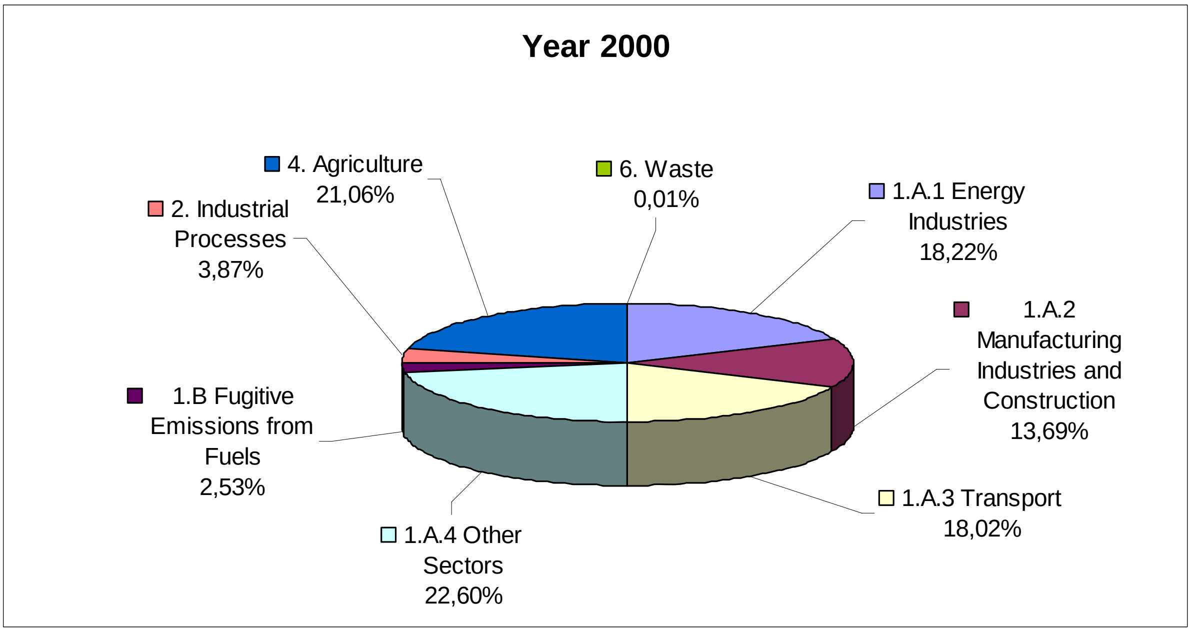
***Table 3.2.8.1.- TSP emissions** (Gg)*

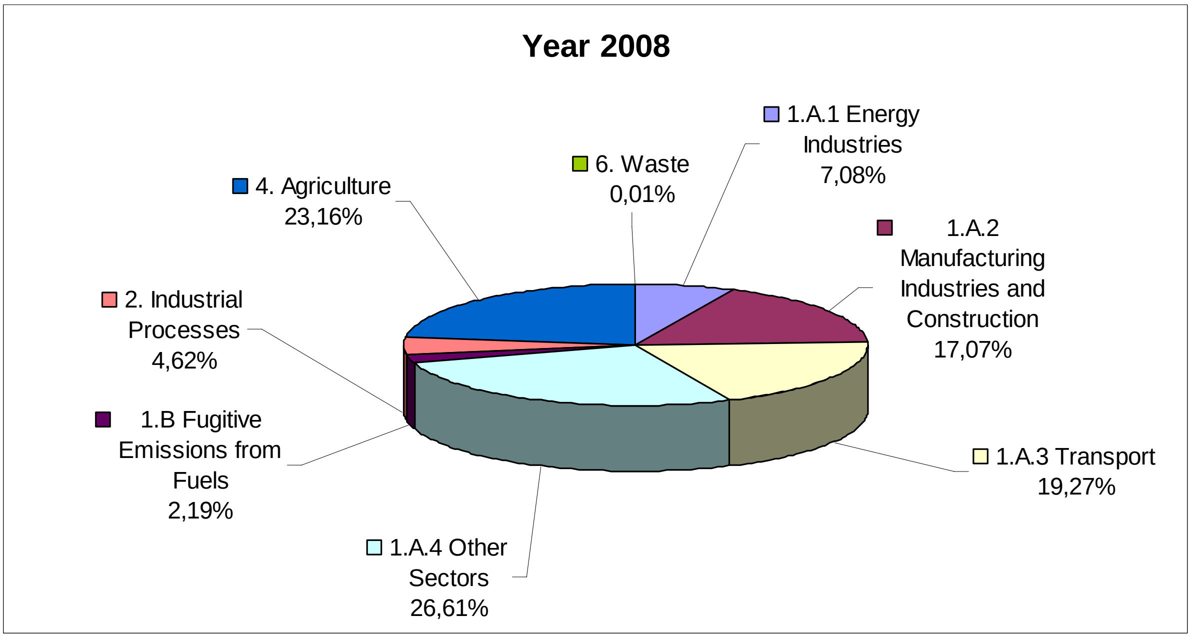
CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	42.2	37.9	43.0	37.5	36.9	34.8	30.3	30.6	15.0
1.A.2 Manufacturing Industries and Construction	31.7	33.9	33.8	34.3	34.1	33.1	33.9	36.9	36.1
1.A.3 Transport	41.7	42.5	41.8	42.6	42.2	42.3	42.4	43.7	40.7
1.A.4 Other Sectors	52.3	53.1	53.8	54.1	54.7	55.0	55.3	55.7	56.3
1.B Fugitive Emissions from Fuels	5.8	5.6	5.6	5.2	5.3	5.0	5.4	4.9	4.6
2. Industrial Processes	9.0	9.2	9.5	10.0	10.0	10.0	10.3	10.1	9.8
3. Solvent and Other Product Use									
4. Agriculture	48.7	48.8	49.2	49.5	50.4	49.9	49.2	50.1	49.0
6. Waste	0.0	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
TOTAL	**231.3**	**230.9**	**236.6**	**233.4**	**233.7**	**230.2**	**226.8**	**232.0**	**211.5**

Table 3.2.8.2.- Contribution by categories to TSP emissions

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	18.2	16.4	18.2	16.1	15.8	15.1	13.4	13.2	7.1
1.A.2 Manufacturing Industries and Construction	13.7	14.7	14.3	14.7	14.6	14.4	14.9	15.9	17.1
1.A.3 Transport	18.0	18.4	17.6	18.3	18.1	18.4	18.7	18.8	19.3
1.A.4 Other Sectors	22.6	23.0	22.7	23.2	23.4	23.9	24.4	24.0	26.6
1.B Fugitive Emissions from Fuels	2.5	2.4	2.4	2.2	2.3	2.2	2.4	2.1	2.2
2. Industrial Processes	3.9	4.0	4.0	4.3	4.3	4.3	4.5	4.4	4.6
3. Solvent and Other Product Use									
4. Agriculture	21.1	21.2	20.8	21.2	21.6	21.7	21.7	21.6	23.2
6. Waste	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 3.2.8.1.- Contribution by categories to TSP emissions





3.2.9.- Lead (Pb)

Lead emissions show a markedly decreasing trend, with a reduction in 2008 of 90.3% over 1990, caused by the emissions in transport, and more specifically by road transport, as a result of the gradual decline in and disappearance of the consumption of leaded petrol, as this category has gone from representing 92.4% of the total Pb emissions in 1990 to 9.2% of the emissions in 2008. Among the other categories, the most significant for this contribution

are combustion in manufacturing and construction industries and industrial processes (mainly in the activities of the metalworking industry), with respective contributions of 57.1% and 31.0% in 2008, although the increase in the share of the emissions from these categories is a result of the decline in the transport category. In absolute terms, the changes are shown in Table 3.2.9.1, and, in terms of the contribution of each category, in Table 3.2.9.2.

Figure 3.2.9.1 graphically illustrates the change experienced in these activities' contribution to the emissions of this pollutant between the start year and the last year of the period inventoried (1990-2008). As can be seen, the change in the transport category is clearly reflected in the contributions of the other categories.

Table 3.2.9.1.- Pb emissions (Mg)

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	9.7	10.4	13.0	11.4	11.1	12.7	12.0	9.6	8.4	9.3
1.A.2 Manufacturing Industries and Construction	148.0	150.6	132.4	132.5	141.1	122.9	139.8	137.5	134.4	141.1
1.A.3 Transport	2,576.1	1,662.7	1,063.6	954.3	933.8	775.5	745.6	677.0	611.2	542.9
1.A.4 Other Sectors	1.6	2.2	2.6	1.9	1.9	1.8	1.5	1.5	1.5	1.3
1.B Fugitive Emissions from Fuels										
2. Industrial Processes	44.8	44.7	44.3	45.6	48.2	49.8	45.9	55.6	60.8	61.7
3. Solvent and Other Product Use										
4. Agriculture										
6. Waste	8.1	8.4	9.5	8.9	7.9	3.9	3.2	2.3	2.2	2.1
TOTAL	**2,788.4**	**1,879.1**	**1,265.4**	**1,154.7**	**1,144.1**	**966.6**	**947.9**	**883.5**	**818.4**	**758.4**

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	9.1	9.0	9.8	8.2	8.5	8.6	7.3	6.6	5.8
1.A.2 Manufacturing Industries and Construction	152.1	153.8	158.9	155.5	147.5	155.8	154.4	155.0	153.8
1.A.3 Transport	394.8	172.3	32.5	31.7	30.3	29.2	27.9	26.9	24.8
1.A.4 Other Sectors	0.8	0.8	0.8	0.9	0.8	0.8	0.6	0.6	0.6
1.B Fugitive Emissions from Fuels									
2. Industrial Processes	67.2	70.8	71.0	73.0	78.6	78.3	84.7	85.2	83.6
3. Solvent and Other Product Use									
4. Agriculture									
6. Waste	2.1	1.9	1.8	1.7	1.0	1.0	1.0	1.0	1.0
TOTAL	**626.2**	**408.6**	**274.8**	**271.0**	**266.8**	**273.5**	**275.9**	**275.2**	**269.5**

Table 3.2.9.2.- Contribution by categories to Pb emissions

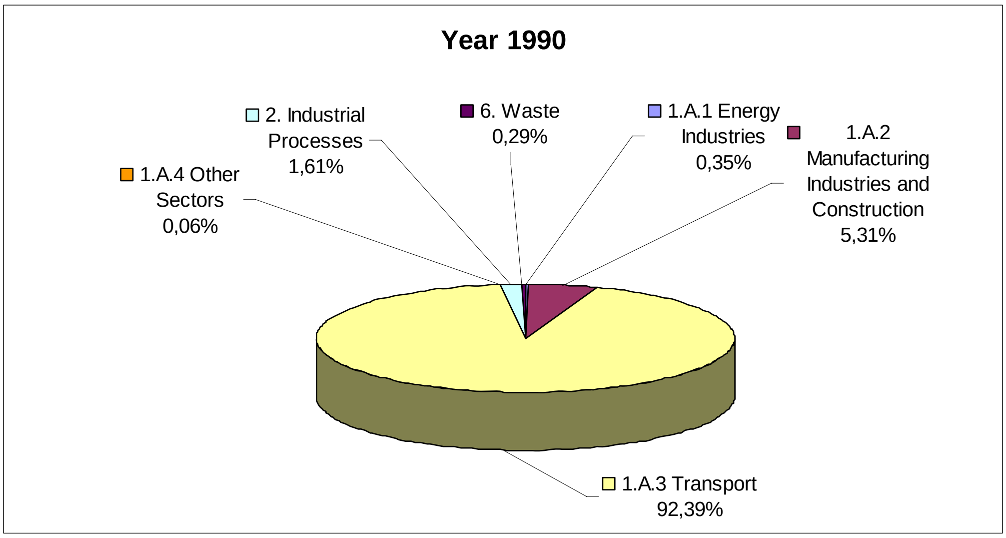
CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	0.35	0.56	1.03	0.99	0.97	1.31	1.26	1.09	1.02	1.23
1.A.2 Manufacturing Industries and Construction	5.31	8.01	10.47	11.47	12.33	12.72	14.74	15.56	16.42	18.61
1.A.3 Transport	92.39	88.48	84.05	82.65	81.62	80.23	78.66	76.62	74.68	71.58
1.A.4 Other Sectors	0.06	0.12	0.20	0.17	0.17	0.18	0.16	0.18	0.18	0.17
1.B Fugitive Emissions from Fuels										
2. Industrial Processes	1.61	2.38	3.50	3.95	4.22	5.16	4.84	6.29	7.43	8.13
3. Solvent and Other Product Use										
4. Agriculture										
6. Waste	0.29	0.45	0.75	0.77	0.69	0.40	0.33	0.26	0.27	0.28

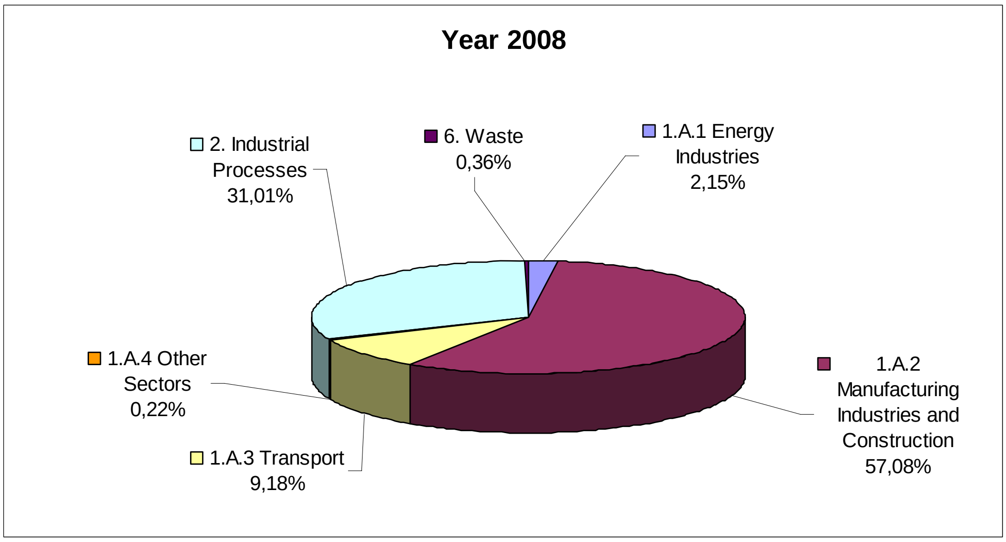
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 3.2.9.2.- Contribution by categories to Pb emissions (Continued)

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	1.46	2.21	3.58	3.03	3.20	3.13	2.66	2.38	2.15
1.A.2 Manufacturing Industries and Construction	24.29	37.65	57.83	57.37	55.29	56.95	55.96	56.32	57.08
1.A.3 Transport	63.05	42.17	11.83	11.69	11.34	10.67	10.10	9.76	9.18
1.A.4 Other Sectors	0.13	0.18	0.29	0.34	0.31	0.27	0.22	0.22	0.22
1.B Fugitive Emissions from Fuels									
2. Industrial Processes	10.73	17.33	25.82	26.93	29.47	28.61	30.70	30.97	31.01
3. Solvent and Other Product Use									
4. Agriculture									
6. Waste	0.34	0.47	0.64	0.64	0.38	0.36	0.36	0.36	0.36
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 3.2.9.1.- Contribution by categories to Pb emissions





3.2.10.- Cadmium (Cd)

The decreasing trend in the Cd emissions, with a decrease in 2008 of 44.4% over 1990, is mainly determined by the similar decline in the emissions of this element in combustion in manufacturing and construction industries as a result of the gradual implementation of emission abatement techniques in the cement industry, which has a notable impact on the emissions in this category, which went from a contribution of 73.9% in 1990 to 41.0% in 2008. Among the remaining categories, it is worth noting, on the one hand, the decrease in combustion for the energy sector starting in 2005 following the changes implemented in the power generation sector (increased number of combined cycle plants and smaller impact of coal consumption in conventional thermal plants), while industrial processes; on the other hand the industrial processes (in particular metal production). The variation in absolute terms is given in Table 3.2.10.1 and, in terms of the contribution of each category, in Table 3.2.10.2.

Figure 3.2.10.1 graphically illustrates the change experienced in these activities' contribution to the emissions of this pollutant between the start year and the last year of the period inventoried (1990 and 2008). As can be seen, the changes in the transport category is reflected in the contribution of the other categories, particularly in industrial processes, which is the category that most increases their share.

Table 3.2.10.1.- Cd emissions (Mg)

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	4.0	4.5	5.5	4.2	4.2	4.8	4.4	4.2	4.8	5.9
1.A.2 Manufacturing Industries and Construction	19.8	18.4	15.9	14.8	15.7	14.9	13.7	13.2	12.6	11.6
1.A.3 Transport	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3
1.A.4 Other Sectors	0.2	0.3	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.3
1.B Fugitive Emissions from Fuels										
2. Industrial Processes	2.3	2.3	2.3	2.3	2.5	2.6	2.4	2.9	3.2	3.2

3. Solvent and Other Product Use										
4. Agriculture										
6. Waste	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
TOTAL	**26.8**	**26.0**	**24.5**	**22.0**	**23.1**	**23.2**	**21.2**	**21.1**	**21.3**	**21.5**

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	5.8	6.0	6.5	5.3	5.3	5.3	4.6	4.0	3.8
1.A.2 Manufacturing Industries and Construction	10.3	10.0	10.0	9.6	8.8	8.4	8.6	6.2	6.1
1.A.3 Transport	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
1.A.4 Other Sectors	0.3	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1
1.B Fugitive Emissions from Fuels									
2. Industrial Processes	3.5	3.7	3.7	3.8	4.1	4.1	4.4	4.5	4.4
3. Solvent and Other Product Use									
4. Agriculture									
6. Waste	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
TOTAL	**20.3**	**20.4**	**21.0**	**19.5**	**18.9**	**18.5**	**18.3**	**15.3**	**14.9**

Table 3.2.10.2.- Contribution by categories to Cd emissions

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	15.08	17.31	22.39	19.00	18.15	20.88	20.56	20.16	22.60	27.60
1.A.2 Manufacturing Industries and Construction	73.89	70.98	64.85	67.17	67.92	64.33	64.74	62.68	59.00	53.83
1.A.3 Transport	0.83	0.90	1.02	1.13	1.14	1.15	1.34	1.35	1.46	1.54
1.A.4 Other Sectors	0.88	1.20	1.55	1.14	1.28	1.75	1.39	1.45	1.50	1.55
1.B Fugitive Emissions from Fuels										
2. Industrial Processes	8.54	8.78	9.23	10.54	10.61	11.34	11.43	13.91	15.01	15.07
3. Solvent and Other Product Use										
4. Agriculture										
6. Waste	0.77	0.83	0.96	1.02	0.91	0.56	0.53	0.45	0.43	0.41
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	28.26	29.34	31.11	26.97	27.91	28.91	25.43	26.42	25.42
1.A.2 Manufacturing Industries and Construction	50.80	48.91	47.58	49.32	46.48	45.20	46.80	40.24	41.04
1.A.3 Transport	1.68	1.76	1.77	2.00	2.11	2.22	2.33	2.90	2.80
1.A.4 Other Sectors	1.36	1.30	1.30	1.51	1.31	1.15	0.81	0.89	0.91
1.B Fugitive Emissions from Fuels									
2. Industrial Processes	17.37	18.25	17.79	19.71	21.90	22.23	24.34	29.20	29.46
3. Solvent and Other Product Use									
4. Agriculture									
6. Waste	0.52	0.44	0.45	0.50	0.29	0.28	0.29	0.35	0.36
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 3.2.10.1.- Contribution by categories to Cd emissions

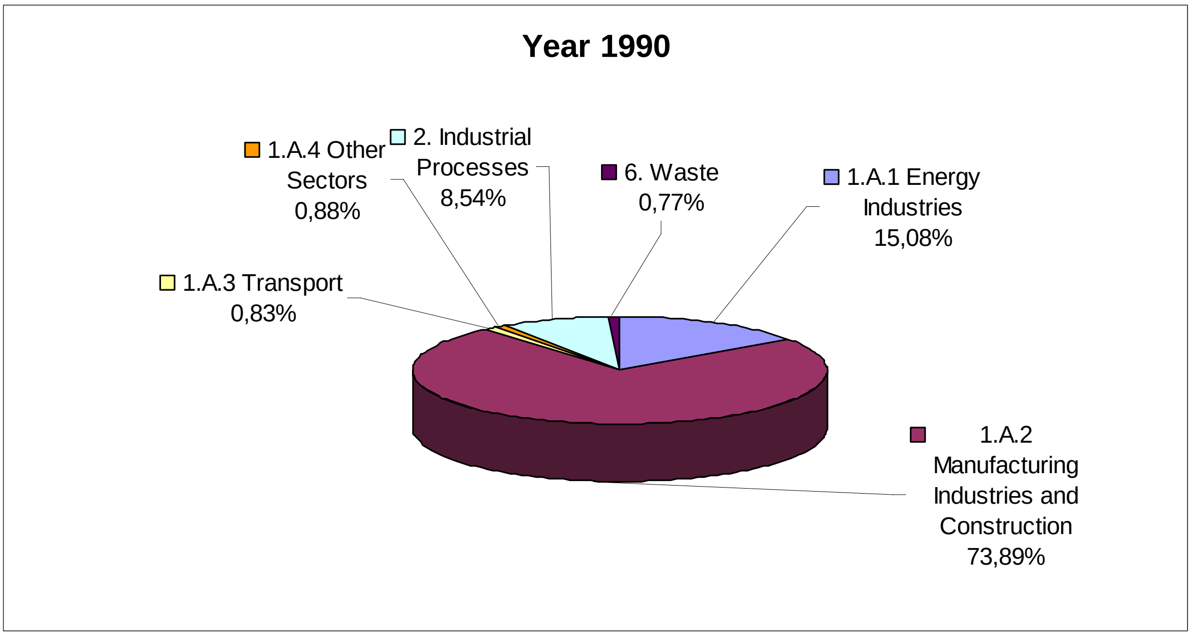
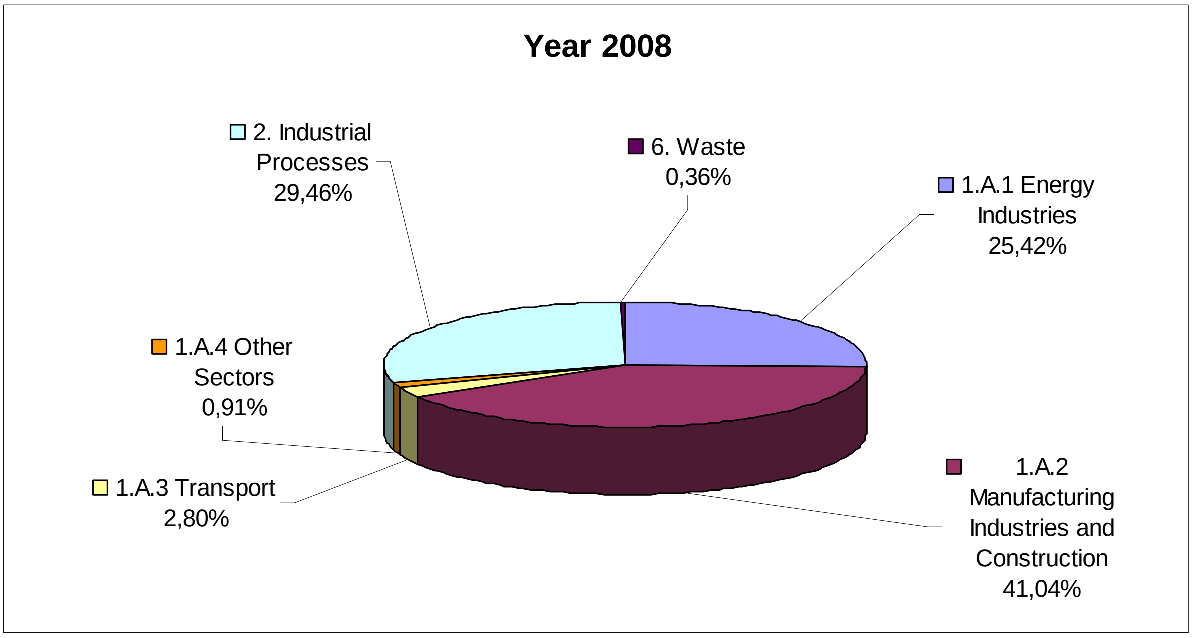


***Figure 3.2.10.1.- Contribution by categories to Cd emissions** (Continued)*



3.2.11.- Mercury (Hg)

The decrease in Hg emissions, with a decrease in 2008 of 35.5% over 1990, is the result of similar behaviour in all categories except for transport, which grew over the period

analyzed, although the marginal importance of this category has no incidence on the inventory as a whole. In absolute terms, the main category is combustion in industries in the energy sector, where the emissions represent between 41.8% of the total in 1990 and 59.4% in 2002, and its fluctuations include falls and rises in the period 1990-2002, with a downward trend since this last year. Next come industrial processes, combustion in manufacturing and construction industries and waste treatment and disposal. This last category is the one that presents the greatest decline in emissions, falling from a contribution of 15.5% in 1990 to 1.4% in 2008 as a result of the gradual disappearance of waste incineration plants that do not recover energy. The variation in absolute terms is shown in Table 3.2.11.1 and, in terms of the contribution of each category, in Table 3.2.11.2.

Figure 3.2.11.1 graphically illustrates the change experienced in these activities' contribution to the emissions of this pollutant between the start year and the last year of the period inventoried (1990 and 2008). As can be seen, the changes in waste treatment and disposal are reflected in the increase in the contribution from the other categories, even though there is a fall in the absolute value of their emissions. Additionally, changes in combustion emissions in the energy sector, in particular the fall recorded during the last years of the series, have an impact on the share of the remaining sectors, as this is the prevailing category in terms of emissions for this pollutant.

***Table 3.2.11.1.- Hg emissions** (Mg)*

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	6.1	6.6	8.0	6.7	6.6	7.5	6.9	5.6	6.3	7.2
1.A.2 Manufacturing Industries and Construction	2.8	2.8	2.4	2.4	2.7	2.7	2.3	2.3	2.3	2.3
1.A.3 Transport	0.0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
1.A.4 Other Sectors	0.2	0.3	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2
1.B Fugitive Emissions from Fuels										
2. Industrial Processes	3.1	3.1	2.9	2.9	3.1	3.3	3.2	2.8	2.7	2.8
3. Solvent and Other Product Use										
4. Agriculture										
6. Waste	2.3	2.4	2.7	2.5	2.2	1.0	0.7	0.5	0.5	0.4
TOTAL	**14.6**	**15.2**	**16.4**	**14.9**	**14.8**	**14.7**	**13.4**	**11.5**	**12.1**	**13.0**

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	7.1	7.2	7.9	6.7	6.6	6.7	5.8	5.4	4.7
1.A.2 Manufacturing Industries and Construction	2.2	2.2	2.2	2.2	2.1	2.0	2.0	1.6	1.6
1.A.3 Transport	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
1.A.4 Other Sectors	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1
1.B Fugitive Emissions from Fuels									
2. Industrial Processes	2.8	2.8	2.8	2.8	3.0	2.9	3.0	3.0	2.9
3. Solvent and Other Product Use									
4. Agriculture									
6. Waste	0.3	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1
TOTAL	**12.6**	**12.7**	**13.3**	**12.1**	**12.1**	**11.9**	**11.2**	**10.3**	**9.4**

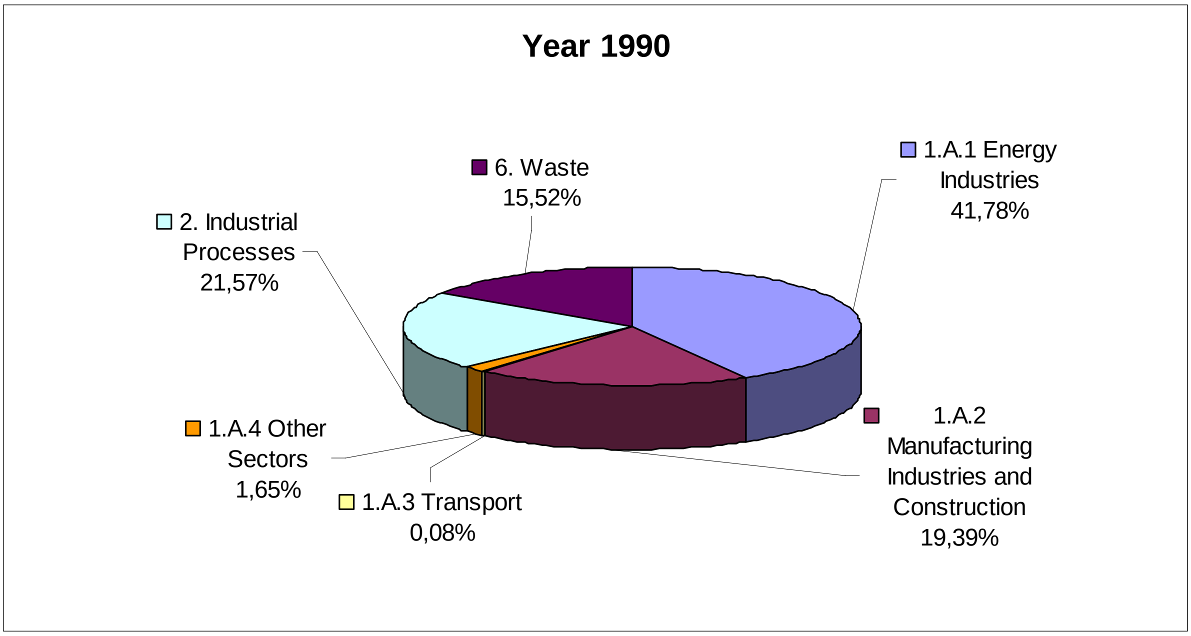
Table 3.2.11.2.- Contribution by categories to Hg emissions

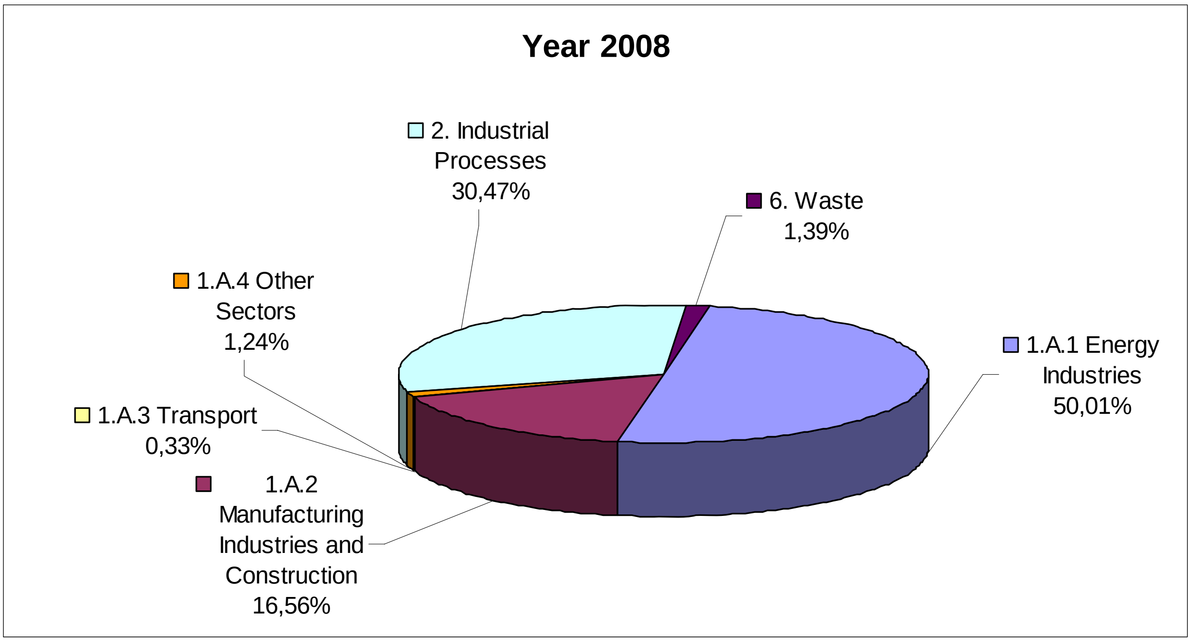
CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	41.78	43.51	48.94	45.07	44.46	51.11	51.81	48.76	52.28	55.62

1.A.2 Manufacturing Industries and Construction	19.39	18.52	14.81	16.37	18.20	18.10	17.25	20.12	19.21	17.50
1.A.3 Transport	0.08	0.08	0.07	0.09	0.10	0.09	0.10	0.10	0.10	0.13
1.A.4 Other Sectors	1.65	2.08	2.20	1.86	1.87	1.87	1.76	2.08	1.94	1.64
1.B Fugitive Emissions from Fuels										
2. Industrial Processes	21.57	20.29	17.71	19.80	20.89	22.33	23.55	24.61	22.65	21.69
3. Solvent and Other Product Use										
4. Agriculture										
6. Waste	15.52	15.52	16.26	16.81	14.49	6.50	5.53	4.32	3.82	3.41
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	56.55	57.09	59.38	55.16	55.00	56.16	52.14	52.39	50.01
1.A.2 Manufacturing Industries and Construction	17.41	17.15	16.52	17.84	17.50	16.66	18.32	15.61	16.56
1.A.3 Transport	0.14	0.15	0.16	0.18	0.19	0.20	0.23	0.30	0.33
1.A.4 Other Sectors	1.22	1.15	1.16	1.41	1.29	1.21	1.08	1.14	1.24
1.B Fugitive Emissions from Fuels									
2. Industrial Processes	21.94	21.87	20.90	23.54	24.84	24.60	26.99	29.26	30.47
3. Solvent and Other Product Use									
4. Agriculture									
6. Waste	2.74	2.59	1.89	1.87	1.19	1.17	1.24	1.30	1.39
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 3.2.11.1.- Contribution by categories to Hg emissions





3.2.12.- Dioxins and furans (DIOX)

The variation in dioxins has been influenced, on the one hand, by a drop in the period 1990-1997 as a consequence of the gradual decommissioning of certain waste incinerators (usually those with less capacity) and, on the other hand, through the application from 1997 on of stricter abatement techniques required by the regulations on the reduction of emissions for these pollutants at incineration plants, reflected in both waste treatment and disposal and combustion in industries in the energy sector, as this last category includes waste incinerators with energy recovery. Nonetheless, from the floor reached in 1997, there has been a sustained upward trend reflecting the corresponding increases in combustion in manufacturing and construction industries and in industrial processes, particularly due to the emissions from the steel and metal sector.

Figure 3.2.12.1 graphically illustrates the change experienced in these activities' contribution to the emissions of these pollutants between the start year and the last year of the period inventoried (1990 and 2008). As can be seen, the significant participation in 1990 of combustion in industries in the energy sector and waste treatment and disposal, with respective contributions of 12.4% and 21.6%, has fallen quite significantly in both, so that their joint contribution in 2008 is 4.5%; in the meantime, the gap left has basically been filled by combustion in manufacturing and construction industries and in industrial processes, which together increased their contribution by 30.7%.

***Table 3.2.12.1.- DIOX emissions** (g I-Teq)*

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	22.9	23.1	29.7	30.1	28.0	32.7	32.5	9.4	9.0	6.9
1.A.2 Manufacturing Industries and Construction	51.1	53.8	50.3	50.9	51.7	42.1	45.9	42.3	44.6	54.1

1.A.3 Transport	6.2	6.4	6.7	6.9	7.3	6.7	7.0	6.5	6.6	7.1
1.A.4 Other Sectors	38.1	39.4	40.1	37.9	37.1	35.5	35.0	35.0	34.5	33.5
1.B Fugitive Emissions from Fuels										
2. Industrial Processes	14.7	14.6	14.6	15.0	15.8	17.3	15.9	19.3	21.1	21.4
3. Solvent and Other Product Use										
4. Agriculture	12.1	12.1	11.7	12.0	11.8	11.5	12.2	13.0	11.8	11.1
6. Waste	39.9	41.5	46.9	44.0	38.7	18.7	15.1	11.0	10.4	10.0
TOTAL	**185.0**	**191.0**	**199.9**	**196.7**	**190.5**	**164.6**	**163.7**	**136.5**	**138.0**	**144.1**

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	7.0	4.5	4.9	4.7	4.9	4.8	4.1	4.2	2.7
1.A.2 Manufacturing Industries and Construction	62.7	60.6	62.9	63.4	68.7	70.5	74.3	77.9	77.3
1.A.3 Transport	7.1	7.4	7.7	7.7	7.6	7.7	7.9	8.4	8.2
1.A.4 Other Sectors	31.8	31.5	31.6	32.0	31.9	31.7	31.5	31.4	31.3
1.B Fugitive Emissions from Fuels									
2. Industrial Processes	23.3	24.6	24.6	25.3	27.3	27.1	29.4	29.6	29.0
3. Solvent and Other Product Use									
4. Agriculture	9.2	8.1	6.1	9.3	7.5	5.6	7.2	7.4	7.4
6. Waste	8.5	7.6	6.8	7.3	4.7	4.6	4.6	4.6	4.5
TOTAL	**149.7**	**144.3**	**144.7**	**149.7**	**152.6**	**152.0**	**159.0**	**163.5**	**160.3**

Table 3.2.12.2.- Contribution by categories to DIOX emissions

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	12.38	12.08	14.86	15.28	14.70	19.90	19.85	6.89	6.49	4.79
1.A.2 Manufacturing Industries and Construction	27.64	28.20	25.17	25.87	27.15	25.59	28.05	30.98	32.33	37.51
1.A.3 Transport	3.35	3.35	3.37	3.49	3.82	4.05	4.28	4.79	4.75	4.96
1.A.4 Other Sectors	20.60	20.62	20.03	19.26	19.49	21.59	21.40	25.62	25.01	23.22
1.B Fugitive Emissions from Fuels										
2. Industrial Processes	7.94	7.66	7.28	7.60	8.31	10.50	9.71	14.13	15.28	14.84
3. Solvent and Other Product Use										
4. Agriculture	6.52	6.34	5.85	6.10	6.21	6.98	7.45	9.56	8.58	7.72
6. Waste	21.57	21.76	23.44	22.40	20.31	11.39	9.25	8.03	7.56	6.96
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	4.69	3.12	3.42	3.11	3.23	3.15	2.59	2.59	1.67
1.A.2 Manufacturing Industries and Construction	41.89	42.01	43.49	42.35	44.99	46.37	46.74	47.65	48.22
1.A.3 Transport	4.76	5.16	5.30	5.17	5.01	5.06	4.96	5.17	5.09
1.A.4 Other Sectors	21.21	21.80	21.86	21.40	20.90	20.88	19.78	19.18	19.51
1.B Fugitive Emissions from Fuels									
2. Industrial Processes	15.57	17.02	17.01	16.92	17.88	17.86	18.50	18.09	18.08
3. Solvent and Other Product Use									
4. Agriculture	6.16	5.62	4.23	6.20	4.92	3.67	4.52	4.52	4.61
6. Waste	5.71	5.26	4.69	4.85	3.07	3.01	2.90	2.80	2.82

TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 3.2.12.1.- Contribution by categories to DIOX emissions

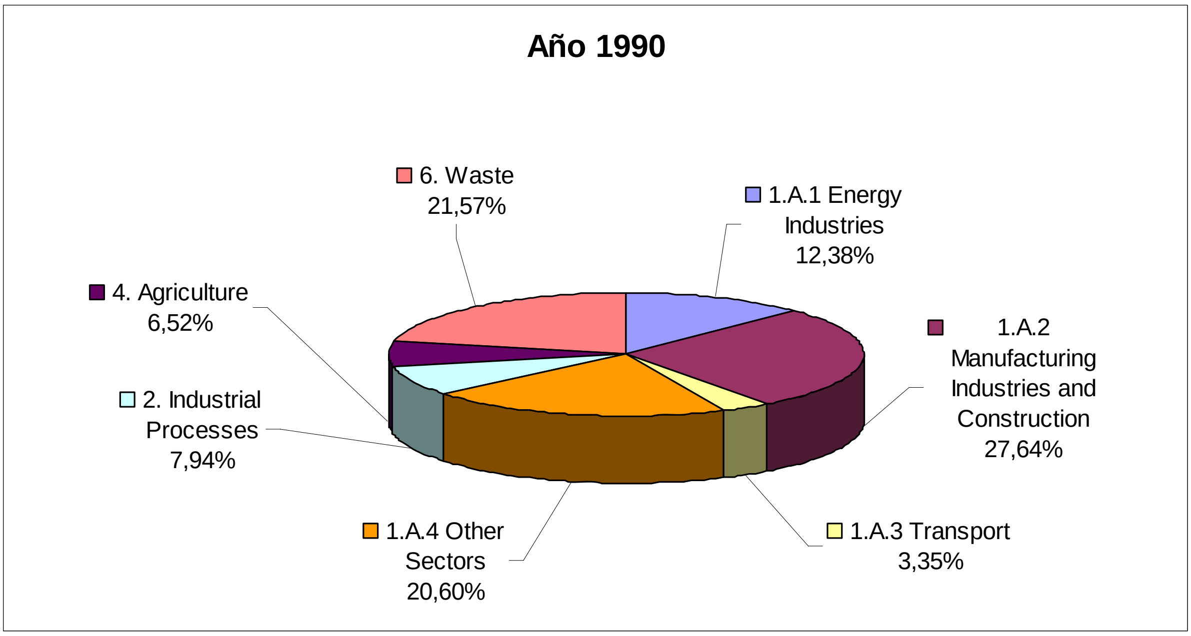
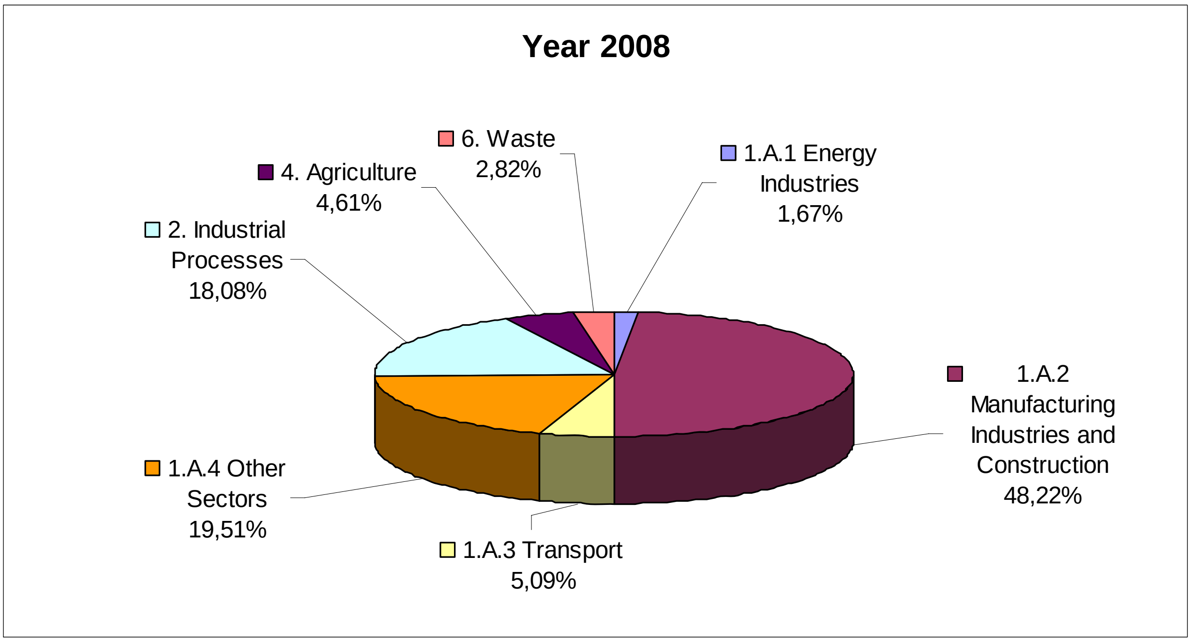


***Figure 3.2.12.1.- Contribution by categories to DIOX emissions** (Continued)*



3.2.13.- Polycyclic Aromatic Hydrocarbons

The changes in the emissions for this group of substances show a clear fall over the period inventoried, with the level of the global index for 2008 at 79.8 with respect to 1990. This variation is caused by the decline in the stubble burning processes in agriculture, as this activity has been regulated with stricter and stricter rules with regard to the permits for its practice, particularly at certain times of year. There is also a moderate increase at a very secondary level in combustion in manufacturing and construction industries, which has counteracted, albeit only partially, the fall in the activity mentioned above. In absolute terms, the fluctuations are shown in Table 3.2.13.1 and, in terms of the contribution of each category, in Table 3.2.13.2.

Figure 3.2.13.1 graphically illustrates the change experienced in these categories' contribution to the emissions of this pollutant. The most noteworthy, as mentioned above, is the lower participation by agriculture, whose contribution has gone from 62.2% in 1990 to 47.7% in 2008, and correspondingly, the increase in the general share of the other categories, particularly that of combustion in manufacturing and construction industries, which increases its share from 13.6% in 1990 to 20.6% in 2008.

***Table 3.2.13.1.- PAH emissions** (Mg)*

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	0.4	0.4	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
1.A.2 Manufacturing Industries and Construction	43.7	44.1	43.6	42.6	43.3	43.7	43.5	43.7	42.7	43.4
1.A.3 Transport	5.2	5.5	5.9	5.9	6.1	6.4	6.7	6.8	7.7	8.2
1.A.4 Other Sectors	22.0	22.3	22.4	21.7	21.4	20.8	20.6	20.6	20.5	20.2
1.B Fugitive Emissions from Fuels	1.5	1.4	1.3	1.4	1.4	1.1	1.1	1.2	1.2	1.1
2. Industrial Processes	48.6	48.5	46.4	47.1	44.9	44.6	43.6	45.6	46.8	46.1
3. Solvent and Other Product Use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Agriculture	199.8	200.5	193.7	198.7	195.9	190.2	201.9	216.0	195.9	184.3
6. Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	**321.3**	**322.7**	**313.5**	**317.6**	**313.1**	**306.9**	**317.5**	**334.1**	**314.8**	**303.4**

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1
1.A.2 Manufacturing Industries and Construction	45.2	47.5	47.9	48.9	50.7	51.0	51.3	53.0	52.9
1.A.3 Transport	8.5	8.9	9.3	10.0	10.1	10.6	11.2	11.9	11.5
1.A.4 Other Sectors	19.7	19.7	19.7	19.8	19.8	19.8	19.8	19.8	19.8
1.B Fugitive Emissions from Fuels	1.3	1.2	1.2	1.2	1.3	1.2	1.3	1.2	1.2
2. Industrial Processes	46.6	47.1	46.9	46.4	47.8	48.5	46.7	49.1	48.5
3. Solvent and Other Product Use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Agriculture	152.8	134.3	101.3	153.6	124.4	92.3	119.1	122.4	122.4
6. Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	**274.3**	**258.9**	**226.5**	**280.2**	**254.4**	**223.6**	**249.6**	**257.5**	**256.3**

Table 3.2.13.2.- Contribution by categories to PAH emissions

CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1.A.1 Energy Industries	0.11	0.12	0.07	0.06	0.06	0.03	0.04	0.03	0.03	0.03
1.A.2 Manufacturing Industries and Construction	13.62	13.67	13.92	13.41	13.81	14.24	13.69	13.09	13.56	14.30
1.A.3 Transport	1.61	1.69	1.88	1.84	1.96	2.07	2.10	2.05	2.44	2.71
1.A.4 Other Sectors	6.86	6.91	7.14	6.84	6.83	6.76	6.50	6.17	6.51	6.66
1.B Fugitive Emissions from Fuels	0.45	0.45	0.43	0.44	0.43	0.36	0.35	0.36	0.38	0.35
2. Industrial Processes	15.14	15.02	14.79	14.83	14.33	14.54	13.73	13.64	14.86	15.20
3. Solvent and Other Product Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4. Agriculture	62.21	62.13	61.77	62.57	62.56	61.99	63.61	64.66	62.23	60.76
6. Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

CATEGORY	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 Energy Industries	0.09	0.09	0.08	0.07	0.09	0.06	0.06	0.04	0.04
1.A.2 Manufacturing Industries and Construction	16.47	18.35	21.14	17.45	19.93	22.81	20.54	20.57	20.62
1.A.3 Transport	3.09	3.44	4.12	3.58	3.96	4.75	4.50	4.61	4.48
1.A.4 Other Sectors	7.20	7.60	8.71	7.08	7.79	8.87	7.94	7.70	7.73
1.B Fugitive Emissions from Fuels	0.46	0.46	0.53	0.44	0.51	0.56	0.52	0.48	0.47
2. Industrial Processes	16.99	18.19	20.72	16.57	18.80	21.68	18.73	19.06	18.91
3. Solvent and Other Product Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4. Agriculture	55.70	51.85	44.70	54.82	48.91	41.28	47.71	47.53	47.75
6. Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 3.2.13.1.- Contribution by categories to PAH emissions

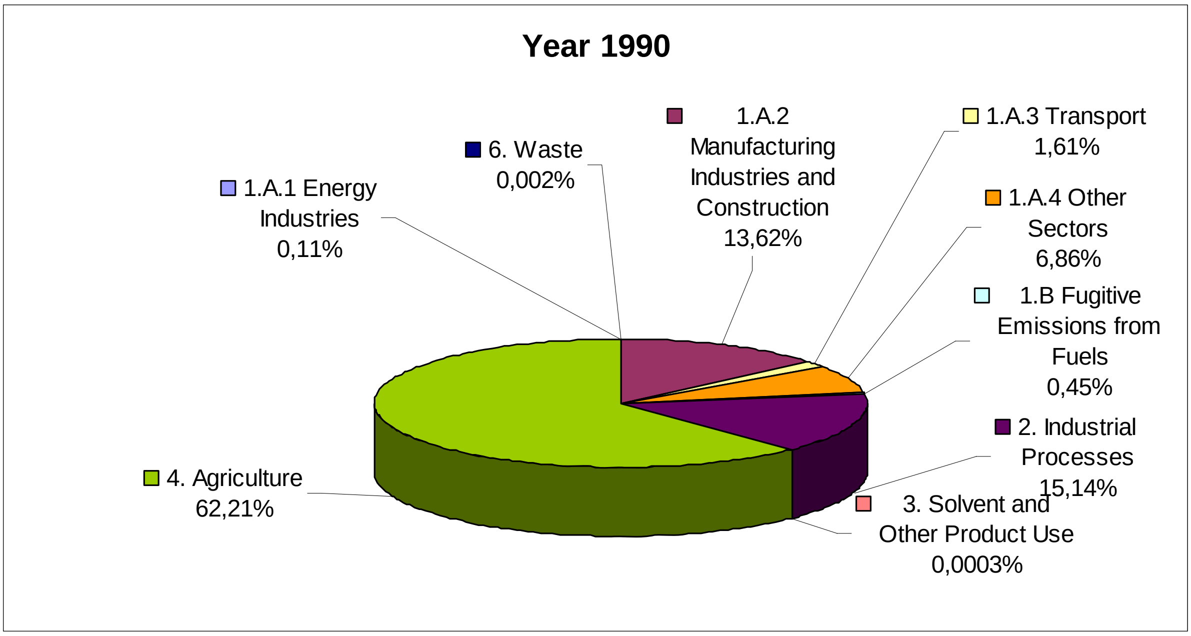
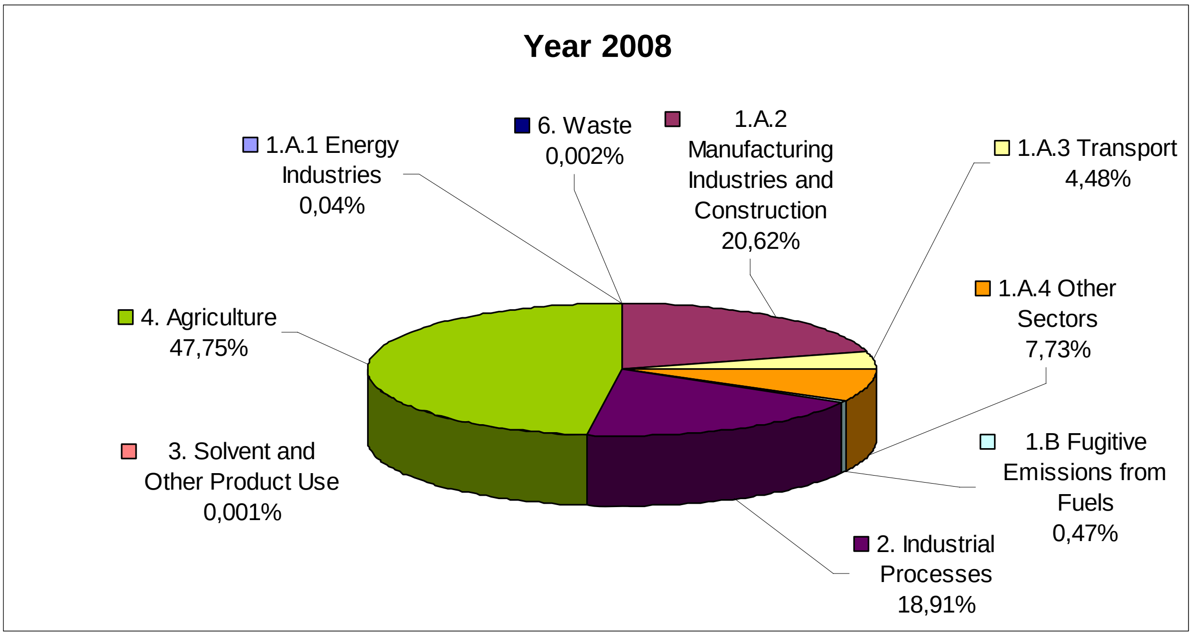


Figure 3.2.13.1.- Contribution by categories to PAH emissions *(Continued)*



4.- Energy

Chapter updated in July, 2010.

4.1.- Sector analysis

This sector includes all activities associated with the production, transformation, distribution, handling and final consumption of fuels for energy-related purposes. Emissions related to these activities mainly result from combustion (category 1A), followed by those corresponding to intentional fuel losses or accidental leaks during production or distribution (category 1B).

Due to the number of activities covered, the CLRTAP-EMEP NFR nomenclature provides a more detailed structure for the emission sources categories based on the social and economic sector at hand:

I) 1A1: Energy industries

II) 1A2: Manufacturing industries and construction

III) 1A3: Transport

IV) 1A4: Other non-industrial consumer sectors, including services, residential, agriculture, forestry and fishing sectors

V) 1A5: Other sectors not specified above

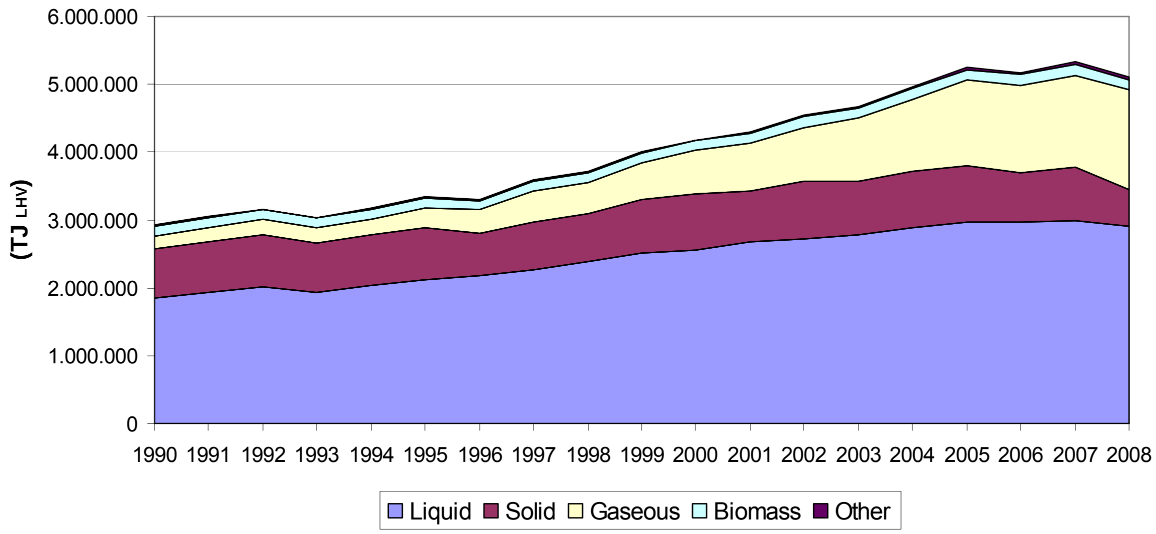
VI) 1B: Fugitive emissions from fuels

Of the categories cited, the Inventory calculates emissions due to military activities and those generated by pleasure craft, which should be included within category 1A5 (1A5a and 1A5b for stationary and mobile combustion, respectively), within the transport and other consumer sectors categories, since the balances available do not provide a breakdown that would allow discrimination of military consumption. Furthermore it should be pointed out that this sector includes some potentially emitting activities that have not been estimated, such as: i) international coastal navigation (category 1A3di(ii)); ii) other fugitive emissions from solid fuels (category 1B1c); and iii) geothermal energy extraction (category 1B2avi), since they are either not significant or do not take place in Spain.

In general, the domestic energy balance for the whole sector is a more relevant source of information to estimate emission levels. With respect to this balance, the following elements are particularly significant: i) the degree of fuel and electricity self-supply; ii) final consumption for energy-related purposes; and iii) distribution of different types of fuels based on social-economic sector. As for the evolution of trends during the period inventoried, it is worth mentioning the gradual penetration of natural gas both in the energy sector (with the installation of combined cycle power plants) and in all final consumption sectors. This fuel accounts for most of the increase in primary and final energy consumption; on the other

hand, there is a parallel and marked drop in coal consumption (all the more acute in 2008), at the same time as a more moderate relative increase in oil-derived fuels with respect to natural gas. Figure 4.1.1 below shows the evolution of fuel consumption for electricity and heat production by type of fuel.

Figure 4.1.1.- Evolution of fuel consumption for electricity and heat production



It is worth noting that potential emissions associated with the industrial use of fuels with non-energy related purposes (inputs in industrial processes) are not included in this sector and fall under the Industrial Processes category described in chapter 5.

4.2.- Analysis by pollutant

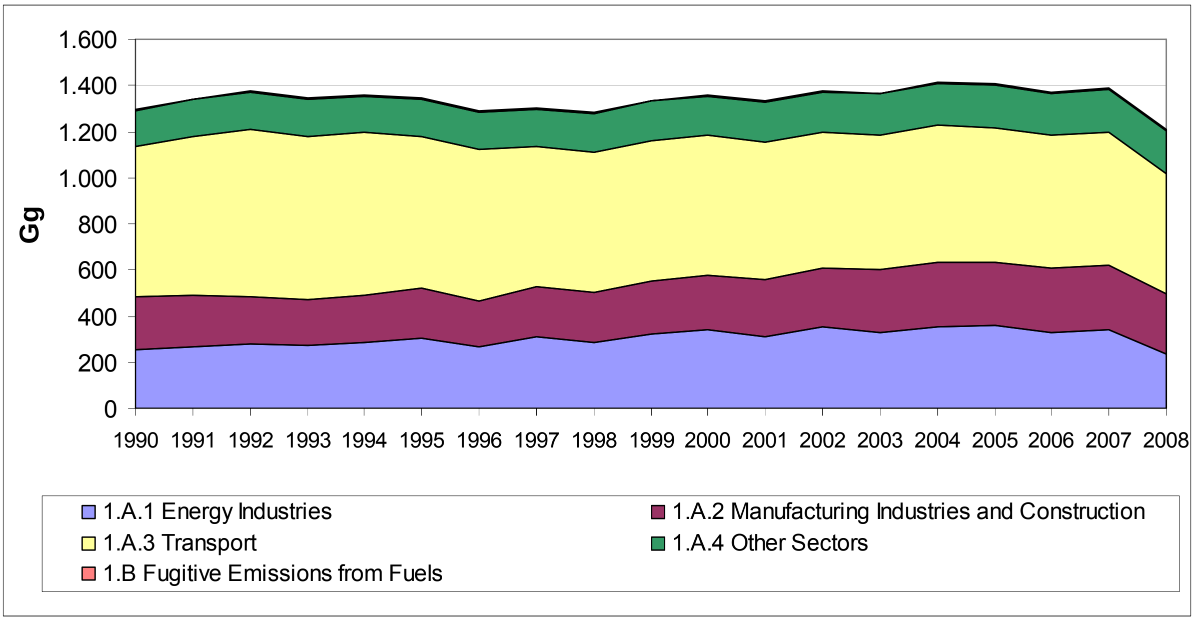
4.2.1.- NO_X

NO_X emissions in the energy sector, whose evolution is illustrated by category in Table 4.2.1.1 and Figure 4.2.1.1, underwent a 6.8% decrease during 2008 with respect to 1990, going from 1,297.8 gigagrammes (Gg) in 1990 to 1,210.0 Gg in 2008.

Table 4.2.1.1- NO_X emissions *(Amounts in Gg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
1A1 Energy Industries	257.1	303.1	342.5	355.5	358.5	330.7	343.0	233.4
1A2 Manufacturing Industries and Construction	224.4	217.6	234.8	276.0	273.0	280.1	277.8	263.0
1A3 Transport	654.2	656.6	604.3	596.5	586.4	572.1	574.3	520.5
1A4 Other Sectors	155.4	162.1	171.9	182.5	183.9	184.4	186.0	187.9
1A5 Others	-	-	-	-	-	-	-	-
1B Fugitive Emissions from Fuels	6.7	5.2	5.0	5.6	5.0	5.2	5.1	5.1
Total Energy	**1,297.8**	**1,344.5**	**1,358.5**	**1,416.1**	**1,406.9**	**1,372.5**	**1,386.3**	**1,210.0**

Figure 4.2.1.1.- Evolution of NO_X emissions by category



As shown in the table and figure above analyzing the profile of both the sector as a whole and its main categories separately, NO_X emissions experienced virtually sustained growth until 2007 and a significant decline in 2008 (essentially caused in the latter case by the activity of coal-fired power stations); these emissions are ultimately influenced by changes in the level of activity for the various categories. In addition to the effect of the production/activity levels on the emissions in the sector, it is necessary to include the impact, on the emission levels, represented by the incorporation of technological improvements and abatement measures in the main categories. Among these actions, the following are noteworthy: i) the technological advances adopted in vehicle fleets to achieve ever more effective reductions in the emission standards for this pollutant (EURO technologies), although the effect of these technological advances has been counteracted by the relative increase in the number of diesel-powered cars with respect to petrol-driven ones; ii) the growth in combined-cycle power stations, with an NO_X emission ratio per unit of electricity produced that is lower than the ratio of conventional power stations; and, complementarily, iii) the dissemination of NO_X abatement measures and energy efficiency improvements in conventional coal-fired power stations and in other industrial combustion sectors.

As shown in the bar chart in Figure 4.2.1.2, the energy sector is clearly the predominant source for this gas, contributing more than 95% of total NO_X emissions throughout the period while exhibiting high stability in terms of share (ranging between 96.8% and 98.1%)[1].

[1] Notice how the height of the bars in the chart exceed 95% in all the years.

Figure 4.2.1.2.- Percentage of NO_X emissions by category with respect to the inventory total

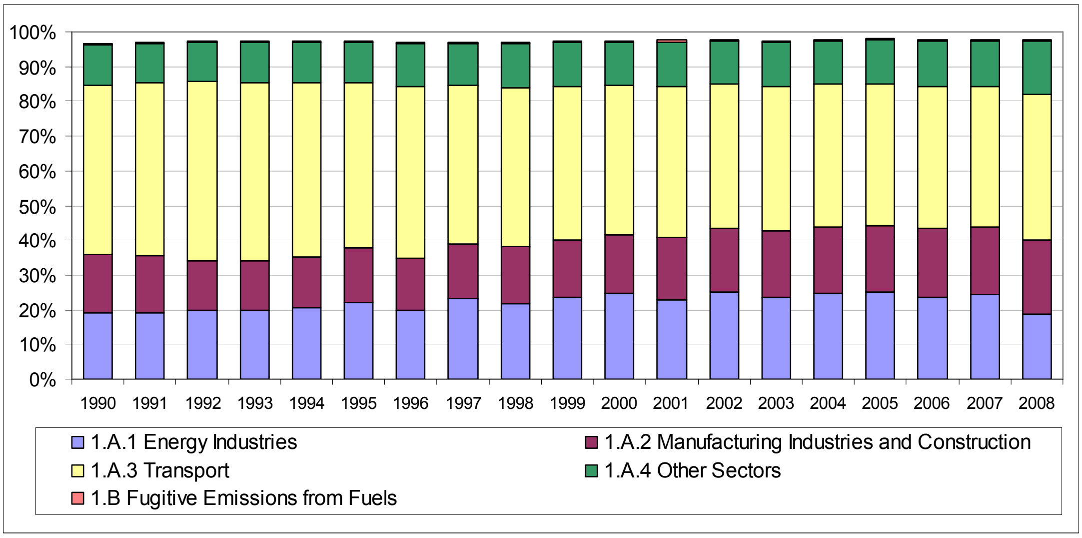
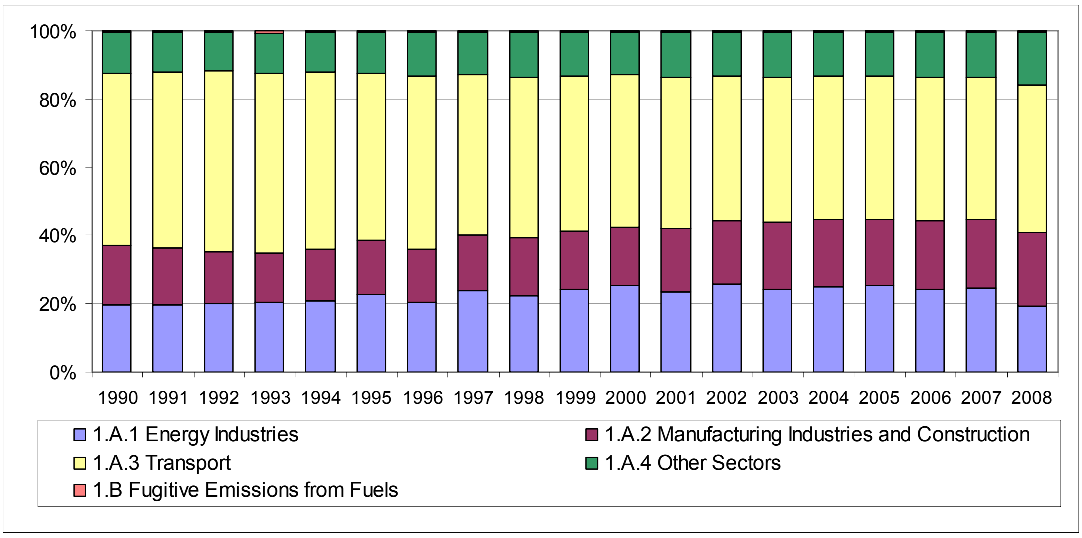


Figure 4.2.1.3 shows the distribution by categories of the emissions in this sector, pointing up slight differences in the contribution of each sector throughout the period. Thus, Transport activities, aside from being the main emitting source (43.0% of the sector's emissions during 2008), decreased their share partly due to continuous technological advances introduced in new vehicle fleets, in favour of the Manufacturing and construction industries (21.7% in 2008), which significantly increased their contribution, and the energy industries (21.7%) and Other sectors (15.5%), both witnessing scarcely relevant variations over the years.

Figure 4.2.1.3.- Percentage of NO_X emissions by category with respect to the sector total



As for the key sources of NO_X in this sector, those identified for the period 1990-2008 are as follows:

- Public electricity and heat production (1A1a) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2008.

- Oil refineries (1A1b) by its emission level throughout the period 1990-2008 and by its trend in the years 1991, 1994-1996 and 1998.

- Transformation of solid fuels and other energy industries (1A1c) by the trend in 1991.

- Manufacturing and construction industries (1A2) by their emission level throughout the period 1990-2008 and by their trend in the years 1991-1998 and 2001-2008.

- Air traffic LTOs (Landing and Take-Off cycles) (1A3a), by its trend in the years 1996-1999 and 2006-2008.

- Road transport – Passenger cars (1A3bi) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2008.

- Road transport - Light duty vehicles (1A3bii) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2008.

- Road transport - Heavy duty vehicles (1A3biii) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2001 and 2004-2005.

- Domestic navigation (1A3dii) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-1994 and 1996-2008.

- Commercial / Institutional / Residential Sectors (1A4a+1A4b) by its emission level throughout the period 1990-2008 and by its trend in the years 1991 and 1996-2008.

- Agriculture / Forestry / Fishing - Stationary combustion and mobile machinery (1A4ci+1A4cii) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2008.

- Domestic fishing (1A4ciii) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2008.

- Fugitive emissions from fuels (1B) by its trend in the years 1991-1992 and 1994-1995.

As a summary of the foregoing, Table 4.2.1.2 below shows, for this sector's key categories for NO_X, the contribution of emissions to the level and trend, the ranking for this category in the key sources catalogue[2], as well as the absolute values, all referring to 2008.

2 Ranking determined by the contribution of the category's emissions to the level or trend.

Table 4.2.1.2- NO_X key sources: Level and Trend contribution

Activity		NO_X (Gg) (2008)	Level Assessment (2008)			Trend Contribution (2008)		
Code	Description		%	Key Source	Rank	%	Key Source	Rank
1A1a	Public electricity and heat production	205.6	16.6	YES	3	1.4	YES	10
1A1b	Oil refineries	22.1	1.8	YES	10	0.1	NO	19
1A1c	Transformation of solid fuels and other energy industries	5.6	0.5	NO	15	0.3	NO	17
1A2	Manufacturing industries and construction	263.0	21.3	YES	1	15.8	YES	2
1A3a	Civil Aviation (LTO)	9.5	0.8	NO	12	1.9	YES	8
1A3bi	Road transport - Passenger cars	173.4	14.0	YES	4	39.3	YES	1
1A3bii	Road transport - Light duty vehicles	30.4	2.5	YES	7	2.8	YES	7
1A3biii	Road transport - Heavy duty vehicles	227.5	18.4	YES	2	0.9	NO	12
1A3dii	National navigation	72.4	5.8	YES	6	11.7	YES	4
1A4a+ 1A4b	Comercial / Institutional / Residential	27.7	2.2	YES	8	2.8	YES	6
1A4ci+ 1A4cii	Agriculture / Forestry / Fishing Stationary + Off-road vehicles and other machinery	136.2	11.0	YES	5	14.0	YES	3
1A4ciii	National Fishing	24.1	1.9	YES	9	4.2	YES	5
1B	Fugitive emissions from fuels	5.1	0.4	NO	16	0.3	NO	15

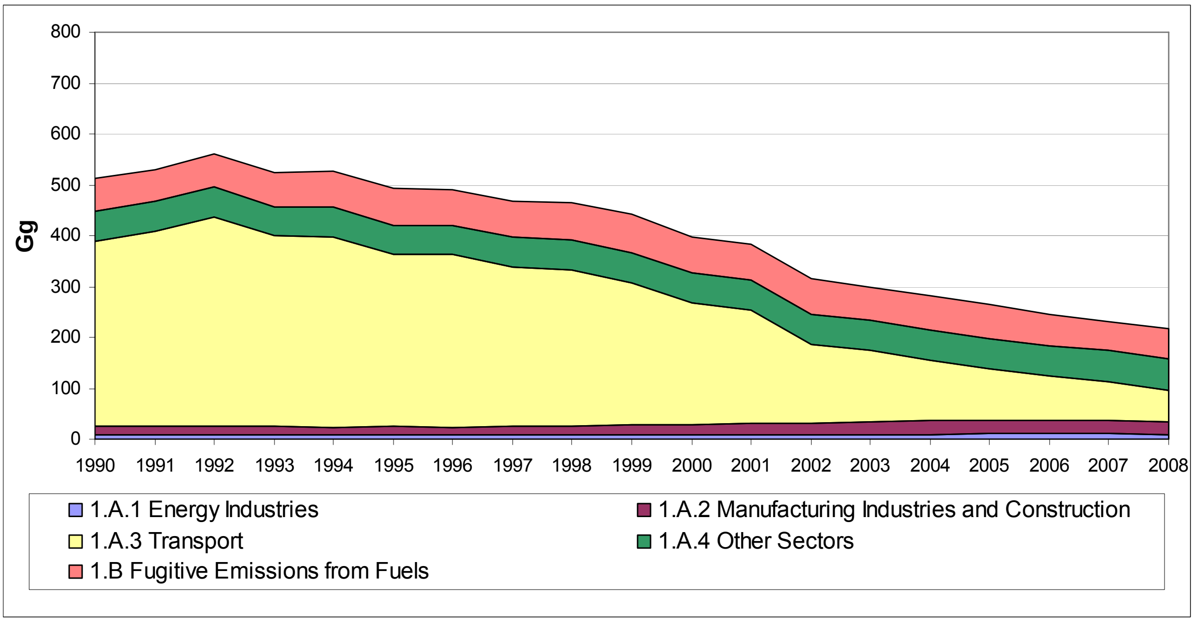
4.2.2.- NMVOC

NMVOC emissions for the energy industries, the variation in which is illustrated by category in Table 4.2.2.1 and Figure 4.2.2.1, dropped by 57.8% in 2008 with respect to 1990, going from 511.8 Gg in 1990 to 215.8 Gg in 2008.

***Table 4.2.2.1.- NMVOC emissions** (Amounts in Gg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
1A1 Energy Industries	9.1	8.1	9.0	9.8	10.2	9.9	9.9	8.2
1A2 Manufacturing Industries and Construction	17.1	16.0	20.1	26.0	27.1	27.7	27.8	26.3
1A3 Transport	363.4	338.7	239.8	118.4	99.7	85.2	75.2	61.6
1A4 Other Sectors	58.8	58.0	58.6	59.9	60.4	61.1	60.8	61.1
1A5 Others								
1B Fugitive Emissions from Fuels	63.5	71.5	70.2	66.8	66.6	60.3	58.5	58.6
Total Energy	**511.8**	**492.3**	**397.7**	**280.9**	**264.0**	**244.2**	**232.2**	**215.8**

Figure 4.2.2.1- Evolution of NMVOC emissions by category



As shown in the table and figure above, the pattern, with a marked downward trend starting in 1992, is determined by the decrease in emissions from Transport activities (category 1A3). This decrease is the result of restrictions imposed on vehicle exhaust emissions of pollutants and the evaporative emissions from petrol-driven vehicles; thus, the new vehicle fleets have been equipped with engine technologies and more effective abatement techniques for VOC reduction (successive introduction of EURO-I to EURO-IV technologies).

As shown in Figure 4.2.2.2, energy industries are a significant emitting source for this gas since, in spite of their smaller contribution, both in absolute values and percentage terms, in 2008 they account for 26.5% of total NMVOC emissions (ranging between 26.5% in 2008 and 52.9% in 1993). It is worth mentioning that, in spite of the drop in emissions during the period 1992-1993, the sector’s share in the inventory as a whole does not decrease, the result of the decrease in emissions for other industries due to changes in economic circumstances during this period.

Figure 4.2.2.2.- Percentage of NMVOC emissions by category with respect to the inventory total

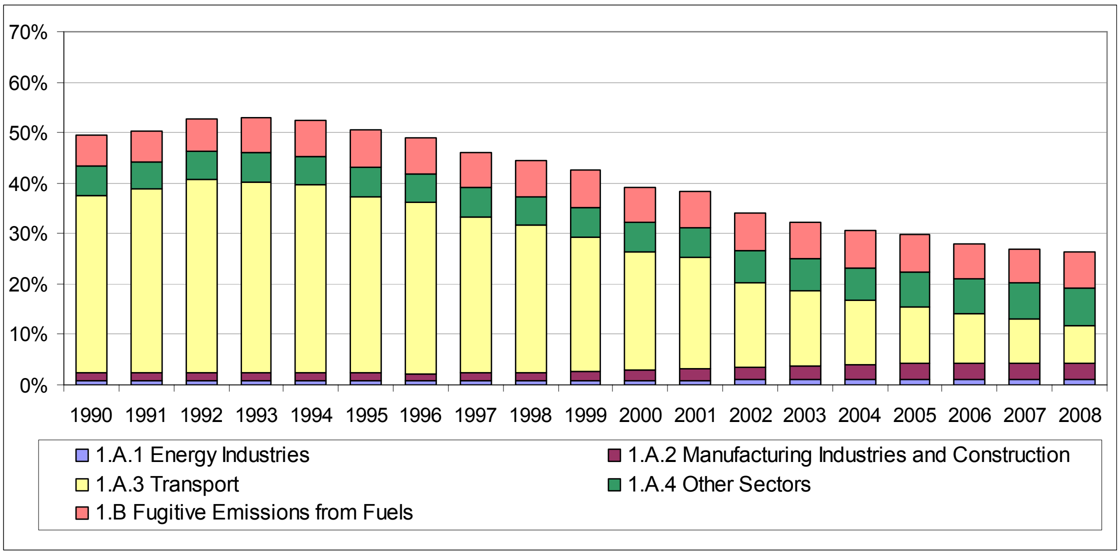
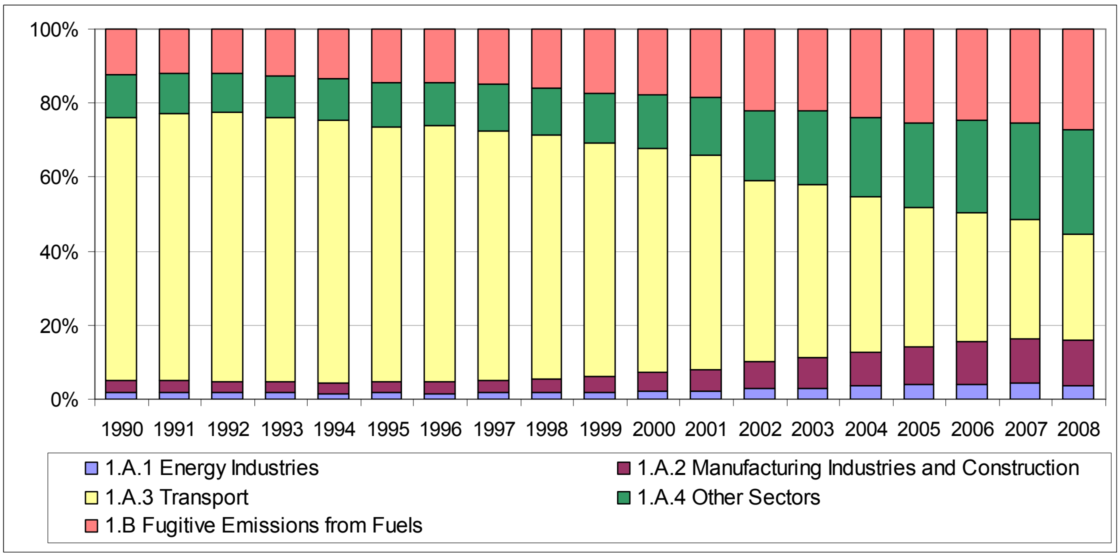


Figure 4.2.2.3 shows how the above-mentioned reductions in absolute levels for Transport activities entail a significant loss in its contribution to the sector's NMVOC emissions, going from 71.0% in 1990 to 28.5% in 2008; on the other hand, the remaining categories, with more moderate variations in terms of absolute emissions, increase their share for this pollutant within the sector to values close to those of Transport in 2008 for Other sectors (28.3%) and fugitive emissions (27.2%); 12.2% in the case of Manufacturing and construction industries; or, more marginally, 3.8% corresponding to Energy industries.

Figure 4.2.2.3.- Percentage of NMVOC emissions by category with respect to the sector total



As for the key sources of NMVOC in this sector, the following have been identified for the period 1990-2008:

- Energy industries (1A1) by its trend in 2007.

- Manufacturing and construction industries (1A2) by the emission level throughout the period 1990-2008 and by its trend in the years 1994 and 2001-2008.

- Road transport - Passenger cars (1A3bi) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-1993 and 1995-2007.

- Road transport – Heavy duty vehicles (1A3biii) by its emission level throughout the period 1990-2008 and by its trend in the years 1994-1996.

- Road transport - Mopeds and motorcycles (1A3biv) by its emission level in the years 1990-2008 and by its trend in the years 1991-2008.

- Road transport – Evaporative emissions (1A3bv) by its emission level in the years 1990-2006 and by its trend in the years 1991-1992 and 1994-2008.

- Commercial / Institutional / Residential Sectors (1A4a+1A4b) by its emission level throughout the period 1990-2008 and by its trend in the years 1992, 1993 and 2005-2008.

- Agriculture / Forestry / Fishing - Stationary combustion and mobile machinery (1A4ci+1A4cii) by its emission level throughout the period 1990-2008 and by its trend in the years 2004-2008.

- Fugitive emissions in oil exploration, production, transport, refining and storage (1B2ai+1B2aiv) by its emission level throughout the period 1990-2008 and by its trend in the years 1994-2000 and 2002-2008.

- Fugitive emissions in distribution of oil-based products (1B2av) by its emission level throughout the period 1990-2008 and by its trend in the years 1991 and 1993-1997.

- Fugitive emissions by natural gas, venting and flaring (1B2b+1B2c) by its trend in the years 1991-1996, 1998 and 2002.

As a summary of the foregoing, Table 4.2.2.2 below reflects, for the key categories for NMVOC in this sector, the emissions' contribution to the level and trend, the ranking of the category in the key sources catalogue[3], as well as the absolute values, all referring to 2008.

[3] Ranking determined by the contribution of the category's emissions to the level or trend.

Table 4.2.2.2.- NMVOC key sources: Level and Trend contribution

Activity		NMVOC (Gg) (2008)	Level Assessment (2008)			Trend Contribution (2008)		
Code	Description		%	Key Source	Rank	%	Key Source	Rank
1A1	Energy industries	8.19	1.0	NO	16	0.2	NO	22
1A2	Manufacturing industries and construction	26.32	3.2	YES	9	2.6	YES	9
1A3bi	Road transport – Passenger cars	20.27	2.5	YES	13	26.5	YES	1
1A3biii	Road transport – Light duty vehicles	6.53	0.8	NO	17	1.0	NO	16
1A3biv	Road transport - Mopeds and Motorcycles	20.13	2.5	YES	14	5.8	YES	6
1A3bv	Road transport - Gasoline evaporation	6.52	0.8	NO	18	12.6	YES	3
1A4a+ 1A4b	Commercial / Institutional / Residential	40.03	4.9	YES	6	1.5	YES	13
1A4ci+ 1A4cii	Agriculture / Forestry / Fishing Stationary + Off-road vehicles and other machinery	20.33	2.5	YES	12	1.5	YES	12
1B2ai+ 1B2aiv	Exploration / Production / Transport / Refinering / Storage	26.65	3.3	YES	7	1.6	YES	11
1B2av	Distribution of oil products	26.51	3.2	YES	8	0.1	NO	23
1B2b+ 1B2c	Fugitive emissions by natural gas & Venting and flaring	5.08	0.6	NO	19	0.0	NO	25

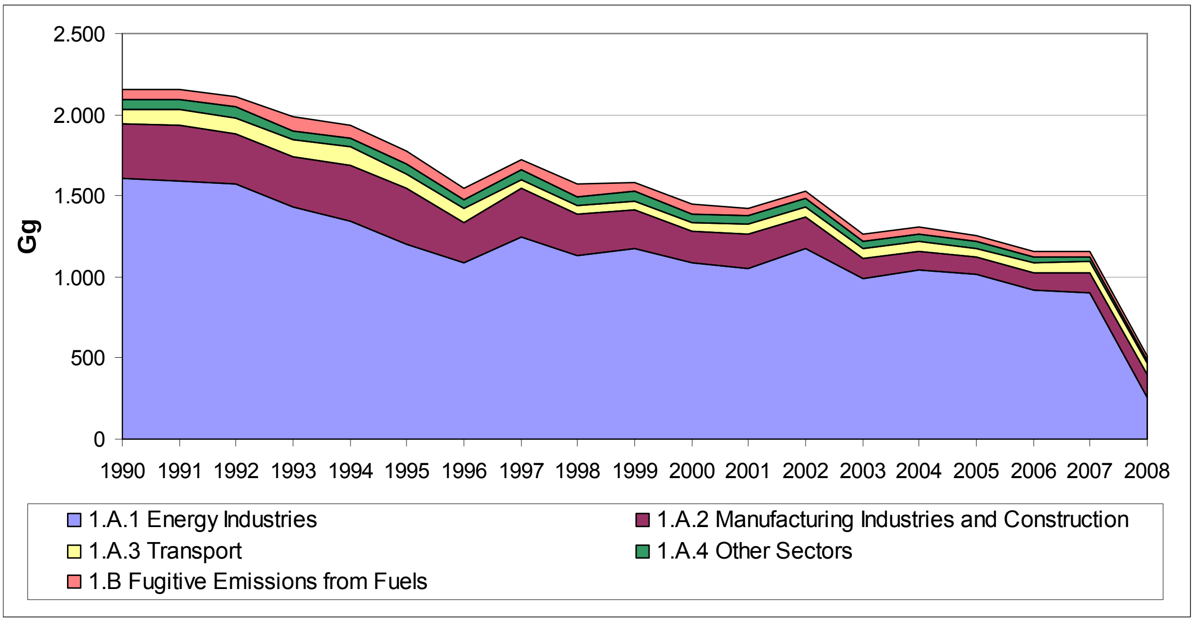
4.2.3.- SO_X

SO_X emissions in the energy sector, the pattern for which is shown by category in Table 4.2.3.1 and Figure 4.2.3.1, decreased by 76.2% in 2008 with respect to 1990, going from 2,156.2 Gg in 1990 to 514.2 Gg in 2008.

Table 4.2.3.1.- SO_X emissions*(Amounts in Gg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
1A1 Energy Industries	1,604.0	1,199.9	1,090.8	1,040.5	1,013.2	914.7	905.2	257.1
1A2 Manufacturing Industries and Construction	336.3	345.5	191.8	117.4	108.7	110.3	115.4	139.7
1A3 Transport	91.9	88.4	53.0	64.5	55.6	61.0	71.5	72.0
1A4 Other Sectors	59.3	64.2	54.0	40.2	38.6	34.5	33.2	20.6
1A5 Others								
1B Fugitive Emissions from Fuels	64.7	75.2	55.4	41.8	40.2	33.4	28.5	24.7
Total Energy	**2,156.2**	**1,773.0**	**1,445.1**	**1,304.4**	**1,256.4**	**1,153.9**	**1,153.9**	**514.2**

Figure 4.2.3.1.- Evolution of SO_X emissions by category



As shown in the above table and figure, the trend is mainly influenced by the reduction of emissions in energy industries (category 1A1) and, secondly, at a lower level, by the decrease in manufacturing and construction industries (category 1A2); however, all categories in the sector show a decreasing pattern. This general trend shows the evolution of consumption in favour of fuels with lower sulphur content, whether replacing current fuels with alternative fuels containing less sulphur, such as natural gas, or altering the characteristics of original fuels. Thus, within the first set of actions, it is worth mentioning the change in the structure of the electricity sector with the installation of combined cycle power stations and the smaller influence of coal in electricity generation at conventional power plants or the strong introduction of natural gas in final demand sectors. In addition, at coal-fired power stations, progress has been made in the introduction of secondary desulphurization techniques, as reflected by the decline in the emissions of this pollutant in the power generation sector. As a complement to this, with respect to the second set of measures, sulphur contents in certain oil-derived products have been progressively reduced, including automotive gasoline, gas-oil and residual oil, in compliance with ever more demanding regulations with respect to limitations on sulphur contents in fuel.

As shown in Figure 4.2.3.2, the energy sector is the predominant SO_X emitting source since, in spite of its decreased contribution to total emissions, a marked drop in absolute values but scarcely significant in relative terms (except for 2008, due to the significant decline in activities, as mentioned above, at coal-fired power stations), its emissions account for more than 97% of total annual SO_X emissions throughout the period (ranging between 97% and 99.1%).

Figure 4.2.3.2.- Percentage of SO_X emissions by category with respect to the inventory total

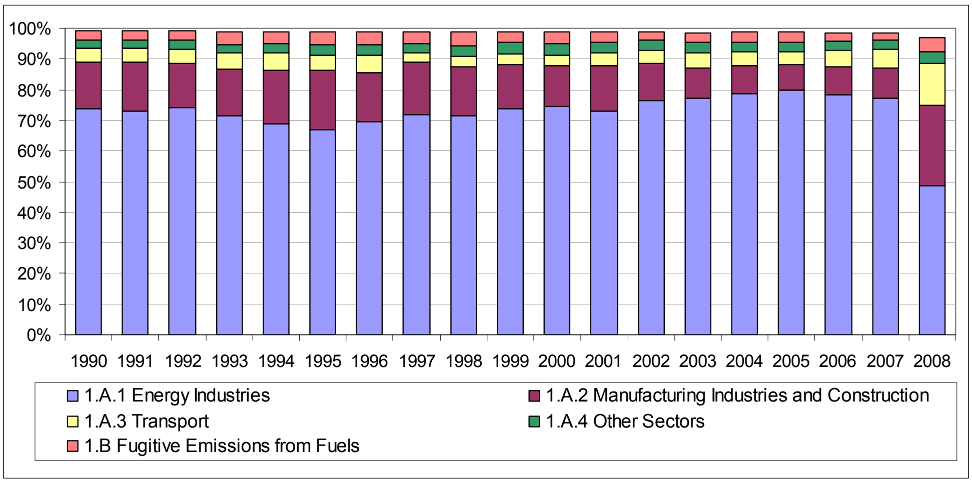
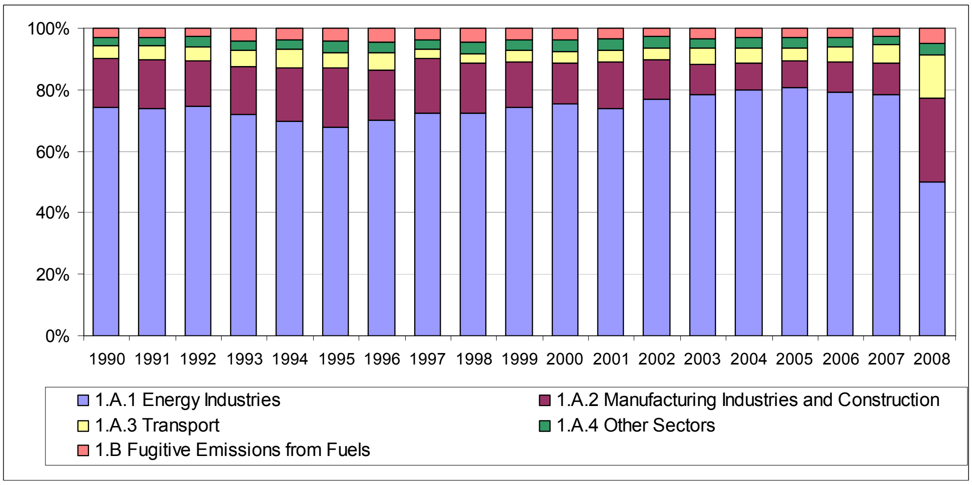


Figure 4.2.3.3 identifies energy industries as the main source contributing to SO_x emissions in the energy sector. However, a distinction must be drawn between the contributions of each category in the period 1990-2007 and those corresponding to 2008. Thus, in the years 1990-2007, the contribution of the energy industries represent between 68% and 81% of the total in the energy sector, followed by Manufacturing and construction industries, where the relative importance shows a decrease in 2007 (10.0%) with respect to 1990 (15.6%) and, at a more secondary level, the Transport categories (6.2% in 2007), Others sectors (2.9% in 2007) and Fugitive emissions (2.5% in 2007), with minor variations in their participation in the course of the period 1990-2007. On the other hand, the marked drop in 2008 in the emissions of Energy industries, the contribution of which feel to 50.0%, notably increases the contributions of the remaining categories in the energy sector: the Manufacturing and construction industries represent 27.2% of the sector total, Transport 14.0%, Fugitive emissions 4.8% and combustion in Other sectors 4.0%.

Figure 4.2.3.3.- Percentage of SO_X emissions by category with respect to the sector total



The following SO_X key sources in this sector were identified for the period 1990-2008:

- Public electricity and heat production (1A1a) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2008.

- Oil refineries (1A1b) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2008.

- Transformation of solid fuels and other energy industries (1A1c) by its emission level in the years 1999-2008 and by its trend in the years 1991,1992 and 1995-2008.

- Iron and steel industry (1A2a) by its emission level in the years 1991-1998, 2001 and 2008, and by its trend in the years 1991,1992, 1997 and 1999-2008.

- Non-ferrous metals (1A2b) by its emission level in the years 1990 and 1997-2008, and by its trend in the years 1991-1999, 2004 and 2008.

- Chemical industry (1A2c) by its emission level in the years 1990-2002 and 2008, and by its trend in the years 1991,1992, 1994, 1995, 1997 and 1999-2007.

- Pulp, paper and print (1A2d) by its emission level in the years 1990-1997, 1999-2002 and 2008, and by its trend in the years 1991-1993 and 1996-2008.

- Food processing, beverages and tobacco (1A2e) by its emission level in the years 1990-2002 and 2008, and by its trend in the years 1993-2007.

- Other manufacturing and construction industries (1A2f) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2008.

- Road transport (1A3b) by its emission level in the years 1990-1999 and 2003-2004, and by its trend in the years 1991-2008.

- Other modes of transport (1A3c+1A3d+1A3e) by its emission level throughout the 1990-2008, period and by its trend in the years 1993-1996 and 1999-2008.

- Commercial / Institutional / Residential Sectors (1A4a+1A4b) by its emission level throughout the period 1990-2008 and by its trend in the years 1991,1992 and 1994-2005.

- Agriculture / Forestry / Fishing - Stationary combustion and mobile machinery (1A4ci+1A4cii) by its emission level in the years 2003 and 2006-2008.

- Fugitive emissions in oil refining and storage (1B2aiv) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2001, 2003, 2006 and 2008.

- Venting and flaring (1B2c) by its emission level in the years 1994-1996, 1998, 2000 and 2003-2005, and by its trend in the years 1991-1994, 1996, 1998, 2000, 2002, 2006 and 2007.

Table 4.2.3.2 summarizes the contribution of emissions for the key SO_X categories in this sector at level and trend, the ranking of categories in the key sources catalogue[4], and absolute values, all referred to 2008.

Table 4.2.3.2.- SO_X key sources: Level and Trend contribution

Activity		SO_X (Gg) (2008)	Level Assessment (2008)			Trend Contribution (2008)		
Code	Description		%	Key Source	Rank	%	Key Source	Rank
1A1a	Public electricity and heat production	187.9	35.4	YES	1	44.9	YES	1
1A1b	Oil refineries	47.3	8.9	YES	4	3.9	YES	6
1A1c	Transformation of solid fuels and other energy industries	21.9	4.1	YES	6	5.2	YES	5
1A2a	Iron and steel	28.2	5.3	YES	5	5.4	YES	4
1A2b	Non-ferrous metals	17.1	3.2	YES	8	2.3	YES	9
1A2c	Chemical industry	21.0	4.0	YES	9	1.5	NO	13
1A2d	Pulp, paper and print	6.2	1.2	YES	12	0.9	YES	12
1A2e	Food processing, beverages & tobacco	6.2	1.2	YES	11	0.8	NO	14
1A2f	Other manufacturing industries and construction	66.4	12.5	YES	3	8.9	YES	3
1A3b	Road transport	2.3	0.4	NO	18	2.9	YES	7
1A3c+ 1A3d+ 1A3e	Other Transport	68.9	13.0	YES	2	16.0	YES	2
1A4a+ 1A4b	Commercial / Institutional / Residential	13.8	2.6	YES	10	1.1	YES	11
1A4ci+ 1A4cii	Agriculture / Forestry / Fishing Stationary + Off-road vehicles and other machinery	5.9	1.1	YES	13	0.7	NO	17
1B2aiv	Refining / Storage	20.4	3.9	YES	7	2.8	YES	8
1B2c	Venting and flaring	4.3	0.8	NO	16	0.4	NO	18

4.2.4.- NH_3

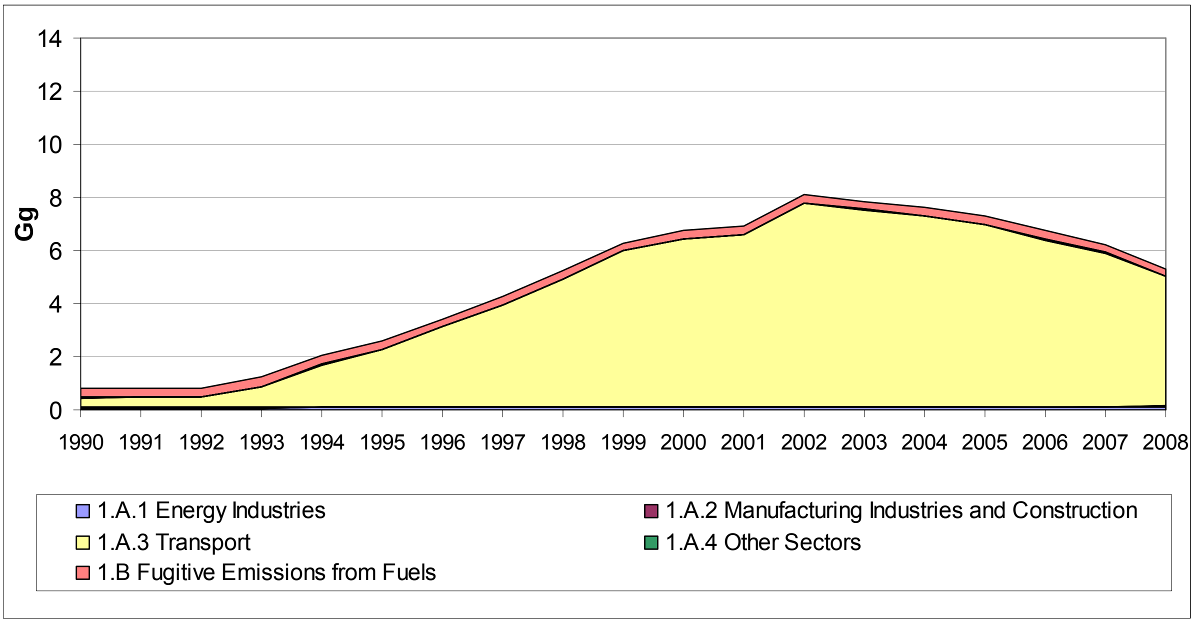
NH_3 emissions to the energy sector, the pattern for which is shown by category in Table 4.2.4.1 and Figure 4.2.4.1, increased by 647.2% in 2008 with respect to 1990, going from 0.8 Gg in 1990 to 5.3 Gg in 2008.

Table 4.2.4.1.- NH_3 emissions *(Amounts in Gg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
1A1 Energy Industries	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
1A2 Manufacturing Industries and Construction	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1A3 Transport	0.4	2.2	6.3	7.2	6.9	6.3	5.8	4.9
1A4 Other Sectors	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
1A5 Others								
1B Fugitive Emissions from Fuels	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total Energy	**0.8**	**2.6**	**6.8**	**7.6**	**7.3**	**6.7**	**6.2**	**5.3**

[4] Ranking determined by the contribution of the category's emissions to the level or trend.

Figure 4.2.4.1.- Evolution of NH_3 emissions by category



As shown in the table and figure above, emissions of this pollutant in the sector have substantially increased since 1990, although three different intervals may be observed: one corresponding to the years 1990 to 1992 with very moderate increases; the period running to 2002 with a more marked positive slope, followed by a period of sustained decline until achieving a level in 2008 close to that estimated for 1998. The evolution in the sector is clearly determined by the behaviour of Transport emissions (1A3) and, more specifically, those generated by road traffic, where technical advances starting in 1992 in petrol-driven vehicles increased emission standards for this pollutant. Thus, in compliance with legislation to control conventional pollutants emitted by vehicle exhausts (CO, VOC, NO_X), the new petrol-driven vehicle fleets (EURO technologies) are equipped with three-way catalysts that are also capable of operating under greater oxidation conditions than standard catalytic converters and generating reduced nitrogen compounds such as NH_3 (as well as N_2O). The effect of petrol-driven vehicles with EURO technologies is mitigated and, from 2002 on, counteracted, however, by the growing importance regarding the total distances covered by diesel cars, with a lower emission standard for this pollutant and the gradual reduction in the sulphur content of petrol in accordance with the legislatve regulations regarding fuel specifications, an action favouring the abatement efficiency of catalysts.

As shown in Figure 4.2.4.2, the large increase in absolute terms is reflected in the relative contribution to the total inventory, raising the energy sector share in 2008 by 647.2% with respect to 1990. In spite of this improved contribution, the energy sector exhibits a limited relative significance in the inventory as a whole (ranging between 0.3% in 1990 2002 and 2.1% in 2002).

Figure 4.2.4.2.- Percentage of NH_3 emissions by category with respect to the inventory total

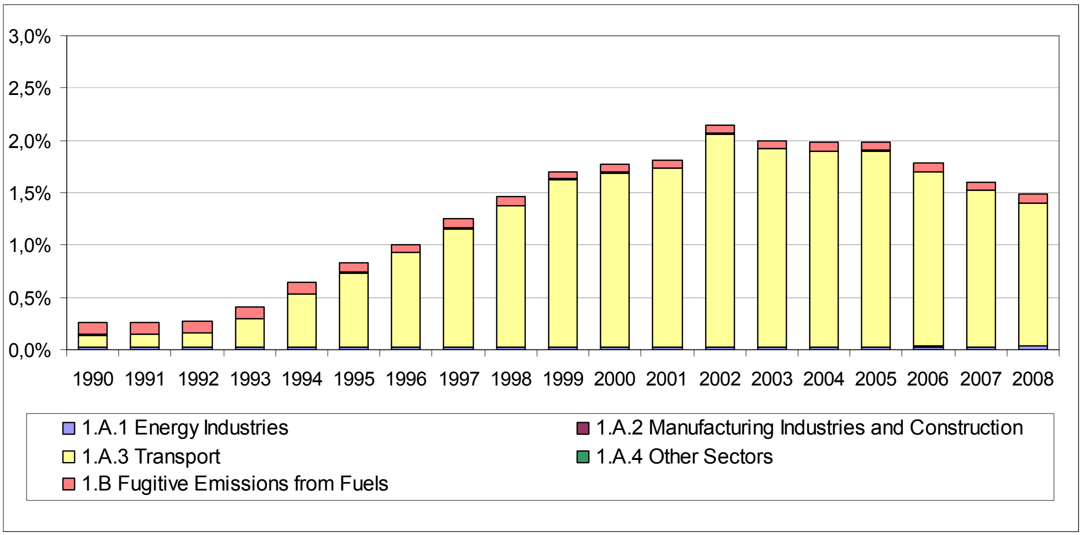
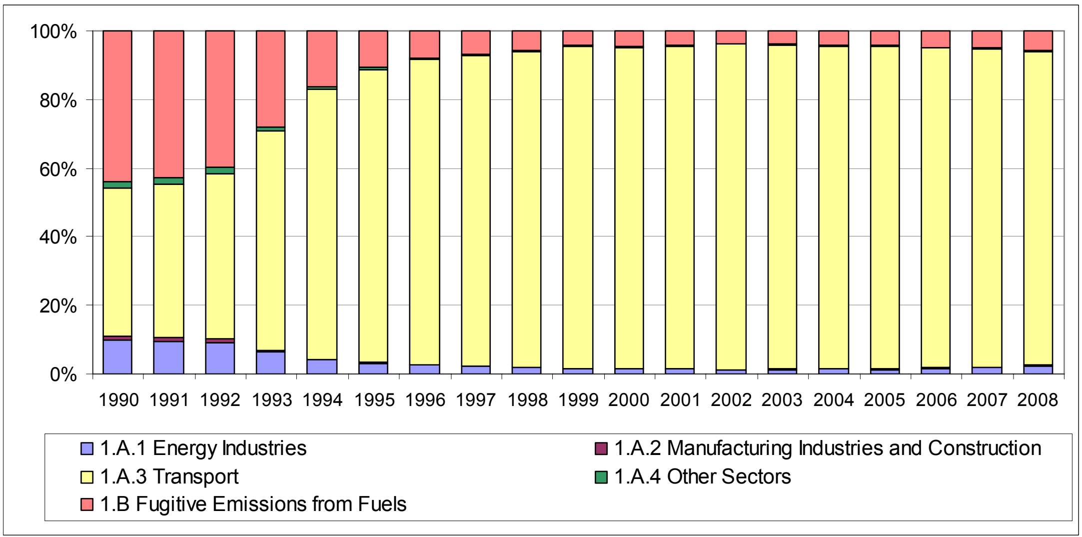


Figure 4.2.4.3 ranks the activities in order of importance with respect to NH_3 emissions within the sector: Transport activities, which increased their share from 43.5% in 1990 to 91.5% in 2008 (with a peak value of 94.9% in 2002), followed by Fugitive emissions, whose significance in the sector decreases by 43.9% in 1990 down to 5.6% in 2008, followed, at a lower level, by the Energy industries (2.4%), Other sectors (0.3%) and Manufacturing and construction industries (0.2%) categories, whose relative contributions begin to drop from 1990 on, as all of them show much more moderate increases in absolute values than that seen in transport activities.

Figure 4.2.4.3.- Percentage of NH_3 emissions by category with respect to the sector total



As for NH_3, the energy sector as a whole is a key source based on its level in 2004 and its trend in 1994-2008. Table 4.2.4.2 shows the contribution of emissions by level and trend, the ranking of the category in the key sources catalogue[5] and absolute values, all referred to 2008.

Table 4.2.4.2.- NH_3 key sources: Level and Trend contribution

Activity		NH_3 (Gg) (2008)	Level Assessment (2008)			Trend Contribution (2008)		
Code	Description		%	Key Source	Rank	%	Key Source	Rank
1	Energy	5.3	1.5	NO	5	8.6	YES	5

4.2.5.- CO

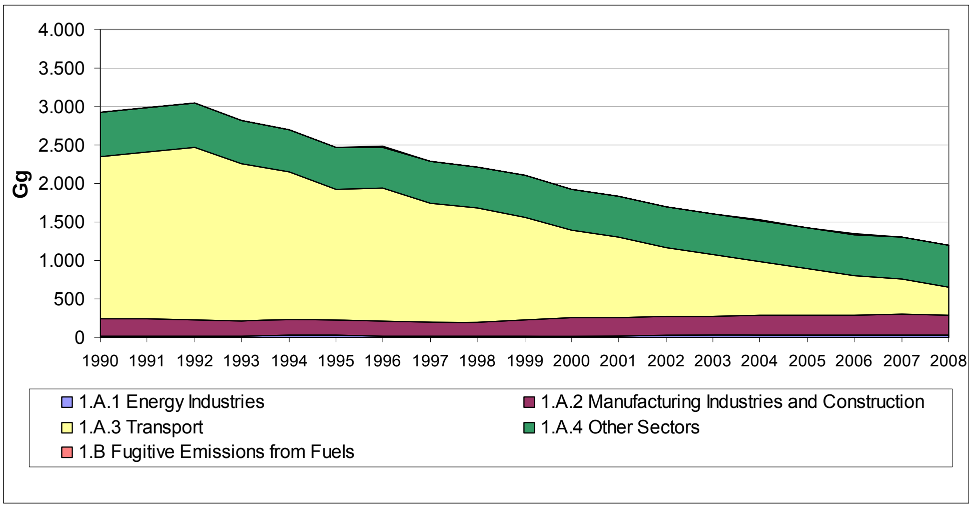
CO emissions in the energy sector, the pattern for which is shown by category in Table 4.2.5.1 and Figure 4.2.5.1, decreased by 59.2% in 2008 with respect to 1990, going from 2,926.0 Gg in 1990 to 1,194.1 Gg in 2008.

Table 4.2.5.1.- CO emissions *(Amounts in Gg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
1A1 Energy Industries	18.5	25.9	21.8	26.7	29.5	27.2	27.7	24.3
1A2 Manufacturing Industries and Construction	225.5	205.1	229.9	262.6	261.1	266.6	282.4	265.1
1A3 Transport	2,109.0	1,691.3	1,140.6	697.9	601.8	509.6	450.2	365.1
1A4 Other Sectors	569.5	540.5	526.8	534.1	535.6	536.2	535.9	536.6
1A5 Others	-	-	-	-	-	-	-	-
1B Fugitive Emissions from Fuels	3.5	2.8	3.1	3.3	3.2	3.2	3.1	3.1
Total Energy	**2,926.0**	**2,465.6**	**1,922.2**	**1,524.7**	**1,431.2**	**1,342.9**	**1,299.4**	**1,194.1**

[5] Ranking determined by the contribution of the category's emissions to the level or trend.

Figure 4.2.5.1.- Evolution of CO emissions by category



As shown in the table and figure above, the evolution, with a marked downward pattern starting in 1992, is determined by the reduction in Transport emissions levels (category 1A3). This decrease in traffic-related emissions is influenced by limitations imposed on the levels of conventional pollutants emitted by exhausts in vehicles registered after 1992; thus, the new vehicle fleets have been equipped with engine technologies and more effective abatement techniques designed to reduce CO (EURO technologies). Furthermore, the structure of vehicle fleets by fuel type reveals a decrease in the contribution of petrol-driven vehicles to the total fleet (and attributed travel distances) in favour of diesel vehicles, whose standard emission values are lower than those of petrol-driven vehicles.

As shown in Figure 4.2.5.2, the energy sector is one of the main emitting sources for this gas throughout the period since, in spite of its decreased contribution both in absolute values and percentages, it accounts for 59.8% of total CO emissions in 2008 (ranging between 59.8% and 81.4%).

Figure 4.2.5.2.- Percentage of CO emissions by category with respect to the inventory total

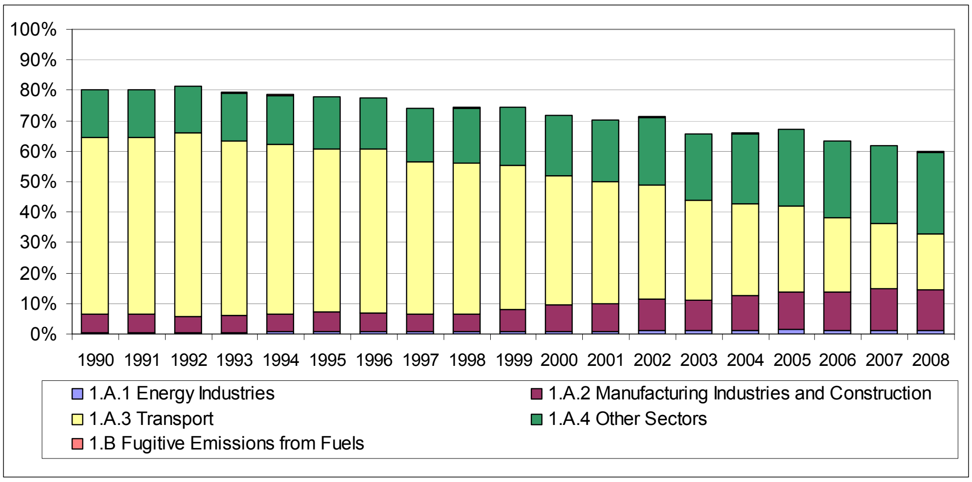
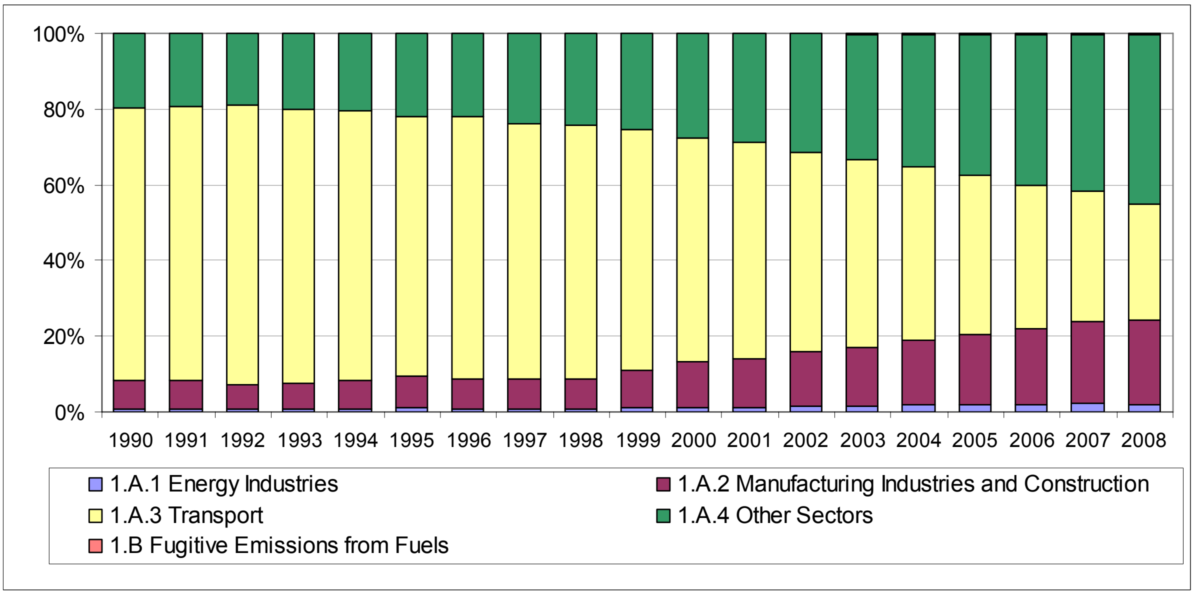


Figure 4.2.5.3 shows how the above-mentioned reduction in absolute values for Transport activities implies a considerable decline in contribution to CO emissions in the sector, going from 72.1% in 1990 to 30.6% in 2008; on the other hand, the remaining categories, with more moderate variations in terms of emissions, increase their share within the sector up to 44.9% (Other sectors) and 22.2% in the case of Manufacturing and construction industries or the more marginal 2.0% from Energy industries and 0.3% from Fugitive emissions.

Figure 4.2.5.3.- Percentage of CO emissions by category with respect to the sector total



As for the key sources of CO in this sector, the following have been identified for the period 1990-2008:

- Energy industries (1A1) by its trend in the years 1994 and 1995.
- Iron and steel industry (1A2a) by its emission level for the whole period 1990-2008, and by its trend in the years 1992-1994, 1996-1998 and 2000-2008.
- Other manufacturing and construction industries (1A2f) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-1994 and 1999-2008.
- Manufacturing and construction industries not specified above (1A2b + 1A2c + 1A2d + 1A2e) by its emission level in the period 2000-2008 and by its trend in the years 1993, 1995 y 1997-2008.
- Road transport – Passenger cars (1A3bi) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2008.
- Road transport - Light duty vehicles (1A3bii) by its emission level in the years 1994 and 1995.

- Road transport – Heavy duty vehicles (1A3biii) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2007.

- Road transport – mopeds and motorcycles (1A3biv) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2003.

- Commercial / Institutional / Residential Sectors (1A4a+1A4b) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2008.

- Agriculture / Forestry / Fishing - Stationary combustion and mobile machinery (1A4ci+1A4cii) by its emission level in the years 1998, 1999 and 2005-2008, and by its trend in the years 1991-1993 and 2008.

As a summary of the foregoing, Table 4.2.5.2 below reflects, for the key categories for CO in this sector, the emissions' contribution to the level and trend, the ranking of the category in the key sources catalogue[6], as well as the absolute values, all referring to 2008.

Table 4.2.5.2.- CO key sources: Level and Trend contribution

Activity		CO (Gg) (2008)	Level Assessment (2008)			Trend Contribution (2008)		
Code	Description		%	Key Source	Rank	%	Key Source	Rank
1A1	Energy industries	24.3	1.2	NO	11	0.9	NO	9
1A2a	Iron and steel	93.5	4.7	YES	6	2.5	YES	6
1A2f	Other manufacturing industries and construction	125.1	6.3	YES	5	4.3	YES	5
1A2b+ 1A2c+ 1A2d+ 1A2e	Manufacturing industries and construction – Others	46.4	2.3	YES	8	1.9	YES	7
1A3bi	Road transport – Passenger cars	219.0	11.0	YES	4	48.3	YES	1
1A3bii	Road transport – Light duty vehicles	17.9	0.9	NO	12	0.4	NO	14
1A3biii	Road transport –Heavy duty vehicles	41.9	2.1	YES	10	0.8	NO	11
1A3biv	Road transport – Mopeds and motorcycles	75.0	3.8	YES	7	0.9	NO	10
1A4a+ 1A4b	Commercial / Institutional / Residential	489.8	24.5	YES	1	12.5	YES	3
1A4ci+ 1A4cii	Agriculture / Forestry / Fishing– Stationary + Off-road vehicles and other machinery	46.0	2.3	YES	9	1.3	YES	8

4.2.6.- $PM_{2.5}$

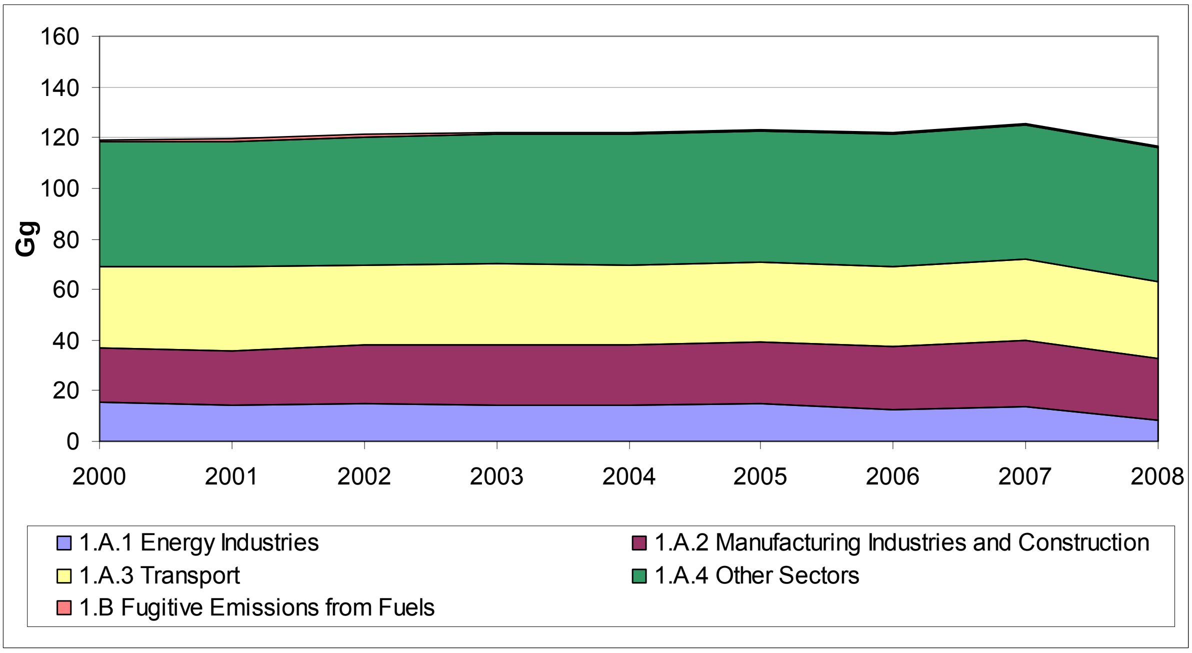
$PM_{2.5}$ emissions in the energy sector, the pattern for which is shown by category in Table 4.2.6.1 and Figure 4.2.6.1, decreased by 2.0% in 2008 with respect to 2000, going from 119.1 Gg in 2000 to 116.7 Gg in 2008.

[6] Ranking determined by the contribution of the category's emissions to the level or trend.

***Table 4.2.6.1.- $PM_{2.5}$ emissions** (Amounts in Gg)*

Category	2000	2004	2005	2006	2007	2008
1A1 Energy Industries	15.4	14.0	14.9	12.7	13.8	8.2
1A2 Manufacturing Industries and Construction	21.2	24.1	24.3	24.9	26.1	24.7
1A3 Transport	32.5	31.8	31.6	31.3	32.2	29.8
1A4 Other Sectors	49.1	51.4	51.7	52.2	52.6	53.2
1A5 Others	-	-	-	-	-	-
1B Fugitive Emissions from Fuels	0.9	0.9	0.8	0.9	0.8	0.8
Total Energy	**119.1**	**122.2**	**123.3**	**122.0**	**125.5**	**116.7**

Figure 4.2.6.1.- Evolution of $PM_{2.5}$ emissions by category



As shown in the table and figure above, at the aggregate level the profile appears to be relatively stable, although a moderate growth is observed in global terms until 2007, followed by a decline in 2008, a result of the drop in activity at coal-fired power stations. In the analysis by categories, it is possible to distinguish between a decrease in the energy industries and other more limited variations, albeit changing sign from one sector to another, in the remaining categories. This has occurred in a context where the fuel mix is significantly altered, with considerable increases in natural gas consumption, stabilization of coal (except for a notable drop in 2008) and decrease in certain oil-derived products (such as residual oil). On the other hand, it is worth mentioning the introduction of abatement techniques in certain industries (such as the cement industry), which has partially countered the effect of increased activity levels in these categories.

As shown in Figure 4.2.6.2, the energy sector is a predominant emitting source for this pollutant throughout the period, its share remaining, with a very narrow variation range, at approximately 94% of $PM_{2.5}$ emissions in the inventory.

Figure 4.2.6.2.- Percentage of $PM_{2.5}$ emissions by category with respect to the inventory total

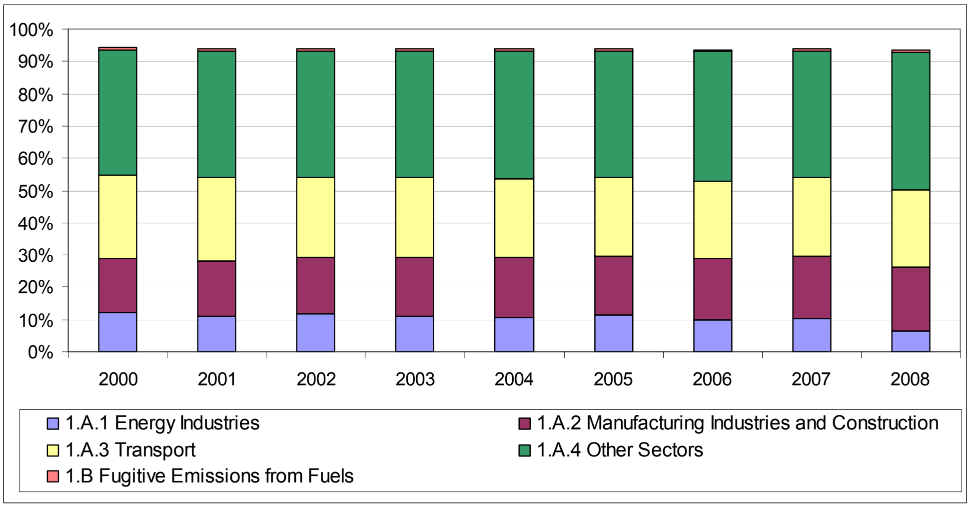
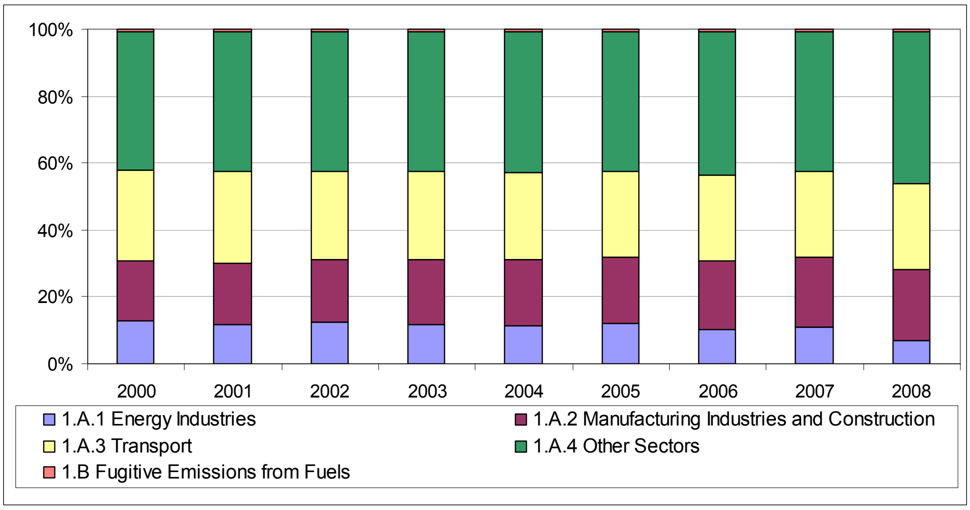


Figure 4.2.6.3 shows the distribution of $PM_{2.5}$ emissions by sector categories, with marked stability throughout the inventory period. In order of relative importance, category 1A4 (Other sectors) stands as the main emitting source in the sector with 45.6% in 2008, followed by Transport (25.6%), Manufacturing and construction industries (21.1%), Energy industries (7.1%) and, on a lesser scale, Fugitive emissions (0.7%).

Figure 4.2.6.3.- Percentage of $PM_{2,5}$ emissions by category with respect to the sector total



The following $PM_{2.5}$ key sources in this sector were identified for the period 1990-2008:

- Energy industries (1A1) by its emission level throughout the period 1990-2008 and by its trend in the years 2001-2008.
- Manufacturing industries and construction (1A2) by its emission level in all the period 2000-2008 and by its trend in the years 2001-2008.

- Transport (1A3) by its emission level throughout the period 2000-2008 and by its trend in the years 2001-2008.

- Other sectors (1A4) by its emission level throughout the period 2000-2008 and by its trend in the years 2001-2008.

- Fugitive emissions from fuels (1B) by its trend in 2002.

In short, Table 4.2.6.2 summarizes the contribution of emissions for the key $PM_{2.5}$ categories in this sector at level and trend, the ranking of categories in the key sources catalogue[7], in absolute values all referring to 2008.

Table 4.2.6.2.- $PM_{2.5}$ key sources: Level and Trend contribution

Activity		$PM_{2.5}$ (Gg) (2008)	Level Assessment (2008)			Trend Contribution (2008)		
Code	Description		%	Key Source	Rank	%	Key Source	Rank
1A1	Energy industries	8.2	6.6	YES	4	36.8	YES	1
1A2	Manufacturing industries and construction	24.7	19.8	YES	3	20.0	YES	3
1A3	Transport	29.8	23.9	YES	2	11.7	YES	4
1A4	Other sectors	53.2	42.6	YES	1	25.4	YES	2
1B	Fugitive emissions from fuels	0.8	0.6	NO	7	0.6	NO	8

4.2.7.- PM_{10}

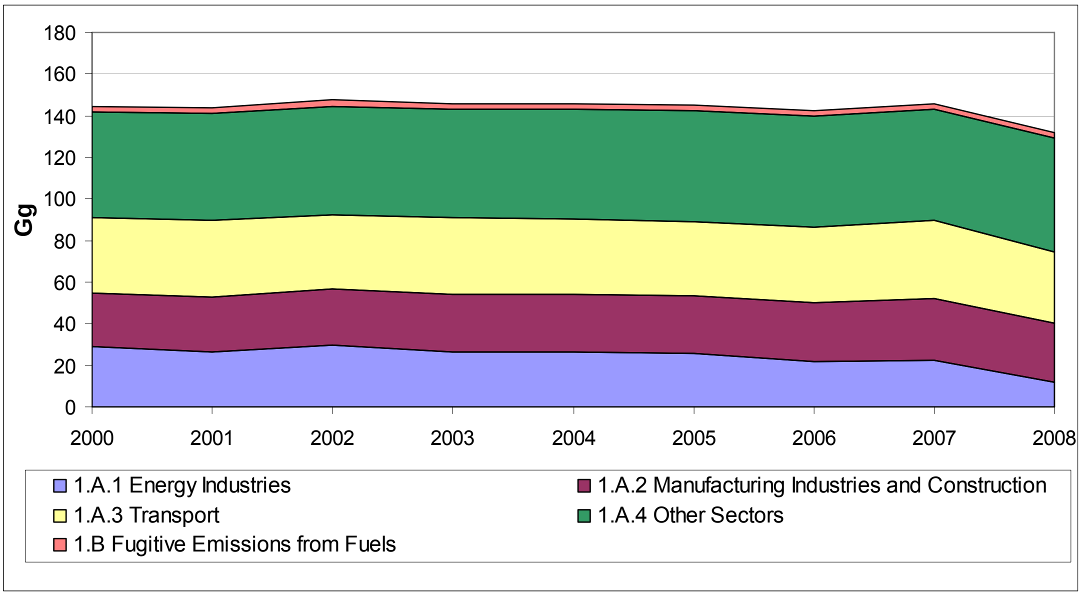
PM_{10} emissions in the energy sector, the pattern for which is shown by category in Table 4.2.7.1 and Figure 4.2.7.1, have decreased by 8.9% in 2008 with respect to 2000, going from 144.6 Gg in 2000 to 131.7 Gg in 2008.

Table 4.2.7.1.- PM_{10} emissions *(Amounts in Gg)*

Category	2000	2004	2005	2006	2007	2008
1A1 Energy Industries	29.1	26.1	25.6	21.9	22.6	11.8
1A2 Manufacturing Industries and Construction	25.4	27.9	27.6	28.4	29.8	28.5
1A3 Transport	36.4	36.2	36.1	36.0	37.0	34.4
1A4 Other Sectors	50.6	52.9	53.2	53.6	54.0	54.6
1A5 Others	-	-	-	-	-	-
1B Fugitive Emissions from Fuels	3.1	2.8	2.7	2.8	2.6	2.4
Total Energy	**144.6**	**145.8**	**145.1**	**142.7**	**146.0**	**131.7**

[7] Ranking determined by the contribution of the category's emissions to the level or trend.

Figure 4.2.7.1.- Evolution of PM_{10} emissions by category



As shown in the table and figure above, the evolution is very similar to that already described for $PM_{2.5}$, and in general the same source contribution and diagnosis for the differing variations among categories may be applied.

As shown in Figure 4.2.7.2, this sector is a predominant emitting source for this pollutant throughout the period, its share remaining within a very narrow variation range (between 82% and 85%) of the PM_{10} emissions in the inventory.

Figure 4.2.7.2.- Percentage of PM_{10} emissions by category with respect to the inventory total

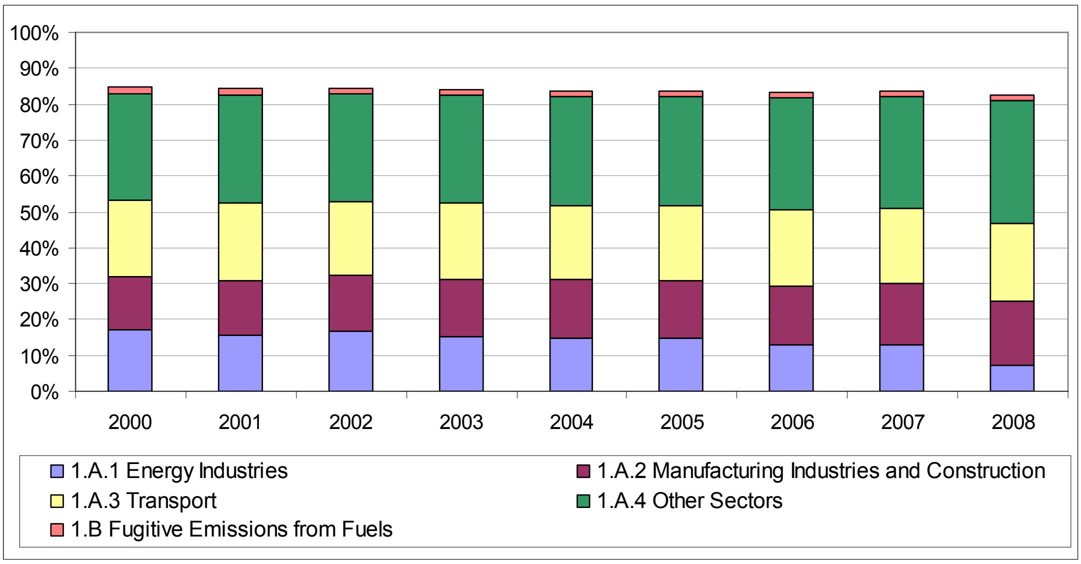
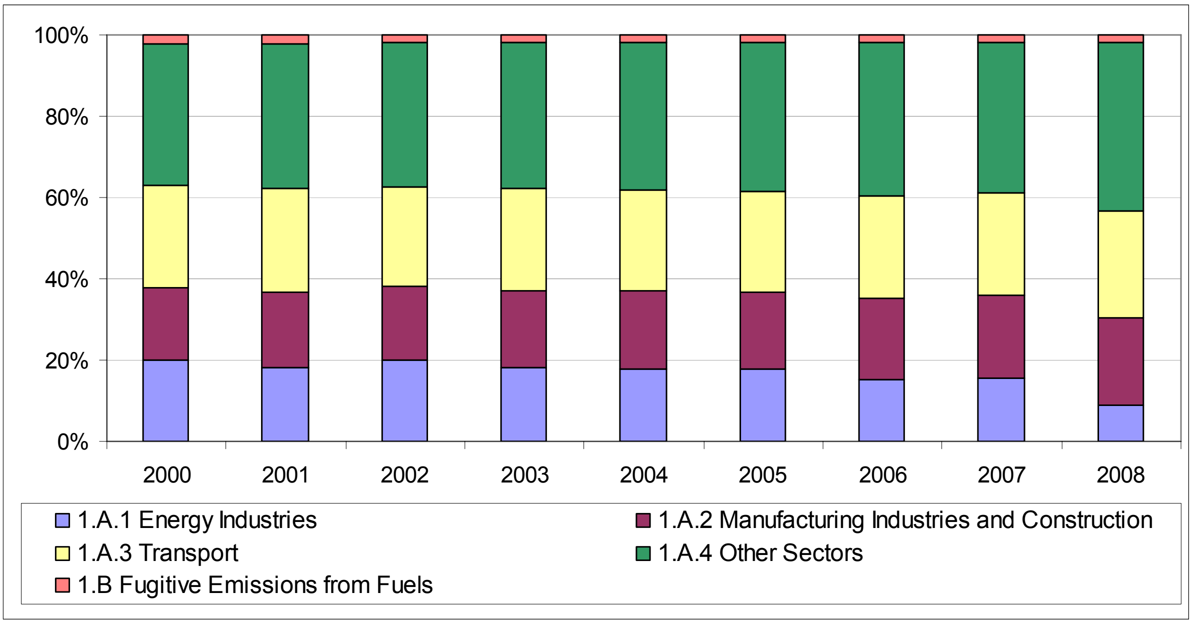


Figure 4.2.7.3 presents the distribution by categories of PM_{10} emissions in the sector, revealing great stability, until 2007, followed in 2008 by a reduction in the weighting of the Energy industries (consequence of the above-mentioned reduction in activity at coal-fired power stations). In order of relative importance, category 1A4 (Other sectors) stands as the main emitting source in the sector with 41.4% in 2008, followed by Transport (26.1%), Manufacturing and construction industries (21.6%), Energy industries (9.0%) and, on a lesser scale, Fugitive emissions (1.9%).

Figure 4.2.7.3.- Percentage of PM_{10} emissions by category with respect to the sector total



The PM_{10} key sources identified for the period 2000-2008 are as follows:

- Energy industries (1A1) by its emission level throughout the period 2000-2008 and by its trend in the years 2001-2008.

- Manufacturing and construction industries (1A2) by its emission level in all the period 2000-2008 and by its trend in the years 2001-2008.

- Transport (1A3) by its emission level throughout the period 2000-2008 and by its trend in the years 2001-2006.

- Other sectors (1A4) by its emission level throughout the period 2000-2008 and by its trend in the years 2001-2008.

- Fugitive emissions from fuels (1B) by its trend in the years 2002-2005 and 2007.

As a summary of the foregoing, Table 4.2.7.2 below shows, for this sector's key categories for PM_{10}, the contribution of emissions to the levels and trends, the ranking for this category in the key sources catalogue[8], as well as the absolute values, all referring to 2008.

Table 4.2.7.2.- PM_{10} key sources: Level and Trend contribution

Activity		PM_{10} (Gg) (2008)	Level Assessment (2008)			Trend Contribution (2008)		
Code	Description		%	Key Source	Rank	%	Key Source	Rank
1A1	Energy industries	11.8	7.4	YES	5	47.8	YES	1
1A2	Manufacturing industries and construction	28.5	17.8	YES	3	14.3	YES	3
1A3	Transport	34.4	21.5	YES	2	1.1	NO	7
1A4	Other sectors	54.6	34.2	YES	1	22.2	YES	2
1B	Fugitive emissions from fuels	2.4	1.5	NO	7	1.4	NO	6

4.2.8.- TSP

The TSP emissions in this sector shown in Table 4.2.8.1 are particularly relevant for the inventory as a whole, as they account for more than two thirds of total emissions for this pollutant. As can be seen, the sector as a whole has undergone a significant decrease in emissions during 2008, going from 173.6 Gg in 2000 to 152.7 Gg in 2008.

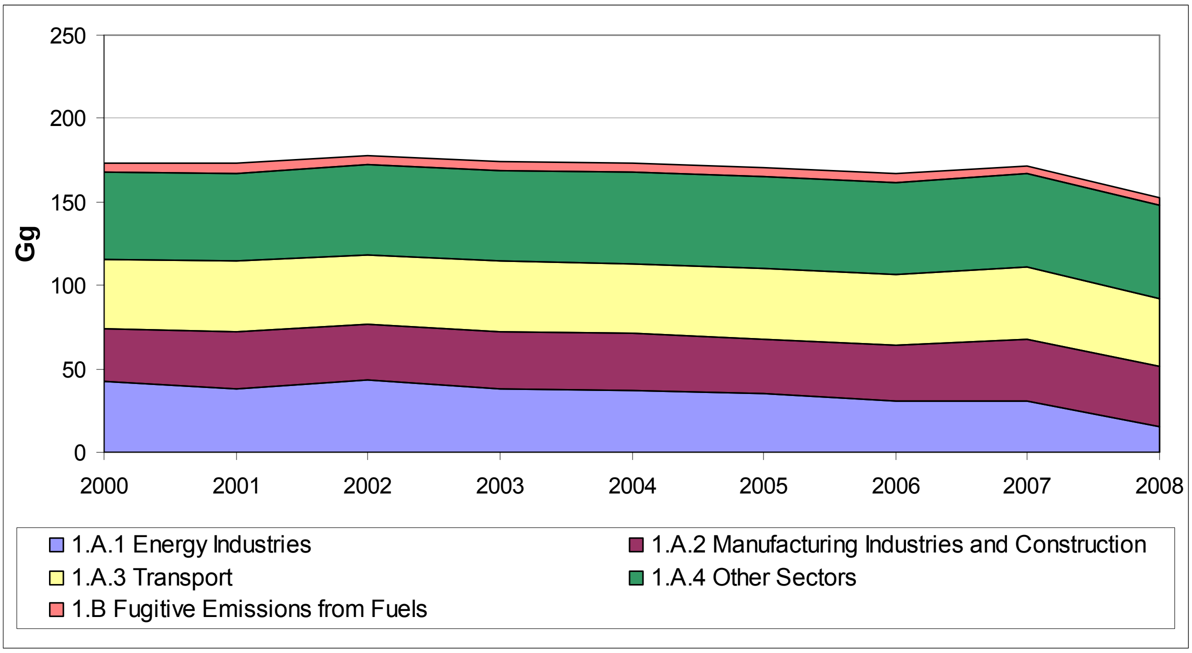
***Table 4.2.8.1.- TSP emissions** (Amounts in Gg)*

Category	2000	2004	2005	2006	2007	2008
1A1 Energy Industries	42.2	36.9	34.8	30.3	30.6	15.0
1A2 Manufacturing Industries and Construction	31.7	34.1	33.1	33.9	36.9	36.1
1A3 Transport	41.7	42.2	42.3	42.4	43.7	40.8
1A4 Other Sectors	52.3	54.7	55.0	55.3	55.7	56.3
1A5 Others	-	-	-	-	-	-
1B Fugitive Emissions from Fuels	5.8	5.3	5.0	5.4	4.9	4.6
Total Energy	**173.6**	**173.2**	**170.2**	**167.3**	**171.7**	**152.7**

Figure 4.2.8.1 shows the evolution of TSP emissions during the period inventoried. Observation of the diagram shows relative stability as the practically dominant pattern in the sector as a whole until 2007, and a significant drop in 2008, as a consequence of the fall in emission levels in the energy industries. This drop is the result, on the one hand, of a lower consumption of coal (particularly in 2008) and residual oil at thermal power stations where there has been a considerable increase in the use of natural gas at new combined cycle power plants; on the other hand, it is also due to the decrease in residual oil consumption at oil refineries, where the use of refinery gas and natural gas also increases. It is worth mentioning that, since public thermal power plants continually monitor their emissions of this pollutant, these emissions are considered to be highly reliable.

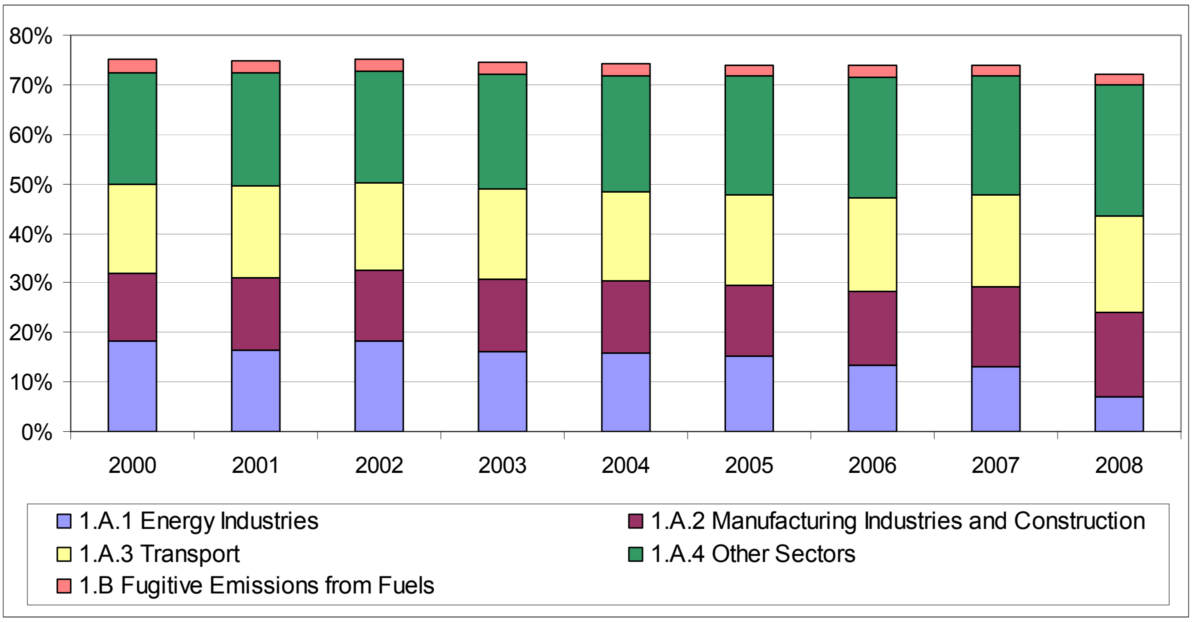
[8] Ranking determined by the contribution of the category's emissions to the level or trend.

Figure 4.2.8.1.- Evolution of TSP emissions by category



As shown in Figure 4.2.8.2, this sector accounts for over 70% of TSP emissions in the inventory, exhibiting great stability in its contribution throughout the period under study.

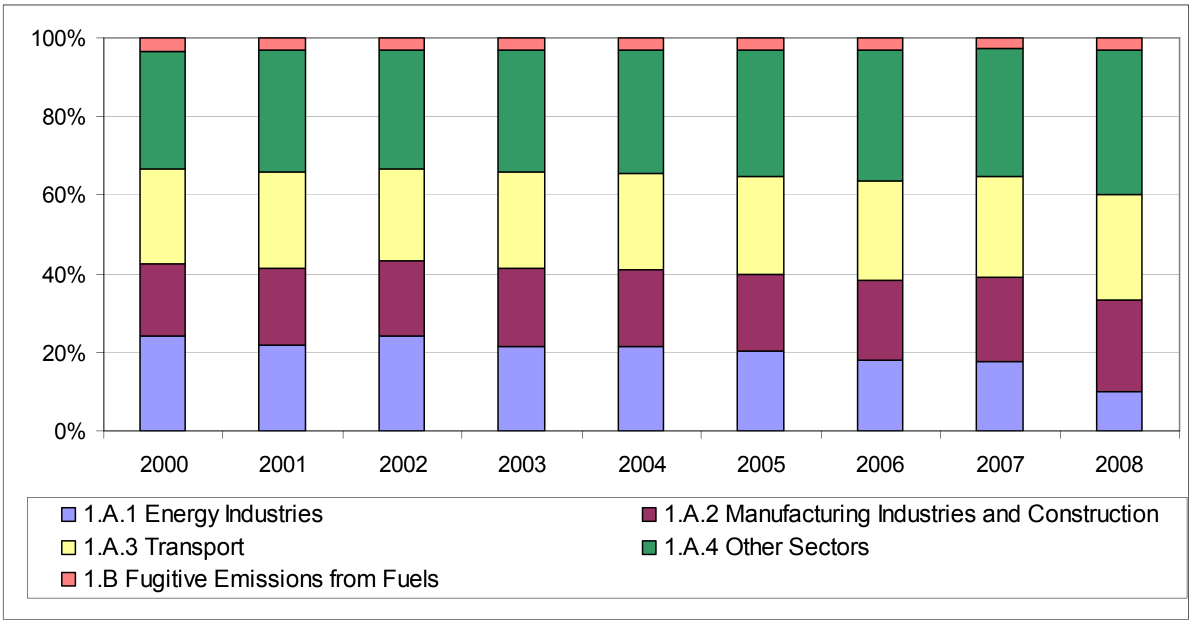
Figure 4.2.8.2.- Percentage of TSP emissions by category with respect to the inventory total



As shown in Figure 4.2.8.3, the distribution of emissions among the sector categories is considerably stable throughout the inventory period. In order of relative importance,

category 1A4 (Other sectors) stands as the main emitting source in the sector with 36.8% in 2008, followed by Transport (26.7%), Manufacturing and construction industries (23.6%), Energy industries (9.8%) and, on a lesser scale, Fugitive emissions (3.0%).

Figure 4.2.8.3.- Percentage of TSP emissions by category with respect to the sector total



The TSP key sources identified for the period 2000-2008 are as follows:

- Energy industries (1A1) by its emission level throughout the period 2000-2008 and by its trend in the years 2001 and 2003-2008.
- Manufacturing and construction industries (1A2) by its emission level in all the period 2000-2008 and by its trend in the years 2001-2008.
- Transport (1A3) by its emission level throughout the period 2000-2008 and by its trend in the years 2001, 2002 and 2005-2008.
- Other sectors (1A4) by its emission level throughout the period 2000-2008 and by its trend in the years 2001-2008.
- Fugitive emissions from fuels (1B) by its trend in the years 2002-2005.

As a summary of the foregoing, Table 4.2.7.2 below shows, for this sector's key categories for PM_{10}, the contribution of emissions to the level and trend, the ranking for this category in the key sources catalogue[9], as well as the absolute values, all referring to 2008.

[9] Ranking determined by the contribution of the category's emissions to the level or trend.

Table 4.2.7.2.- TSP key sources: Level and Trend contribution

Activity		TSP (Gg) (2008)	Level Assessment (2008)			Trend Contribution (2008)		
Code	Description		%	Key Source	Rank	%	Key Source	Rank
1A1	Energy industries	15.0	7.1	YES	6	46.5	YES	1
1A2	Manufacturing industries and construction	36.1	17.1	YES	3	14.1	YES	3
1A3	Transport	40.8	19.3	YES	2	5.2	YES	5
1A4	Other sectors	56.3	26.6	YES	1	16.7	YES	2
1B	Fugitive emissions from fuels	4.6	2.2	NO	8	1.4	NO	8

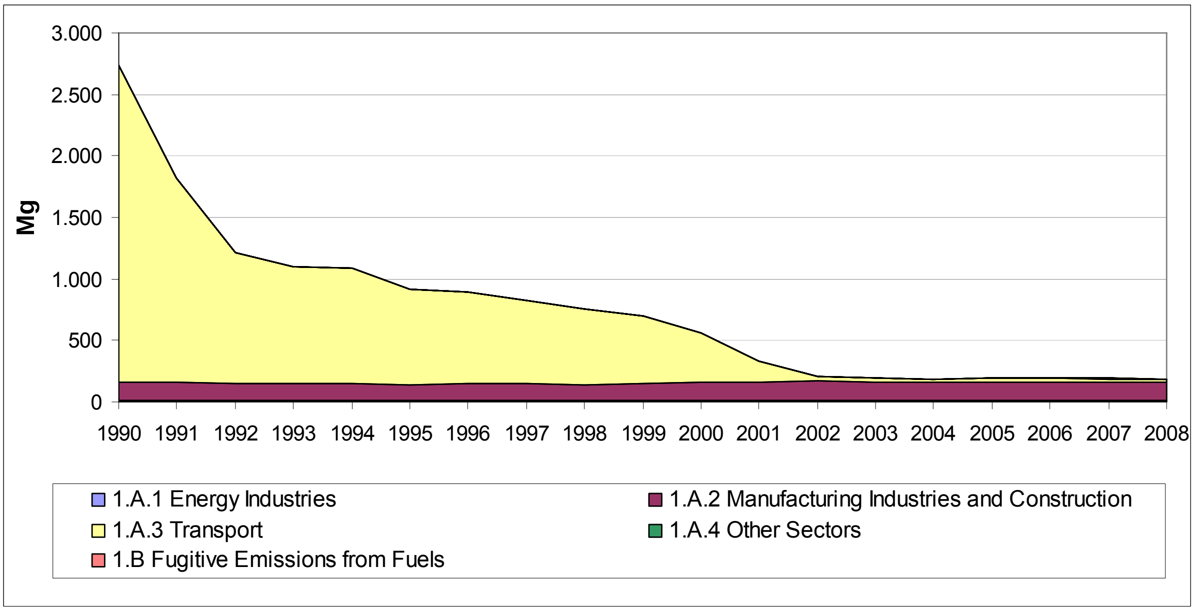
4.2.9.- Pb

Pb emissions in the energy sector, the pattern for which is illustrated by category in Table 4.2.9.1 and Figure 4.2.9.1, decreased by 93.2% in 2008 with respect to 1990, going from 2,735.5 megagrammes (Mg) in 1990 to 185.0 Mg in 2008.

Table 4.2.9.1.- Pb emissions*(Amounts in Mg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
1A1 Energy Industries	9.7	12.7	9.1	8.5	8.6	7.3	6.6	5.8
1A2 Manufacturing Industries and Construction	148.0	122.9	152.1	147.5	155.8	154.4	155.0	153.8
1A3 Transport	2,576.1	775.5	394.8	30.3	29.2	27.9	26.9	24.8
1A4 Other Sectors	1.6	1.8	0.8	0.8	0.8	0.6	0.6	0.6
1A5 Others	-	-	-	-	-	-	-	-
1B Fugitive Emissions from Fuels	-	-	-	-	-	-	-	-
Total Energy	**2,735.5**	**912.9**	**556.9**	**187.2**	**194.3**	**190.2**	**189.0**	**185.0**

Figure 4.2.9.1.- Evolution of Pb emissions by category

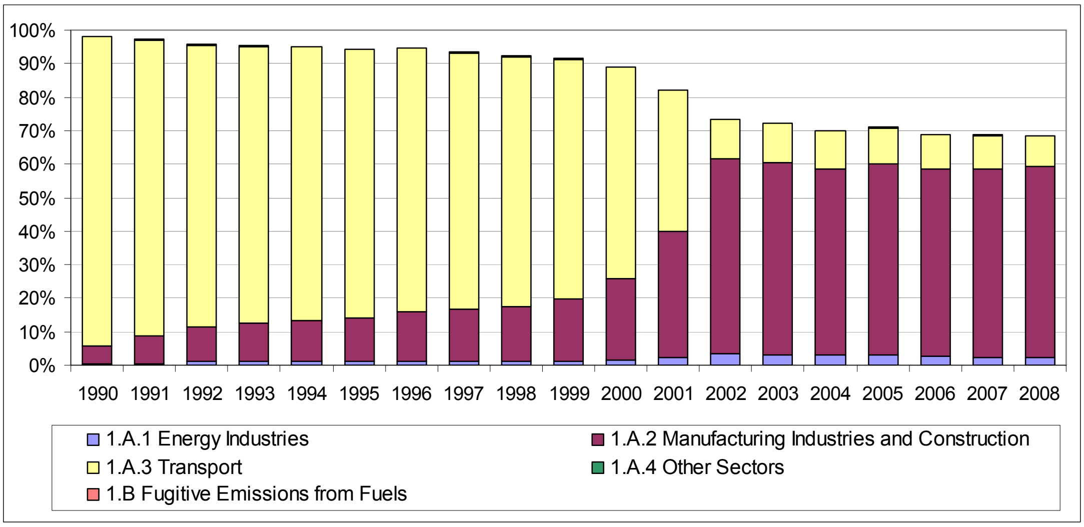


According to the table and figure above, the evolution of Pb emissions for this sector is clearly influenced by the emissions trend corresponding to the Transport category as a consequence of the progressive decrease and disappearance of leaded petrol consumption in road transport[10]. As for Manufacturing and construction industries, the other relevant category in the sector, the evolution of emissions exhibits greater stability, the iron and steel industry, non-ferrous metals and glass manufacturing being the main contributing activities to emissions of this pollutant.

Of all relevant categories in terms of emission levels, Transport is a key category when explaining the decreasing profile of the series. Thus, in terms of road traffic, whose lead emissions basically depend on the composition and amount of leaded petrol consumed, three circumstances have influenced this profile over time: i) the continued reduction in the maximum lead content allowed in petrol during the period 1990-1992; ii) starting in 1993, the new fleets of petrol-driven vehicles (EURO technologies) are equipped with three-way catalytic converters requiring the use of unleaded fuels; iii) from August 2001 onwards, the regulations in force prohibited the sales of leaded petrol; together with these measures, gradual changes have been introduced in the composition of vehicle fleets through the increase in the number of diesel vehicles, whereas since 1992, petrol-driven vehicles have been decreasing virtually continuously.

As shown in Figure 4.2.9.2, the energy sector is a significant emission source in the inventory during the whole period despite the decrease in its relative contribution. Thus, the relevance of this sector decreases, going from 98.1% of total emissions in 1990 to 68.6% in 2008, a direct consequence of the reduction in absolute emission levels in the sector and followed, at a lower level, by the growing evolution in the remaining categories taken together.

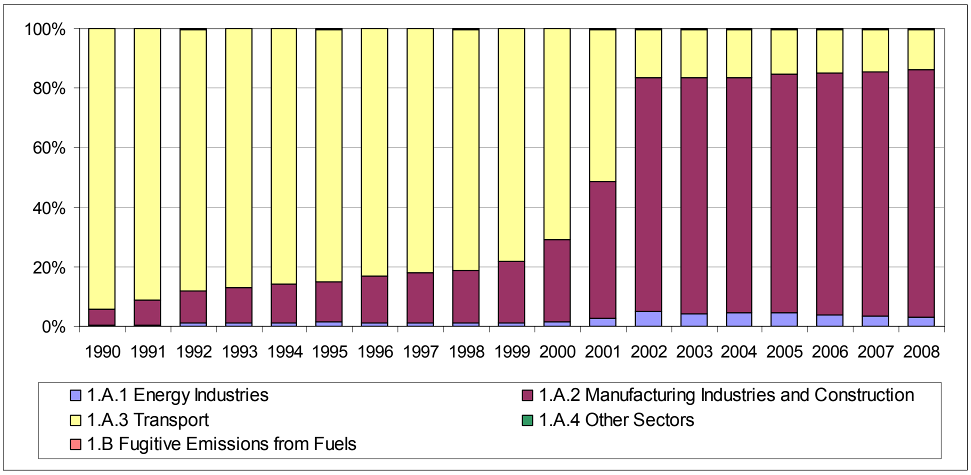
Figure 4.2.9.2.- Percentage of Pb emissions by category with respect to the inventory total



[10] It is worth noting that unleaded gasoline is not completely lead-free.

Figure 4.2.9.3 shows how the above-mentioned reduction in absolute levels for Transport activities has entailed a significant loss in terms of contribution to Pb emissions in the sector, going from 94.2% in 1990 to 13.4% in 2008; on the other hand, the remaining categories, with more moderate variations in terms of emissions, have increased their share within the sector up to 83.2% in the case of Manufacturing and construction industries and, to a lesser extent, 3.1% for Energy industries and 0.3% for Other sectors.

Figure 4.2.9.3.- Percentage of Pb emissions by category with respect to the sector total



The following Pb key sources in this sector were identified for the period 1990-2008:

- Energy industries (1A1) by its trend in the years 1991-1995.
- Manufacturing and construction industries (1A2) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2008.
- Transport (1A3) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2008.

In short, Table 4.2.9.2 below summarizes the contribution of emissions for the key Pb categories in this sector at level and trend, the ranking of categories in the key sources catalogue[11], and absolute values referred to 2008.

Table 4.2.9.2.- Pb key sources: Level and Trend contribution

Activity		Pb (Mg) (2008)	Level Assessment (2008)			Trend Contribution (2008)		
Code	Description		%	Key Source	Rank	%	Key Source	Rank
1A1	Energy industries	5.8	2.2	NO	4	1.1	NO	4
1A2	Manufacturing industries and construction	153.8	57.1	YES	1	31.1	YES	2
1A3	Transport	24.8	9.2	YES	3	50.0	YES	1

[11] Ranking determined by the contribution of the category's emissions to the level or trend.

4.2.10.- Cd

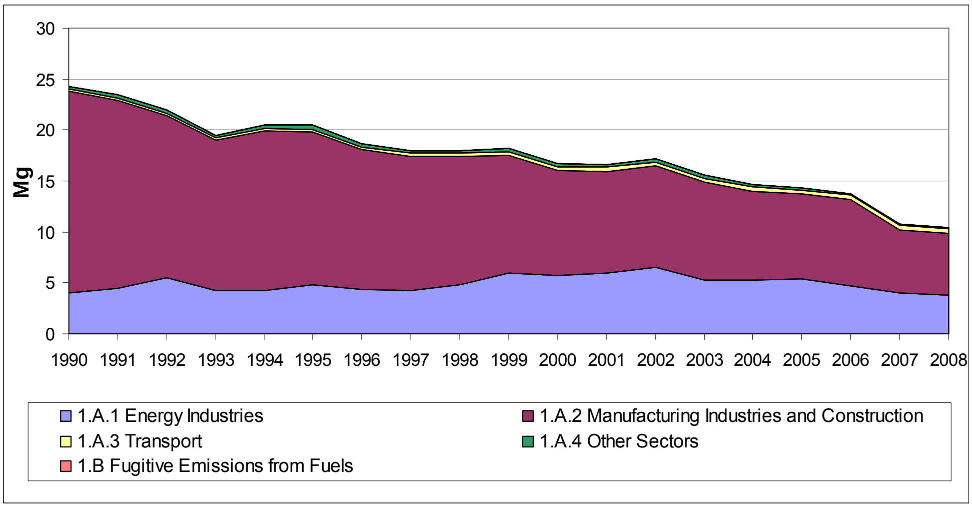
Cd emissions in this sector, shown in Table 4.2.10.1, are mainly generated by manufacturing industries, particularly cement manufacturing activity, and by energy industries (thermal power stations and oil refineries). As can be seen, they have decreased by 57% in 2008 with respect to 1990, going from 24.3 Mg in 1990 to 10.4 Mg in 2008.

Table 4.2.10.1.- Cd emissions *(Amounts in Mg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
1A1 Energy Industries	4.0	4.8	5.8	5.3	5.3	4.6	4.0	3.8
1A2 Manufacturing Industries and Construction	19.8	14.9	10.3	8.8	8.4	8.6	6.2	6.1
1A3 Transport	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.4
1A4 Other Sectors	0.2	0.4	0.3	0.2	0.2	0.1	0.1	0.1
1A5 Others	-	-	-	-	-	-	-	-
1B Fugitive Emissions from Fuels	-	-	-	-	-	-	-	-
Total Energy	**24.3**	**20.4**	**16.7**	**14.7**	**14.3**	**13.8**	**10.8**	**10.4**

Figure 4.2.10.1 illustrates the evolution of Cd emissions throughout the inventory period. The Figure shows the decrease in emissions generated by the cement industry as a consequence of the gradual implementation of emissions abatement technologies in the activity, strongly influencing both the sector's evolution and the total inventory, although during the period 1990-1993 the observed decreasing curve is slightly more pronounced as the consequence of a downward phase in the economic cycle which leads to lower cement production. Next, energy industries, mainly thermal power stations and oil refining plants due to residual oil and coal combustion[12], exhibit a more stable evolution over the years, since the increase in energy associated with fuel consumption in these activities mostly involved fuels with little or no impact on Cd emissions.

Figure 4.2.10.1.- Evolution of Cd emissions by category



[12] Coal-fired power plants are equipped with efficient particulate abatement techniques that have a direct impact on the reduction of heavy metal emissions.

As shown in Figure 4.2.10.2, the energy sector is a significant emission source within the inventory throughout the whole period in spite of the decline in its relative contribution. Thus, the relevance of this sector decreases from accounting for 90.7% of total emissions in 1990 down to 70.2% in 2008 as a direct consequence of the reduction in absolute emission levels for this sector and, to a lesser extent, of the growing evolution in the remaining categories, particularly industrial processes.

Figure 4.2.10.2.- Percentage of Cd emissions by category with respect to the inventory total

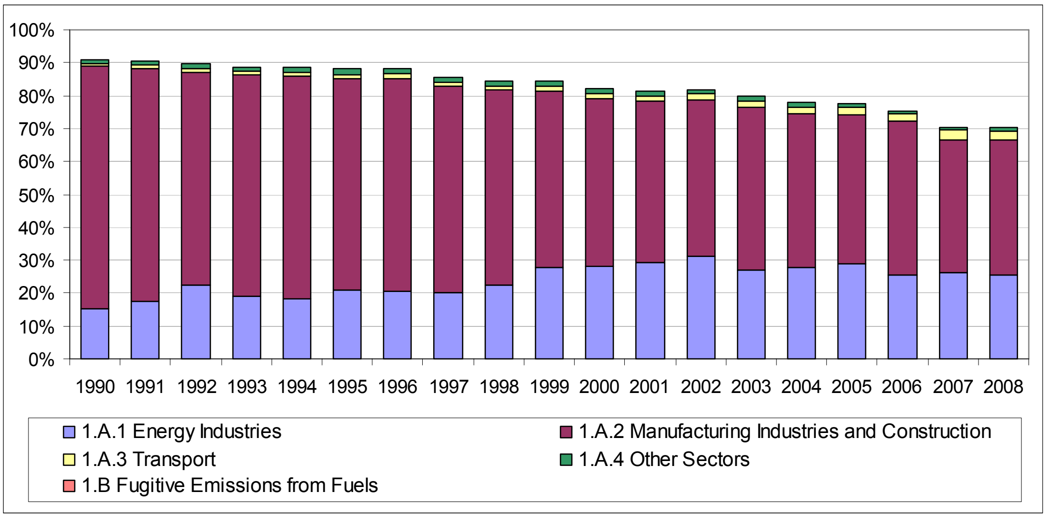
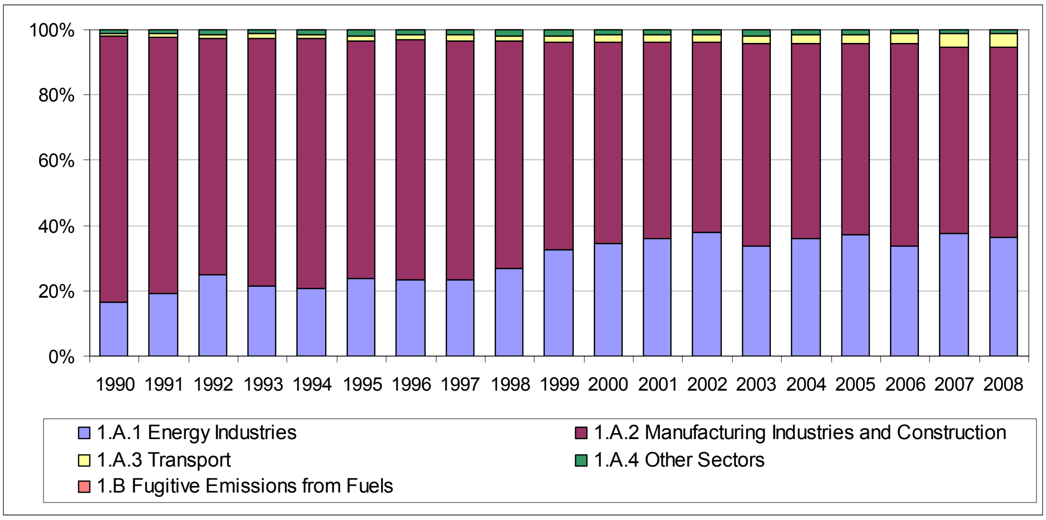


Figure 4.2.10.3 shows how the above-mentioned reduction in absolute levels for the Manufacturing and construction industries leads to a significant loss in terms of contribution to sector emissions, going from 81.5% in 1990 to 58.5% in 2008; on the other hand, the remaining categories, with increases in their emissions in 2008 with respect to 1990, expand their share for this pollutant within the sector up to 36.2% (Energy industries) and, to a lesser extent, 4.0% in the case of Transport and 1.3% for Other sectors.

Figure 4.2.10.3.- Percentage of Cd emissions by category with respect to the sector total



The following Cd key sources in this sector were identified for the period 1990-2008:

- Energy industries (1A1) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2008.

- Manufacturing and construction industries (1A2) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2008.

- Transport (1A3) for its trend in the years 1993, 1996 and 1998.

- Other sectors (1A4) by its trend in the years 1991, 1992, 1994, 1995 and 1997.

In short, Table 4.2.10.2 summarizes the contribution of emissions for the key Cd categories in this sector at level and trend, the ranking of categories in the key sources catalogue[13], and absolute values referred to 2008.

Table 4.2.10.2.- Cd key sources: Level and Trend contribution

Activity		Cd (Mg) (2008)	Level Assessment (2008)			Trend Contribution (2008)		
Code	Description		%	Key Source	Rank	%	Key Source	Rank
1A1	Energy industries	3.8	25.4	YES	3	15.5	YES	3
1A2	Manufacturing industries and construction	6.1	41.0	YES	1	49.4	YES	1
1A3	Transport	0.4	2.8	NO	4	3.0	NO	4
1A4	Other sectors	0.1	0.9	NO	5	0.04	NO	7

4.2.11.- Hg

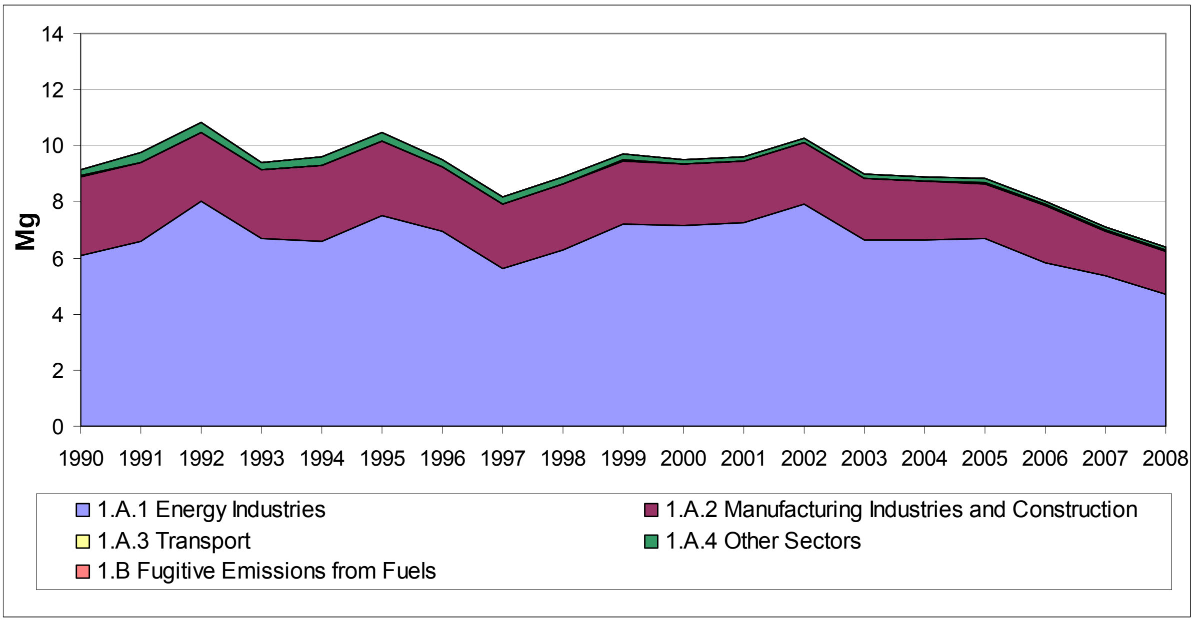
Hg emissions in the energy sector, the pattern for which is shown by category in Table 4.2.11.1 and Figure 4.2.11.1, decreased by 30.2% in 2008 with respect to 1990, going from 9.2 Mg in 1990 to 6.4 Mg in 2008.

Table 4.2.11.1.- Hg emissions *(Amounts in Mg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
1A1 Energy Industries	6.1	7.5	7.1	6.6	6.7	5.8	5.4	4.7
1A2 Manufacturing Industries and Construction	2.8	2.7	2.2	2.1	2.0	2.0	1.6	1.6
1A3 Transport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1A4 Other Sectors	0.2	0.3	0.2	0.2	0.1	0.1	0.1	0.1
1A5 Others								
1B Fugitive Emissions from Fuels								
Total Energy	**9.2**	**10.5**	**9.5**	**8.9**	**8.8**	**8.0**	**7.1**	**6.4**

[13] Ranking determined by the contribution of the category's emissions to the level or trend.

Figure 4.2.11.1.- Evolution of Hg emissions by category



Based on the table and figure above, Hg emissions in this sector mostly come from activities in the energy industries, basically those of thermal power stations and refining plants, as well as the Manufacturing and construction industries, particularly the cement industry, included in category 1A2f, and non-specific combustion (boilers, gas turbines or stationary engines) in several industries.

The irregular profile of the series in the energy sector is linked to the evolution of emissions in energy industries, subject in turn to annual variations in the use of potentially emitting fuels, residual oil or coal, associated with the activities falling under this category; more specifically, residual oil consumption at thermal power plants, with specific emissions exceeding those of coal[14], is the determining factor in the erratic behaviour of the series throughout the period. In this sense, the influence of incinerators with energy recovery should also be noted, as shown by the emissions in 1997, which, after growing moderately, suffered a considerable drop due to the enforcement of regulations on these emissions. The 1997 drop resulted in reduced emissions for the energy sector.

As shown in Figure 4.2.11.2, the energy sector is a significant emission source within the inventory throughout the entire period, its share exceeding 60% of inventory emissions (62.9% in 1990 and 68.1% in 2008). When comparing the profiles corresponding to contribution in absolute and relative values, the impact of decreasing emission levels in other sectors[15] has been found to have favoured the increase in the relative contribution of the energy sector.

---

[14] Coal-fired power plants are equipped with efficient particulate abatement techniques that have a direct impact on the reduction of heavy metal emissions.

[15] For more detailed information, see comments relative to this pollutant in the chemical industry (chlorine manufacture) and landfilling described in the chapters on Industrial processes and Waste.

Figure 4.2.11.2.- Percentage of Hg emissions by category with respect to the inventory total

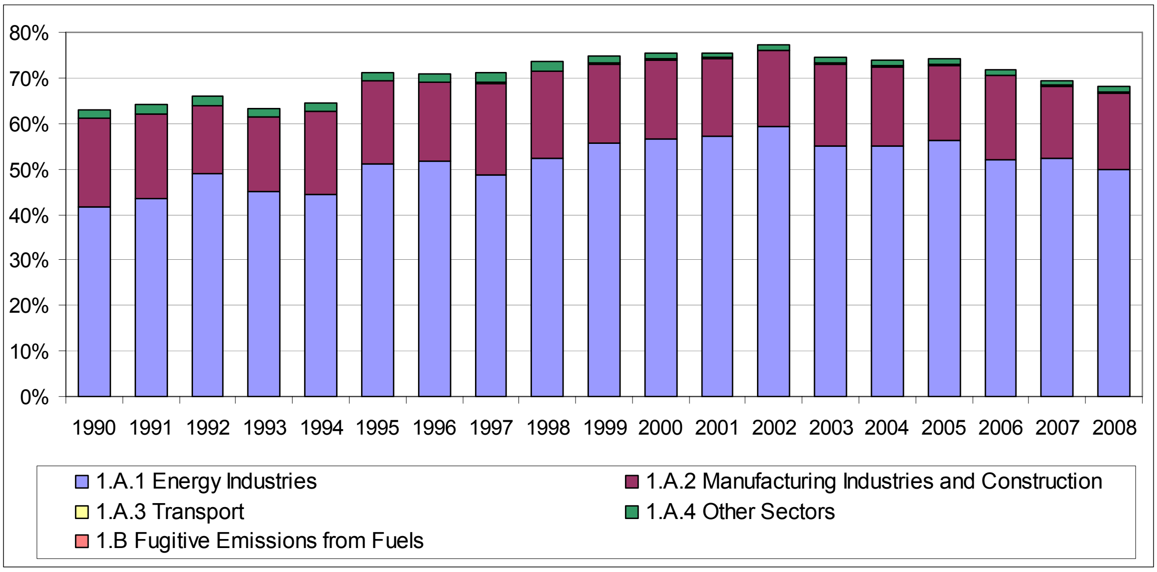
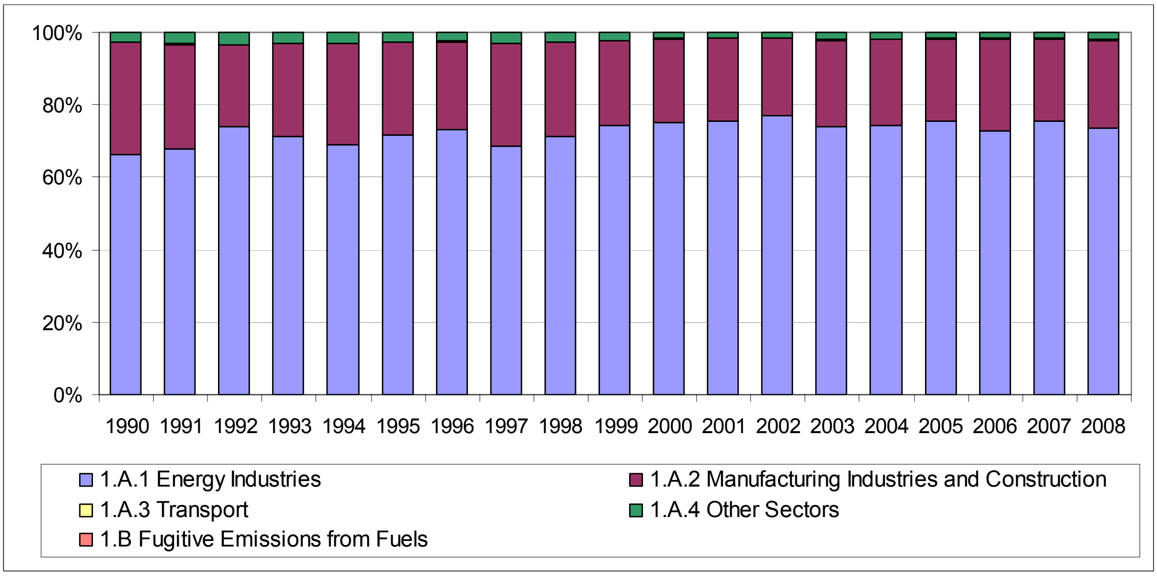


Figure 4.2.11.3 illustrates the distribution of Hg emissions by categories throughout the period. It is worth noting the contribution of Energy industries (73.4% in 2008) and, to a lesser extent, that of Manufacturing and construction industries (24.3% in 2008). Variation in the contribution of the different categories throughout the period is the result of a combination of the factors already described (the use of residual oil and/or coal at thermal power plants and non-specific combustion facilities in industrial sectors, and the limitations on incinerators' emission levels) by means of particulate abatement measures implemented in the cement industry.

Figure 4.2.11.3.- Percentage of Hg emissions by category with respect to the sector total



As for the key sources of Hg in this sector, the following have been identified for the period 1990-2008:

- Energy industries (1A1) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-2008.
- Manufacturing and construction industries (1A2) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-1996, 1999-2002, 2005, 2007 y 2008.
- Other sectors (1A4) by its trend in the years 1991.

As a summary of the foregoing, Table 4.2.11.2 below reflects, for the key categories for Hg in this sector, the emissions' contribution to the level and trend, the ranking of the category in the key sources catalogue[16], as well as the absolute values, all referring to 2008.

Table 4.2.11.2.- Hg key sources: Level and Trend contribution

Activity		Hg (Mg) (2008)	Level Assessment (2008)			Trend Contribution (2008)		
Code	Description		%	Key Source	Rank	%	Key Source	Rank
1A1	Energy industries	4.7	50.0	YES	1	15.8	YES	4
1A2	Manufacturing industries and construction	1.6	16.6	YES	3	5.4	YES	6
1A4	Other sectors	0.1	1.2	NO	5	0.8	NO	7

4.2.12.- DIOX

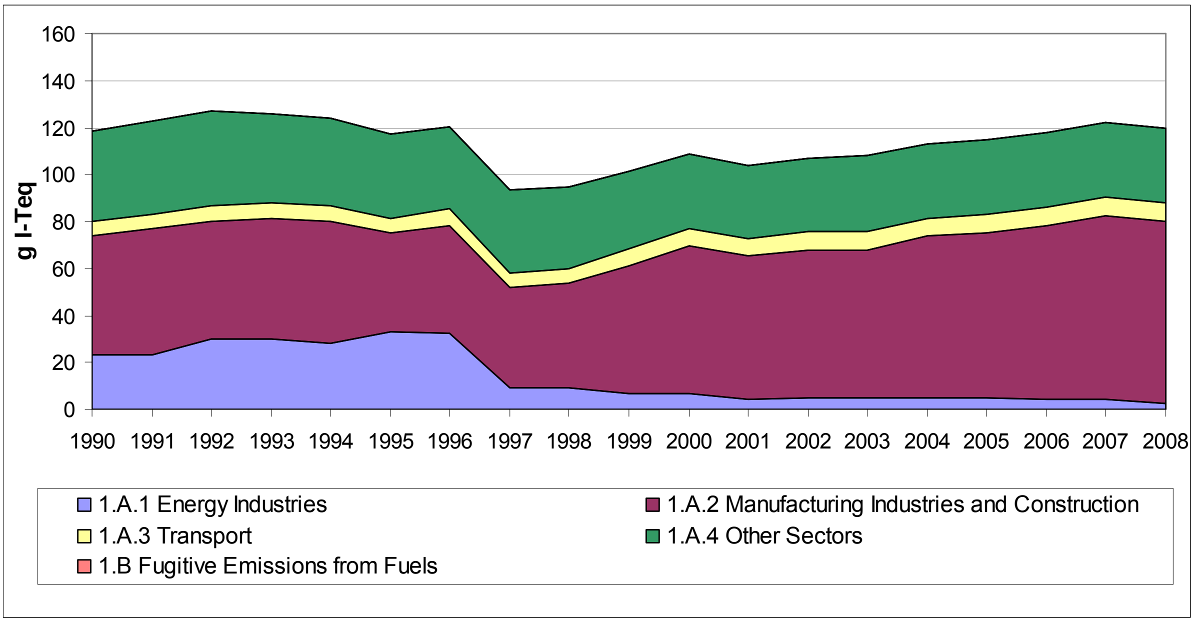
Dioxin and furan emissions (DIOX) from the energy sector, the pattern for which is shown by category in Table 4.2.12.1 and Figure 4.2.12.1, have shown a slight increase of 0.9% in 2008 with respect to 1990, going from 118.4 grammes in International Toxic Equivalent units (g I-Teq) in 1990 to 119.4 g I-Teq in 2008.

Table 4.2.12.1.- DIOX emissions *(Amounts in g I-Teq)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
1A1 Energy Industries	22.9	32.7	7.0	4.9	4.8	4.1	4.2	2.7
1A2 Manufacturing Industries and Construction	51.1	42.1	62.7	68.7	70.5	74.3	77.9	77.3
1A3 Transport	6.2	6.7	7.1	7.6	7.7	7.9	8.4	8.2
1A4 Other Sectors	38.1	35.5	31.8	31.9	31.7	31.5	31.4	31.3
1A5 Others	-	-	-	-	-	-	-	-
1B Fugitive Emissions from Fuels	-	-	-	-	-	-	-	-
Total Energy	**118.4**	**117.1**	**108.6**	**113.1**	**114.7**	**117.8**	**122.0**	**119.4**

16 Ranking determined by the contribution of the category's emissions to the level or trend.

Figure 4.2.12.1.- Evolution of DIOX emissions by category



DIOX evolution in the energy sector is illustrated in a step graph divided into two different tranches: the first corresponds to a relatively stable period up to 1996, followed by a sudden drop in 1997 and a virtually sustained growth since then until 2007, followed by a slight decrease in 2008 to a level of emissions similar to that estimated for 1990. Based on the preceding table and figure, the main emitting categories in this activity, on account of their relevance in the evolution of emissions for the energy sector, are Energy industries and Manufacturing and construction industries. Thus, the adaptation of the MSW incineration facilities to comply with the maximum levels imposed in the legislation in force from 1997 has implied, for that year, a very marked drop in emissions from incineration plants with energy recovery, the main emission source in the Energy industries category to date for the energy sector. On the other hand, the effect of the production levels in industrial activities with a high emission potential, particularly sinterization, with an irregular pattern defined by a marked fall from 1990 to 1998, followed by a partial recovery in the next two years and a period of stability, combined with secondary aluminium production, with a relatively sustained growth, determine the general upward trend in the period 1997-2007, finishing with a decline in 2008 originated by the downturn in the level of economic activity.

As shown in Figure 4.2.12.2, the energy sector is a significant emission source within the inventory for all the years in the period, increasing its relative importance from 64.0% of the total inventory in 1990 up to 74.5% in 2008. Comparing the profiles corresponding to the contribution in absolute and relative values, the impact of lower emission levels from other sectors[17] is found to have favoured an increase in the energy sector's relative contribution.

[17] For more detailed information, see the comments on this pollutant in landfilling and waste incineration in the chapter on Waste.

Figure 4.2.12.2.- Percentage of DIOX emissions by category with respect to the inventory total

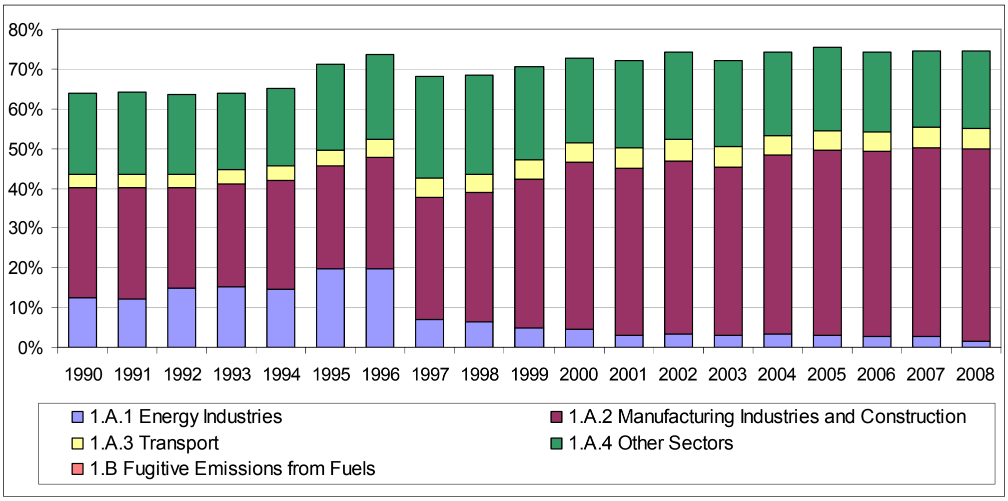
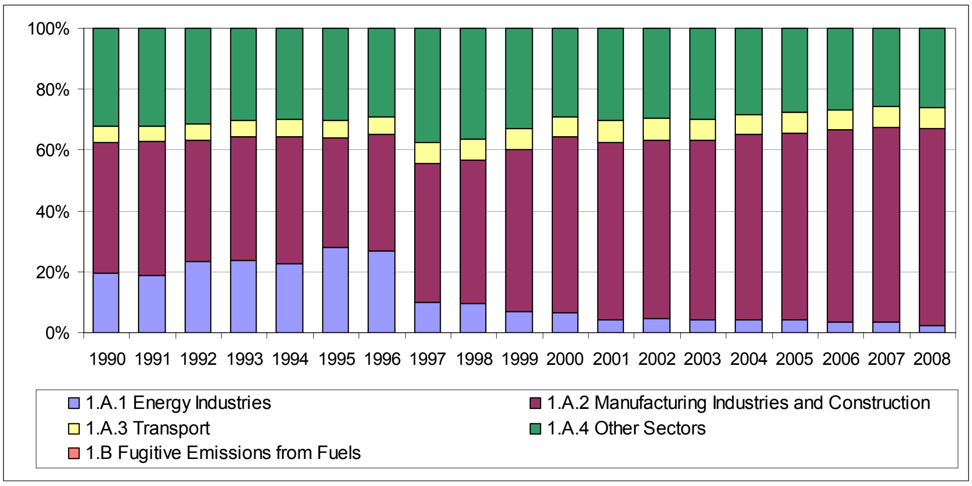


Figure 4.2.12.3 shows differences based on variations for Manufacturing and construction industries that, after the initial drop up to 1995, increase their share in the sector from 43.2% in 1990 up to 64.7% in 2008, while energy industries, exhibiting the opposite pattern, reach their turning point in 1996, reducing their share from 19.4% in 1990 down to 2.2% in 2008. As already noted, this evolution is the result of the combined influence exerted by the drop in sinter production and increased emissions from incinerating plants with energy recovery (category 1A2) during the period 1990-1995 and, from this date on, the increased production of primary aluminium and the notable reduction in emissions from incinerators after 1997 and, in 2008, due to the decline in the activity of coal-fired power stations. As for the remaining categories, Other sectors, the second most important in terms of relative weight, shows a slight overall reduction in its contribution (26.2% in 2008), due in part to the reduction in its own emissions through a change in the energy consumption towards less polluting fuels (for example natural gas); in the meantime, the participation of Transport activities, at a much lower level, undergoes a slight increase (6.8% in 2008).

Figure 4.2.12.3.- Percentage of DIOX emissions by category with respect to the sector total



As for the key DIOX sources for this sector, the following have been identified for the period 1990-2008:

- Energy industries (1A1) by its emission level in the years 1990-2001 y 2004-2007, by its trend in the years 1991-2008.
- Manufacturing and construction industries (1A2) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-1995 and 1997-2008.
- Transport (1A3) by its emission level in the years 1997-2008 by its trend in 1994, 1996, 1999, 2001-2004 and 2007.
- Other sectors (1A4) by its emission level throughout the period 1990-2008 and by its trend in the years 1993-1995 and 1997-1999.

As a summary of the foregoing, Table 4.2.12.2 below reflects, for the key categories for DIOX in this sector, the emissions' contribution to the level and trend, the ranking of the category in the key sources category[18], as well as the absolute values, all referring to 2008.

Table 4.2.12.2.- DIOX key sources: Level and Trend contribution

Activity		DIOX (g I-Teq) (2008)	Level Assessment (2008)			Trend Contribution (2008)		
Code	Description		%	Key Source	Rank	%	Key Source	Rank
1A1	Energy industries	2.7	1.7	NO	7	16.5	YES	3
1A2	Manufacturing industries and construction	77.3	48.2	YES	1	31.7	YES	1
1A3	Transport	8.2	5.1	YES	4	2.7	NO	7
1A4	Other sectors	31.3	19.5	YES	2	1.7	NO	8

4.2.13.- PAH

As shown in Table 4.2.13.1, PAH emissions in this sector are mainly generated by combustion in Manufacturing and construction industries and Other sectors, with the remaining categories being considerably less relevant. As can be seen, the sector as a whole underwent an increase in PAH emissions, going from 72.8 Mg in 1990 2008 to 85.5 Mg in 2008.

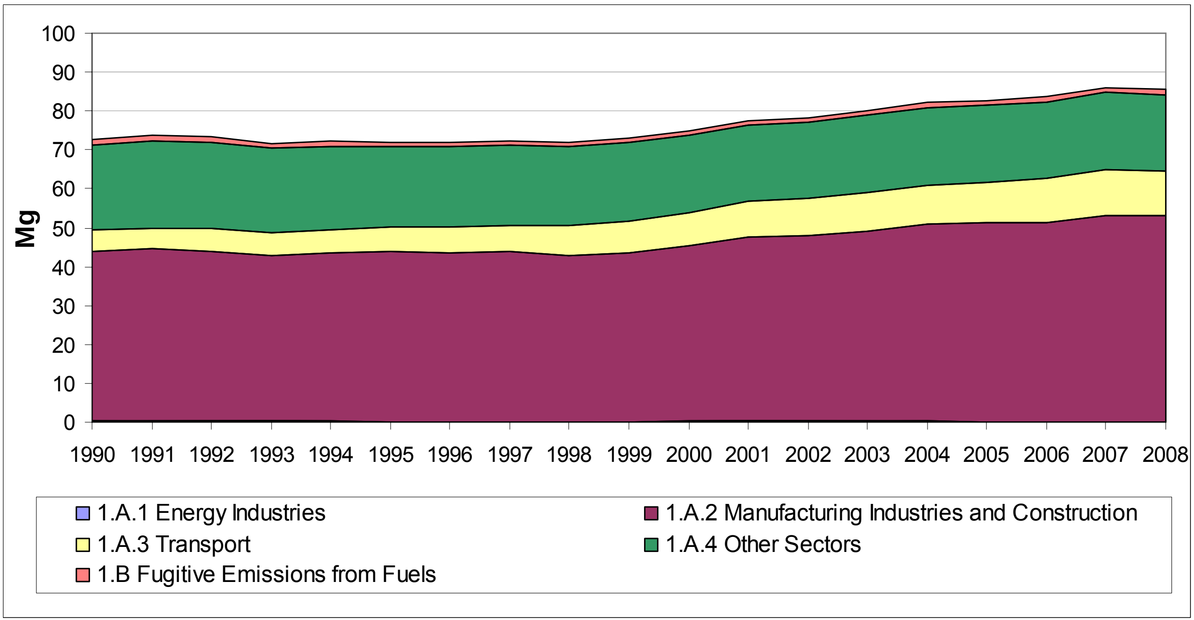
Table 4.2.13.1.- PAH emissions *(Amounts in Mg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
1A1 Energy Industries	0.4	0.1	0.2	0.2	0.1	0.1	0.1	0.1
1A2 Manufacturing Industries and Construction	43.7	43.7	45.2	50.7	51.0	51.3	53.0	52.9
1A3 Transport	5.2	6.4	8.5	10.1	10.6	11.2	11.9	11.5
1A4 Other Sectors	22.0	20.8	19.7	19.8	19.8	19.8	19.8	19.8
1A5 Others								
1B Fugitive Emissions from Fuels	1.5	1.1	1.3	1.3	1.2	1.3	1.2	1.2
Total Energy	**72.8**	**72.0**	**74.9**	**82.1**	**82.8**	**83.7**	**86.0**	**85.5**

[18] Ranking determined by the contribution of the category's emissions to the level or trend.

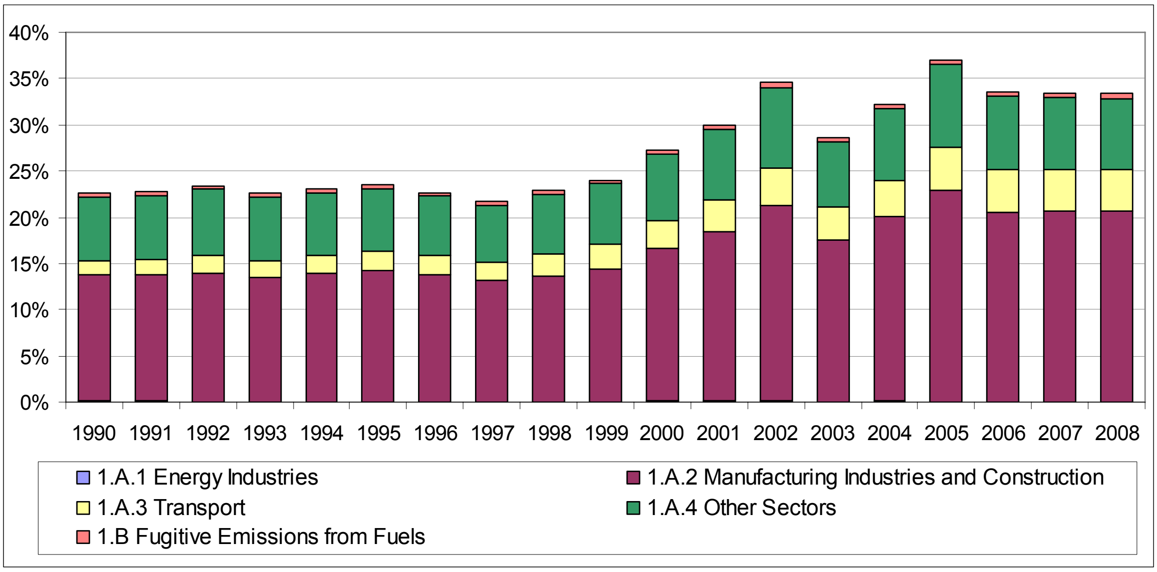
Figure 4.2.13.1 shows the evolution of PAH emissions throughout the period inventoried. The trend observed is relatively stable, with category 1A2 (Manufacturing and construction industries) exerting the greatest influence on the (growing) profile of the evolution. Within this category, emissions from anode furnaces in the primary aluminium industry are particularly significant, as this activity is responsible for most of the sector's emissions. The following category is combustion in Other sectors where the emissions come from wood and wood waste combustion and, to a lesser extent, from coal, although the evolution for this category is considerably stable throughout the period inventoried. Finally, the transport sector shows very significant growth (in excess of 120%), as a result of the corresponding growth in road traffic although, in terms of absolute emission values, by a smaller amount than the two preceding categories.

Figure 4.2.13.1.- Evolution of PAH emissions by category



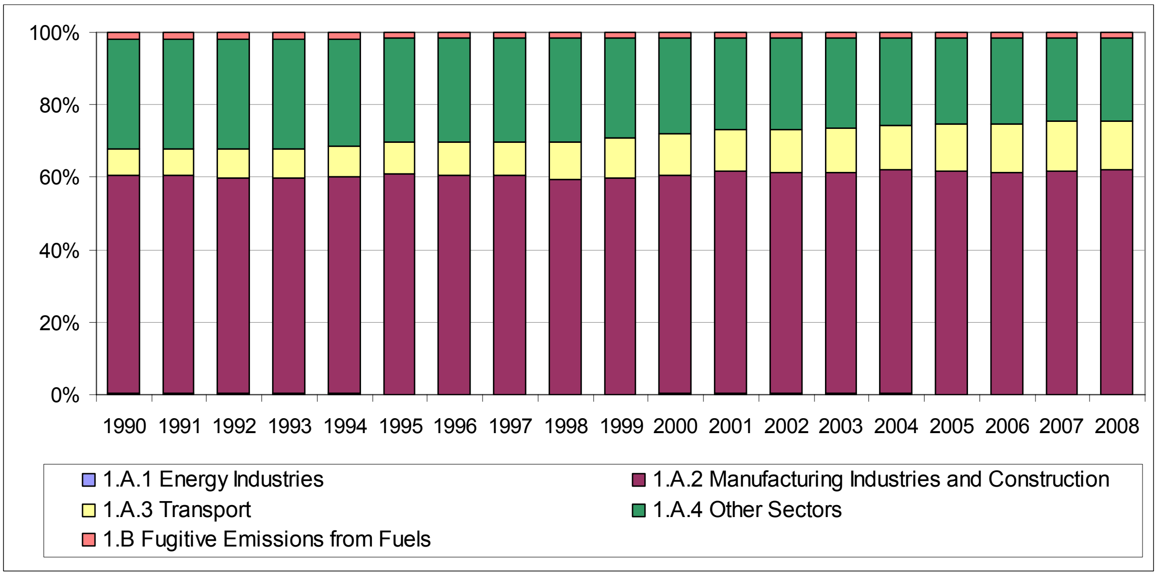
As shown in Figure 4.2.13.2, the variation in the share of PAH emissions from this sector in the inventory total is mainly determined by the contribution of other sectors, since their shares vary to a greater extent than variations in absolute values for the sector's emissions. More specifically, variations in PAH emissions from stubble burning of agricultural waste in the Agriculture sector have the greatest impact on the contributions by the remaining sectors.

Figure 4.2.13.2.- Percentage of PAH emissions by category with respect to the inventory total



With regard to the distribution of PAH emissions among the different sector categories, Figure 4.2.13.3 shows a similar pattern to those of the absolute values as a result of the stability in the emissions from the different categories in the sector. As can be seen in the diagram, Manufacturing and construction industries account for 59% and 62% of sector emissions (more specifically, as already noted, from anode furnaces in the primary aluminium industry), while combustion in other sectors is the category with the second-largest contribution, with values ranging between 23% and 30%, with the remaining emissions falling under other sector categories.

Figure 4.2.13.3.- Percentage of PAH emissions by category with respect to the sector total



The PAH key sources identified for the period 1990-2008 are as follows:

- Energy industries (1A1) by its trend in the years 1993, 1994 and 1998.
- Manufacturing and construction industries (1A2) by its emission level throughout the period 1990-2008 and by its trend in the years 1991-1995, 1997 and 1999-2008.
- Transport (1A3) for its trend in the years 2005-2007 and by its trend in the years 1991-2008.
- Other sectors (1A4) by its emission level throughout the period 1990-2008 and by its trend in the years 1991, 1992, 1995-1999, 2002 and 2005.
- Fugitive emissions from fuels (1B) by its trend in the years 1995, 1996, 1998 and 1999.

As a summary of the foregoing, Table 4.2.13.2 below shows, for this sector's key categories for PAH, the contribution of emissions to the levels and trends, the ranking for this category in the key sources catalogue[19], as well as the absolute values, all referring to 2008.

Table 4.2.13.2.- PAH key sources: Level and Trend contribution

Activity		PAH (Mg) (2008)	Level Assessment (2008)			Trend Contribution (2008)		
Code	**Description**		**%**	**Key Source**	**Rank**	**%**	**Key Source**	**Rank**
1A1	Energy industries	0.1	0.0	NO	7	0.2	NO	6
1A2	Manufacturing industries and construction	52.9	20.6	YES	2	24.1	YES	2
1A3	Transport	11.5	4.5	NO	5	9.9	YES	4
1A4	Other sectors	19.8	7.7	YES	4	3.0	NO	5
1B	Fugitive emissions from fuels	1.2	0.5	NO	6	0.1	NO	7

4.3.- Analysis by key categories

The remainder of this chapter provides detailed information for the key sources in this sector.

4.3.1.- Public electricity and heat production (1A1a)

Public service heat and power generation plants are included here, where they constitute one of the main contributions to the emissions in the inventory as a whole. It should be noted that conventional power plants are included here alongside municipal solid waste plants and municipal solid waste landfills carrying out energy recovery (electricity generation).

19 Ranking determined by the contribution of the category's emissions to the level or trend.

In the power plants, the dominant type of installation is boilers, and, among these, those with power ratings in excess of 300 MWt. Besides boilers, installations of engines and gas turbines are also significant.

4.3.1.1.- Activity variables

Table 4.3.1.1 shows the activity variable, fuel consumption, expressed in energy terms (terajoules of lower heating value, TJ_{LHV}). This is derived information calculated from the consumption in physical units (tonnes or m^3N) and the corresponding heating values. The information about fuel characteristics and consumption obtained via the individualized questionnaires to thermal power stations includes their composition and, among their characteristics, apart from the LHV parameter cited above, the contents in carbon, sulphur, ash, etc. determined by means of analytical methods. These results provide the annual mean values of these parameters. With regard to MSW incinerators and landfills and industrial waste incinerators recovering energy from the waste or captured biogas, the information about the quantities of waste and biogas burnt has been obtained in the same way: by means of individualized questionnaires to each incineration plant and large landfills, with a request in each case for the composition of the waste and biogas, as well as other parameters required for the application of emission estimation algorithms.

Table 4.3.1.1.- Fuel consumption *(Amounts in TJ_{LHV})*

Type	1990	1995	2000	2004	2005	2006	2007	2008
Liquid	***79,772***	***103,438***	***141,263***	***156,438***	***170,293***	***148,387***	***127,005***	***123,179***
Diesel	6,947	9,307	11,431	34,255	43,487	47,247	50,161	48,038
Residual oil	72,825	94,131	129,832	121,003	126,747	101,084	76,811	75,111
Petroleum coke				1,134				
Other liquid fuels				46	59	55	33	30
Solid	***581,243***	***645,835***	***759,041***	***766,055***	***778,218***	***670,057***	***724,436***	***475,264***
Hard coal	401,954	460,387	625,681	641,872	656,325	559,634	614,122	430,883
Sub-bituminous coal	53,162	104,118	54,584	46,932	47,585	42,556	41,995	31,722
Brown coal	114,539	75,380	65,701	65,080	61,976	57,032	56,385	1,748
Coke								
Brown coal briquettes	5,860							
Coke oven gas	944	591	2,947	2,732	2,410	2,327	1,834	1,219
Blast furnace gas	4,784	5,359	10,127	9,438	9,922	8,508	10,099	9,693
Gases	***7,337***	***2,841***	***40,038***	***212,139***	***357,842***	***420,890***	***457,390***	***595,545***
Natural gas	7,337	2,841	33,970	204,601	351,376	414,244	450,651	588,833
Other gaseous fuels			6,069	7,538	6,466	6,645	6,739	6,712
Biomass	***4***	***282***	***1,270***	***5,740***	***6,019***	***6,542***	***6,082***	***6,005***
Wood/Wood waste			3	405	352	266	266	267
Other solid biomass				719	1,080	1,209	612	612
Biogas	4	282	1,266	4,616	4,587	5,068	5,205	5,126
Other	***3,103***	***5,708***	***11,741***	***17,983***	***18,568***	***19,808***	***20,494***	***20,363***
MW	3,103	5,708	11,741	15,423	15,598	17,461	18,532	18,568
Industrial wastes				2,561	2,969	2,347	1,962	1,795
Total	**671,459**	**758,104**	**953,352**	**1,158,355**	**1,330,940**	**1,265,684**	**1,335,407**	**1,220,355**

With regard to fuels, there is a clear predominance of solid fuels (domestic and imported coal) and by classes, coals and anthracites are followed by brown lignite and sub-bituminous coal and, to a lesser extent, gases derived from primary solid fuels (gas from coke ovens and furnaces), although 2008 saw a significant drop in the consumption of coal together with an increase in the consumption of natural gas that makes this latter fuel the dominant one in this year. The main consumption among liquid fuels corresponds to residual

oil with a complementary contribution of gas-oil, although a clear decrease in residual oil consumption can be observed from 2006 on as a consequence of the shutdown of some power plants that used this type of fuel. As for gaseous fuels, the increase in natural gas consumption is clear especially since 2002 as a consequence of the commissioning of the new combined cycle thermal power stations that mostly use this fuel. Finally, in the group of other fuels, the consumption due to MSW and industrial waste in incineration is included, whereas the main fuel for biomass is the biogas from landfills recovering biogas and this waste stream. Figure 4.3.1.1 shows the corresponding evolution of fuel consumption by types over the period inventoried.

Figure 4.3.1.1.- Evolution of fuel consumption

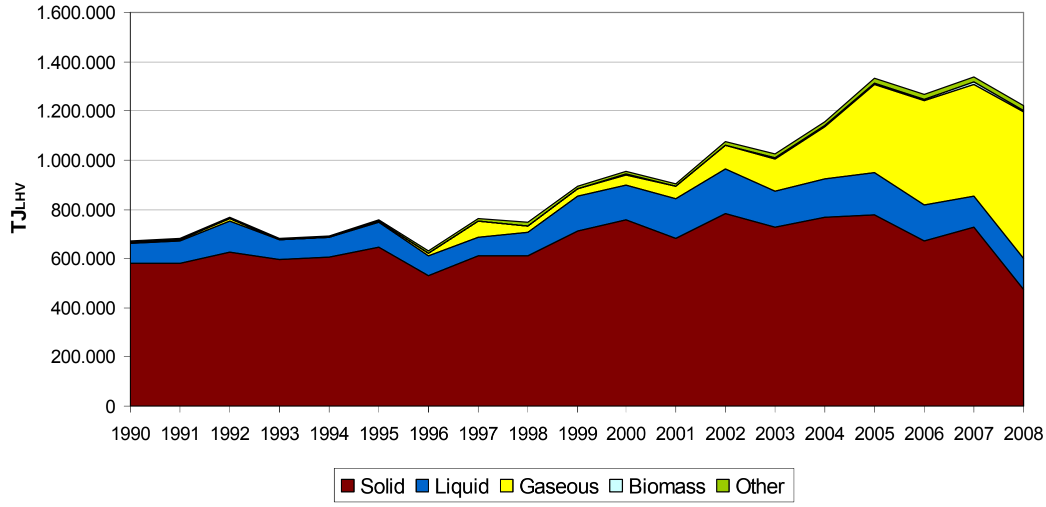
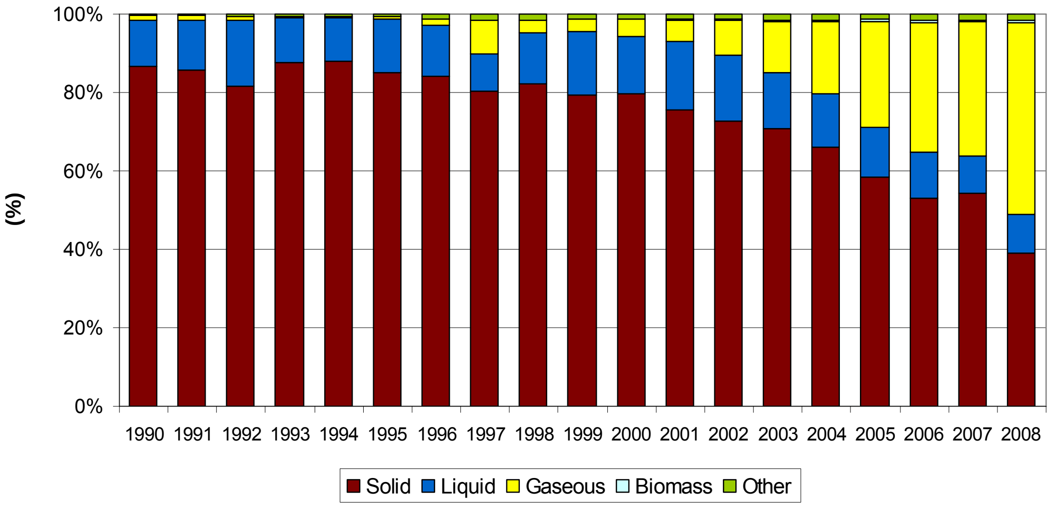


Figure 4.3.1.2 shows the distribution of consumption in terms of energy by type of fuel during the inventory period.

Figure 4.3.1.2.- Fuel consumption distribution, based on TJ_{LHV}



4.3.1.2.- Methodology

The results regarding estimated emissions have been derived according to the following order of priorities:

1) On the basis of the direct data provided by the plants, when this information was available (through individualized questionnaires from 1994 on), for the cases of SO_x, NO_x and TSP (in some special cases, CO as well), supplemented with the estimates provided by the OFICO (Office for Electricity Compensation) for the first three years at the start of the period under analysis (1990-1993) when no individual questionnaire was available.

2) Based on measurements from specific studies on emission factors (as in the case of the heavy metals Cd, Hg and Pb for the coal power plants).

3) Using individualized information taken from the questionnaires filled out by the plants regarding the activity variables (amounts and characteristics of the fuels) as well as the combustion modes and techniques for reducing emissions.

4) Generic emission factor procedure for those plants and/or groups for which no information from questionnaires was available but data on activity variables were.

4.3.1.2.1.- Advanced methodology

Boilers, gas turbines and stationary engines

For the main pollutants, a differentiated treatment has been provided for SO_x, NO_x and TSP as, generally speaking, information was held on the concentrations of these compounds in the flue gases and regarding the estimated emissions supplied by the plants themselves. That is why the default estimation methods have been resorted to only in exceptional cases in order to make up for shortcomings (verifying anomalous data) in the information from some plants. In the years 1997-2001, a very important data source has been available for these three pollutants in terms of the reliability and verification of the data provided. The source in question is the Environmental Impact of Energy Department at the Centre for Research into Energy, Environment and Technology (CIEMAT), through its Working Group on "Air Pollution: Characterization and Study of Physical and Chemical Processes". These data were delivered as part of the collaboration agreement established between the Directorate General for Environmental Quality at the Ministry of the Environment, Rural and Marine Affairs and the Directorate General for Energy Policy at the Ministry of Industry, Trade and Tourism. Apart from CIEMAT, the Resources and Environment Area of UNESA[20] has also participated within this collaboration framework. As a result, the data on emissions received from the various sources was verified by means of the emission determination algorithms indicated above, and, with slight modifications where necessary, the estimated emissions figures were validated prior to their incorporation into the Inventories.

[20] UNESA: Spanish Electricity Industry Association

In addition, it must be pointed out that, in the specific cases of cadmium, mercury and lead, information on estimated emissions has been available in the study entitled *"Emisiones de metales pesados..."* ("Heavy metal emissions") provided by UNESA, used to obtain more specific emission factors depending on the type and characteristics of the fuels used at each power station.

Finally, particulates have been subjected to separate processing, depending on whether or not data were available by power station, group and year, on the measured emissions (of TSP). If this information was not available, the absolute value of the measured emission has been used to calculate the specific emission level (of the four proposed by CEPMEIP) and, once this level had been determined, the proportions of the emissions of the other two diameters of particles ($PM_{2.5}$ and PM_{10}), have been obtained by taking the same proportion proposed by CEPMEIP for the selected level with respect to the estimation of the TSP provided by the power station.

MSW and industrial waste incineration plants (with energy recovery)

For these installations the information has been taken regarding the existing emission abatement techniques, and measured or estimated emission data as provided in the questionnaire completed by the plants themselves.

4.3.1.2.2.- Default Methodology

Boilers, gas turbines and stationary engines

The default emission factors for the main pollutants and heavy metals have been taken as the central values within a wide range of variability shown directly in the reference tables of the EMEP/CORINAIR Handbook. The variability within the range corresponds to the different peculiarities of the fuels and the techniques used at the combustion installations. For the selection of the factors shown in the Table, it has been assumed that, in the case of coal-fired power stations, the basic combustion technique used has been DBB[21] and. for subsequent gas scrubbing treatments (desulphurization), the data have been taken from those provided by the plants themselves; in the case of the residual-oil and gas power stations, on the other hand, only one option (DBB with particulate abatement) is shown in the EMEP/CORINAIR Handbook.

On the other hand, for stationary engines using natural gas, the emission factors used for NO_X, NMVOC and CO were those obtained from an emissions survey of these pollutants carried out on the basis of the information furnished by the main companies installing this kind of facility.

For particulate matter, but only where no measured emissions of TSP were available, the CEPMEIP default emission factors have been applied, assuming in each case an emissions level in accordance with the abatement techniques in place at the power station.

---

[21] DBB: Dry Bottom Boiler

As for persistent organic pollutants, only the emissions of dioxins and furans (DIOX) and polycyclic aromatic hydrocarbons (PAH) have been considered significant. The information for DIOX, expressed in terms of international toxicity equivalence units (I-Teq), comes from OSPARCOM-HELCOM-UNECE (1995), see section 4.5 with the bibliographical references, selected from the column corresponding to the maximum reduction of emissions through the application of abatement techniques. In the case of PAH, the information comes from the EMEP/CORINAIR Handbook and refers solely to wood and coal fuels; the compounds considered are the four contained in the Geneva Convention Protocol on persistent organic pollutants (Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene and Indene(1,23-cd)pyrene).

MSW incineration plants (with energy recovery)

For these installations, information has been obtained on the existing emission abatement techniques, and measured or estimated emission data as provided in the questionnaire completed by the plants themselves. In the case of pollutants for which there was no such direct information in the questionnaires, default emission factors have been used. The information on the emission factors has been taken by considering the different options on abatement techniques used, according to the information on this matter supplied by the plants or, where not available, those assumed by the working team to be in the most general use.

The breakdown of the sources of reference for the emission factors is as follows: for SO_2, NO_X, VOC, CO and NH_3, Annex I Tables A1.1 to A1.6 from Chapter B-921 in the Third Edition of the EMEP/CORINAIR Guidebook. In the case of VOC, a speciation of 95% of NMVOC and 5% of CH_4 has been assumed. In the case of particulate matter, measured TSP emission values have been made available and, bearing in mind that all particulates are less than 2.5 μm in diameter as inferred from the CEPMEIP's proposed factors, the $PM_{2.5}$ and PM_{10} emissions have been assumed to be equal to TSP. For the heavy metals, the information comes from Table 2.5.2 of the PARCOM-ATMOS Manual. The Third Edition of the EMEP/CORINAIR Guidebook has also been used for DIOX (see Table 8.2 in Chapter B-921) and for the PAH as the sum of the corresponding factors for benzo[k]fluoranthene, value 6.3 mg/t, and benzo[a]pyrene, value 0.7 mg/t.

Industrial waste incineration plants (with energy recovery)

As with MSW incinerators, the available information on the existing emission abatement techniques at this kind of facility was used along with measured or estimated emission data provided in the individualized questionnaires completed by the plants themselves. In those cases where these emissions were not available, default emission factors were used taking into account the different options on abatement techniques used, also provided by the plants via the questionnaire.

The breakdown of the reference sources for the emission factors is as follows: for SO_2, NO_X, VOC, CO, As, Cd, Cr, Cu, Hg, Ni, Pb, Zn, $PM_{2.5}$, P_{10}, TSP, DIOX, HCB and PAH, Table 3.2 in Chapter 6-c-b of the 2009 EMEP/EEA Guidebook was used. In the case of VOC, a split of 95% NMVOC and 5% of CH_4 has been assumed. For Se, information has been taken from Table 2.5.2 of the PARCOM-ATMOS Manual. This same source, section 2.5.1.2, has been taken as the reference for PCP; however, the data in the table have been corrected (in the belief that there were errors in the data or in the units in which these were expressed)

by comparison with the reference entitled "Compilation of Emission Factors for POPs, a case study of Czech and Slovak Republics").

Combustion in managed landfills with biogas capture

The emissions of pollutants coming from the burning of methane from the biogas collected at controlled landfills have been calculated by multiplying the tonnes of methane burnt by the corresponding emission factors, in proportion to the tonnes of methane burnt corresponding to boilers, engines or turbines. The original source of information for the factors has been the 5th Edition of the EPA AP-42, Table 2.4-4 in section 2.4 "Municipal Solid Waste Landfill"[22].

4.3.2.- Oil refineries (1A1b)

In the oil-refining sector, the plants differ from one another not only through their capacity for processing crude oil, but also through the type of processes they perform. The simplest facilities may just simply apply processes for separating the crude and a limited treatment of the products obtained. Intermediate refineries may also use catalytic or thermal cracking processes, catalytic reforming, additional processing procedures as well as the manufacture of products such as lubricating oils and asphalts. The most sophisticated refineries, generally with a greater capacity, include the distillation of crude, cracking, the production of lubricant oils, asphalts, paraffin, as well as processes for enhancing petrol products such as catalytic reforming, alkylation or isomerization.

From all of the activities in refineries, those corresponding to the combustion processes are envisaged in this section. Among these, a distinction is drawn between different types of boilers (by nominal thermal power ranges), gas turbines, stationary engines and contactless processing furnaces. The first three types of facilities are used for generating electricity, steam or heat in accordance with the requirements of the refining plants and do not present any special feature with respect to the facilities of this type that may exist in other sectors, except for the use of fuels that are characteristic of refineries. Processing furnaces are however specific to this sector, where a number of physical and chemical reactions take place in the crude, such as distillation, catalytic reforming, hydrotreatment, catalytic cracking, alkylation, hydrocracking, etc., that give rise to the fractions of crude into which the latter is broken down. In these ovens there is no contact between the flame or combustion gases and the crude or its resulting fractions. As regards the emissions of pollutants, consideration is given exclusively to those gases coming from the combustion carried out in the furnaces. The emissions that these furnaces might generate through non-combustive processes taking place inside them are included within category 1.B.2.a.iv. Moreover, the emissions from waste gas flaring are not covered in this section, but are envisaged in category 1.B.2.c.

---

[22] The factors for these pollutants, classified by type of combustion facility, are expressed in the original source quoted in: kg POLLUTANT/millions of m^3 of standard dry methane burnt. To express the factor in g POLLUTANT / t METHANE burnt, the appropriate conversion factors were applied to convert m^3 S (standard cubic metre) to m^3 N (normal cubic metre), i.e. (273.15+15)/(273.15), and the standard density under normal circumstances of methane (715 g /m^3 N) to convert volume into mass.

4.3.2.1.- Activity variables

Table 4.3.2.1 shows fuel consumptions, expressed in terms of energy (TJ of lower heating value), used as the activity variable in the estimation of emissions. Information on this consumption, as well as their characteristics, has been gathered through individualized questionnaires sent to each of the ten existing refineries. The main fuels consumed in this category are residual oil and refinery gas, with slightly lower amounts of gas-oil and natural gas and practically marginal amounts of LPG and naphtha. Figure 4.3.2.1 shows the corresponding evolution of the consumption by type of fuel over the inventory period.

Table 4.3.2.1.- Fuel consumption *(Amounts in TJ_{LHV})*

Type	1990	1995	2000	2004	2005	2006	2007	2008
Liquid	***155,424***	***181,155***	***182,559***	***183,203***	***176,194***	***178,379***	***176,060***	***166,486***
Kerosene				129	22	2	36	105
Diesel	369	8,119	1,728	1,971	1,981	2,449	252	1,127
Residual oil	75,469	80,980	88,158	80,871	73,867	73,496	74,086	68,942
L.P.G.		3,799	389	54	172	206	512	11
Naphtha	195	900	34					
Refinery gas	79,392	87,357	92,250	100,177	100,152	102,226	101,174	96,300
Gases	***820***	***1,084***	***12,166***	***23,027***	***24,563***	***21,048***	***25,820***	***29,374***
Natural gas	820	1,084	12,126	22,346	23,259	20,016	24,757	28,284
Other gaseous fuels			40	681	1,304	1,032	1,062	1,090
Total	**156,244**	**182,239**	**194,724**	**206,230**	**200,757**	**199,428**	**201,880**	**195,860**

As can be seen in the preceding table, there is a change in the mix of liquid fuels between residual oil and refinery gas, particularly in the last years of the period inventoried. Thus, residual oil shows a downward trend from 2004 on, going from representing 49% of the consumption of liquid fuels in 1990 to 41% in 2008. On the other hand, refinery gas, which increased in consumption until 2004 and has been practically stable since that year, goes from having a 51% share of liquid fuels in 1990 to representing 58% in 2008.

In addition, the increase observed in the consumption of natural gas throughout the period inventoried, is the consequence of the progressive installation of cogeneration units (gas turbines) at oil refinery plants. Finally, mention should be made of the inclusion within gas fuels of the consumption of various residual gases used in oil refinery plants

Figure 4.3.2.1.- Evolution of fuel consumption

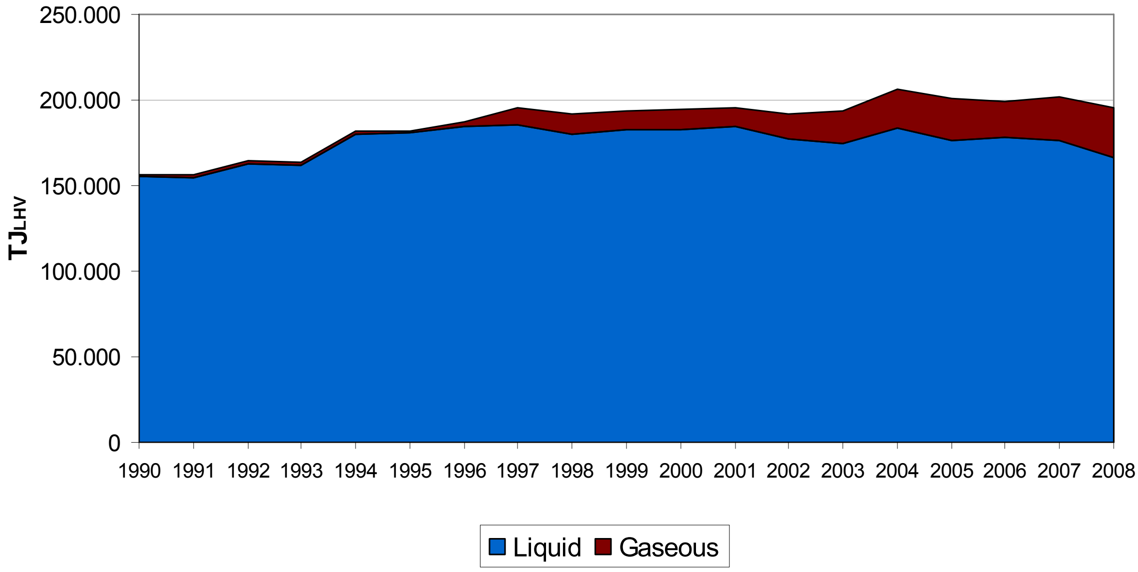
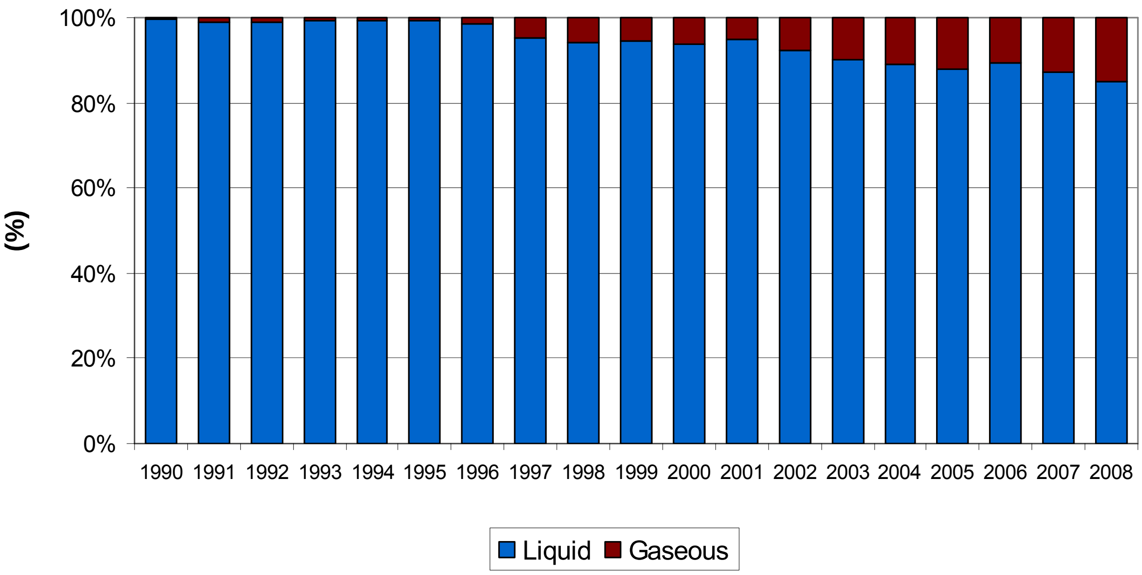


Figure 4.3.2.2 shows the distribution of the consumption by type of fuel over the inventory period. The increase seen in gas fuel consumption (natural gas) is due to the progressive commissioning of co-generation facilities at refineries.

Figure 4.3.2.2.- Fuel consumption distribution, based on TJ_{LHV}



Given that the fuels used, except for natural gas, are produced at the refineries themselves, their physical and chemical characteristics vary from one centre to another, and even from one year to another in the same refinery. The ranges for the fuels used throughout the period of the Inventory are shown in table 4.3.2.2.

Table 4.3.2.2.- Fuel characteristics

FUEL	% SULPHUR	% CARBON	LHV	
			kcal/kg	GJ/t
RESIDUAL OIL	0,05 – 4,49	82,9 – 90,3	9.285 – 10.063	38,86 – 42,12
DIESEL	0,035 – 0,87	83,7 – 86,4	9.500 – 10.501	39,76 – 43,95
KEROSENE	0,035 – 0,3	84,8 – 85,94	10.223 – 10.360	42,79 – 43.36
NAPHTA	0		10.675 – 10.749	44,68 – 44,99
NATURAL GAS	0	69,4 – 78,5	10.680 – 12.493	44,70 – 52,29
LPG	0 – 0,03	73,3 – 81,85	10.501 – 11.075	43,95 – 46,35
REFINERY GAS	0 – 10,58	42,6 – 87,77	8.501 – 14.060	35,58 – 58,85
PURGING GAS				

No characteristics are given in the table for purging gas in view of the wide range of variation in the specifications of this gas and because no information is available regarding its characteristics in some refineries.

The ranges of values for the characteristics corresponding to refinery gas vary greatly, as can be seen in the table, reflecting the great variability in the composition of this type of fuel from one refinery to another and even within the same refinery over time.

4.3.2.2.- Methodology

4.3.2.2.1.- Advanced methodology

SO_x data have been processed separately since information was generally available on the concentrations in the exhaust gases and regarding the estimated emissions supplied by the plants themselves. To a lesser extent, this type of information was also available for NO_x, and occasionally the emissions were provided for other pollutants (CO and TSP). This is why we have only resorted to the default estimation methods in those cases where this information was missing.

4.3.2.2.2.- Default methodology

As regards the emission factors, two large categories of facilities will be distinguished. On the one hand, those that are not specific to the refining plants but rather are common to plants in the power generation and transformation sector, such as boilers, gas turbines and stationary engines. On the other hand, the contactless processing furnaces specific to the refining plants. Each of these categories is dealt with separately below.

Boilers, gas turbines and stationary engines

To estimate the main pollutants emitted, and in those cases for which no emissions measurements were available, the default emission factors used were obtained from the EMEP/CORINAIR Guidebook (part B, chapter 111, 112 and 136). When estimating NO_X emissions, the influence exerted by the presence of low NO_X-emission burners was taken into consideration when applying the corresponding emission factor. Similarly, to estimate SO_X emissions the emission factors applied take into account fuel-specific characteristics (sulphur content and, whenever applicable, sulphur retention in ash).

The default emission factors for heavy metals have been taken from those proposed in the reference tables from the EMEP/CORINAIR Guidebook, where emission factors for only

residual oil and natural gas are shown, using DBB with particle abatement as the combustion technique.

With respect to particles, information has been available for some refineries on measured or estimated TSP emissions supplied by the facilities themselves. For this reason, only where this information has not been available have the emission factors proposed by CEPMEIP for refinery combustion been used to estimate emissions. In those cases where measured TSP emissions were available, $PM_{2.5}$ and PM_{10} emissions have been estimated by applying to the TSP emission the ratios derived from the emission factors data proposed by CEPMEIP regarding the proportion of $PM_{2.5}$ and PM_{10} emissions to TSP.

As regards persistent organic pollutants, only the emissions of dioxins and furans (DIOX) have been deemed significant. The information, expressed in terms of international toxicity equivalent units (I-Teq), comes from OSPARCOM-HELCOM-UNECE (1995), please see section 4.5 for the bibliographical references, selected from the column corresponding to the maximum reduction of emissions through the application of abatement techniques.

Process furnaces

The same comments as those made above for the boilers, turbines and engines are applicable, with the clarification that mean values have selected from the ranges proposed for the specific emission factors of the main pollutants in the EMEP/CORINAIR Guidebook for process furnaces in refineries.

For heavy metals, the EMEP/CORINAIR Guidebook specifically proposes emission factors for refinery gas in process furnaces, while for residual oil it is stated that generic combustion factors should be used.

For particulates, the same comments given above for boilers, turbines and engines are applicable.

4.3.3.- Transformation of solid fuels and other energy industries (1A1c)

This category deals with emissions generated in the transformation of solid fuels (coke ovens, coal gasification) as well as emissions generated at non-specific combustion installations both in this fuel transformation sector and in other energy industries (coal mining, oil and natural gas production).

4.3.3.1.- Activity variables

Fuel consumption is used as the basic activity variable to estimate emissions. In the cases of coke ovens located at integrated iron and steel plants and coal gasification, information has been gathered from individualized questionnaires sent to plants where these processes are conducted. For all other activities in this category, including coke ovens not contemplated above, information has been based on IEA and EUROSTAT data. The main fuels used in this category are coke oven gas and blast furnace gas (solid fuels), residual oil and gas oil (liquid fuels), and natural gas (gaseous fuels). Table 4.3.3.1 shows fuel consumptions expressed in terms of energy (TJ of net heating value). It can be seen that for

some fuels (especially coking coal and liquid fuels) there are important interruptions (even complete absence in some years) over the series. Figure 4.3.3.1 shows the corresponding evolution of the consumption by type of fuel over the inventory period.

Table 4.3.3.1.- Fuel consumption *(Amounts in TJ_{LHV})*

Type	1990	1995	2000	2004	2005	2006	2007	2008
Liquid	***822***	***10,880***	***5,860***	***7,274***	***8,179***	***7,826***	***7,890***	***8,052***
Diesel	243	127					1	
Residual oil	132	10,753						
L.P.G.	448				9			
Petroleum coke			5,860	7,274	8,170	7,826	7,889	8,052
Solid	***15,776***	***9,984***	***13,067***	***12,940***	***11,245***	***11,452***	***11,123***	***11,053***
Coking coal								
Hard coal	4,102	513	2,646	1,869	624	433	484	432
Sub-bituminous coal	13							
Gas works gas	10	5						
Coke oven gas	7,534	6,611	8,398	9,139	8,694	9,284	8,624	8,662
Blast furnace gas	4,116	2,856	2,023	1,932	1,927	1,735	2,015	1,959
Gases	***3,867***	***4,682***	***8,148***	***4,662***	***5,644***	***3,904***	***3,705***	***4,138***
Natural gas	3,867	4,682	8,148	4,662	5,644	3,904	3,705	4,138
Total	**20,465**	**25,546**	**27,075**	**24,876**	**25,068**	**23,183**	**22,718**	**23,243**

Figure 4.3.3.1.- Evolution of fuel consumption

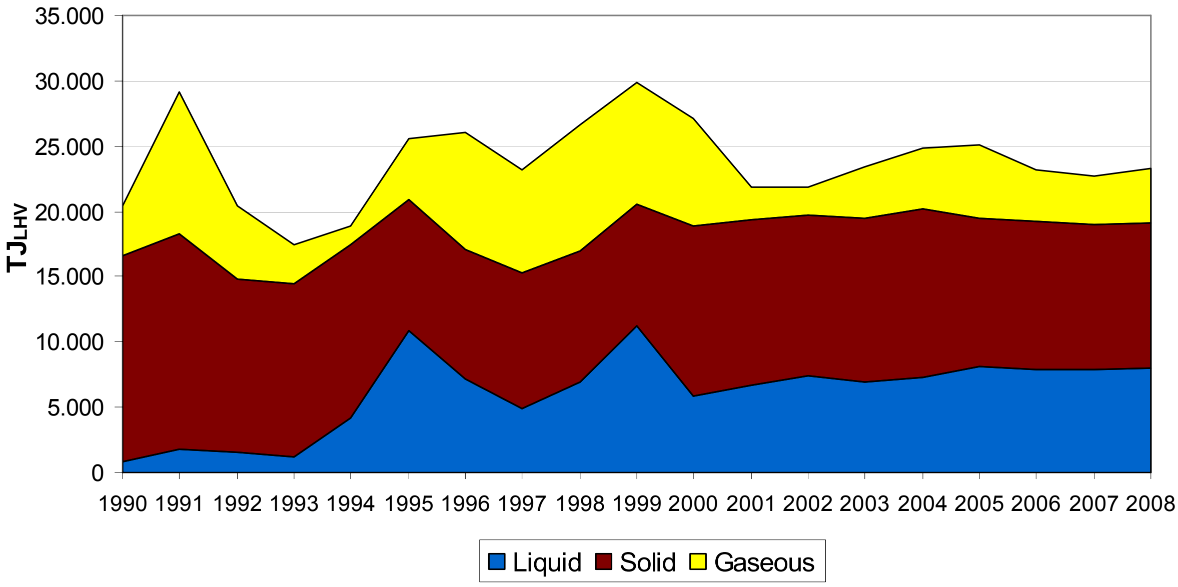
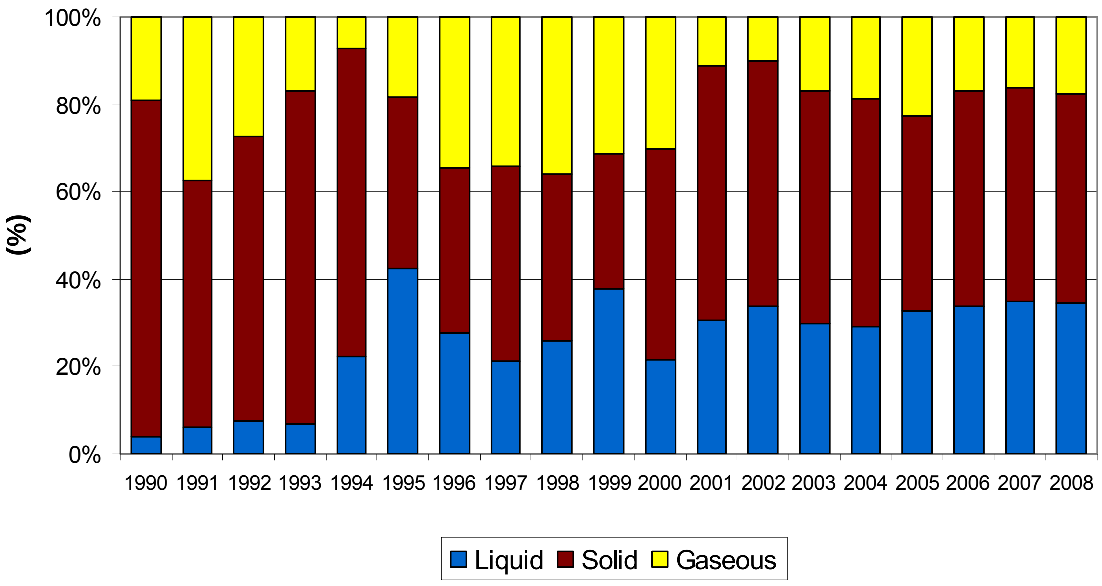


Figure 4.3.3.2 shows consumption distribution by type of fuel over the inventory period. This distribution reflects the interruptions in the consumption data indicated in the previous table.

Figure 4.3.3.2.- Fuel consumption distribution, based on TJ_{LHV}



4.3.3.2.- Methodology

A different methodological approach was used for this category based on the availability of information relative to emissions measurements, information obtained by means of plant-specific questionnaires (particularly for integrated steel plants and coal gasification).

4.3.3.2.1.- Advanced methodology

Coke oven furnaces

1) For coke ovens located in the two existing integrated steel plants, emissions measured during 2003 for all pollutants except for $PM_{2.5}$. particulates were used. Furthermore, one plant provided SO_2 emission measurements for 1990-2008. For pollutants for which no measurements were available and no default emission factor had been applied, the following estimation methodology was used:

   - In order to estimate SO_2, mass balancing was applied to fuel sulphur content.

   - For NH_3, PM_{10}, TSP, heavy metals and PAH, implicit emission factors obtained for each plant in 2003 were applied.

   - For $PM_{2.5}$ particulates, the ratio derived from the information of default emission factors proposed by CITEPA, page 114 (see references) for $PM_{2.5}$ emission ratio with respect to PM_{10} was applied to implicit PM_{10} emission factors.

2) For coke ovens located in the already closed integrated steel plant, PAH emissions were estimated applying the emission factor obtained for 2003 in one of the existing

integrated steel plants due to the absence of a default emission factor and the similarities between the fuel mix used for coke ovens in both plants.

3) For coke ovens not located in integrated steel plants, the implicit emission factors obtained from one integrated plant in 2003 were used due to the similarities in the fuels consumed (coke oven gas), except for SO_2, whose emissions were estimated by means of mass balancing based on the characteristics (sulphur contents) of coke oven gas attributed to these plants, and NH_3, for which no emissions were estimated (no default emission factor is found in the literature for this pollutant).

Coal gasification

Emission estimates were based on measurement data obtained by means of questionnaires. For particulate matter, direct TSP emissions were available and particulates were assumed to have diameters below 2.5 μm.

4.3.3.2.2.- Default methodology

The default methodology applied to estimate emissions in these facilities was that of EMEP/CORINAIR. However, in certain cases other references were used to estimate emissions whenever the EMEP/CORINAIR guidelines do not provide any emission factors. More specifically, the references used to obtain default emission factors included:

a) Coke oven furnaces

- EMEP/CORINAIR Guidebook, Chapter B-146.
- CORINAIR Manual (1992), Part 7 Annex, heading 13 on NMVOC.
- CITEPA, for particulate matter emissions (TSP, PM_{10} y $PM_{2.5}$).

b) Boilers, gas turbines and stationary engines

- EMEP/CORINAIR Guidebook, Chapters B-111 and B-112.
- CEPMEIP. Co-ordinated European Programme on Particulate Matter Emission Inventories, Projections and Guidance. This reference was used to estimate particulate matter emissions (TSP, PM_{10} and $PM_{2.5}$).
- OSPARCOM-HELCOM-UNECE (1995), for dioxin emissions.

On the other hand, for stationary engines using natural gas, the emission factors used for NO_X, NMVOC and CO were those obtained from an emissions survey of these pollutants carried out on the basis of the information furnished by the main companies installing this kind of facility.

4.3.4.- Combustion in industry (1A2)

This category covers the set of activities relating to industrial combustion. These processes are divided into the following three large groups:

- Non-specific industrial combustion.

- Combustion industrial in furnaces without contact.

- Industrial combustion processes with contact.

Non-specific industrial combustion is understood to be that which takes place in industrial complexes but which is not specific to any particular industrial branch (so the generation of heat or electricity by combustion in boilers, of gas turbines or stationary engines). Industrial combustion in furnaces without contact is understood as the combustion that is carried out in furnaces (which normally differ from one branch to another in industry) in which neither the flames nor the combustion gases come into direct contact with the materials treated in the furnace. Industrial combustion processes with contact are understood to be those types of combustion in furnaces where either the flames, or the combustion gases do come into contact with the materials treated in the furnace.

This distinction is important when it comes to estimating the emissions given the differentiation of the characteristics that, from the physical point of view, is established between the combustion processes in the activities that make up each category.

4.3.4.1.- Activity variables

For industrial combustion, the basic information sources for the activity variables (fuel consumption) have been the direct data supplied in individualized questionnaires from plants and the national fuel balance, supplemented by information from the main business associations in the sector (among these: Union of Iron and Steel Companies (UNESID); Spanish Federation of Foundry Associations (FEAF); Spanish Cement Association (OFICEMEN); National Association of Lime and Derivatives Manufacturers of Spain (ANCADE); Vidrio España (Spanish Glass); National Association of Manufacturers of Frits, Enamels and Ceramic Colours (ANFFECC); Spanish Association of Manufacturers of Baked Clay Bricks and Roof Tiles (HISPALYT); Spanish Association of Manufacturers of Wall Tiles, Flooring and Ceramic Floor Tiles (ASCER); Association of Spanish Pulp and Paper Manufacturers (ASPAPEL)).

Table 4.3.4.1 shows estimated fuel consumptions for this key source expressed in terms of energy (lower heating value TJ_{LHV}), while Figure 4.3.4.1 shows the evolution of the consumption by type of fuel over the inventory period.

Table 4.3.4.1.- Fuel consumption *(Amounts in TJ_{LHV})*

Type	1990	1995	2000	2004	2005	2006	2007	2008
Liquid	***311,621***	***362,504***	***314,324***	***344,424***	***336,522***	***328,068***	***317,291***	***303,883***
Crude oil							248	257
Diesel	70,850	57,218	94,569	120,811	123,001	121,867	113,383	107,721
Residual oil	170,061	207,874	97,436	83,626	74,614	65,707	71,708	69,791
L.P.G.	13,110	17,117	18,169	18,498	18,289	16,841	16,350	16,022
Bitumen								266
Petroleum coke	55,664	78,205	103,598	121,489	120,618	123,653	115,603	109,488
Refinery gas	1,937	2,090	552					
Other petroleum products								339
Solid	***112,500***	***85,111***	***46,968***	***43,895***	***40,950***	***39,182***	***51,903***	***47,559***
Coking coal								
Hard coal	60,830	24,332	17,604	14,546	14,460	14,655	22,138	19,903
Sub-bituminous coal	1,004							
Coke	18,184	33,323	10,263	12,728	8,844	8,231	12,466	10,887
Gas works gas	82							
Coke oven gas	15,057	14,389	9,654	7,928	8,064	8,193	8,396	8,149
Blast furnace gas	16,612	11,661	8,558	8,187	8,189	6,932	7,699	7,483
Other coal & derived fuels	732	1,405	889	505	1,393	1,171	1,204	1,137
Gases	***153,009***	***245,683***	***467,375***	***645,636***	***676,154***	***663,314***	***652,899***	***628,573***
Natural gas	153,009	245,683	467,375	645,636	676,154	663,314	652,899	628,573
Biomass	***58,937***	***59,788***	***64,376***	***72,882***	***73,081***	***74,271***	***75,707***	***70,284***
Wood/Wood waste	23,502	22,670	21,128	22,710	23,109	23,906	24,594	21,517
Other solid biomass	13,633	13,252	13,175	14,039	14,541	14,678	14,828	14,682
Black liquor	18,217	20,428	26,658	32,880	32,106	32,389	32,923	30,518
Biogas	3,585	3,438	3,414	3,253	3,325	3,298	3,361	3,547
Other liquid biofuels								19
Other			***1,106***	***4,497***	***5,225***	***5,274***	***6,512***	***4,370***
Industrial wastes			1,106	4,497	5,225	5,274	6,512	4,370
Total	**636,067**	**753,086**	**894,149**	**1,111,333**	**1,131,932**	**1,110,109**	**1,104,312**	**1,054,669**

Figure 4.3.4.1.- Evolution of fuel consumption

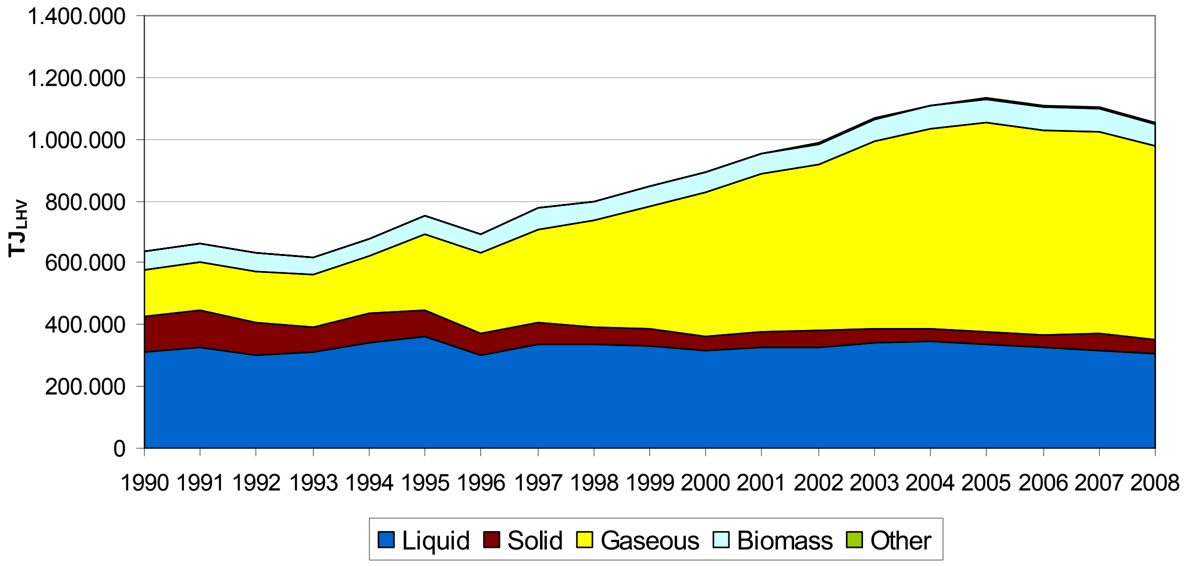
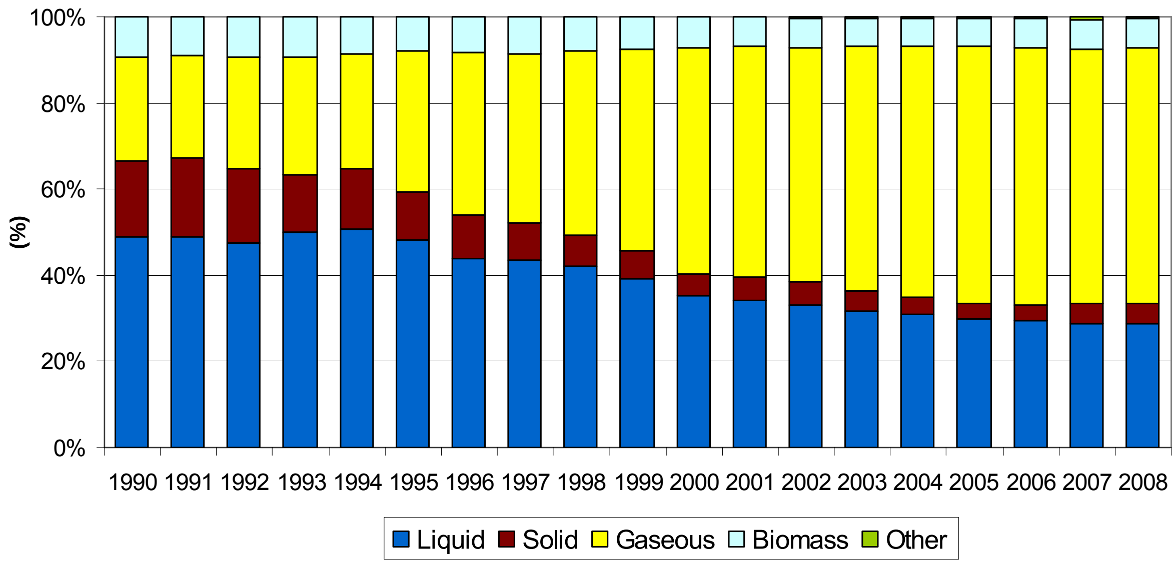


Figure 4.3.4.2 shows the distribution of fuel consumptions by type over the period inventoried. As can be seen, there is substantial increase in natural gas consumption, which in relative terms has a 59.6% contribution in 2008, with a decrease in the liquid fuel participation (of 49% in 1990 and 28.8% in 2008); moreover, in solid fuels (of 17.7% in 1990 and 4.5% in 2008) as a consequence of the progressive replacement of fuels used in the industry.

Figure 4.3.4.2.- Fuel consumption distribution, based on TJ_{LHV}



4.3.4.2.- Methodology

The estimate of the emissions has been carried out based on the default emission factor method, except in those cases in which direct information about the emissions was available (provided by the plants themselves).

4.3.4.2.1.- Advanced methodology

Information regarding combustion in manufacturing industries for certain sectors was compiled by means of individual questionnaires submitted to plants. Data has thus being gathered for different pollutant emissions, generally SO_X and TSP, as well as other pollutants (particularly those associated with integrated steel plants).

On the other hand, for stationary engines using natural gas, the emission factors used for NO_X, NMVOC and CO were those obtained from an emissions survey of these pollutants carried out on the basis of the information furnished by the main companies installing this kind of facility.

A specific methodology was used for cement production activities. In the Inventory edition that covered the period 1990-2005, the values of the emission factors provided by OFICEMEN as an average of the values measured within the Environmental Benchmarking

programme for the clinker production plants located in Spain in 2003. The list of substances included in the Inventory for which there has been data available are: SO_2, NO_X, NMVOC, CO, Cd, Hg, Pb, TSP and dioxins. Considering these new data as better in quality than the ones provided by the default emission factors, which do not take into account the penetration and efficacy of the reduction technologies, the values provided by OFICEMEN in tonnes of clinker produced[23], were taken as representative values for 2005.

However, in order to apply an estimation procedure that is homogeneous over time, it was necessary to project the previous emission factors until 1990. To do that, OFICEMEN worked out the expected evolution of the incorporation of reduction technologies, as well as their impact on the emissions of the pollutants considered. The result in this respect, which in turn has made it possible to quantify the emission factors for 1990-2004, was as follows:

a) Substances with linear reduction over the years (1990-2005): SO_X, NO_X, NMVOC and CO.

b) Substances with linear reduction in the differentiated periods (1990-2005, 2000-2005): Cd, Hg, Pb, and TSP.

c) Period 2006-2008:

For each of these years, the updated information furnished by OFICEMEN has been similar to that supplied for 2005.

The algorithm applied with the data on the reduction rates indicated is as follows:

- For particles and metals. There are two periods depending on the annual penetration rate of the techniques and the level of reduction achieved: 1990-2000 and 2000-2005

$$FE_{X,t} = FE_{X,t'} \cdot \frac{\beta_{t',1990}(2000-t) + \beta_{t',2000}(t-1990)}{(2000-1990)} \quad si\ 1990 \leq t \leq 2000$$

$$FE_{X,t} = FE_{X,t'} \cdot \frac{\beta_{t',2000}(t'-t) + (t-2000)}{(t'-2000)} \quad si\ 2000 \leq t \leq t'$$

- For other pollutants: linear progression in the reduction levels

$$FE_{X,t} = FE_{X,t'} \cdot \frac{\beta_{t',1990}(t'-t) + (t-1990)}{(t'-1990)}$$

where

$FE_{X,t}$, $FE_{X,t'}$: Emission factors of the pollutant X estimated for the year t and the reference year t' (t' = 2005)

23 It is preferable to refer the emission factors to the clinker produced instead of to cement, in order to avoid errors due to clinker imports/exports.

$\beta_{t',1990}$, $\beta_{t',2000}$: Increase detected in the factor for the years 1990 and 2000 in relation with the one applied for the reference year t' (t' = 2005) (that is, $\beta_{t',t} = 1/(1-\alpha_{t',t})$, $\alpha_{t',t}$ representing the factor reduction for the year t' as opposed to the one corresponding to the year t).

The values indicated below have been assumed as complementary data for the application of the emission estimation algorithm for the following parameters:

Volume of effluent gases per tonne of clinker:	2,300 m^3N/t clinker[24]
Clinker/cement mass ratio (OFICEMEN):	0,77

Additionally, in the case of dioxins, the emission factor used, 36.53 ng I-Teq/t for clinker, was obtained from the survey carried out by CIEMAT for the cement industry (please refer to heading 4.5 with bibliographical references).

Finally, it should be mentioned that, in those cases where measured TSP emissions were available, $PM_{2.5}$ and PM_{10} emissions have been estimated by applying to the TSP emission the ratios derived from the emission factors data proposed by CEPMEIP regarding the proportion of $PM_{2.5}$ and PM_{10} emissions to TSP.

4.3.4.2.2.- Default methodology

Boilers, gas turbines and stationary engines

As follows, the main specific characteristics are mentioned regarding the emission factors, with it being understood that, unless stated otherwise, the information is of a generic type and is summed up in an average emission factor for each type of combustion and fuel unit used.

a) Main pollutants

One specific feature referring to the characteristics of the fuels, such as the content of sulphur in gas-oils or residual oils, which have changed throughout the time interval for 1990-2008 covered by the Inventory has a direct impact on the determination of the emission factor for SO_X. Specifically speaking, the dependence of the emission factor on this pollutant with respect to the content of sulphur in the fuel is shown in formula 4.3.4.2.1 below:

$$EF_{SO2}[g/GJ] = 2 \cdot S_{fuel} \cdot (1-\alpha_S) \cdot (1/H_U) \cdot 10^6 \qquad [4.3.4.2.1]$$

with the following meanings for the symbols:

S_{fuel}: sulphur content in the fuel (expressed in kg of sulphur per kg of fuel)

α_S: retention of sulphur in the ash

H_U: lower heating value of the fuel (in MJ per kg of fuel).

[24] Source: BREF European Reference Document on Best Available Technologies in the Lime and Cement Manufacturing Industries.

As a result of applying formula 4.3.4.2.1, the downward trend observed throughout the period 1990-2008 in the gas-oil's sulphur content shows up in a similarly downward shift in the SO_x emission factor for this type of fuel. Identical behaviour is seen in residual oil, in particular the range of factors inferred from the composition of the different residual oils provided by the plants in the questionnaire.

For the rest of the pollutants in this block, the working team for the Inventory has selected a central value for the emission factors when the original information, taken from the EMEP/CORINAIR Guidebook (Chapters B111 and B112), shows a possible range (not a specific value) of variation in the factors.

On the other hand, for stationary engines using natural gas, the emission factors used for NO_X, NMVOC and CO were those obtained from an emissions survey of these pollutants carried out on the basis of the information furnished by the main companies installing this kind of facility.

b) Priority metals

Emission factors for heavy metals were obtained from EMEP/CORINAIR Guidebook (chapters B111 and B112).

For particles, the emission factors proposed by CEPMEIP have been taken with a medium emission level, and taking into account the socio-economic sector in which the combustion occurs. However, it has been possible to make use of measured TSP emissions in certain installations treated as point sources and with data obtained via questionnaire. In these cases, the absolute value of the measured emission has been used to calculate the specific emission level (of the four proposed by CEPMEIP) and, once this level had been determined, the proportions of the emissions of the other two diameters of particles ($PM_{2.5}$ and PM_{10}), have been obtained by taking the same proportion proposed by CEPMEIP for the selected level with respect to the estimation of the TSP provided by the facilities.

c) Persistent organic pollutants

As for persistent organic pollutants, only the emissions of dioxins and furans (DIOX) and polycyclic aromatic hydrocarbons (PAH) have been considered significant.

The information for the DIOX, expressed in terms of international units for toxicity equivalent (I-Teq), comes from Table 4.5.1 in OSPARCOM-HELCOM-UNECE (1995), see bibliography, having selected the values that appear in the column corresponding to "limited implementation of the technique for the reduction of emissions" (*semi-abatement*), since it is considered that this situation is generally prevalent for the facilities in this group. For fuel oil, only the factor appears corresponding to the case in which there is a lack of control techniques, hence a reduction of 90% has been assumed for the value that corresponds to the option of no reduction (*no abatement*). For gas-oil, for which no information was available in the aforementioned source either, a value of 1/5 of the factor corresponding to the fuel oil has been taken, similar to that used in inventories for other countries, and specifically speaking in the French case (according to a personal report supplied by the CITEPA). For the wood waste products, the value taken for the factor means that such waste products are not impregnated with PCP (pentachlorophenol). Finally, for coke, the information used has been that appearing in Parma, Z. et al. (1993), Tables 13 and 19, in which the emission factors are stated for the coke used in boilers. Comparing the said values with those for coal it

may be seen that the emission factor for coke is approximately 1/6 of the value stated in the said source for coal (13.7 for coke and 75.3 for coal), hence that proportion has been assumed in the value that is stated in OSPARCOM-HELCOM-UNECE (1995) for coal.

As regards to the PAH information, it comes from the EMEP/CORINAIR Guidebook (Part B, Chapter PAH) and refers exclusively to the carbon and wood fuels. Amongst the compounds considered, exclusively the four from the Protocol for persistent organic pollutants have been included (Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k) fluoranthene and Indene(1,2,3-cd)pyrene).

Process furnaces

The default methodology applied to estimate emissions is essentially that of EMEP/CORINAIR. However, in certain cases other references were used to estimate emissions whenever the EMEP/CORINAIR guidelines do not provide any emission factors. More specifically, the references used to obtain default emission factors included:

- EMEP/CORINAIR Guidebook.
- Manual CORINAIR (1992).
- CEPMEIP. This reference was used to estimate particulate emissions (TSP, PM_{10} and $PM_{2.5}$), assuming emission levels according to the status of plants or industries.
- PARCOM-ATMOS (1992) for heavy metals emissions and, in certain activities, for dioxins.
- OSPARCOM-HELCOM-UNECE (1995), for dioxin emissions.
- Holoubek I. et al. (1993) to estimate PAH emissions from certain activities.

4.3.5.- Domestic air traffic (1A3a)

This category includes activities related to air traffic within or in the surroundings of airports (landing and take-off cycles, LTO). More specifically, LTOs include landing operations (below 1000 m altitude), airplane manoeuvring until reaching the landing point, airplane manoeuvring from landing points to head lanes and take-off (again until reaching 1000 m. altitude).

Within this category two types of air traffic (segments) may be distinguished based on country of origin and destination for flights, regardless of air carrier nationality; thus, domestic traffic is defined as all airplane traffic between two domestic airports, and international traffic includes all flights whose origin or final destination is a foreign airport.

With regard to the pollutants analyzed in the present report, NO_X, NMVOC, SO_X, CO, particulate matter, Cd and PAH, their emissions were estimated for this category; whereas the remaining pollutants (NH_3, Pb, Hg and DIOX) could not be estimated due to the lack of representative factors, although these are presumably of scant relevance for this activity. As for their contribution to the entire inventory, this activity is a scarcely significant emitting source, accounting for less than 0.8% of the inventory for all pollutants.

4.3.5.1.- Activity variables

The socio-economic variable needed to estimate consumption and emissions for this category activities is the number of **landing and take-off cycles (LTO) by segment (domestic and international)**. This information is published in air traffic statistics produced by the Ministry of Public Works[25] for each airport[26].

The estimation of consumption attributed to LTOs is carried out per domestic civil airport by applying an average annual consumption factor (total volume of fuel consumed per LTO) obtained from the characterization of the aircraft operating in each airport.

For the period between 1996 and 1998, the public business entity in charge of running civil airports and controlling air navigation, AENA[27], developed an exhaustive study on the types of planes landing and taking off from each airport, separating them according to their domestic or international nature. In order to assign consumption ratios to the various LTO operations, the database designed by ICAO [28] regarding exhaust emissions and consumptions by type of engine was consulted. The Fleet Planning and Environment Unit of the IBERIA airline company provided considerable assistance in the task of integrating information from both sources, national and international, which allowed a representative aircraft class identified by ICAO[29] made up of an IATA code and an engine configuration (number, models and representation in the class) to be established for each denomination of plane considered by AENA.

For the remaining years of the period inventoried, information gathering by AENA was unviable given the volume of information requested. For this reason, it has been decided that mean factors per airport inferred for the nearest available year should be assumed in the appropriate reference year

Table 4.3.5.1.1 shows the number of landing and take-off cycles and fuel consumption expressed in energy terms (TJ of lower heating value) based on segment-type. Figure 4.3.5.1.1 shows a virtually sustained increment throughout the period in fuel consumption as a direct consequence of the growth in air traffic, in continuous expansion throughout the period, only altered by the economic crisis in 1993 and 2001-2002[30] and 2008 (see traffic evolution in Figure 4.3.5.1.2).

---

[25] "Tráfico comercial en los aeropuertos españoles", Directorate-General for Civil Aviation (DGAC), Ministry of Public Works.

[26] Military and official state flights, private traffic and air-related activities are not included.

[27] AENA (Spanish Airports and Air Navigation)

[28] "Engine Exhaust Emissions Data Bank". 1995 Edition. ICAO (International Civil Aviation Organization)

[29] Combination of data included in "ICAO Aircraft Type Designators" and in "ICAO Engine Exhaust Emissions Data Bank"

[30] With respect to the reduction in air traffic activity in 2002, it is worth mentioning other relevant factors in the slowdown such as the international repercussions following the terrorist attacks in the United States in September, 2001.

Table 4.3.5.1.1.- Number of LTO cycles and fuel consumption in airports

Segment	1990	1995	2000	2004	2005	2006	2007	2008
Domestic								
Number of cycles	204.353	264.079	400.524	446.556	487.708	515.313	548.121	525.959
Consumption (TJ_{LHV})	6.413	8.299	12.726	13.923	15.206	15.983	16.975	16.165
CF (GJ_{LHV} /LTO)	31,4	31,4	31,8	31,2	31,2	31,0	31,0	30,7
International								
Number of cycles	171.628	237.488	348.030	412.025	435.080	454.321	493.344	484.117
Consumption (TJ_{LHV})	5.298	7.322	10.833	12.701	13.360	13.933	15.149	14.883
CF (GJ_{LHV} /LTO)	30,9	30,8	31,1	30,8	30,7	30,7	30,7	30,7
Total LTO								
Number of cycles	**375.981**	**501.566**	**748.554**	**858.581**	**922.788**	**969.633**	**1.041.465**	**1.010.076**
Consumption (TJ_{LHV})	**11.710**	**15.621**	**23.559**	**26.624**	**28.566**	**29.915**	**32.124**	**31.048**
CF (GJ_{LHV} /LTO)	**31,1**	**31,1**	**31,5**	**31,0**	**31,0**	**30,9**	**30,8**	**30,7**

Figure 4.3.5.1.1.- Fuel consumption in airports

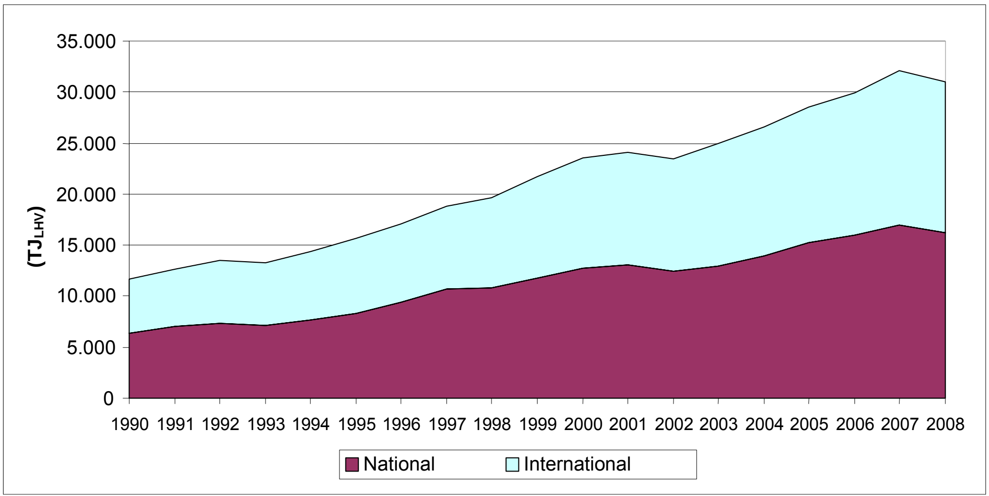
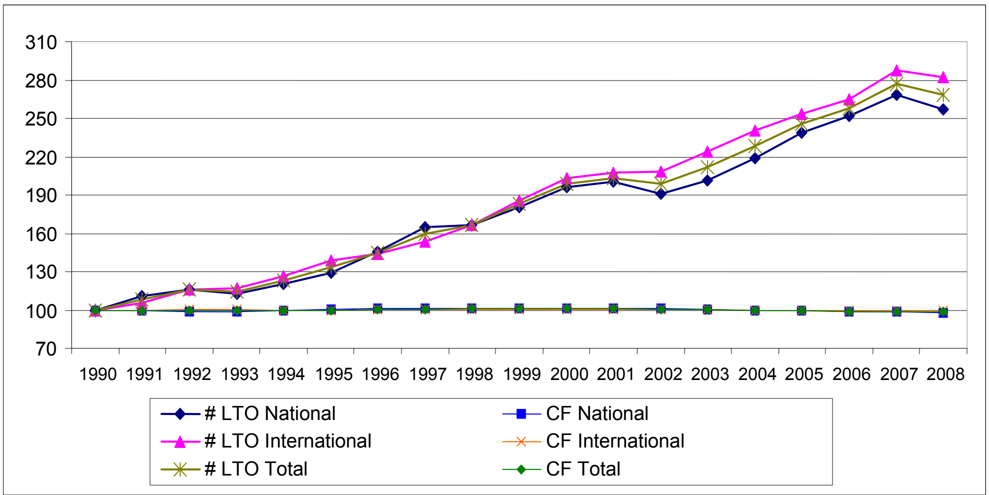


Figure 4.3.5.1.2.- Evolution index for the number of LTO cycles and airport implicit consumption factor per LTO (baseline year 1990=100)



4.3.5.2.- Methodology

4.3.5.2.1.- Advanced methodology

To estimate NO_X, CO, VOC (volatile organic compounds) the procedure chosen was similar to that applied when determining the airport consumption factor (see section above). Thus, specific emission factors were estimated in each airport for these pollutants based on detailed baseline information for airport traffic for 1996-1998 and the ICAO database on engine exhaust emissions. Using the IPCC Reference Manual and EMEP/CORINAIR Guidebook, methane emissions were assumed to account for 10% of total volatile organic compound (VOC) emissions, the remaining 90% corresponding to NMVOC.

4.3.5.2.2.- Default methodology

To estimate the remaining pollutants (SO_X, Cd, particulate matter and PAH) the simple methodology (Tier 1) proposed by IPPC's Good Practice Guidance 2000, based on fuel consumption, was used.

With regard to emission factors, the following reference sources were chosen:

- Chapter B-851 from EMEP/CORINAIR Guidebook for SO_X, obtaining a fuel consumption factor based on original emission and consumption factors corresponding to an average fleet in terms of length of service (both expressed in terms of number of cycles).

- Chapter B-810 from EMEP/CORINAIR Guidebook for Cd and PAH.

- The compilation of factors developed within the CEPMEIP programme framework for particulates. For kerosene, the factor with low to medium-high abatement levels (levels 1 to 3) was used, specifying 1.16 grammes of emissions per gigajoule of fuel for any of the particulate categories considered. For conversion into mass units, a mean lower heating value of 43.36 gigajoules was applied per tonne of fuel.

4.3.6.- Road Transport (1A3b)

This category contemplates pollutant emissions due to vehicle traffic whose main purpose is the transportation of passengers or merchandise. The category does not include those groups of self-propelled vehicles that, despite performing or being able to perform a transportation service, are classified and used instead as industrial or agricultural-forestry machinery (these vehicles are dealt with in categories 1A2 and 1A4, respectively).

4.3.6.1.- Activity Variables

There are three main activity variables used to calculate road traffic emissions:

1. Fuel consumption figures based on information from the following sources:[31]:

   "Energy Statistics of OECD Countries" by the International Energy Agency

   "Energy Balance Sheets" by EUROSTAT, and

   "Oil-derived Product Consumption Statistics" by the Sub-Directorate-General for Hydrocarbons at the Spanish Ministry of Industry, Tourism and Commerce.

2. Official figures on registered vehicles, distributed by category, age, cubic capacity and useful load, published in the *Statistical Yearbook* of the Directorate-General for Traffic at the Ministry of the Interior.

3. Figures regarding journeys including: the State Road Network (Red de Carreteras del Estado), Regional Community networks and Provincial networks. These figures are provided by the Directorate-General for Roads at the Ministry for Public Works. These journey figures are broken down by vehicle category and correspond to what the inventory refers to as interurban and rural routes.

   In addition, the information derived from the "Standing Survey of Road Freight" (prepared by the Subdirectorate-General for Statistics and Surveys at the Directorate-General for Economic Programming of the Ministry of Public Works) has been included for the determination of the journeys by heavy vehicles engaged in freight transport.

4. The distribution of the journeys for each vehicle category into interurban, rural and urban routes depending on the cylinder capacity, age, maximum authorized weight and fuel type, as prepared by the inventory task force on the basis of the information from the Directorate-General for Roads cited above and the samplings effected in the roads of Madrid city during 2008 and 2009.

4.3.6.1.1.- Fuel consumption

The most outstanding facet are the sustained growth in fuel consumption till the year 2007 included as a result of interannual increases in vehicle use, and the 6% decrease in year 2008, consistent with the 5% decrease in the total distance travelled in that same year. A separate analysis for each type of fuel can be find below.

Petrol and diesel

Making a distinction by type of fuel, the steady growth of the participation of diesel consumption against the gasoline, consumption which, after a growth in the initial years was followed by stability in the intermediate years, shows a decreasing pattern from 1998. The

[31] Starting from the original data of the various references sources the emissions inventory team estimates the road fuel consumption, subtracting as appropriate from the sold fuel figures the fuel consumption that should be attributed to another mobile sources other than that of road transport (mainly mobile industrial equipment). Additionally, in case of data discrepancies among the various original sources, the emission inventory team estimates what is to be considered a most accurate figure to be introduce as the fuel consumption (based on sold fuel amounts) for the road transport activity.

evolution in figures for gasoline ranges between 8,000 to 9,000 Gg until 2003, steadily descending to 6,142 Gg in 2008; while diesel has shot from 7,788 Gg in 1990 to 22,826 Gg in 2008 (consumption of liquefied gases is marginal). This has led to a modification in the relative distribution of consumption between petrol and diesel fuel, starting with a practically equal distribution in 1990 and reaching a situation where diesel fuel represents almost three-quarters the total consumption in 2008, as can be seen in table 4.3.6.1 and in figure 4.3.6.1.

Natural Gas

The series of natural gas consumptions in road transport provided by SEDIGAS have been available for the period 2006-2008, together with the historical information on the vehicle fleets using natural gas. Based on this information, the series of consumption figures for this fuel has been constructed from 1997 to 2005, having regard for the vehicle fleet consumptions requirement. Table below shows this series in energy terms expressed as lower heating values (LHV).

Natural gas consumption in the period 1997-2008

Año	Consumo (TJ)
1997	103
1998	206
1999	309
2000	412
2001	515
2002	623
2003	721
2004	824
2005	927
2006	1,030
2007	1,607
2008	1,819

GLP

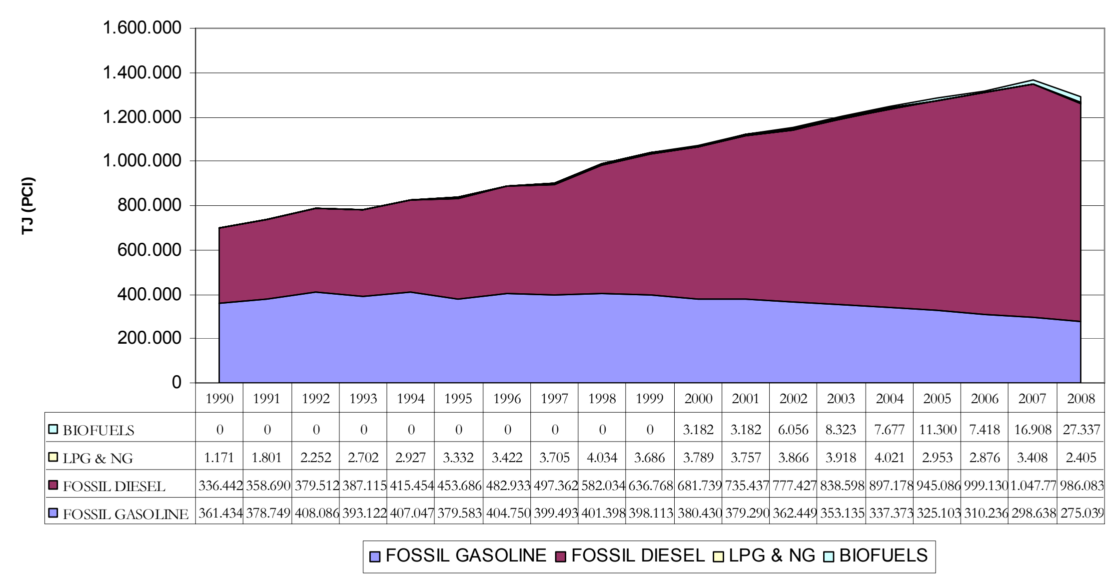
In Spain, the consumption of liquefied petroleum gases in road traffic has always been marginal in comparison with that of other fuels, with a clearly downward trend from 2004, more marked in 2008 with a fall of about 66% with respect to 2007 (i.e. from 40 kt in 2007 to 13 kt in 2008).

Biogenic componets in petrol and diesel fuels

With respect to the biogenic components, that of diesel (ester) has grown significantly in the last two years, reaching 2.5% of the total consumption of this fuel, whereas that of gasoline (ethanol), which started from levels around 175 kt in 2005-2007 (2.6% of consumption in 2007), has fallen in 2008 to 144 kt (2.3% of the total), in other words a drop of almost 20%.

The contribution to the emissions of the fossil and renewable part of the liquids fuels contributions used in road transportation is shown in the Excel spreadsheets elaborated by the CRF in the following way: the CH_4 and N_2O emissions have been included totally within the fossil liquid fuels, this is indicated in the stated pollutant emissions for the biomass with the label “IE” (estimated elsewhere); while for the CO_2 each part (fossil and renewable) has its own emission, reflecting the associated to the renewable part as *Memo* concept only.

Figure 4.3.6.1.- Gasoline and Diesel consumption *(Amounts in Gg)*



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
BIOFUELS	0	0	0	0	0	0	0	0	0	0	3.182	3.182	6.056	8.323	7.677	11.300	7.418	16.908	27.337
LPG & NG	1.171	1.801	2.252	2.702	2.927	3.332	3.422	3.705	4.034	3.686	3.789	3.757	3.866	3.918	4.021	2.953	2.876	3.408	2.405
FOSSIL DIESEL	336.442	358.690	379.512	387.115	415.454	453.686	482.933	497.362	582.034	636.768	681.739	735.437	777.427	838.598	897.178	945.086	999.130	1.047.77	986.083
FOSSIL GASOLINE	361.434	378.749	408.086	393.122	407.047	379.583	404.750	399.493	401.398	398.113	380.430	379.290	362.449	353.135	337.373	325.103	310.236	298.638	275.039

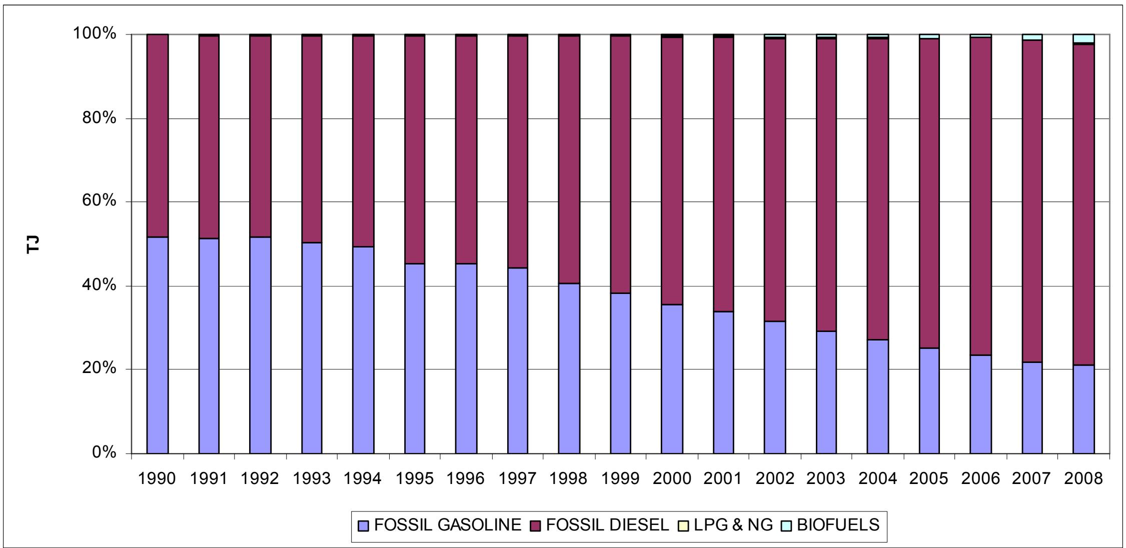


Table 4.3.6.1.- Fuel consumption *(Amounts in Gigagrammes)*

Type	**1990**	**1995**	**2000**	**2004**	**2005**	**2006**	**2007**	**2008**
Diesel	**7,788**	**10,502**	**15,861**	**20,881**	**22,039**	**23,191**	**24,557**	**23,414**
Fossil	*7,788*	*10,502*	*15,781*	*20,768*	*21,877*	*23,128*	*24,254*	*22,826*
Renewable (pure biogenic gas oil)			*80*	*113*	*162*	*63*	*303*	*588*
Gasoline	**8,145**	**8,534**	**8,524**	**7,650**	**7,437**	**7,107**	**6,846**	**6,286**
Fossil Leaded	*8,047*	*6,268*	*3,109*					
Fossil Unleaded	*98*	*2,266*	*5,415*	*7,534*	*7,260*	*6,928*	*6,669*	*6142*
Renewable (pure biogenic ethanol)				*116*	*177*	*179*	*177*	*144*
L.P.G.	**26**	**74**	**75**	**71**	**45**	**41**	**40**	**13**
Natural Gas	**0**	**0**	**9**	**17**	**19**	**21**	**33**	**38**

4.3.6.1.2.- Vehicle fleets

In the *"Anuario Estadístico General"* ("General Statistical Yearbook") published annually by the Dirección General de Tráfico or DGT (Spanish Traffic Department), information is given regarding the number of registered vehicles using the following classification of self-propelled vehicles (hereinafter referred to as the *DGT classification*):

1) **Buses**

All vehicles specifically designed to transport passengers with a capacity of more than 9 people, including the driver, are included in this category; this term also covers vehicles powered by an electrical cable (trolley buses).

2) **Lorries**

All vehicles specifically designed for goods transport are included in this category, with the exception of three-wheel motorcycles with a tare weight that does not exceed 400 kg.

3) **Motorcycles**

Motorcycles are two-wheel vehicles with or without a sidecar.

4) **Private cars**

Vehicles designed to transport people with a capacity of up to nine people including the driver.

5) **Industrial Tow Units**

Vehicles designed to pull trailers or semi-trailer units.

6) **Mopeds**

Vehicles with two wheels and cylinder capacity less than 50 c.c.

The information is published with varying degrees of itemisation per vehicle class and age, depending on the field it belongs to. For the emissions estimation under consideration here, the following tables have been used:

I) **Distribution of the number of vehicles by fuel type and years of age.**

This table provides information about the number of vehicles still active in the year of publication (in the terminology of DGT *active fleet),* corresponding to each cross-tab for the following variables: **year registered**, **vehicle class** (according to the classification given above) and **type of fuel**: gasoline or diesel. An example of the information offered for the year 2008 regarding the fleet situation is given in Table 4.3.6.2.

Table 4.3.6.2.- National vehicle fleets on 31/12/2008 by class of fuel and vehicle age

YEAR	TRUCKS		BUSES		PASSENGERS CARS		MOTORCYCLES		INDUSTRIAL TOW UNITS	
REGD.	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel
1988	449,746	781,107	488	15,801	4,489,987	459,423	1,063,963	2,849	488	24,008
1989	33,324	86,690	34	865	284,464	45,595	71,359	40	75	2,618
1990	32,169	95,473	10	934	286,538	50,850	82,447	5	67	2,368
1991	35,038	95,049	28	1,213	317,887	50,942	86,155	3	55	1,977
1992	38,705	107,525	26	1,563	401,032	85,994	76,155	3	30	1,736
1993	27,342	81,408	32	1,351	330,158	100,795	38,594	1	12	967
1994	22,840	100,581	30	1,372	410,976	157,927	27,526	2	25	1,705
1995	17,282	115,387	26	2,023	354,476	194,225	25,522	1	50	3,652
1996	15,540	139,402	17	2,394	400,998	284,487	24,413	3	60	3,944
1997	17,107	178,356	18	2,798	470,118	386,788	35,289	1	89	6,203
1998	17,819	213,506	22	3,213	540,112	537,135	48,434	4	160	8,248
1999	19,543	259,634	29	3,625	627,461	680,637	60,930	4	174	11,428
2000	18,178	256,193	65	3,096	590,904	700,486	63,154	11	148	12,895
2001	19,990	247,663	55	3,295	637,191	703,313	59,854	9	115	14,133
2002	15,388	238,162	75	2,922	525,385	724,674	59,114	12	119	14,026
2003	15,759	272,438	34	3,091	520,185	829,573	72,671	27	117	15,402
2004	16,378	309,898	22	3,553	515,034	996,451	119,158	69	126	17,857
2005	14,912	360,653	15	4,052	487,943	1,068,244	215,905	161	137	19,875
2006	15,522	370,157	34	3,730	466,860	1,082,679	270,782	113	67	20,481
2007	13,405	375,946	42	3,860	454,774	1,077,997	282,261	129	74	22,577
2008	7,190	210,535	10	3,753	364,396	788,671	220,556	65	44	16,199
TOTAL	863,177	4,895,763	1112	68,504	13,476,879	11,006,886	3,004,242	3,512	2,232	222,299

Source: "Anuario Estadístico General. 2008". Dirección General de Tráfico. Ministerio del Interior (Published by Spanish Traffic Department).

II) Distribution of the Number of Lorries in the Country by payload and age.

This table provides the number of transport trucks and vans, given in the previous table, broken down into different categories according to kilogrammes of payload, although it does not take into account the type of fuel used. This data, for 2008, is presented in Table 4.3.6.3 y 4.3.6.4.

Table 4.3.6.3.- National fleet of lorries on 31/12/2008, according to payload and age

YEAR RGD.	Up to 999	1,000 to 1,499	1,500 to 2,999	3,000 to 4,999	5,000 to 6,999	7,000 to 9,999	Over 9,999
1988	52,131	45,717	23,749	20,120	11,224	15,351	30,864
1989	4,892	6,720	4,147	3,508	1454	2200	4,297
1990	6,173	8,036	4,181	3,772	1685	2,469	4,442
1991	6,816	8,133	3,314	3,079	1,514	2,243	3,706
1992	8,820	8,628	3,231	3,007	1,337	2,117	2,798
1993	9,425	5,516	2,051	1,777	874	1,224	1,325
1994	16,596	7,132	2,258	2,013	794	1,279	1,696
1995	35,120	9,666	3,056	2,538	1,176	1,732	1,878
1996	61,211	11,406	3,816	2,645	1173	1,787	1,784
1997	89,450	16,034	5,261	3,264	1562	2,427	2,652
1998	108,006	20,263	6,908	3,694	1,824	2,927	3,732
1999	129,158	24,599	8,407	4,252	2,351	3,972	5,384
2000	132,080	27,193	10,228	4,131	2,449	4,035	5,640
2001	124,592	24,494	8,815	4,113	2,414	4,152	6,269
2002	116,746	25,108	6,791	3,585	2,310	4,209	6,307
2003	132,676	33,167	6,589	3,627	2,258	4,329	7,257
2004	148,058	38,894	6,853	3,822	2,572	4,137	7,725
2005	172,283	42,387	8,015	4,054	2,859	4,813	8,043
2006	185,401	42,322	8,446	4,065	2,645	4,879	8,467
2007	185,837	39,670	9,589	4,147	2,905	4,976	8,348
2008	93,457	20,746	5,645	3,026	2,266	3,359	5,083
TOTAL	**1,818,928**	**465,831**	**141,350**	**88,239**	**49,646**	**78,617**	**127,697**

Source: "Anuario Estadístico General. 2008". Dirección General de Tráfico. Ministerio del Interior (Published by Spanish Traffic Department).

Table 4.3.6.4.- National fleet of light duty vehicles according to payload and age

Year RGD.	Up to 499 kg	500 to 749 kg	750 to 999 kg	Over 999 kg
1988	201,251	121,593	65,186	76,322
1989	18,530	51,198	11,257	11,814
1990	22,968	52,767	10,101	11,050
1991	26,147	51,593	11,352	12,202
1992	26,980	66,466	11,894	11,023
1993	19,635	50,385	9,476	7,065
1994	17,531	56,498	9,814	7,810
1995	13,282	48,379	8,154	7,689
1996	10,790	45,939	8,030	6,362
1997	11,009	46,335	10,782	6,687
1998	11,695	51,892	13,501	6,890
1999	14,077	61,196	17,214	8,569
2000	15,703	49,863	15,184	7,878
2001	14,039	52,660	14,439	11,685
2002	14,005	50,194	11,540	12,791
2003	16,006	51,943	14,676	15,683
2004	19,963	57,153	18,112	19,019
2005	22,123	70,538	20,897	19,579
2006	19,358	72,772	20,338	17,046
2007	20,054	69,680	20,438	23,950
2008	13,977	41,106	12,616	16,523
Total	**549,123**	**1,220,150**	**335,001**	**317,637**

Source: "Anuario Estadístico General. 2008". Dirección General de Tráfico. Ministerio del Interior (Published by Spanish Traffic Department).

III) Distribution of the Number of cars and motorcycles in the country, by engine capacity and age.

With regard to passenger cars and motorcycles, the figures given in Table 4.3.6.2 are broken down by engine capacity and, as in the previous case, without taking into account the fuel used (please see Tables 4.3.6.5 and 4.3.6.6 respectively).

Table 4.3.6.5.- National fleet of passengers cars on 31/12/2008 according to engine

YEAR RGD.	Up to 1,199 cc	1,200 to 1,599 cc	1,600 to 1,999 cc	Over 1,999 cc
1988	1,231,672	797,744	353,464	224,677
1989	59,972	133,635	101,662	34,837
1990	63,007	129,141	107,792	37,466
1991	68,518	137,255	125,820	37,540
1992	79,211	151,943	208,327	50,099
1993	56,291	135,512	194,247	44,918
1994	77,677	193,024	252,710	45,502
1995	60,934	182,245	252,035	53,492
1996	62,893	237,816	314,570	70,209
1997	79,930	290,332	397,168	89,479
1998	82,424	346,867	539,500	108,470
1999	98,015	395,558	708,271	106,271
2000	76,200	386,294	716,725	112,392
2001	84,753	413,036	708,061	134,724
2002	78,701	386,109	650,722	134,547
2003	79,676	438,042	677,981	154,067
2004	78,349	528,556	734,727	169,893
2005	62,978	625,016	695,597	172,612
2006	67,709	648,219	647,172	186,456
2007	57,246	644,142	651,752	179,665
2008	49,890	516,136	471,324	115,753
TOTAL	**2,656,046**	**7,716,622**	**9,509,627**	**2,263,069**

Source: "Anuario Estadístico General. 2008". Dirección General de Tráfico. Ministerio del Interior (Published by Spanish Traffic Department).

Table 4.3.6.6.- National fleet of Motorcycles on 31/12/2008 according to engine capacity and age

YEAR RGD.	Up to 75 cc	75 to 124 cc	125 to 249 cc	250 to 499 cc	500 to 749 cc	Over 750 cc
1988	116.597	94.293	232.204	62.059	31.496	22.884
1989	20.154	14.548	10.767	5.882	16.465	3.583
1990	21.661	12.647	12.475	7.692	23.186	4.792
1991	18.943	14.369	10.736	9.388	26.113	6.613
1992	14.129	11.203	10.044	8.830	24.768	7.185
1993	6.907	6.772	4.676	4.125	12.303	3.813
1994	4.291	4.649	5.658	2.745	7.331	2.854
1995	4.033	5.435	5.812	1.752	5.776	2.716
1996	2.193	6.727	5.597	1.586	5.365	2.948
1997	1.112	10.572	10.281	1.876	7.236	4.213
1998	489	15.328	14.882	2.217	9.592	5.931
1999	314	19.263	16.856	3.576	13.116	7.810
2000	212	17.398	18.499	3.660	14.947	8.449
2001	188	14.071	18.734	4.304	14.033	8.533
2002	109	12.196	18.350	4.649	14.544	9.281
2003	86	15.378	21.899	6.731	17.730	10.878
2004	126	37.246	29.297	10.363	26.643	15.562
2005	98	102.860	40.158	14.652	37.362	20.967
2006	128	123.551	43.937	18.780	55.395	29.156
2007	129	121.782	40.254	22.778	61.643	35.867
2008	210	88.665	26.577	20.320	51.389	33.631
TOTAL	**212.109**	**748.953**	**597.693**	**217.965**	**476.433**	**247.666**

Source: "Anuario Estadístico General. 2008". Dirección General de Tráfico. Ministerio del Interior (Published by Spanish Traffic Department).

IV) Registration of mopeds

Another data set in the Yearbook that is provided for the first time in 2001 is that comprising the number of registrations of mopeds by provinces, used together with other information to obtain an approximation to the total fleet of mopeds and its age structure for all of the years in the period with which we are concerned. This data are presented for the year 2008 in the table 4.3.6.7 bellow.

Table 4.3.6.7.- Moped registration by provinieses at 31/12/2008

PROVINCIA	CICLOMOTORES
ÁLAVA	264
ALBACETE	954
ALICANTE/ALACANT	4.097
ALMERÍA	1.869
ASTURIAS	1.200
ÁVILA	219
BADAJOZ	1.656
BALEARS (ILLES)	4.743
BARCELONA	11.378
BURGOS	240
CÁCERES	697
CÁDIZ	6.374
CANTABRIA	768
CASTELLÓN/CASTELLÓ	1.185
CEUTA	273
CIUDAD REAL	1.165
CÓRDOBA	2.081
CORUÑA (A)	1.374
CUENCA	381
GIRONA	2.353
GRANADA	2.981
GUADALAJARA	331
GUIPÚZCOA	971
HUELVA	1.244
HUESCA	310
JAÉN	1.504
LEÓN	581
LLEIDA	691
LUGO	423
MADRID	5.184
MÁLAGA	4.999
MELILLA	182
MURCIA	3.742
NAVARRA	880
OURENSE	433
PALENCIA	131
PALMAS (LAS)	1.972
PONTEVEDRA	1.577
RIOJA (LA)	337
SALAMANCA	302
SANTA CRUZ DE TENERIFE	1.393
SEGOVIA	157
SEVILLA	5.621
SORIA	103
TARRAGONA	1.768
TERUEL	225
TOLEDO	1.200
VALENCIA/VALÈNCIA	4.610
VALLADOLID	438
VIZCAYA	868
ZAMORA	251
ZARAGOZA	1.716
TOTAL	90.396

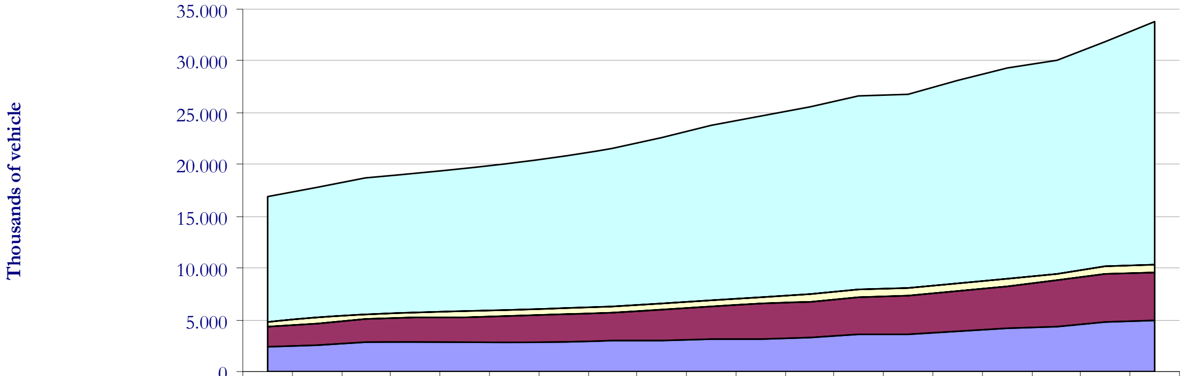
Source: "Anuario Estadístico General. 2008". Dirección General de Tráfico. Ministerio del Interior (Published by Spanish Traffic Department).

Registered fleet evolution

After describing the vehicles categories within the vehicles registered fleet, we turn now to show how that fleet has evolved along the years, and in this regard it is apparent that the vehicle numbers have increase significantly along the inventoried period (1990-2008). As

can be seen in figure 4.3.6.2, it has grown between 44% and 144% depending on the category of vehicles being considered: motorcycles and mopeds 105%, light cargo vehicles 144%, heavy cargo vehicles 44% and private cars 95%.

Figure 4.3.6.2.- Vehicle fleets

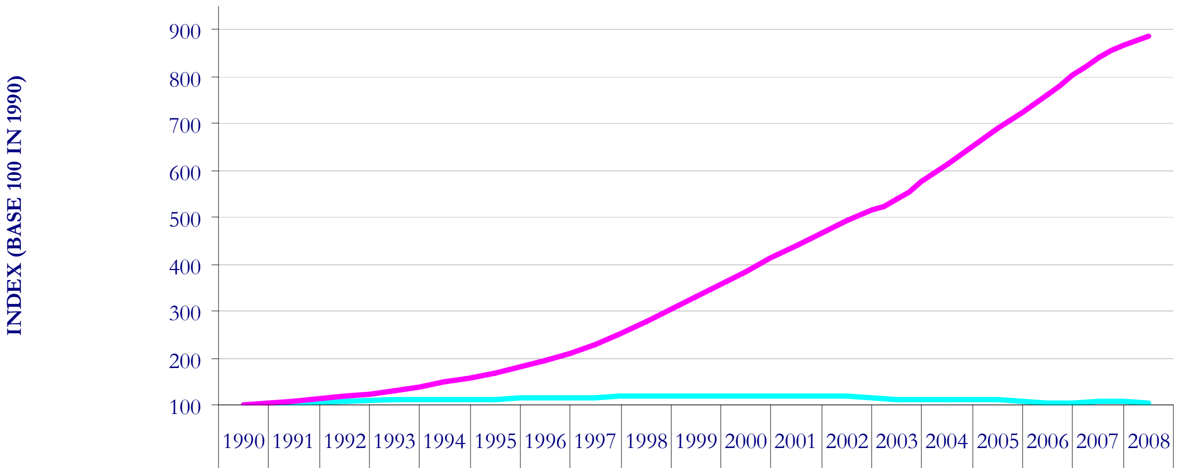


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Passenger cars	11.99	12.53	13.10	13.44	13.73	14.21	14.75	15.29	16.05	16.84	17.44	18.15	18.73	18.68	19.54	20.25	20.63	21.75	23.38
Heavy duty veh & buses	511	532	520	540	541	534	563	581	610	644	652	701	723	728	755	778	718	767	738
Light duty vehicles	1.934	2.082	2.230	2.318	2.411	2.519	2.637	2.778	2.950	3.144	3.305	3.459	3.591	3.690	3.905	4.129	4.371	4.645	4.728
Motorcycles & mopeds	2.393	2.617	2.788	2.846	2.866	2.893	2.909	2.947	3.021	3.110	3.206	3.288	3.559	3.655	3.852	4.115	4.383	4.739	4.909

Year

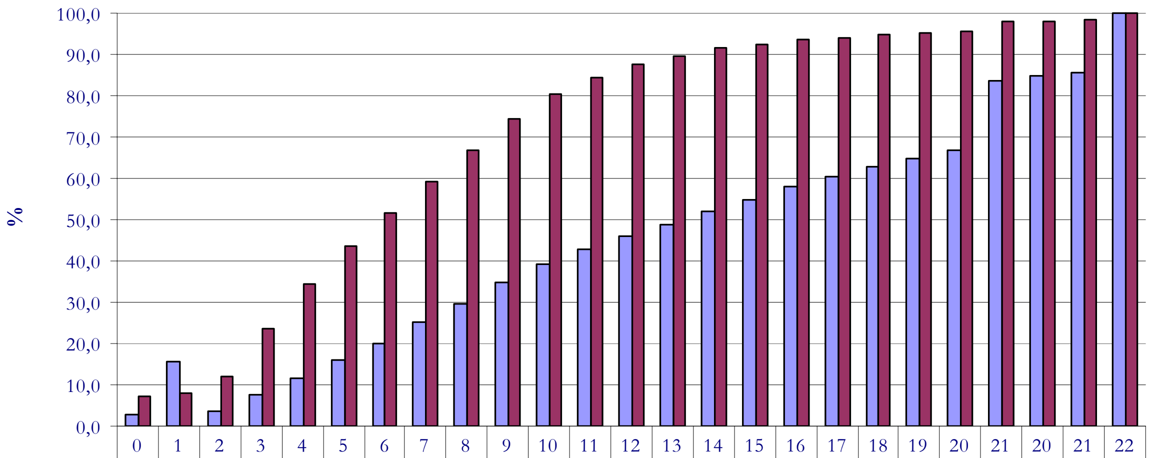
If we look at the distribution by type of fuel for each class of vehicle, the evolution of private cars shows a large degree of disparity. Although considerable at around 5%, the growth in petrol-driven private cars does not compare with the growth in diesel cars, near to 884%. This disparity is consequently shown in the distribution of the vehicles by age, an aspect that is very important in terms of emission calculations, giving rise to newer diesel-powered private cars in comparison with petrol-driven ones (the average age for diesel private cars is between 5 and 6 years while for petrol it is over 13 years). This is clearly consistent with the trend to progressively replace petrol with diesel fuel as experienced over recent years (both the evolution of all private cars according to fuel and the distribution by age for 2008 can be seen in figures 4.3.6.3 and 4.3.6.4 below).

Figure 4.3.6.3.- Evolution of private cars according to type of fuel used



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GASOLINE	100,0	104,1	108,0	109,9	110,7	112,8	114,7	115,9	117,7	118,8	118,3	118,8	118,1	112,3	111,7	109,7	105,5	106,7	105,3
DIESEL	100,0	107,9	119,7	131,2	148,0	168,7	195,9	229,9	276,0	331,3	385,2	438,7	491,8	540,0	614,9	690,9	759,3	840,1	884,4

Figure 4.3.6.4.- Age of private cars in 2007



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	20	21	22
GASOLINE	2,7	15,7	3,7	7,6	11,7	15,8	20,0	25,1	29,7	34,7	39,0	42,8	45,9	48,8	52,0	54,7	57,8	60,4	62,6	64,9	66,7	83,6	84,8	85,5	100,
DIESEL	7,2	8,1	11,9	23,6	34,5	43,6	51,5	59,2	66,9	74,3	80,2	84,5	87,6	89,7	91,4	92,5	93,5	94,0	94,6	95,1	95,5	97,8	98,1	98,5	100,

4.3.6.1.3.- Distances travelled

The source consulted to obtain travel data was the Directorate General for Roads (DGC in its Spanish acronym) of the Ministry of Development.

The scope of the information obtained has varied over the years. From 1990 to 1993, two provincial series were obtained with the distances travelled on the national road network and on roads controlled by Autonomous Communities. For 1994 and 1995, a single provincial series of distances travelled on the national highway system and a total for the autonomous roads network are available. Finally, for the period from 1996 to 2007, data has also been obtained on state, regional and provincial road networks.

The DGC itself admits that, over the years, the representativity of the information has been increasing, especially with respect to the Autonomous Communities. Thus, the increase in the 1996 figures (see table 4.3.6.8), is more the consequence of greater rigour and completeness in gathering information than a true increase in traffic. The DGC has stated that the 1996 figures already cover practically all the non-urban roads in Spain.

Table 4.3.6.8 as well as Figure 4.3.6.5, give examples for each type of information gathered: in the first, the total distances travelled for the period from 1990 to 2008, in the second the distribution by provinces of the total distances travelled broken down by type of vehicle as obtained from 1990 to 1993 and 1996 to 2008 on the state road network.

Table 4.3.6.8.- Distances travelled on spanish roads *(Amounts in thousands of kilometres)*

YEAR	STATE CONTROLLED ROAD NETWORK	AUTONOMOUS COMMUNITIES NETWORK	PROVINCE – CONTROLLED NETWORK
1990	65,010,118	49,465,749	
1991	68,370,641	51,588,908	
1992	73,678,812	52,849,102	
1993	77,091,268	52,375,577	
1994	80,362,422	53,752,555	
1995	83,053,732	55,208,716	
1996	85,614,453	72,035,602	15,232,992
1997	89,970,636	73,621,997	15,936,000
1998	96,562,310	77,100,997	14,906,992
1999	100,587,961	85,845,207	15,436,924
2000	105,639,462	90,371,602	18,074,504
2001	110,826,306	93,562,998	13,540,992
2002	114,757,095	97,978,998	15,486,128
2003	119,618,937	100,969,011	15,668,440
2004	122,644,453	104,403,555	14,715,453
2005	125,822,696	104,459,200	14,797,105
2006	129,121,367	103,319,299	15,356,103
2007	133,313,500	107,249,994	16,098,007
2008	128,867,757	107,700,003	15,347,010

Source: Dirección General de Carreteras. Ministerio de Fomento

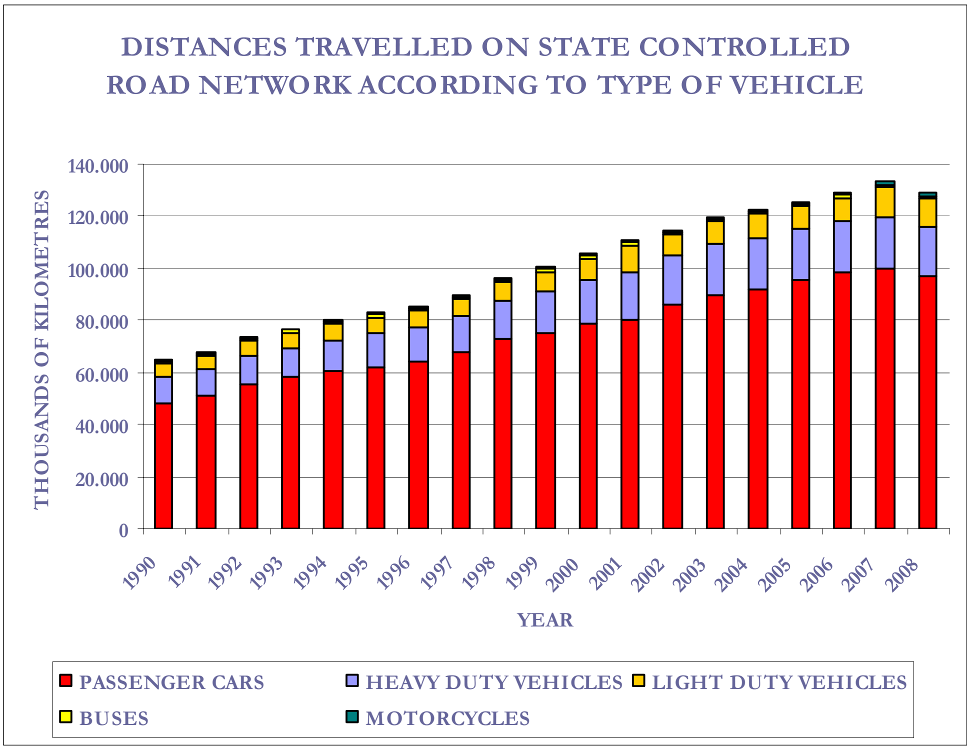
A preliminary step in order to be able to use this information has included the homogenization and completion of the data shown in Table 4.3.6.8. The following guidelines have been applied for this purpose:

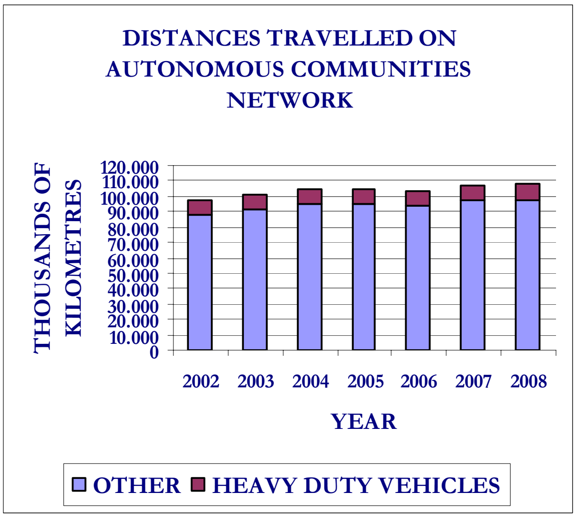
- No adjustment has been made to the figures for the state-controlled network in the period from 1990 to 2008.

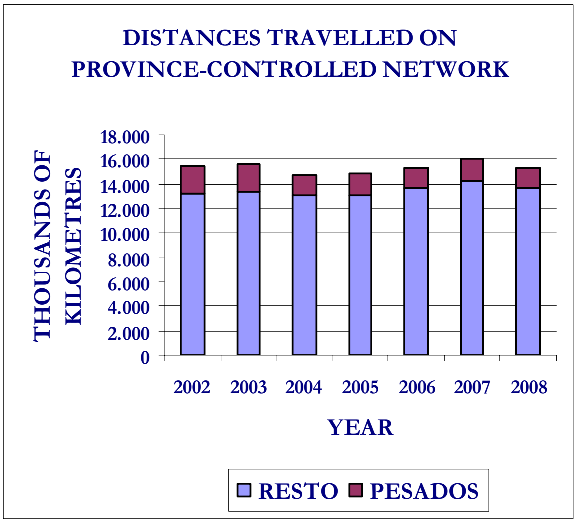
- In view of the lack of homogeneity in the representativity of the figures for the regional road network between the years for the period 1990 to 1995, it has been decided to ignore these figures and to replace them with those obtained from the backward projection of the figures from the regional network in 1996; this projection was effected in accordance with the evolution pattern followed by traffic on the State road network in this period.

- The figures for the road network under the control of the provincial authorities have been projected backwards from 1996 in the same way as those for roads controlled by the regional authorities so that, when the algorithm for the allocation of kilometres covered is applied to the SNAP nomenclature (urban, rural and highway), the percentage of kilometres travelled in rural driving is around 20%, approximately the mean percentage corresponding to rural driving in the years 1996 to 2008. The estimations of the distance covered in the three driving styles indicated are described below.

Figure 4.3.6.5







Applying these guidelines to the data in Table 4.3.6.8 gives the figures shown in Table 4.3.6.9, considered as the *input data* for the algorithm (please note that in Table 4.3.6.9 estimated data has been inserted in italics to fill blank spaces in Table 4.3.6.8).

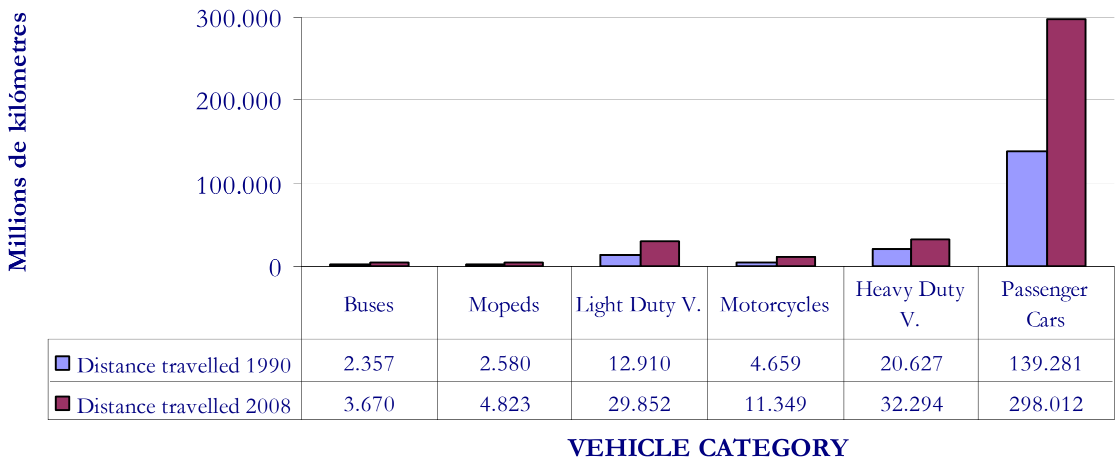
Table 4.3.6.9 Estimated distances travelled on Spanish roads (Amounts in thousands of kilometres)

YEAR	STATE CONTROLLED ROAD NETWORK	AUTONOMOUS COMMUNITIES NETWORK	PROVINCE – CONTROLLED NETWORK
1990	65,010,118	55,411,009	11,164,606
1991	68,370,641	57,979,304	11,814,021
1992	73,678,812	61,422,156	12,503,045
1993	77,091,268	62,979,626	13,099,651
1994	80,362,422	65,327,603	13,696,016
1995	83,053,732	66,859,484	14,106,382
1996	85,614,453	72,035,602	15,232,992
1997	89,970,636	73,621,997	15,936,000
1998	96,562,310	77,100,997	14,906,992
1999	100,587,961	85,845,207	15,436,924
2000	105,639,462	90,371,602	18,074,504
2001	110,826,306	93,562,998	13,540,992
2002	114,757,095	97,978,998	15,486,128
2003	119,618,937	100,969,011	15,668,440
2004	122,644,453	104,403,555	14,715,453
2005	125,822,696	104,459,200	14,797,105
2006	129,121,367	103,319,299	15,356,103
2007	133,313,500	107,249,994	16,098,007
2008	128,867,757	107,700,003	15,347,010

Source: Own production based on data from Dirección General de Carreteras (Ministerio de Fomento)

Between 1990 and 2007, there has been a sustained growth in journeys made using any of the three types of driving considered, interurban, rural and urban, increasing from a total of 192,078 million kilometres in 1990 to 399,573 in 2007, representing an increase of approximately 119% in eighteen years. The year 2008 has been the first were it has been produced a decrease of the distances travelled, a total of 380,000 thousand kilometres, which is 4,9% lower than the previous year.

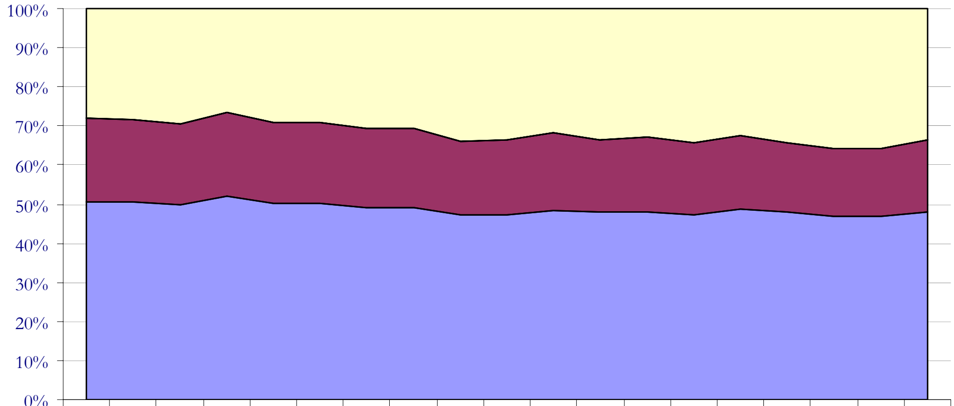
Figure 4.3.6.6.- Journeys made by type of vehicle



With regard to the distribution of journeys according to driving patterns, it can be said that stability is shown over the years in the inventoried period, with interurban roads representing between 46.9% and 52.0% of the total distance, rural roads between 17.4% and 21.3% and urban roads between 26.7% and 35.8% whilst, in the course of the years, it is apparent an increase of the urban driving pattern and a corresponding decrease of the interurban and rural driving patterns. In what concerns the distribution of journeys according to categories of vehicles where the main categories show very little variation: private cars range between 77.6% of the total in 1990 and 75.9% in 2008 while heavy vehicles, both for goods and passengers, vary between 12.6% in 1990 and 9.0% in 2008. Figure 4.3.6.7 below shows both distributions (journeys are expressed in millions of kilometres).

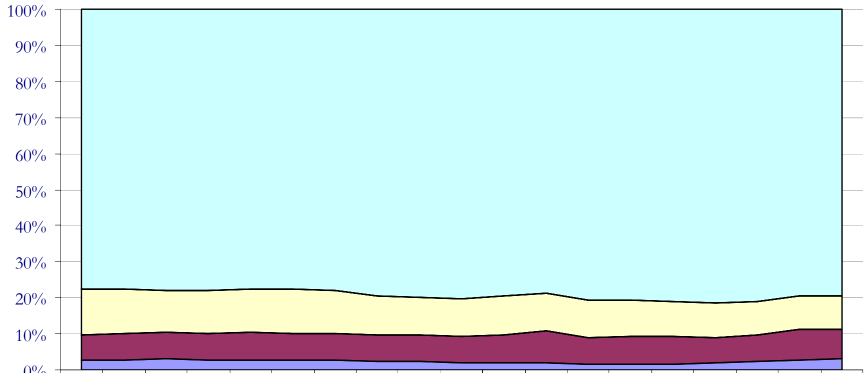
Figure 4.3.6.7.- Distribution of journeys made

a) By driving patterns



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
URBAN	51.165	54.880	61.382	55.643	64.932	67.081	75.571	79.231	96.918	102.121	98.847	109.800	111.790	122.770	117.173	127.430	137.962	143.034	128.14
RURAL	38.784	40.710	43.120	44.496	46.264	47.438	51.137	52.647	53.351	58.246	63.185	60.298	64.452	66.122	66.881	67.001	66.992	69.690	69.181
INTERURBAN	92.464	97.088	104.112	108.306	112.747	116.195	121.324	126.504	134.806	143.203	150.636	157.540	163.689	170.024	174.754	177.981	180.713	186.849	182.67

b) By type of vehicle



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
PASSENGER CARS	138.87	146.19	159.16	159.03	170.51	175.49	188.95	201.30	222.81	238.38	244.58	253.26	268.81	284.09	284.17	297.04	306.84	311.89	297.80
HEAVY DUTY VEH & BUSES	22.610	23.416	23.781	24.365	26.128	27.319	29.468	26.717	28.727	30.808	32.930	33.659	34.449	35.418	34.331	34.904	35.117	36.455	35.171
LIGHT DUTY VEHICLES	12.910	13.823	15.106	15.285	16.300	16.842	18.116	18.856	20.837	22.279	23.912	28.963	24.574	26.020	26.662	25.692	27.363	32.915	29.852
MOTORCYCLES	4.613	5.316	6.088	5.581	6.283	6.124	6.131	5.943	6.309	5.757	5.386	5.605	5.367	6.082	5.934	7.283	9.121	10.976	11.349

4.3.6.1.4.- Meteorological data

Four weather variables are needed to estimate the different emission factors: temperature of the environment (the average temperature from 7:00 to 18:00 has been used to describe this variable), the minimum daily temperature, average daily temperature increase and finally, the average daily temperature. The weather reports from all the weather stations belonging to the Instituto Nacional de Meteorología (Spanish National Meteorological Institute) as well as the time data from the synoptic stations for the period under study were used as the basis to obtain this information. With the information obtained and after having completed missing data from stations with incomplete series, an average value for the four variables mentioned above was produced for each year, province and month.

4.3.6.2.- Methodology

The methodology used for the road transport emissions estimation is based on publications and documents from the COPERT project, or more specifically on the methodology explained in the European Environment Agency technical report *"COPERT IV Computer Programme to Calculate Emissions from Road Transport"*.

The Copert methodology is considered, within the class of methodologies applicable to the estimation of road transport emissions, an advanced one. In what follows, some detailed aspects of the said methodology are commented, aspects that could influence, in a qualifying way, on aspects previously treated when presenting the basic activity variables within the former 4.3.6.1 paragraph.

4.3.6.2.1.- Vehicle classification

The first rules on air pollution emissions by automobiles in Europe were presented on the United Nations Economic Commission for Europe's initiative (UN-ECE). The formal expression of these rules is *15/00 to 04* [32]*ECE* regulations. As time passed, the European Community gradually assumed responsibility for the emissions through the Motor Vehicle Emission Group (MVEG) that issued a group of regulations[33].

The European Union's Directives are mandatory for the countries that have signed the Treaty of Rome. This fact allows the corresponding Governments to prevent the marketing in their territory of vehicles that do not comply with the environmental requirements stipulated in the above Directives. Therefore, the emissions estimation has been carried out taking into account the year of registration of the vehicles as an indicator of the vehicles' environmental characteristics, thus allowing the creation of a correspondence between the age of the fleet

[32] ECE, acronym for the United Nations' Economic Commission for Europe.

[33] It is not possible in this volume to give detailed information on all of the Directives, the pollutants affected and the vehicle categories involved. To this end we recommend the examination of the following documents: *MOTOR VEHICLE EMISSION REGULATIONS AND FUEL SPECIFICATIONS PART 2 DETAILED INFORMATION AND HISTORIC REVIEW (1970-1996) and (1996-2000)* prepared by the CONCAWE Automotive Emissions Management Groups Special Task Force, AE/STF-3.

in the country and the categories defined in the COPERT methodology (please see Table 4.3.6.10).

Table 4.3.6.10.- Vehicle classification

Vehicles	Fuel	Legislation			
Passengers Cars	**Gasoline**		**< 1,4l**	**>=1,4l y <=2,0l**	**> 2,0l**
		PRE ECE	- 1971	- 1971	- 1971
		ECE 15/00-01	1972 – 1977	1972 - 1977	1972 - 1977
		ECE 15/02	1978 – 1979	1978 - 1979	1978 - 1979
		ECE 15/03	1980 – 1984	1980 - 1984	1980 - 1984
		ECE 15/04	1985 – 1992	1985 - 1992	1985 - 1989
		Euro 1 - 91/441/CEE	1993 – 1996	1993 - 1996	1990 - 1996
		Euro 2 - 94/12/CE	1997 – 1999	1997 - 1999	1997 - 1999
		Euro 3 - 98/69/CE S 2000	2000 – 2004	2000 - 2004	2000 - 2004
		Euro 4 - 98/69/CE S 2005	2005 – 2010	2005 – 2010	2005 – 2010
		Euro 5 - 715/2007/CE S 2011[34]	2011 – 2014	2011 – 2014	2011 – 2014
		Euro 6 - 715/2007/CE S 2015	2015 -	2015 -	2015 -
		Two-stroke engine			
	Diesel		**<=2,0l**	**> 2,0l**	
		Conventional	- 1992	- 1992	
		Euro 1 - 91/441/CEE	1993 – 1996	1993 – 1996	
		Euro 2 – 94/12/CE	1997 – 1999	1997 – 1999	
		Euro 3 - 98/69/CE S 2000	2000 – 2004	2000 – 2004	
		Euro 4 - 98/69/CE S 2005	2005 – 2010	2005 – 2010	
		Euro 5 - 715/2007/CE S 2011	2011 – 2014	2011 – 2014	
		Euro 6 - 715/2007/CE S 2015	2015 -	2015 -	
	LPG	Conventional	- 1992		
		Euro 1 - 91/441/CEE	1993 - 1996		
		Euro 2 - 94/12/CE	1997 - 1999		
		Euro 3 - 98/69/CE S 2000	2000 - 2004		
		Euro 4 - 98/69/CE S 2005	2005 -		
	Hybrid	Euro 4 - 98/69/CE S 2005	2005 -		
Light-duty vehicle < 3,5t	**Gasoline**	Conventional	- 1992		
		Euro 1 – 93/59/CEE	1993 - 1996		
		Euro 2 – 96/69/CE	1997 - 1999		
		Euro 3 - 98/69/CE S 2000	2000 - 2004		
		Euro 4 - 98/69/CE S 2005	2005 - 2010		
		Euro 5 - 715/2007/CE S 2011	2011 – 2014		
		Euro 6 - 715/2007/CE S 2015	2015 -		
	Diesel	Conventional	- 1992		
		Euro 1 - 93/59/CEE	1993 - 1996		
		Euro 2 - 96/69/CE	1997 - 1999		
		Euro 3 - 98/69/CE S 2000	2000 - 2004		
		Euro 4 - 98/69/CE S 2005	2005 - 2010		
		Euro 5 - 715/2007/CE S 2011	2011 – 2014		
		Euro 6 - 715/2007/CE S 2015	2015 -		

Table 4.3.6.10.- Vehicle classification *(Continued)*

Heavy-duty vehicle > 3,5t	**Gasoline**	Conventional				
	Diesel		**Rigid**			
			<=7,5t	**7,5t- 12t**	**12t- 14t**	**14t-20t**

[34] The inicial date for aplicability of this Directive is Janaury 2007. The Euro 5 standard will be mandatory since 1 Janaury 2011 and the Euro 6 mandatory since 1 Janaury 2015, in what concerns regristering and sale of new vehicle classes.

		Conventional	- 1991	- 1991	- 1991	- 1991
		Euro I - 91/542/CEE S I	1992 - 1994	1992 - 1994	1992 - 1994	1992 - 1994
		Euro II - 91/542/CEE S II	1995 - 1999	1995 - 1999	1995 - 1999	1995 - 1999
		Euro III - 1999/96/CE S I [35]	2000 - 2004	2000 - 2004	2000 - 2004	2000 - 2004
		Euro IV - 1999/96/CE S II	2005 – 2007	2005 – 2007	2005 – 2007	2005 – 2007
		Euro V - 1999/96/CE S III	2008 -	2008 -	2008 -	2008 -
		Euro VI – Not proposed				
			20t- 26t	**26t- 28t**	**28t- 32t**	**>32t**
		Conventional	- 1991	- 1991	- 1991	- 1991
		Euro I - 91/542/CEE S I	1992 - 1994	1992 - 1994	1992 - 1994	1992 - 1994
		Euro II - 91/542/CEE S II	1995 - 1999	1995 - 1999	1995 - 1999	1995 - 1999
		Euro III - 1999/96/CE S I [36]	2000 - 2004	2000 - 2004	2000 - 2004	2000 - 2004
		Euro IV - 1999/96/CE S II	2005 – 2007	2005 – 2007	2005 – 2007	2005 – 2007
		Euro V - 1999/96/CE S III	2008 -	2008 -	2008 -	2008 -
		Euro VI – Not proposed				
			Articulated			
			14t- 20t	**20t- 28t**	**28t- 34t**	**34t- 40t**
		Conventional	- 1991	- 1991	- 1991	- 1991
		Euro I - 91/542/CEE S I	1992 - 1994	1992 - 1994	1992 - 1994	1992 - 1994
		Euro II - 91/542/CEE S II	1995 - 1999	1995 - 1999	1995 - 1999	1995 - 1999
		Euro III - 1999/96/CE S I [37]	2000 - 2004	2000 - 2004	2000 - 2004	2000 - 2004
		Euro IV - 1999/96/CE S II	2005 – 2007	2005 – 2007	2005 – 2007	2005 – 2007
		Euro V - 1999/96/CE S III	2008 -	2008 -	2008 -	2008 -
		Euro VI – Not proposed				
			40t- 50t		**50t- 60t**	
		Conventional	- 1991		- 1991	
		Euro I - 91/542/CEE S I	1992 - 1994		1992 - 1994	
		Euro II - 91/542/CEE S II	1995 - 1999		1995 - 1999	
		Euro III - 1999/96/CE S I [38]	2000 - 2004		2000 - 2004	
		Euro IV - 1999/96/CE S II	2005 – 2007		2005 – 2007	
		Euro V - 1999/96/CE S III	2008 -		2008 -	
		Euro VI – Not proposed				
Buses			**Urban buses**			
			<=15t	**15t- 18t**	**>18t**	
		Conventional	- 1991	- 1991	- 1991	
		Euro I - 91/542/CEE S I	1992 – 1994	1992 – 1994	1992 – 1994	
		Euro II - 91/542/CEE S II	1995 – 1999	1995 – 1999	1995 – 1999	
		Euro III - 1999/96/CE S I	2000 – 2004	2000 – 2004	2000 – 2004	
		Euro IV - 1999/96/CE S II	2005 – 2007	2005 – 2007	2005 – 2007	
		Euro V - 1999/96/CE S III	2008	2008	2008	
		Euro VI – Not proposed				
			Coaches			
			<=18t		**>18t**	
		Conventional	- 1991		- 1991	
		Euro I - 91/542/CEE S I	1992 – 1994		1992 - 1994	
		Euro II - 91/542/CEE S II	1995 – 1999		1995 - 1999	
		Euro III - 1999/96/CE S I	2000 – 2004		2000 - 2004	
		Euro IV - 1999/96/CE S II	2005 – 2007		2005 – 2007	
		Euro V - 1999/96/CE S III	2008		2008	
		Euro VI – Not proposed				
	Natural gas	Euro I - 91/542/CEE S I	1992 – 1994			
		Euro II - 91/542/CEE S II	1995 – 1999			
		Euro III - 1999/96/CE S I	2000 – 2004			
		EEV – 1999/96/CE	2000 -			

Table 4.3.6.10.- Vehicle classification *(Continued)*

Mopeds < 50cm3		Conventional	- 1998
		Euro 1 - 97/24/CE S I	1999 - 2001
		Euro 2 - 97/24/CE S II	2002 -

[35] The Directive 1999/96/CE was repealed by the Directive 2005/55/CE.

[36] The Directive 1999/96/CE was repealed by the Directive 2005/55/CE.

[37] The Directive 1999/96/CE was repealed by the Directive 2005/55/CE

[38] The Directive 1999/96/CE was repealed by the Directive 2005/55/CE

		Euro 3 - Proposed				
Motorcycles			**2 stroke > 50cm3**	**4 stroke 50 – 250cm3**	**4 stroke 250 – 750cm3**	**4 stroke > 750cm3**
		Conventional	- 1998	- 1998	- 1998	- 1998
		Euro 1 - 97/24/CE	1999 - 2002	1999 – 2002	1999 – 2002	1999 - 2002
		Euro 2 - 2002/51/CE S I	2003 - 2005	2003 – 2005	2003 – 2005	2003 - 2005
		Euro 3 - 2002/51/CE S II	2006 -	2006 -	2006 -	2006 -

4.3.6.2.2.- Driving patterns

Travelling speed affects the amount of contamination emitted. The COPERT methodology deals with the travelling classification according to the speed reached and defines three driving patterns: *highway driving (I), rural driving (R)* and *urban driving (U)*, without a strict European rule in force regarding the representative speeds selection for each driving style.

In the Spanish inventory it was deemed important to make a distinction between vehicles categories before determining average speeds. This way the different characteristics of the vehicles taken into account are reflected in the driving styles thus obtaining a better estimation of fuel consumption and the pollutant emission factors. The speed values used in the calculation are stated in Table 4.3.6.11.

Table 4.3.6.11 Speed: Ranges and mean values (km/h)

		Highway	**Rural**	**Urban**
Passenger cars	Range	80 - 130	40 - 80	10 - 40
	Mean value	105	65	25
Light duty	Range	80 - 130	40 - 80	10 - 40
	Mean value	100	65	25
Buses and coaches	Range	80 - 105	40 - 80	10 - 40
	Mean value	95	60	25
Motorcycles	Range	80 - 130	40 - 80	10 - 40
	Mean value	105	65	25
Mopeds	Range		40 - 50	10 - 40
	Mean value		45	25

In the COPERT IV methodology, the fuel emission and consumption functions of heavy vehicles depend on the degree of load in the vehicle and the slope of the road it is travelling on. The inventory has not had sufficient information about the characteristics of how these vehicles are driven, on the basis of which to assign speeds to the different driving cycles, therefore it has been decided to estimate these speeds by assuming that road haulage of goods tries to minimize the time spent travelling. In this sense, it has been considered that vehicles in an interurban cycle are mostly travelling at 90% of the maximum speed limit for which the corresponding emission or consumption function is defined, whereas in rural driving they travel at 70% of this speed. Table 4.3.6.12 shown below gives the minimum, mean and maximum speeds applied in each driving cycle for each year of the inventory.

Tabla 4.3.6.12.-Heavy vehicles minimum, mean and maximum speeds

Año	**Interurbano**			**Rural**			**Urbano**
	Mínimo	**Media**	**Máximo**	**Mínimo**	**Media**	**Máximo**	
1990	69.4	74.6	77.3	54.0	58.0	60.1	20.0
1991	69.4	74.6	77.3	54.0	58.0	60.1	20.0

1992	69.4	74.5	77.3	54.0	58.0	60.1	20.0
1993	69.3	74.6	77.3	53.9	58.0	60.1	20.0
1994	69.4	74.6	77.3	53.9	58.0	60.1	20.0
1995	69.3	74.6	77.3	53.9	58.0	60.1	20.0
1996	69.3	74.6	77.3	53.9	58.0	60.1	20.0
1997	69.3	74.6	77.3	53.9	58.0	60.1	20.0
1998	69.4	74.6	77.3	53.9	58.0	60.1	20.0
1999	69.4	74.6	77.3	54.0	58.0	60.1	20.0
2000	69.3	74.6	77.3	53.9	58.0	60.1	20.0
2001	69.4	74.7	77.3	54.0	58.1	60.1	20.0
2002	69.4	74.6	77.3	54.0	58.0	60.1	20.0
2003	69.4	74.6	77.3	54.0	58.0	60.1	20.0
2004	68.4	74.6	77.3	53.2	58.1	60.1	20.0
2005	68.2	74.7	77.3	53.0	58.1	60.1	20.0
2006	68.4	74.6	77.3	53.2	58.0	60.1	20.0
2007	68.5	74.6	77.3	53.2	58.1	60.1	20.0
2008	68.2	74.7	77.3	53.1	58.1	60.1	20.0

4.3.6.2.3.- Distribution of vehicle fleets

Starting from the original data on the registered vehicles fleet that has already been presented in paragraph 4.3.6.1.2 we address now the elaboration of a finer distribution of the vehicles fleet in accordance to the vehicles classes (des-aggregation from former vehicle categories) as required for the implementation of the COPERT IV emissions estimating algorithm. In this sense, the first task has been to obtain the **distribution of vehicle classes** set out in Table 4.3.6.10. The algorithm applied in the project comprises the following steps:

1) Obtaining the number of passenger cars according to the distribution by engine capacity in the COPERT methodology

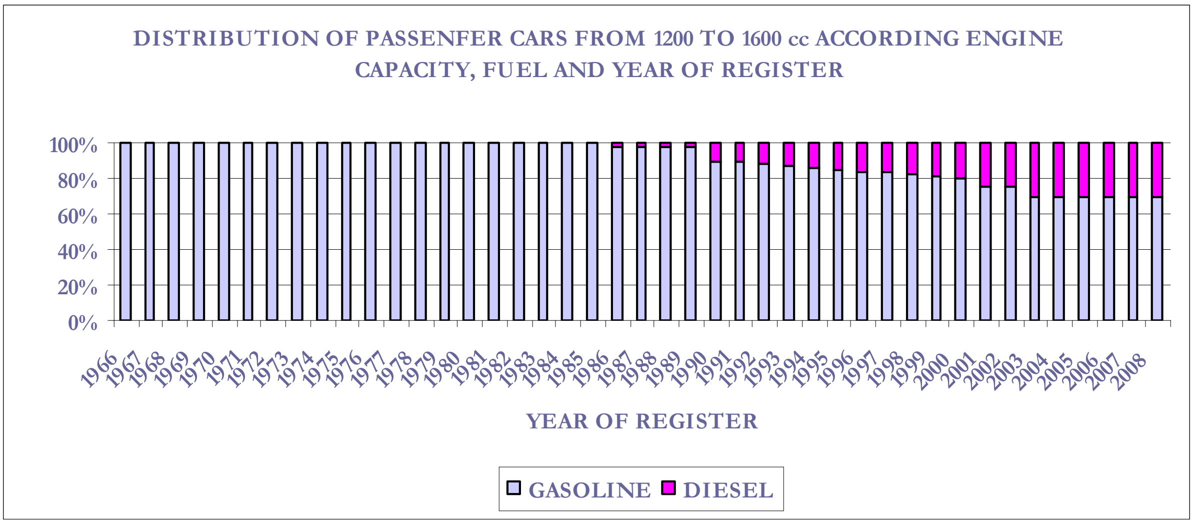
As indicated in Tables 4.3.6.2 and 4.3.6.5, the DGT does not report on the cubic capacity and fuel distribution groups, it only publishes the marginal distributions those tables reflect. Based on the partial information on vehicle registration and assuming that the proportion of diesel-powered vehicles sold has not decreased with respect to the petrol-powered ones during the period covered by the study, a relative participation chart has been drafted for both vehicle classes by cubic capacity presented graphically in Figure 4.3.6.8 (vehicles with less than 1200 cc. have not been included in the graphs since all of them haven been deemed to be petrol-powered).

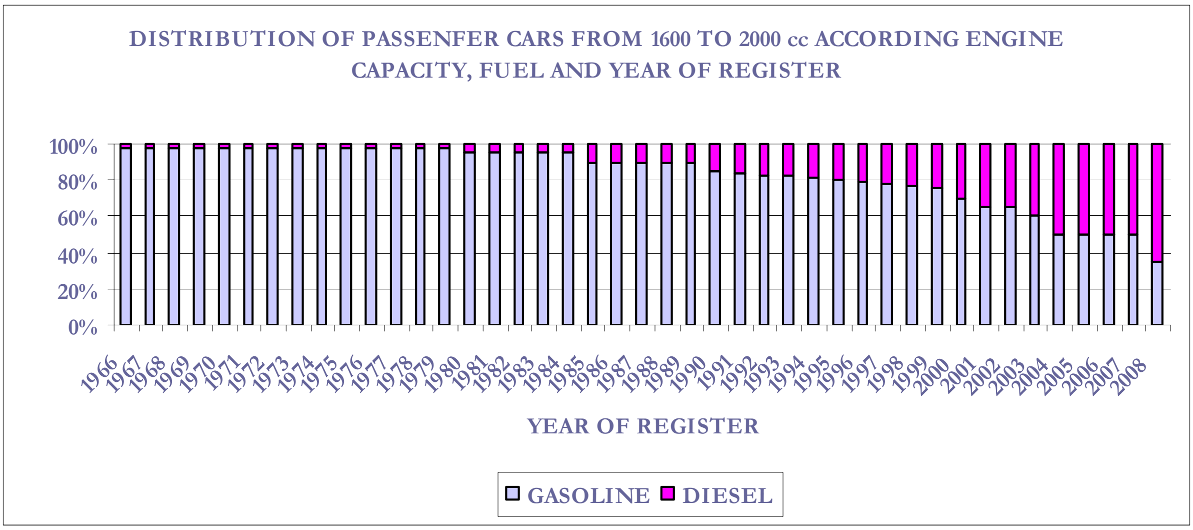
The distribution among the different cubic capacity levels of the COPERT vehicle classification has been done assuming that 50% of the petrol-powered vehicles that belong to the cubic capacity between 1200 and 1600 cc. have less than 1400 cc, thus assigning the remaining 50% to the 1400 – 2000 cc level.

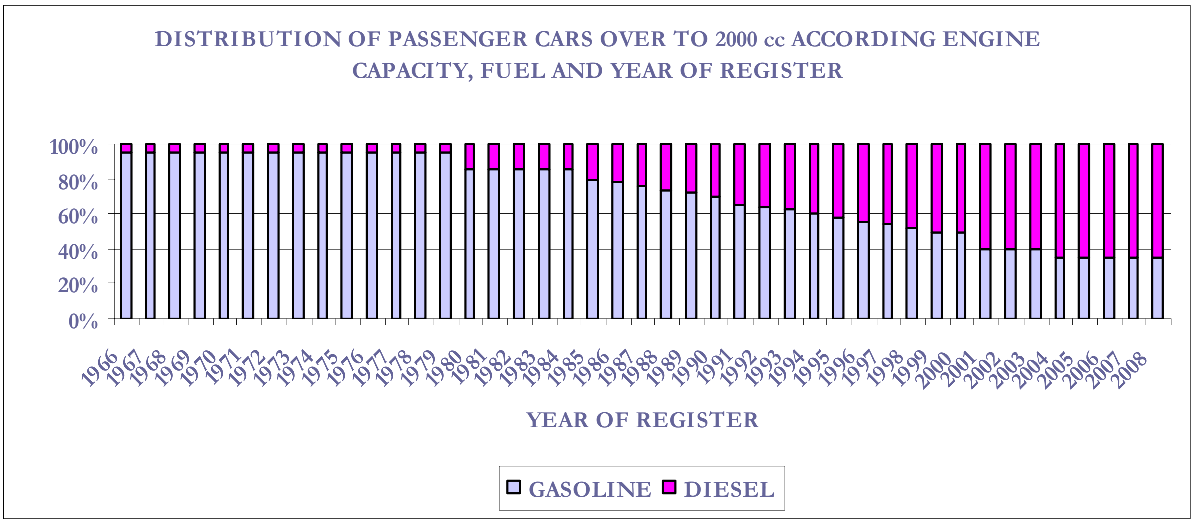
Lastly, regarding the age (regulation) distribution, we have assumed that the diesel-powered vehicles and petrol-powered ones have the same structure.[39]

[39] According to expert opinion, both the mean life and the total kilometres covered are higher in diesel-powered vehicles than in petrol-powered ones; however, in view of the lack of sufficiently detailed information on this respect, it has been preferred to adopt the age structure shown in Table 4.3.6.5.

Figure 4.3.6.8


DISTRIBUTION OF PASSENFER CARS FROM 1200 TO 1600 cc ACCORDING ENGINE CAPACITY, FUEL AND YEAR OF REGISTER
100%
80%
60%
40%
20%
0%
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
YEAR OF REGISTER
GASOLINE
DIESEL


DISTRIBUTION OF PASSENFER CARS FROM 1600 TO 2000 cc ACCORDING ENGINE CAPACITY, FUEL AND YEAR OF REGISTER
100%
80%
60%
40%
20%
0%
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
YEAR OF REGISTER
GASOLINE
DIESEL


DISTRIBUTION OF PASSENGER CARS OVER TO 2000 cc ACCORDING ENGINE CAPACITY, FUEL AND YEAR OF REGISTER
100%
80%
60%
40%
20%
0%
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
YEAR OF REGISTER
GASOLINE
DIESEL

2) Distribution of motorcycles

As far as motorcycles are concerned, only gasoline-driven motorcycles have been considered. The *Yearbook* offers no information on the cross-tab between types of engine (two or four stroke) or distribution by engine capacity, so it has been necessary to resort to the opinion of experts in the sector in order to obtain a distribution that is a priori reasonably reliable. Table 4.3.6.13 presents the coefficient vector that, when applied to the number of gasoline-driven motorcycles, produces the breakdown of motorcycles into COPERT classes.

Table 4.3.6.13.- Distribution factors for gasoline driven motorcycles

Motor	Capacity	Fraction
2 stroke		0.5 of those less than de 500 cm^3
4 stroke	50 cm^3 - 250 cm^3	0.5 of those less than de 250 cm^3
	250 cm^3 - 750 cm^3	0.5 of the total from 250 to 500 cm^3 + 0.625 of those more than 500 cm^3
	>750 cm^3	0.375 of those more than de 500 cm^3

3) Fleet and age of mopeds

2002 is the first year in which information is available on the registration of mopeds, so, in order to cover the information for the full period, it has been necessary to resort to certain hypotheses about the evolution of the registrations and the rate of replacement of these vehicles, as well as the information on the provincial fleet of vehicles shown in Table 4.3.6.7.

The backward projection for the fleet of mopeds has been performed under the hypothesis that the total for these vehicles has, in each province and for the years between 1990 and 2001, followed the same growth pattern as the total for motorcycles, so the figure for the fleet in each year has been obtained by applying the following formula:

$$PC_t^p = PC_{2001}^p \frac{PM_t^p}{PM_{2001}^p}$$

where PC_t^p and PM_t^p represent the total number of mopeds and motorcycles for the province *p* in year *t*, respectively.

On the other hand, the age structure has also been obtained by making use of the information on the fleet of motorcycles. Two hypotheses have been applied in this case: first of all that the maximum life of a moped does not exceed 3 years, and secondly that the survival pattern for mopeds is the same as for motorcycles. That is to say, the percentage of mopeds registered in one year, that remain active in the fleet for a subsequent year, is equal to the percentage of motorcycles, registered in the same year as the mopeds, and continuing to operate in the fleet for the same subsequent year, regardless of their cylinder capacity.

4) Obtaining the number of light and heavy duty vehicles

As mentioned above, the COPERT classification considers vehicles having a **gross laden weight not exceeding 3,5 tonnes** as **light** vehicles and the rest as being **heavy**

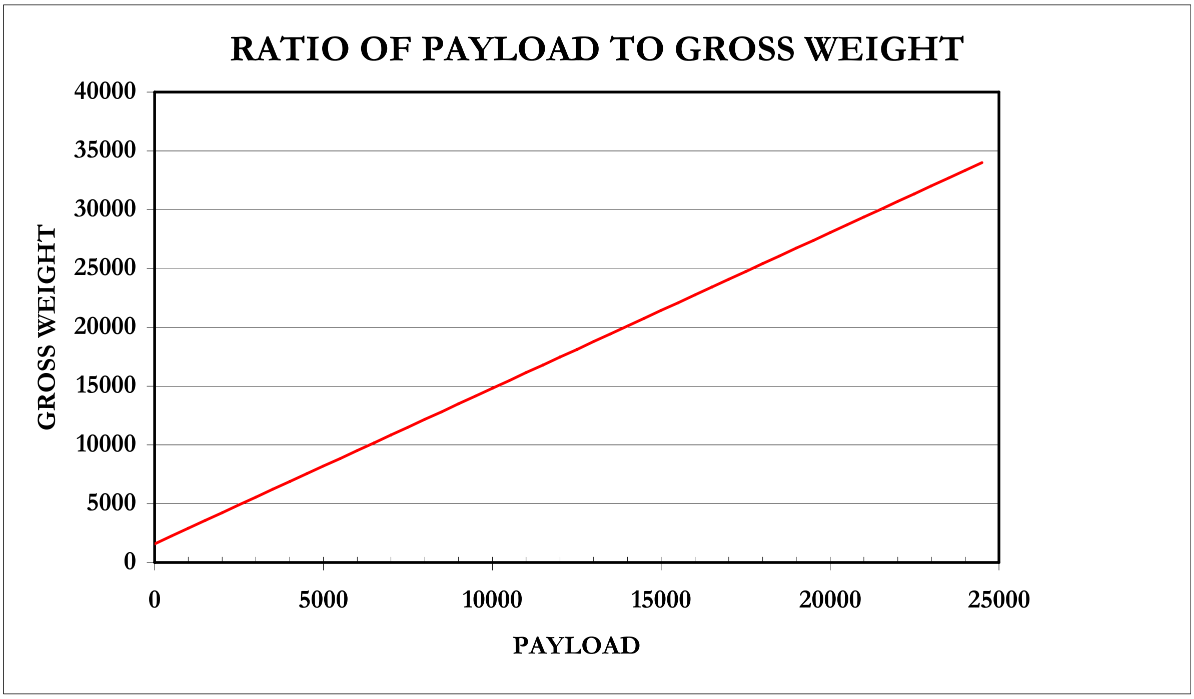
vehicles. In the *Yearbook,* however, load vehicles are not broken down according to this criteria, but rather according to the **transported payload**, making it necessary (as in the case of motorcycles and cars) to resort to the opinion of experts and the experience of other countries in order to obtain the distribution sought.

The function that expresses the interdependence assumed between payload and gross weight can be seen in figure 4.3.6.9. It shows the following formula:

$$GW = 1{,}3228LC + 1.592$$

Where GW and LC are respectively the gross weight and the payload of the vehicle.

Figure 4.3.6.9



Applying this formula and bearing in mind the limitations in the *Yearbook* used with respect to the precision of the itemisation, the number of vehicles in each class has been obtained in the following manner:

a) Vehicles with a payload capacity under 1.5 tonnes according to the DGT's classification have been classified as **light** by the COPERT system. The division between petrol and diesel has been made based on the supposition that the greater the payload capacity, the greater the diesel weights, thus attributing low payload vehicles as petrol-powered.

b) The application of the following correspondence has been used to break heavy vehicles down into COPERT categories:

$$P_{3,5-7,5t} = CT_{1,5-5t}$$
$$P_{7,5-16t} = CT_{5-10t}$$
$$P_{16-32t} = 0,9CT_{>10t}$$
$$P_{>32t} = 0,1CT_{>10t}$$

Where P represents COPERT heavy vehicles, that is, classified according to gross weight, and CT represents DGT lorries and tow units broken down by payload.

With respect to fuel, it has been considered that the heavy petrol-powered vehicles remaining, after having assigned the light vehicles, belong to the lower load category, with the remaining vehicles being diesel.

All industrial tow units, both petrol and diesel have been assigned to the CORINAIR class load vehicles >32t.

5) Buses

Forty-four per cent of all buses have been considered to be urban buses, with the rest being assigned to the category of coaches.

6) Applicability of regulations

The assignment of vehicles to applicable regulations has been effected by taking into consideration the age structure of the vehicles and the year the regulations came into force, as seen in the tables 4.3.6.2 and 4.3.6.10. As can be deduced from the tables, the *Yearbook* only provides an age structure for the whole of Spain, thus it has been necessary to introduce the additional assumption of territorial homogeneity in order to obtain a provincial distribution by age.

4.3.6.2.4.- RUNNING FLEET

This document refers to the sum of running fleet as the fleet of vehicles made up of the relative participations of the different classes of vehicles travelling. A class of vehicles is identified by the cross-tabbing of the following characteristics, listed in order of detail: *category* (coaches, private cars, motorcycles, mopeds and light or heavy duty vehicles), *fuel* used (petrol, diesel, LPG, natural gas), cylinder capacity or maximum weight depending on the category and age (the basis on which the regulations applicable to the vehicle are determined: *conventional*, *EURO I*, etc.).

Previous editions of the inventory

In the previous editions of the inventory, the running fleet applied was obtained from three components: 1) the breakdown of distances travelled on interurban and rural roads by vehicle categories, 2) the fleet of registered vehicles (the *active fleet* in the terminology of the Traffic Department (DGT)) and 3) a partial structure of *a priori* weightings for some relevant characteristics of the vehicles, such as the distribution of fuels used in private vehicles or the greater unit participation of urban buses versus other categories in urban circuits. More specifically, two fleets of running fleet were considered:

I) The interurban and rural running fleets, constructed by breaking down the distances travelled by each *category of vehicles* into *fuels*, *cylinder capacity*, *applicable regulations*, etc. in proportion to the relative participation of the combination of these characteristics in the DGT's fleet, that is to say, assuming that each vehicle belonging to a category covers the same number of kilometres as any other in the same category regardless of its size, fuel or any other property (except for private cars, for which, as indicated above, an *a priori* weighting was applied to the distances travelled with petrol and with diesel).

II) The urban fleet of running fleet, constructed by assuming that the relative participations in the distances travelled coincide with those of the registered fleet, except for urban buses and light cargo vehicles, which, like the fuels for private cars in interurban and rural circuits, have *a priori* weightings on their unit distances covered.

Current edition

In the current edition, the running fleet has been obtained from a survey undertaken in the central area of the city of Madrid in the course of 2008 in order to help decisions to be taken on the reduction of undesired nitrogen oxide emissions due to road traffic; the resulting distribution of distances travelled in this survey is given in Table 4.3.6.14 below:

Table 4.3.6.14.- Distribution of distances travelled within the Municipality of Madrid in the year 2008

CATEGORY	CLASS	FUEL	NORMATIVE	%
A	BUS	BIODIESEL	EURO II - 91/542/EEC S II	0.11%
A	BUS	BIODIESEL	EURO III - COM(97) 627	0.84%
A	BUS	BIODIESEL	EURO IV - COM(1998) 776	0.16%
A	BUS	DIESEL	CONVENTIONAL	0.00%
A	BUS	DIESEL	EURO I - 91/542/EEC S I	0.01%
A	BUS	DIESEL	EURO II - 91/542/EEC S II	0.35%
A	BUS	DIESEL	EURO III - COM(97) 627	0.61%
A	BUS	DIESEL	EURO IV - COM(1998) 776	0.32%
A	BUS	DIESEL	EURO V - COM(1998) 776	0.11%
A	BUS	GASOLINE	CONVENTIONAL	0.01%
A	BUS	CNG	EEV	0.42%
A	BUS	CNG	EURO III - COM(97) 627	0.05%
A	BUS	OTHERS	CONVENTIONAL	0.01%
C	MOPED	GASOLINE	97/24/EC SII	0.86%
L	LIGHT VEHICLE	DIESEL	CONVENTIONAL	0.11%
L	LIGHT VEHICLE	DIESEL	EURO I - 93/59/EEC	0.16%
L	LIGHT VEHICLE	DIESEL	EURO II - 96/69/EC	0.67%
L	LIGHT VEHICLE	DIESEL	EURO III - 98/69/EC S 2000	2.79%
L	LIGHT VEHICLE	DIESEL	EURO IV - 98/69/EC S 2005	2.21%
L	LIGHT VEHICLE	GASOLINE	CONVENTIONAL	0.01%
L	LIGHT VEHICLE	GASOLINE	EURO I - 93/59/EEC	0.00%
L	LIGHT VEHICLE	GASOLINE	EURO II - 96/69/EC	0.01%
L	LIGHT VEHICLE	GASOLINE	EURO III - 98/69/EC S 2000	0.03%
L	LIGHT VEHICLE	GASOLINE	EURO IV - 98/69/EC S 2005	0.02%
M	MOTORCYCLE	DIESEL	CONVENTIONAL	0.00%

Table 4.3.6.14.- Distribution of distances travelled within the Municipality of Madrid in the year 2008 *(Continued)*

CATEGORY	CLASS	FUEL	NORMATIVE	%

CATEGORY	CLASS	FUEL	NORMATIVE	%
M	250 - 750	GASOLINE	CONVENTIONAL	0.08%
M	250 - 750	GASOLINE	2002/51/EC SI	0.54%
M	250 - 750	GASOLINE	2002/51/EC SII	0.83%
M	250 - 750	GASOLINE	97/24/EC	0.11%
M	50 - 250	GASOLINE	CONVENTIONAL	0.11%
M	50 - 250	GASOLINE	2002/51/EC SI	1.02%
M	50 - 250	GASOLINE	2002/51/EC SII	1.57%
M	50 - 250	GASOLINE	97/24/EC	0.22%
M	>750	GASOLINE	CONVENTIONAL	0.07%
M	>750	GASOLINE	2002/51/EC SI	0.21%
M	>750	GASOLINE	2002/51/EC SII	0.33%
M	>750	GASOLINE	97/24/EC	0.06%
P	14 - 32	DIESEL	CONVENTIONAL	0.01%
P	14 - 32	DIESEL	EURO I - 91/542/EEC S I	0.01%
P	14 - 32	DIESEL	EURO II - 91/542/EEC S II	0.05%
P	14 - 32	DIESEL	EURO III - COM(97) 627	0.24%
P	14 - 32	DIESEL	EURO IV - COM(1998) 776	0.17%
P	14 - 32	DIESEL	EURO V - COM(1998) 776	0.02%
P	>32	DIESEL	CONVENTIONAL	0.00%
P	>32	DIESEL	EURO I - 91/542/EEC S I	0.00%
P	>32	DIESEL	EURO II - 91/542/EEC S II	0.00%
P	>32	DIESEL	EURO III - COM(97) 627	0.01%
P	>32	DIESEL	EURO IV - COM(1998) 776	0.05%
P	>32	DIESEL	EURO V - COM(1998) 776	0.00%
P	3,5 - 7,5	DIESEL	CONVENTIONAL	0.01%
P	3,5 - 7,5	DIESEL	EURO I - 91/542/EEC S I	0.00%
P	3,5 - 7,5	DIESEL	EURO II - 91/542/EEC S II	0.02%
P	3,5 - 7,5	DIESEL	EURO III - COM(97) 627	0.06%
P	3,5 - 7,5	DIESEL	EURO IV - COM(1998) 776	0.06%
P	3,5 - 7,5	DIESEL	EURO V - COM(1998) 776	0.02%
P	7,5 - 14	DIESEL	CONVENTIONAL	0.03%
P	7,5 - 14	DIESEL	EURO I - 91/542/EEC S I	0.01%
P	7,5 - 14	DIESEL	EURO II - 91/542/EEC S II	0.05%
P	7,5 - 14	DIESEL	EURO III - COM(97) 627	0.13%
P	7,5 - 14	DIESEL	EURO IV - COM(1998) 776	0.07%
P	7,5 - 14	DIESEL	EURO V - COM(1998) 776	0.01%
P	HEAVY VEHICLE	GASOLINE	CONVENTIONAL	0.00%
P	HEAVY VEHICLE	OTHERS	CONVENTIONAL	0.00%
T	PASSENGER CAR	GASES	EURO III - 98/69/EC S 2000	0.00%
T	<=2	DIESEL	CONVENTIONAL	0.19%
T	<=2	DIESEL	EURO I - 91/441/EEC	0.84%
T	<=2	DIESEL	EURO II - 94/12/EC	3.64%
T	<=2	DIESEL	EURO III - 98/69/EC S 2000	20.32%
T	<=2	DIESEL	EURO IV - 98/69/EC S 2005	24.55%
T	>2	DIESEL	CONVENTIONAL	0.09%
T	>2	DIESEL	EURO I - 91/441/EEC	0.25%
T	>2	DIESEL	EURO II - 94/12/EC	0.61%
T	>2	DIESEL	EURO III - 98/69/EC S 2000	2.80%
T	>2	DIESEL	EURO IV - 98/69/EC S 2005	4.39%
T	<1,4	GASOLINE	ECE 15/00-01	0.08%
T	<1,4	GASOLINE	ECE 15/02	0.07%
T	<1,4	GASOLINE	ECE 15/03	0.05%
T	<1,4	GASOLINE	ECE 15/04	0.47%
T	<1,4	GASOLINE	EURO I - 91/441/EEC	0.80%
T	<1,4	GASOLINE	EURO II - 94/12/EC	1.26%
T	<1,4	GASOLINE	EURO III - 98/69/EC S 2000	3.62%
T	<1,4	GASOLINE	EURO IV - 98/69/EC S 2005	2.51%
T	1,4 - 2	GASOLINE	ECE 15/00-01	0.01%
T	1,4 - 2	GASOLINE	ECE 15/02	0.02%
T	1,4 - 2	GASOLINE	ECE 15/03	0.02%
T	1,4 - 2	GASOLINE	ECE 15/04	0.75%

***Table 4.3.6.14.- Distribution of distances travelled within the Municipality of Madrid in the year 2008** (Continued)*

CATEGORY	CLASS	FUEL	NORMATIVE	%
T	1,4 - 2	GASOLINE	EURO I - 91/441/EEC	1.40%
T	1,4 - 2	GASOLINE	EURO II - 94/12/EC	2.19%
T	1,4 - 2	GASOLINE	EURO III - 98/69/EC S 2000	5.32%
T	1,4 - 2	GASOLINE	EURO IV - 98/69/EC S 2005	3.51%
T	>2	GASOLINE	ECE 15/00-01	0.00%
T	>2	GASOLINE	ECE 15/02	0.00%
T	>2	GASOLINE	ECE 15/03	0.01%
T	>2	GASOLINE	ECE 15/04	0.23%
T	>2	GASOLINE	EURO I - 91/441/EEC	0.35%
T	>2	GASOLINE	EURO II - 94/12/EC	0.59%
T	>2	GASOLINE	EURO III - 98/69/EC S 2000	1.67%
T	>2	GASOLINE	EURO IV - 98/69/EC S 2005	1.32%
T	SOLAR	SOLAR	CONVENTIONAL	0.00%

Notes: Buses (A); Mopeds (C); Light duty vehicles (L); Motorcycles (M); Heavy duty vehicles (P); Passenger cars (T).

Taking this study as its basis, the participation of the different classes of heavyweight vehicles in goods transport, and the fleets of vehicles registered by the DGT in each of the years for this edition of the inventory, fleets of vehicles have been constructed for the interurban, rural and urban cycles in each of the territorial units underlying the inventories; more specifically:

I) Highway and rural driving fleet

A three-step process is used to reach the desired degree of disaggregation from the starting data:

1.- Assignment of rural and highway driving styles to state, regional and provincial networks:

- The State-controlled network trips are assumed to have been made under the highway driving pattern,
- The autonomous community network is distributed 50-50 between highway and rural driving pattern,
- The road network under provincial council control is assumed to be 100% rural.

2.- Autonomous community network and province council network trips distribution by vehicle classes according to the Dirección General de Carreteras (Directorate General for Roads).

As can be seen in figure 4.3.6.5, the breakdown of the trips made in these networks is limited to the distinction between heavy vehicles and the rest of the vehicles. The breakdown of the rest has been done assuming that the different classes of light vehicles (*not heavy*) take part in these trips according to the same proportions they do in the State-controlled network. The result is presented in table 4.3.6.15.

3.- The driving styles are distributed by type of fuel used and the age (regulation) of the vehicle.

The structure of distances travelled by heavy vehicles by classes (articulated and rigid lorries, maximum authorized tonnage, age and load level) has been obtained from the information provided by the Permanent survey of road haulage of goods (EPTMC),

complemented, for vehicles belonging to lower tonnage strata (not included or under-represented in the EPTMC), by the information on the registered fleet of vehicles. The *standard heavy vehicle* finally determined is shown in Table 4.3.6.15 below:

Table 4.3.6.15.- Standard heavy vehicle

Category	Fuel	Normative	Class	%
Heavy duty vehicle	Diesel	CONVENCIONAL	14 - 32	22.24%
Heavy duty vehicle	Diesel	CONVENCIONAL	>32	15.80%
Heavy duty vehicle	Diesel	EURO I - 91/542/EEC S I	14 - 32	4.48%
Heavy duty vehicle	Diesel	EURO I - 91/542/EEC S I	>32	3.97%
Heavy duty vehicle	Diesel	EURO II - 91/542/EEC S II	14 - 32	8.21%
Heavy duty vehicle	Diesel	EURO II - 91/542/EEC S II	>32	13.37%
Heavy duty vehicle	Diesel	EURO III - COM(97) 627	14 - 32	7.05%
Heavy duty vehicle	Diesel	EURO III - COM(97) 627	>32	17.21%
Heavy duty vehicle	Diesel	EURO IV - COM(1998) 776	14 - 32	1.62%
Heavy duty vehicle	Diesel	EURO IV - COM(1998) 776	>32	5.73%
Heavy duty vehicle	Diesel	EURO V - COM(1998) 776	14 - 32	0.06%
Heavy duty vehicle	Diesel	EURO V - COM(1998) 776	>32	0.24%

As for the rest of the classes of vehicles, the distribution of distances covered by categories of vehicles provided in the information from the Directorate-General for Roads at the Ministry of Public Works has been considered representative.

The categories of light cargo vehicles, motorcycles and coaches have been broken down by fuels, sizes and ages according to the results of the Madrid survey corrected in accordance with the structure of the provincial vehicle fleets in the case of the rural driving cycle, and with the structure of the national vehicle fleet for travelling on interurban routes.

Table 4.3.6.16.- Distances travelled on State, Autonomous Community and Province-controlled networks *(Amounts in thousands of kilometres)*

Year	Type of vehicle	State-controlled network	Community	Province-controlled network	TOTAL
1990	Buses	773,067	637,832	123,593	1,534,492
	Trailer lorries	2,796,064	2,007,912	459,208	5,263,184
	Lorries without trailer	7,435,220	5,539,875	1,237,836	14,212,931
	Trucks	4,903,901	4,342,073	879,779	10,125,753
	Motorcycles	625,238	464,280	110,452	1,199,970
	Passenger cars	48,281,092	42,307,859	8,323,477	98,912,428
	TOTAL	**64,814,582**	**55,299,831**	**11,134,345**	**131,248,758**
1995	Buses	943,992	751,628	147,739	1,843,359
	Trailer lorries	3,537,261	2,444,159	588,752	6,570,172
	Lorries without trailer	9,089,119	6,553,890	1,539,154	17,182,163
	Trucks	6,296,032	5,242,880	1,121,623	12,660,535
	Motorcycles	744,569	535,287	127,038	1,406,894
	Passenger cars	62,218,196	51,204,125	10,547,372	123,969,693
	TOTAL	**82,829,169**	**66,731,969**	**14,071,678**	**163,632,816**

Table 4.3.6.16.- Distances travelled on State, Autonomous Community and Province-controlled networks *(Amounts in thousands of kilometres) (Continued)*

Year	Type of vehicle	State-controlled network	Community	Province-controlled network	TOTAL
2000	Buses	1,108,595	637,562	156,234	1,902,391
	Trailer lorries	8,632,035	4,165,924	1,326,630	14,124,589
	Lorries without trailer	8,543,674	4,902,263	1,381,052	14,826,989
	Trucks	7,976,811	7,813,795	1,493,679	17,284,285
	Motorcycles	650,328	599,322	131,130	1,380,780
	Passenger cars	78,591,343	72,146,905	13,563,564	164,301,812
	TOTAL	**105,502,786**	**90,265,771**	**18,052,289**	**213,820,846**
2004	Buses	1,123,786	625,961	89,268	1,839,015
	Trailer lorries	12,443,069	5,738,140	999,530	19,180,739
	Lorries without trailer	7,212,666	3,565,034	652,929	11,430,629
	Trucks	9,027,048	8,577,010	1,215,696	18,819,754
	Motorcycles	700,272	637,690	96,713	1,434,675
	Passenger cars	92,073,023	85,203,849	11,653,132	188,930,004
	TOTAL	**122,579,864**	**104,347,684**	**14,707,268**	**241,634,816**
2005	Buses	1,130,928	555,999	95,310	1,782,237
	Trailer lorries	13,267,297	5,679,751	1,120,617	20,067,665
	Lorries without trailer	7,026,463	3,209,449	664,498	10,900,410
	Trucks	8,419,863	7,635,947	1,058,954	17,114,764
	Motorcycles	770,365	758,456	110,644	1,639,465
	Passenger cars	95,156,412	86,579,569	11,741,408	193,477,389
	TOTAL	**125,771,328**	**104,419,171**	**14,791,431**	**244,981,930**
2006	Buses	1,032,239	528,435	82,825	1,643,499
	Trailer lorries	13,414,575	5,916,220	1,066,154	20,396,949
	Lorries without trailer	6,747,896	3,170,587	601,952	10,520,435
	Trucks	8,950,108	7,745,503	1,141,228	17,836,839
	Motorcycles	834,778	814,557	121,356	1,770,691
	Passenger cars	98,091,926	85,107,816	12,337,124	195,536,866
	TOTAL	**129,071,522**	**103,283,118**	**15,350,639**	**247,705,279**
2007	Buses	1,077,300	745,031	107,432	1,929,763
	Trailer lorries	13,427,300	6,459,632	1,170,329	21,057,261
	Lorries without trailer	6,669,000	3,548,278	634,721	10,851,999
	Trucks	11,506,900	9,990,333	1,513,376	23,010,609
	Motorcycles	974,700	946,863	161,200	2,082,763
	Passenger cars	99,594,700	85,508,128	12,503,479	197,606,307
	TOTAL	**133,249,900**	**107,198,265**	**16,090,537**	**256,538,702**
2008	Buses	1,280,448	697,369	118,378	2,096,195
	Trailer lorries	12,017,670	6,463,735	1,065,273	19,546,678
	Lorries without trailer	6,741,114	3,815,349	629,631	11,186,094
	Trucks	10,792,013	8,855,132	1,405,258	21,052,403
	Motorcycles	896,964	768,874	133,941	1,799,779
	Passenger cars	97,107,438	87,075,046	11,990,309	196,172,793
	TOTAL	**128,835,647**	**107,675,505**	**15,342,790**	**251,853,942**

II) Urban running fleet

The distribution of journeys resulting from the Madrid survey corrected according to the structure of the provincial vehicle fleets has been considered a better approximation to the vehicles on urban roads than that applied in previous editions. Is summary at the national scale can be seen in Table 4.3.6.17 below:

Table 4.3.6.17.- Urban distances travelled distribution

Year 1990

CATEGORY	FUEL	CLASS	NORMATIVE	%
A	Diesel	COACH	CONVENTIONAL	0.88%
A	Diesel	URBAN	CONVENTIONAL	0.73%
TOTAL A	Diesel			**1.61%**
C	Gasoline	MOPED	CONVENTIONAL	5.04%
L	Diesel	LIGHT VEHICLE	CONVENTIONAL	4.93%
L	Gasoline	LIGHT VEHICLE	CONVENTIONAL	0.52%
M	Gasoline	2-STROKE	CONVENTIONAL	2.68%
M	Gasoline	250 – 750	CONVENTIONAL	1.22%
M	Gasoline	50 – 250	CONVENTIONAL	2.33%
M	Gasoline	>750	CONVENTIONAL	0.53%
TOTAL M	**Gasoline**			**6.76%**
P	Diesel	14 – 32	CONVENTIONAL	1.14%
P	Diesel	>32	CONVENTIONAL	0.10%
P	Diesel	3,5 - 7,5	CONVENTIONAL	0.52%
P	Diesel	7,5 – 14	CONVENTIONAL	0.48%
TOTAL P	Diesel			**2.24%**
P	Gasoline	HEAVY VEHICLE	CONVENTIONAL	0.01%
TOTAL P				**2.25%**
T	Diesel	<=2	CONVENTIONAL	14.19%
T	Diesel	>2	CONVENTIONAL	2.95%
TOTAL T	Diesel			**17.13%**
T	Gasoline	<1,4	ECE 15/00-01	3.84%
T	Gasoline	<1,4	ECE 15/02	2.94%
T	Gasoline	<1,4	ECE 15/03	9.28%
T	Gasoline	<1,4	ECE 15/04	17.22%
T	Gasoline	<1,4	PRE ECE	0.45%
T	Gasoline	1,4 – 2	ECE 15/00-01	1.01%
T	Gasoline	1,4 – 2	ECE 15/02	0.93%
T	Gasoline	1,4 – 2	ECE 15/03	3.05%
T	Gasoline	1,4 – 2	ECE 15/04	14.29%
T	Gasoline	1,4 – 2	PRE ECE	0.03%
T	Gasoline	>2	ECE 15/00-01	0.25%
T	Gasoline	>2	ECE 15/02	0.24%
T	Gasoline	>2	ECE 15/03	2.69%
T	Gasoline	>2	ECE 15/04	4.76%
T	Gasoline	>2	PRE ECE	0.00%
TOTAL T	**Gasoline**			**60.97%**
T	LPG	PASSENGER CAR	CONVENTIONAL	0.80%
TOTAL T				**78.90%**

Year 2008

CATEGORY	FUEL	CLASS	NORMATIVE	%
-A	Diesel	COACH	CONVENTIONAL	0.00%
A	Diesel	COACH	EURO I - 91/542/EEC S I	0.01%
A	Diesel	COACH	EURO II - 91/542/EEC S II	0.15%
A	Diesel	COACH	EURO III - COM(97) 627	0.24%
A	Diesel	COACH	EURO IV - COM(1998) 776	0.19%
A	Diesel	COACH	EURO V - COM(1998) 776	0.02%
A	Diesel	URBAN	CONVENTIONAL	0.00%
A	Diesel	URBAN	EURO I - 91/542/EEC S I	0.00%
A	Diesel	URBAN	EURO II - 91/542/EEC S II	0.14%
A	Diesel	URBAN	EURO III - COM(97) 627	0.27%
A	Diesel	URBAN	EURO IV - COM(1998) 776	0.08%
A	Diesel	URBAN	EURO V - COM(1998) 776	0.07%
TOTAL A	Diesel			**1.17%**
A	Natural Gas	COACH	EEV	0.00%
A	Natural Gas	COACH	EURO I - 91/542/EEC S I	0.01%
A	Natural Gas	COACH	EURO II - 91/542/EEC S II	0.02%
A	Natural Gas	COACH	EURO III - COM(97) 627	0.03%
TOTAL A	Natural Gas			**0.06%**
TOTAL A				**1.23%**

Table 4.3.6.17.- Urban distances travelled distribution (Continued)

Year 2008 (Continued)

CATEGORY	FUEL	CLASS	NORMATIVE	%
C	Gasoline	MOPED	97/24/EC SII	3.76%
L	Diesel	LIGHT VEHICLE	CONVENTIONAL	0.12%
L	Diesel	LIGHT VEHICLE	EURO I - 93/59/EEC	0.18%
L	Diesel	LIGHT VEHICLE	EURO II - 96/69/EC	0.76%
L	Diesel	LIGHT VEHICLE	EURO III - 98/69/EC S 2000	3.18%
L	Diesel	LIGHT VEHICLE	EURO IV - 98/69/EC S 2005	2.52%
TOTAL L	Diesel			**6.77%**
L	Gasoline	LIGHT VEHICLE	CONVENTIONAL	0.01%
L	Gasoline	LIGHT VEHICLE	EURO I - 93/59/EEC	0.00%
L	Gasoline	LIGHT VEHICLE	EURO II - 96/69/EC	0.02%
L	Gasoline	LIGHT VEHICLE	EURO III - 98/69/EC S 2000	0.05%
L	Gasoline	LIGHT VEHICLE	EURO IV - 98/69/EC S 2005	0.02%
TOTAL L	Gasoline			**0.10%**
TOTAL L				**6.87%**
M	Gasoline	2-STROKE	CONVENTIONAL	0.10%
M	Gasoline	2-STROKE	2002/51/EC SI	0.84%
M	Gasoline	2-STROKE	2002/51/EC SII	1.30%
M	Gasoline	2-STROKE	97/24/EC	0.18%
M	Gasoline	250 - 750	CONVENTIONAL	0.10%
M	Gasoline	250 - 750	2002/51/EC SI	0.67%
M	Gasoline	250 - 750	2002/51/EC SII	1.04%
M	Gasoline	250 - 750	97/24/EC	0.14%
M	Gasoline	50 - 250	CONVENTIONAL	0.08%
M	Gasoline	50 - 250	2002/51/EC SI	0.74%
M	Gasoline	50 - 250	2002/51/EC SII	1.14%
M	Gasoline	50 - 250	97/24/EC	0.16%
M	Gasoline	>750	CONVENTIONAL	0.10%
M	Gasoline	>750	2002/51/EC SI	0.30%
M	Gasoline	>750	2002/51/EC SII	0.48%
M	Gasoline	>750	97/24/EC	0.09%
TOTAL M	Gasoline			**7.45%**
P	Diesel	14 - 32	CONVENTIONAL	0.02%
P	Diesel	14 - 32	EURO I - 91/542/EEC S I	0.01%
P	Diesel	14 - 32	EURO II - 91/542/EEC S II	0.05%
P	Diesel	14 - 32	EURO III - COM(97) 627	0.27%
P	Diesel	14 - 32	EURO IV - COM(1998) 776	0.19%
P	Diesel	14 - 32	EURO V - COM(1998) 776	0.02%
P	Diesel	>32	CONVENTIONAL	0.00%
P	Diesel	>32	EURO I - 91/542/EEC S I	0.00%
P	Diesel	>32	EURO II - 91/542/EEC S II	0.00%
P	Diesel	>32	EURO III - COM(97) 627	0.02%
P	Diesel	>32	EURO IV - COM(1998) 776	0.08%
P	Diesel	>32	EURO V - COM(1998) 776	0.00%
P	Diesel	3,5 - 7,5	CONVENTIONAL	0.01%
P	Diesel	3,5 - 7,5	EURO I - 91/542/EEC S I	0.00%
P	Diesel	3,5 - 7,5	EURO II - 91/542/EEC S II	0.02%
P	Diesel	3,5 - 7,5	EURO III - COM(97) 627	0.07%
P	Diesel	3,5 - 7,5	EURO IV - COM(1998) 776	0.06%
P	Diesel	3,5 - 7,5	EURO V - COM(1998) 776	0.02%
P	Diesel	7,5 - 14	CONVENTIONAL	0.04%
P	Diesel	7,5 - 14	EURO I - 91/542/EEC S I	0.01%
P	Diesel	7,5 - 14	EURO II - 91/542/EEC S II	0.06%
P	Diesel	7,5 - 14	EURO III - COM(97) 627	0.14%
P	Diesel	7,5 - 14	EURO IV - COM(1998) 776	0.08%
P	Diesel	7,5 - 14	EURO V - COM(1998) 776	0.01%
TOTAL P	Diesel			**1.21%**
P	Gasoline	HEAVY VEHICLE	CONVENTIONAL	0.01%
TOTAL P				**1.22%**

Table 4.3.6.17.- Urban distances travelled distribution *(Continued)*

Year 2008 (Continued)

CATEGORY	FUEL	CLASS	NORMATIVE	%
T	Diesel	<=2	CONVENTIONAL	0.17%
T	Diesel	<=2	EURO I - 91/441/EEC	0.75%
T	Diesel	<=2	EURO II - 94/12/EC	3.25%
T	Diesel	<=2	EURO III - 98/69/EC S 2000	18.16%
T	Diesel	<=2	EURO IV - 98/69/EC S 2005	21.95%
T	Diesel	>2	CONVENTIONAL	0.08%
T	Diesel	>2	EURO I - 91/441/EEC	0.22%
T	Diesel	>2	EURO II - 94/12/EC	0.55%
T	Diesel	>2	EURO III - 98/69/EC S 2000	2.50%
T	Diesel	>2	EURO IV - 98/69/EC S 2005	3.93%
TOTAL T	Diesel			**51.56%**
T	Gasoline	<1,4	ECE 15/04	0.72%
T	Gasoline	<1,4	EURO I - 91/441/EEC	0.85%
T	Gasoline	<1,4	EURO II - 94/12/EC	1.34%
T	Gasoline	<1,4	EURO III - 98/69/EC S 2000	3.85%
T	Gasoline	<1,4	EURO IV - 98/69/EC S 2005	2.67%
T	Gasoline	1,4 - 2	ECE 15/04	0.70%
T	Gasoline	1,4 - 2	EURO I - 91/441/EEC	1.49%
T	Gasoline	1,4 - 2	EURO II - 94/12/EC	2.33%
T	Gasoline	1,4 - 2	EURO III - 98/69/EC S 2000	5.65%
T	Gasoline	1,4 - 2	EURO IV - 98/69/EC S 2005	3.73%
T	Gasoline	>2	ECE 15/04	0.20%
T	Gasoline	>2	EURO I - 91/441/EEC	0.38%
T	Gasoline	>2	EURO II - 94/12/EC	0.62%
T	Gasoline	>2	EURO III - 98/69/EC S 2000	1.78%
T	Gasoline	>2	EURO IV - 98/69/EC S 2005	1.41%
TOTAL T	Gasoline			**27.74%**
T	LPG	TURISMO	CONVENTIONAL	0.04%
T	LPG	TURISMO	EURO I - 91/441/EEC	0.03%
T	LPG	TURISMO	EURO II - 94/12/EC	0.02%
T	LPG	TURISMO	EURO III - 98/69/EC S 2000	0.04%
T	LPG	TURISMO	EURO IV - 98/69/EC S 2005	0.03%
TOTAL T	LPG			**0.17%**
TOTAL T				**79.47%**

Notes: Buses (A); Mopeds (C); Light duty vehicles (L); Motorcycles (M); Heavy duty vehicles (P); Passenger cars (T).

The following tables 4.3.6.18 and 4.3.6.19 present the distances travelled and the fuel consumption estimated in Spain for the year 2008, break down. in the Highway (H), Rural (R) and Urban (U) patterns and the different vehicle class of COPERT methodology.

Table 4.3.6.18.- Distances travelled by highway, rural and urban driving patterns year 2008

					DISTANCES TRAVELLED (Thousands kilometres)			
VEHICLE CATEGORY AND CLASS				NÚM. VEH.	TOTAL	H	R	U
A	NATURAL GAS	COACH	EEV		4,548			4,548
			EURO I - 91/542/EEC S I		13,645			13,645
			EURO II - 91/542/EEC S II		22,741			22,741
			EURO III - COM(97) 627		36,386			36,386
	DIESEL	COACH	CONVENTIONAL	7,307	16,230	9,174	2,630	4,426
			EURO I - 91/542/EEC S I	2,783	51,585	29,159	8,360	14,067
			EURO II - 91/542/EEC S II	9,133	697,791	394,427	113,080	190,285
			EURO III - COM(97) 627	10,373	1,149,554	649,786	186,290	313,478
			EURO IV - COM(1998) 776	7,567	874,040	494,051	141,642	238,347
			EURO V - COM(1998) 776	2,438	92,941	52,535	15,061	25,345
		URBAN BUS	EURO II - 91/542/EEC S II	4,916	180,905			180,905
			EURO III - COM(97) 627	5,592	341,256			341,256
			EURO IV - COM(1998) 776	4,072	99,519			99,519
			EURO V - COM(1998) 776	1,311	89,237			89,237
			TOTAL	**55,492**	**3,670,380**	**1,629,133**	**467,063**	**1,574,185**
C	GASOLINE	MOPED	97/24/EC SII	2,058,577	4,823,117			4,823,117
			TOTAL	**2,058,577**	**4,823,117**			**4,823,117**
L	DIESEL	LIGHT DUTY	CONVENTIONAL	820,733	536,702	273,737	104,778	158,187
			EURO I - 93/59/EEC	382,160	800,862	408,467	156,349	236,046
			EURO II - 96/69/EC	786,113	3,319,963	1,693,295	648,144	978,524
			EURO III - 98/69/EC S 2000	1,245,210	13,814,634	7,045,314	2,696,741	4,072,579
			EURO IV - 98/69/EC S 2005	840,167	10,938,402	5,578,960	2,135,463	3,223,979
	GASOLINE	LIGHT DUTY	CONVENTIONAL	248,981	42,829	21,339	8,868	12,623
			EURO I - 93/59/EEC	122,349	16,613	8,277	3,440	4,896
			EURO II - 96/69/EC	107,074	74,847	37,291	15,497	22,059
			EURO III - 98/69/EC S 2000	121,501	203,180	101,229	42,069	59,882
			EURO IV - 98/69/EC S 2005	53,235	103,711	51,671	21,474	30,566
			TOTAL	**4,727,523**	**29,851,744**	**15,219,579**	**5,832,824**	**8,799,341**
M	GASOLINE	TWO STROKES	CONVENTIONAL	418,713	158,759	17,926	7,252	133,581
			2002/51/EC SI	156,832	1,285,923	145,197	58,738	1,081,988
			2002/51/EC SII	253,190	1,973,216	222,801	90,132	1,660,283
			97/24/EC	58,479	269,187	30,395	12,296	226,496
		250 - 750	CONVENTIONAL	223,524	152,605	17,231	6,971	128,403
			2002/51/EC SI	114,377	1,023,159	115,528	46,736	860,896
			2002/51/EC SII	199,196	1,580,374	178,444	72,188	1,329,742
			97/24/EC	47,817	212,481	23,992	9,706	178,783
		50 - 250	CONVENTIONAL	364,666	124,061	14,008	5,667	104,387
			2002/51/EC SI	138,654	1,123,668	126,876	51,327	945,465
			2002/51/EC SII	222,276	1,730,683	195,416	79,054	1,456,213
			97/24/EC	52,711	243,249	27,466	11,111	204,672
		>750	CONVENTIONAL	67,465	149,162	16,842	6,813	125,507
			2002/51/EC SI	56,640	453,797	51,239	20,728	381,829
			2002/51/EC SII	98,567	732,147	82,669	33,443	616,036
			97/24/EC	24,775	136,140	15,372	6,219	114,549
			TOTAL	**2,497,882**	**11,348,610**	**1,281,401**	**518,378**	**9,548,831**
P	DIESEL	14 - 32	CONVENTIONAL	37,249	412,125	304,755	87,137	20,233
			EURO I - 91/542/EEC S I	5,000	283,959	208,207	59,531	16,220
			EURO II - 91/542/EEC S II	13,267	1,022,215	740,366	211,688	70,162
			EURO III - COM(97) 627	28,553	2,346,283	1,554,112	444,357	347,815
			EURO IV - COM(1998) 776	21,381	1,931,756	1,311,533	374,998	245,225
			EURO V - COM(1998) 776	4,370	183,517	123,799	35,397	24,321
		>32	CONVENTIONAL	24,150	180,405	138,804	39,687	1,913
			EURO I - 91/542/EEC S I	4,961	150,966	114,611	32,770	3,586
			EURO II - 91/542/EEC S II	34,950	1,586,170	1,230,829	351,923	3,418
			EURO III - COM(97) 627	77,490	5,390,719	4,168,743	1,191,941	30,035
			EURO IV - COM(1998) 776	65,308	6,520,372	4,988,989	1,426,468	104,916
			EURO V - COM(1998) 776	16,682	627,475	486,224	139,023	2,228
		3,5 - 7,5	CONVENTIONAL	62,953	524,653	395,201	112,997	16,455
			EURO I - 91/542/EEC S I	13,694	410,721	315,898	90,323	4,500
			EURO II - 91/542/EEC S II	41,896	860,795	650,611	186,025	24,160

					DISTANCES TRAVELLED (Thousands kilometres)			
VEHICLE CATEGORY AND CLASS				NÚM. VEH.	TOTAL	H	R	U
			EURO III - COM(97) 627	55,951	2,884,690	2,175,996	622,168	86,526
			EURO IV - COM(1998) 776	36,621	2,348,523	1,763,746	504,296	80,480
			EURO V - COM(1998) 776	8,288	138,527	87,988	25,158	25,381
		7,5 - 14	CONVENTIONAL	36,451	489,919	344,601	98,529	46,789
			EURO I - 91/542/EEC S I	7,282	312,442	229,789	65,702	16,951
			EURO II - 91/542/EEC S II	19,997	856,740	606,767	173,489	76,484
			EURO III - COM(97) 627	31,409	1,509,730	1,030,771	294,721	184,238
			EURO IV - COM(1998) 776	22,049	1,044,853	732,680	209,490	102,683
			EURO V - COM(1998) 776	5,376	103,314	66,277	18,950	18,087
	GASOLINE	HEAVY DUTY	CONVENTIONAL	1,744	173,013	127,030	37,680	8,304
			TOTAL	**677,072**	**32,293,882**	**23,898,326**	**6,834,446**	**1,561,110**
T	DIESEL	<=2	CONVENTIONAL	1,839,667	811,944	425,754	168,091	218,098
			EURO I - 91/441/EEC	519,542	3,625,690	1,907,565	753,123	965,002
			EURO II - 94/12/EC	1,166,083	14,646,013	7,512,867	2,966,144	4,167,001
			EURO III - 98/69/EC S 2000	2,853,143	69,422,969	33,085,346	13,062,377	23,275,245
			EURO IV - 98/69/EC S 2005	2,902,415	87,686,544	42,703,709	16,859,789	28,123,047
		>2	CONVENTIONAL	346,206	382,448	201,215	79,441	101,791
			EURO I - 91/441/EEC	96,108	1,069,820	562,859	222,221	284,740
			EURO II - 94/12/EC	173,443	2,591,246	1,353,211	534,259	703,776
			EURO III - 98/69/EC S 2000	448,411	11,604,418	6,021,530	2,377,351	3,205,537
			EURO IV - 98/69/EC S 2005	451,599	18,471,624	9,636,509	3,804,576	5,030,539
	GASOLINE	<1,4	ECE 15/04	2,143,993	2,288,095	975,592	385,172	927,331
			EURO I - 91/441/EEC	625,679	2,701,690	1,151,940	454,796	1,094,955
			EURO II - 94/12/EC	637,815	4,224,372	1,801,177	711,120	1,712,075
			EURO III - 98/69/EC S 2000	1,066,670	12,183,816	5,194,905	2,050,993	4,937,918
			EURO IV - 98/69/EC S 2005	815,472	8,452,782	3,604,076	1,422,920	3,425,786
		1,4 - 2	ECE 15/04	835,083	2,225,344	948,837	374,609	901,899
			EURO I - 91/441/EEC	1,095,431	4,703,299	2,002,735	790,697	1,909,867
			EURO II - 94/12/EC	1,260,152	7,333,878	3,113,683	1,229,309	2,990,886
			EURO III - 98/69/EC S 2000	2,160,012	17,871,434	7,617,497	3,007,453	7,246,484
			EURO IV - 98/69/EC S 2005	1,229,297	11,625,013	4,907,649	1,937,582	4,779,783
		>2	ECE 15/04	126,151	646,689	275,734	108,862	262,093
			EURO I - 91/441/EEC	121,912	1,188,928	506,932	200,141	481,855
			EURO II - 94/12/EC	118,789	1,970,907	840,350	331,777	798,779
			EURO III - 98/69/EC S 2000	207,475	5,613,875	2,392,977	944,768	2,276,130
			EURO IV - 98/69/EC S 2005	139,798	4,456,878	1,900,312	750,260	1,806,306
	LPG	TURISMO	CONVENTIONAL		50,561			50,561
			EURO I - 91/441/EEC		40,449			40,449
			EURO II - 94/12/EC		30,337			30,337
			EURO III - 98/69/EC S 2000		50,561			50,561
			EURO IV - 98/69/EC S 2005		40,449			40,449
			TOTAL	**23,380,346**	**298,012,074**	**140,644,961**	**55,527,832**	**101,839,281**

Notes: Buses (A); Mopeds (C); Light duty vehicles (L); Motorcycles (M); Heavy duty vehicles (P); Passenger cars (T).

Table 4.3.6.19.- Fuel consumption by highway, rural and urban driving patterns year 2008

VEHICLE CATEGORY AND CLASS				NÚM. VEH.	FUEL CONSUMPTION (t)			
					TOTAL	H	R	U
A	NATURAL GAS	GOACH	EEV		2,069			2,069
			EURO I - 91/542/EEC S I		7,573			7,573
			EURO II - 91/542/EEC S II		11,712			11,712
			EURO III - COM(97) 627		16,556			16,556
	DIESEL	GOACH	CONVENTIONAL	7,307	5,158	2,287	684	2,188
			EURO I - 91/542/EEC S I	2,783	14,932	6,632	1,985	6,315
			EURO II - 91/542/EEC S II	9,133	200,878	90,123	27,107	83,648
			EURO III - COM(97) 627	10,373	347,267	152,352	45,977	148,939
			EURO IV - COM(1998) 776	7,567	249,117	108,766	32,796	107,555
			EURO V - COM(1998) 776	2,438	27,315	11,850	3,583	11,882
		URBAN BUS	EURO II - 91/542/EEC S II	4,916	66,817			66,817
			EURO III - COM(97) 627	5,592	131,215			131,215
			EURO IV - COM(1998) 776	4,072	36,254			36,254
			EURO V - COM(1998) 776	1,311	33,237			33,237
			TOTAL	**55,492**	**1,150,101**	**372,009**	**112,132**	**665,960**
C	GASOLINE	CICLOMOTOR	97/24/EC SII	2,058,577	58,263			58,263
			TOTAL	**2,058,577**	**58,263**			**58,263**
L	DIESEL	LIGHT DUTY	CONVENTIONAL	820,733	48,136	26,062	6,908	15,165
			EURO I - 93/59/EEC	382,160	67,887	34,646	9,097	24,144
			EURO II - 96/69/EC	786,113	281,426	143,625	37,712	100,089
			EURO III - 98/69/EC S 2000	1,245,210	1,171,047	597,584	156,910	416,553
			EURO IV - 98/69/EC S 2005	840,167	927,226	473,207	124,252	329,767
	GASOLINE	LIGHT DUTY	CONVENTIONAL	248,981	3,582	1,357	531	1,693
			EURO I - 93/59/EEC	122,349	1,631	620	242	769
			EURO II - 96/69/EC	107,074	7,347	2,791	1,091	3,465
			EURO III - 98/69/EC S 2000	121,501	19,943	7,577	2,961	9,405
			EURO IV - 98/69/EC S 2005	53,235	10,180	3,868	1,511	4,801
			TOTAL	**4,727,523**	**2,538,404**	**1,291,338**	**341,216**	**905,850**
M	GASOLINE	TWO STROKES	CONVENTIONAL	418,713	5,347	674	229	4,444
			2002/51/EC SI	156,832	27,026	3,837	1,397	21,792
			2002/51/EC SII	253,190	31,900	4,529	1,649	25,722
			97/24/EC	58,479	6,217	883	321	5,013
		250 - 750	CONVENTIONAL	223,524	6,558	622	195	5,741
			2002/51/EC SI	114,377	34,980	5,132	1,331	28,517
			2002/51/EC SII	199,196	54,029	7,927	2,055	44,048
			97/24/EC	47,817	7,264	1,066	276	5,922
		50 - 250	CONVENTIONAL	364,666	4,106	521	144	3,441
			2002/51/EC SI	138,654	31,371	7,260	1,395	22,715
			2002/51/EC SII	222,276	48,317	11,183	2,149	34,986
			97/24/EC	52,711	6,791	1,572	302	4,917
		>750	CONVENTIONAL	67,465	7,951	667	231	7,052
			2002/51/EC SI	56,640	23,620	2,193	765	20,662
			2002/51/EC SII	98,567	38,108	3,538	1,234	33,335
			97/24/EC	24,775	7,086	658	229	6,199
			TOTAL	**2,497,882**	**340,670**	**52,261**	**13,903**	**274,505**
P	DIESEL	14 - 32	CONVENTIONAL	37,249	108,004	76,293	22,862	8,848
			EURO I - 91/542/EEC S I	5,000	64,927	45,511	13,569	5,847
			EURO II - 91/542/EEC S II	13,267	225,565	156,011	46,128	23,427
			EURO III - COM(97) 627	28,553	571,729	343,132	102,400	126,197
			EURO IV - COM(1998) 776	21,381	444,757	276,749	83,121	84,887
			EURO V - COM(1998) 776	4,370	40,983	25,218	7,545	8,220
		>32	CONVENTIONAL	24,150	63,104	47,236	14,757	1,111
			EURO I - 91/542/EEC S I	4,961	47,790	35,031	10,938	1,820
			EURO II - 91/542/EEC S II	34,950	523,696	397,280	124,635	1,781
			EURO III - COM(97) 627	77,490	1,891,370	1,424,766	449,688	16,917
			EURO IV - COM(1998) 776	65,308	2,195,199	1,625,917	513,380	55,902
			EURO V - COM(1998) 776	16,682	213,368	161,285	50,871	1,212
		3,5 - 7,5	CONVENTIONAL	62,953	73,809	55,255	15,174	3,379
			EURO I - 91/542/EEC S I	13,694	49,910	38,752	10,438	720
			EURO II - 91/542/EEC S II	41,896	104,179	79,166	21,268	3,744
			EURO III - COM(97) 627	55,951	343,208	259,773	70,141	13,294
			EURO IV - COM(1998) 776	36,621	299,031	223,432	61,520	14,079
			EURO V - COM(1998) 776	8,288	21,563	12,686	3,551	5,326

VEHICLE CATEGORY AND CLASS				NÚM. VEH.	FUEL CONSUMPTION (t) TOTAL	H	R	U
		7,5 - 14	CONVENTIONAL	36,451	86,958	58,156	16,407	12,395
			EURO I - 91/542/EEC S I	7,282	49,259	35,522	9,919	3,818
			EURO II - 91/542/EEC S II	19,997	132,957	91,353	25,416	16,188
			EURO III - COM(97) 627	31,409	251,218	162,464	45,868	42,887
			EURO IV - COM(1998) 776	22,049	161,614	108,297	30,646	22,671
			EURO V - COM(1998) 776	5,376	16,936	9,995	2,838	4,104
	GASOLINE	HEAVY DUTY	CONVENTIONAL	1,744	28,480	20,960	5,652	1,868
			TOTAL	**677,072**	**8,009,616**	**5,770,241**	**1,758,732**	**480,643**
T	DIESEL	<=2	CONVENTIONAL	1,839,667	49,628	22,999	7,090	19,539
			EURO I - 91/441/EEC	519,542	195,901	95,832	32,250	67,819
			EURO II - 94/12/EC	1,166,083	816,386	377,168	130,884	308,333
			EURO III - 98/69/EC S 2000	2,853,143	3,672,388	1,541,917	570,399	1,560,072
			EURO IV - 98/69/EC S 2005	2,902,415	4,622,813	1,990,173	736,222	1,896,418
		>2	CONVENTIONAL	346,206	23,353	10,869	3,351	9,133
			EURO I - 91/441/EEC	96,108	77,396	37,389	12,975	27,032
			EURO II - 94/12/EC	173,443	187,681	89,890	31,194	66,597
			EURO III - 98/69/EC S 2000	448,411	841,319	399,992	138,808	302,519
			EURO IV - 98/69/EC S 2005	451,599	1,338,086	640,124	222,141	475,821
	GASOLINE	<1,4	ECE 15/04	2,143,993	131,901	48,389	16,917	66,595
			EURO I - 91/441/EEC	625,679	150,683	54,996	19,186	76,501
			EURO II - 94/12/EC	637,815	233,875	82,076	28,200	123,598
			EURO III - 98/69/EC S 2000	1,066,670	687,061	242,494	87,389	357,178
			EURO IV - 98/69/EC S 2005	815,472	500,941	177,055	62,540	261,346
		1,4 - 2	ECE 15/04	835,083	149,762	51,327	18,796	79,639
			EURO I - 91/441/EEC	1,095,431	308,964	106,280	38,704	163,981
			EURO II - 94/12/EC	1,260,152	468,758	154,274	59,252	255,233
			EURO III - 98/69/EC S 2000	2,160,012	1,199,158	414,041	151,007	634,110
			EURO IV - 98/69/EC S 2005	1,229,297	800,680	276,889	103,093	420,698
		>2	ECE 15/04	126,151	56,473	19,894	6,139	30,440
			EURO I - 91/441/EEC	121,912	100,221	33,926	12,540	53,754
			EURO II - 94/12/EC	118,789	173,238	57,051	21,895	94,291
			EURO III - 98/69/EC S 2000	207,475	437,538	138,022	55,281	244,234
			EURO IV - 98/69/EC S 2005	139,798	416,653	126,738	52,119	237,795
	LPG	TURISMO	CONVENTIONAL		3,221			3,221
			EURO I - 91/441/EEC		2,445			2,445
			EURO II - 94/12/EC		1,834			1,834
			EURO III - 98/69/EC S 2000		3,056			3,056
			EURO IV - 98/69/EC S 2005		2,445			2,445
			TOTAL	**23,380,346**	**17,653,857**	**7,189,807**	**2,618,374**	**7,845,676**

Notes: Buses (A); Mopeds (C); Light duty vehicles (L); Motorcycles (M); Heavy duty vehicles (P); Passenger cars (T).

4.3.6.2.5.- Other variables and parameters information

In addition to the variables already described, the estimation method includes a series of constants that qualify or constrain emission factors. The following are included in this category:

1.- Fuel Characteristics:

To calculate SO_2 and Pb emissions, it is necessary to start by taking into account the sulphur and lead content in the fuel. Legislation establishes maximum contents of each which have become more and more restrictive over the years. Table 4.3.6.20 gives the mean values assumed in the calculations, as well as the volatility of petrol, a parameter required in order to estimate NMVOC emissions due to evaporation of petrol.

Table 4.3.6.20.- Fuel specifications

Fuel	Years	PVR (kPa) Winter	PVR (kPa) Summer	Sulphur (g/kg)	Lead (mg/kg)
Conventional gasoline	1990	73.4	60.8	1,04	426,67
	1991	73.4	60.8	1,04	266,67
	1992 – 2001	73.4	60.8	1,04	160
Unleaded gasoline	1990 – 1995	73.4	60.8	0,8	13,87
	1996 – 1999	73	63	0,4	13,87
	2000 – 2004	74	57	0,12	5,33
	2005 – 2007	74	57	0,04	5,33
Diesel	1990 – 1994			2,4	
	1995 – 1996			1,6	
	1997 – 1999			0,4	
	2000 – 2004			0,28	
	2005 – 2007			0,04	

2.- Average length of journey:

This variable is needed to calculate the parameterβ. The value of **12 km** has been assumed in accordance with the mean estimates made in the rest of the countries in Europe (please refer to Table 4.4 of the *COPERT III Methodology and Emission Factors* document cited above)

3.- Percentage of **injection engine** vehicles and percentage of vehicles equipped with **evaporation control**

These constants are necessary to estimate emissions caused by evaporation. Given the difficulty in establishing accurate figures for these percentages, the results from the application of the following guidelines have been assumed:

- Vehicles manufactured before Directive 91/441/CEE are assumed to be equipped with conventional carburettors (non-injection engines) and are not equipped with evaporation control.

- Vehicles manufactured after this Directive, but before Directive 94/12/CE are assumed to have engines with fuel injection, but not with evaporation control systems.

- Vehicles corresponding to Directive 94/12/CE and later are equipped both with fuel injection engines and evaporation control.

4.3.6.2.6.- Emission factors

As for the data sources regarding emission factors, the most outstanding, on the one hand, are the combustion-related emissions emerging from the exhaust pipe and the evaporation emissions while, on the other hand, there are emissions associated with the wear and tear of brakes and tyres and the erosion of the road surface.

Emission factors per kilometre travelled are, in general, as functions of vehicle travelling speed and the surrounding temperature, therefore the complete relationship of the same must cover a range of these variables too extensive to be presented in this document.

The emission with a cold engine is assigned in its entirety to the category of urban driving, with the understanding that all the trips are started in the urban circuit. Therefore, in applying the factors to obtain total emissions, the following formulae must be applied for each pollutant and type of vehicle:

$$E_I^T = E_I^C = R_I f_I^C$$
$$E_R^T = E_R^C = R_R f_R^C$$
$$E_U^T = R_U f_U^C + \beta (R_I + R_R + R_U) f_U^C \left(\frac{f_U^F}{f_U^C} - 1 \right)$$

where the superscript indicates the type of emission (total (T), hot (C) and cold (F)) and the subscripts indicate driving category (I,R,U).

It should be noted, that for those pollutants whose emission is calculated by the balance of fuel mass, the factors per kilometre travelled that appear in the tables, have been calculated by determining the content of metal, carbon, etc., in the quantity of fuel required by type of vehicle, to travel one kilometre

For emissions emerging from the exhaust pipe as well as for evaporation emissions, the reference source is the COPERT IV Manual. It should be noted that, regarding particles (referred to in COPERT IV as PM), according to a personal communication from the head of the COPERT IV team, it is assumed that all of the emission is concentrated in $PM_{2.5}$ granulometry, meaning that the results for $PM_{2.5}$, PM_{10} and PST all coincide. With respect to PAH, regard has been had only for the four substances in the Protocol: benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene and indeno(123cd)pyrene.

For emissions associated with tyre and brake wear and with road surface erosion (in which the relevant emissions correspond to particles and metals), the reference source selected has been the EMEP/CORINAIR Guide Book (August 2003 edition, chapter B770).

4.3.7.- National navigation (1A3d)

This category reflects the merchant navy’s maritime traffic for voyages between domestic ports, regardless of the flag the vessel sails under or the nationality of its owner.

This category provides estimates on all of the pollutants contained within the scope of the analysis in this report. In terms of its contribution to the inventory, despite the increase, generally speaking, in its relative significance over the course of the period inventoried, this activity constitutes a moderate or low emission source for all of the pollutants analyzed in this inventory excepting sulphur oxides, for which its contribution is notable. Having regard for its contribution level, it is worth highlighting its relative importance, with respect to 2008, in SO_X (13.0%), NO_X (5.8%), particulates (between 3.9% for TSP and 6.6% for $PM_{2.5}$) and DIOX (2.7%).

4.3.7.1.- Activity variables

National energy balances[40] and information provided by the State Ports Authority and the Spanish Ship-owners Association (ANAVE) have been considered in order to estimate fuel consumption in this activity. Depending on the availability of information from ANAVE, the following sub-periods must be distinguished with regard to data processing:

- the baseline data for the period 1993-2002 records the fuel consumptions declared by the fleets belonging to companies in ANAVE, regardless of the voyage undertaken (domestic and international traffic). The information referring to ANAVE are taken from the statistical processing of a survey sent out to the shipping companies in ANAVE by the State Ports Authority regarding fuel consumption for each vessel owned by the respective companies;
- the previous sub-series was completed and extended to preceding years (1990-1992) by projecting the available consumption data;
- for 2002-2004, since no survey was available, the aggregated information by fuel type was provided directly by ANAVE; and
- from 2005 on, since the information previously provided by ANAVE was no longer available, fuel consumption has been estimated from a mean consumption factor per unit of Gross Registered Tonnage (GRT). The consumption factor was obtained from the energy consumption series for this activity during the most recent period and from the information contained in the Statistical Yearbook published by the Ministry of Public Works relative to merchant ship tonnage carrying out cabotage activities[41].

The breakdown of fuel type has been processed by sub-periods as indicated in continuation:

- In the period 1990-2004, the consumption figure provided by ANAVE has been taken as the reference value for gas-oil and then, following the estimations by ANAVE experts, this has been allocated 70% of the consumption as corresponding to domestic traffic (the remaining 30% is considered by the ANAVE experts to be consumption corresponding to international traffic). As for the consumption of residual oil, in a

[40] Please refer to the publications entitled "Energy Statistics of OECD countries" published by the International Energy Agency (IEA) and the EUROSTAT's "Energy Balance Sheets", supplemented by the international questionnaire on oil-based products (AOS) submitted by the Subdirectorate-General for Hydrocarbons at the MITYC to the two international bodies mentioned, the IEA and EUROSTAT.

[41] Due to a change in the contents of the reference publication, the information about the tonnage of merchant navy vessels conducting cabotage activities is not available for 2008. In order to overcome this shortcoming, it has been decided to estimate the energy consumption of this activity in the said year using the annual variation in the total tonnages (cabotage and international traffic) reported by the Ministry of Public Works.

compromise solution between the two reference sources[42] [43], the larger of the following values has been taken: the energy balances and 65% of the consumption reported by ANAVE (this percentage corresponds to the domestic traffic estimated by ANAVE experts).

- Since 2004, the breakdown by fuel type has been estimated by applying the mean contribution of gas-oil and residual oil to the total energy calculated according to the breakdown in previous years. [44]

Table 4.3.7.1.1 and Figure 4.3.7.1.1 show the fuel consumption estimated for this activity expressed in terms of energy (TJ of lower heating value). Between 1994 and 2002, a pronounced valley is observed for fuel consumption that may be partly explained by the integration of two different sources of information and is currently under study to discern whether this pattern may be misleadingly influenced by the integration from disparate sources.

Table 4.3.7.1.1.- Fuel consumption *(Amounts in TJ_{LHV})*

Type	1990	1995	2000	2004	2005	2006	2007	2008
Residual oil	16,072	16,393	15,628	22,048	23,033	25,323	29,879	30,416
Diesel	3,659	4,223	8,413	9,992	10,256	11,276	13,304	13,543
Total	**19,731**	**20,617**	**24,041**	**32,040**	**33,289**	**36,599**	**43,183**	**43,960**

[42] During consultations with ANAVE staff, with regard to the period 1990-2004, these experts considered that the traffic between domestic ports was primarily carried out by Spanish-owned vessels, with the participation of foreign companies being deemed practically irrelevant. As a result, the estimation of the consumption due to domestic traffic derived from the ANAVE data (discounting the fraction of the consumption with which ANAVE's fleet operates in the international segment by applying adjustment factors of – 0.7 for gas-oil and 0.65 for residual oil) would be comparable to the figures presented by the International Energy Agency by fuel type.

[43] It should be mentioned that the consumption allocated to ANAVE vessels in international traffic (estimated at 30% of the amount of gas-oil consumed by the ANAVE fleet and 35% of the total residual oil consumed by ANAVE) only represents a fraction of the total consumption for international sailing (as reported in the IEA's energy balance under the heading "International maritime bunkers"). For this reason, in order to estimate international maritime traffic, the information published in the IEA energy balances have been taken directly.

[44] From 2004 on, the structure of maritime traffic (by fuel types – gas-oil vs residual oil – and by company origin – domestic vs foreign –) may have varied but no new verified statistical information has been obtained in order to apply it to the years 2005 to 2008; for this reason, the coefficients for the period 1990-2004 have been maintained for both the weightings of domestic vs international traffic and for the coverage coefficient of ANAVE's vessels within the total of domestic traffic.

Figure 4.3.7.1.1.- Fuel consumption

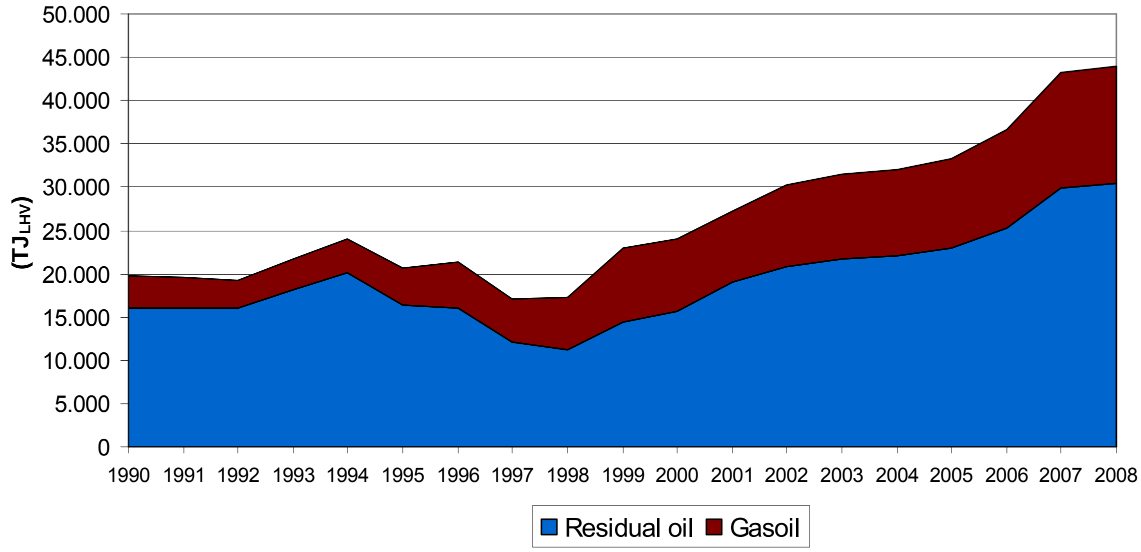
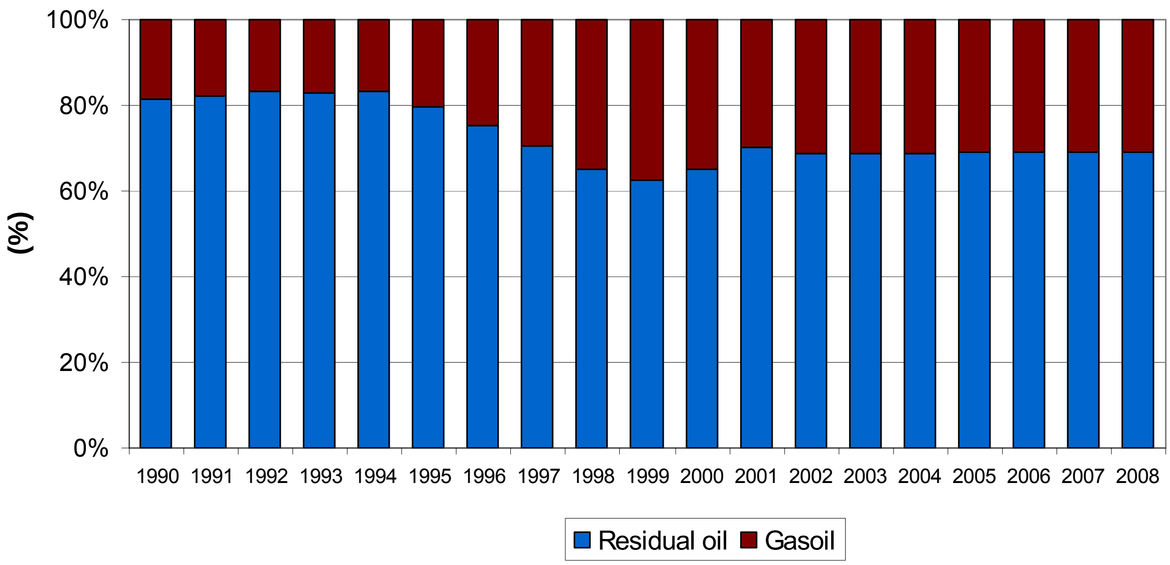


Figure 4.3.7.1.2 shows the distribution of consumption by fuel type throughout the period inventoried. Although residual oil continues to be the main energy source for this activity, its share decreases in 2008 with respect to 1990, showing a more marked decline during the central years in the series (period 1995-2000) as a result of the valley already described for its consumption profile and the increased use of gas-oil in this activity.

Figure 4.3.7.1.2.- Fuel consumption distribution, based on TJ_{LHV}



4.3.7.2.- Methodology

4.3.7.2.1.- Advanced methodology

No advanced methodologies were applied to this activity when estimating emissions.

4.3.7.2.2.- Default methodology

The default methodology applied to estimate emissions is essentially that proposed by EMEP/CORINAIR. Mass balance based on the mean annual sulphur content of fuels was used to estimate SO_X.

For the remaining pollutants included in the present report, the default emission factors proposed in the following references were used:

- "*Marine Exhaust Emissions Research Programme*" by Lloyd's Register of Shipping for NO_X, CO and VOC factors, choosing S3-type ships (*barge*) for gas-oil and S7 (*ferry*) for residual oil. In the case of VOC, the speciation was assumed to have 5% methane content.
- CORINAIR Manual (1992) for ammonia factor. Due to the lack of specific data for this category, a generic factor was used for agricultural, forestry, industrial and military activities.
- Chapter B-842 of the EMEP/CORINAIR Guidebook for heavy metals (2002 August edition), DIOX (2002 August edition) and PAH (1998 May edition). For DIOX the average range value used was obtained from the said source.
- The report entitled "Development of a Database System for the Calculation of Indicators of Environmental Pressure Caused by Transport. Transport and Environment Database System (TRENDS). Detailed Report 2: Maritime and Inland Shipping Modules" was used to estimate particulate emissions. The report provides an emission factor for total particulate matter (PM) for medium-low speed diesel engines based on sulphur content according to the following formula:

$$\frac{PM}{PM_{ref}} = 0{,}6 * \left(\frac{\%S - \%S_{ref}}{\%S_{ref}} \right) + 1$$

where PM_{ref} (1.2 kg/Mg of gas-oil and 7.6 kg/Mg of residual oil) and $\%S_{ref}$ (0.5% for gas-oil and 2.7% for residual oil) are the reference values and PM and %S represent the actual values. To discriminate the particulate matter by size, the diameter of every particulate emitted was assumed to be under 2.5 microns.

4.3.8.- Other means of transportation (1A3c and 1A3e)

Two scarcely significant categories within the inventory are described in the present heading: category 1A3c of railway traffic, including gas-oil combustion in heating coaches, diesel-powered train units and locomotives, and category 1A3e, with emissions from combustion in pipeline compressors throughout the transport network.

4.3.8.1.- Activity variables

Basic sources of information on activity variables (fuel consumption) applied to these two categories are listed below:

- For railway traffic, fuel data (standard gas-oil) attributed to diesel-powered fleets refer to unit provision, this information being directly provided by the main railway operators, whether owned by the state or regional governments.

- For pipeline compressors, the source on “Transport and Postal Services” published by the Ministry of Public Works provides figures relative to the supply of fuels, gas-oil and LPG to pipeline compressors.

Table 4.3.8.1.1 and Figure 4.3.8.1.1 show fuel consumption estimated for each activity and expressed in terms of energy (TJ of lower heating value). The consumption series for these activities show different evolution patterns: while railway transportation with diesel-powered units progressively decreases in terms of activity and subsequently in terms of consumption, combustion in compressors shows a generally upward pattern with considerable fluctuations and even changes in trend which have been compared to the original source and are nevertheless being analyzed for time consistency against other reference indicators and experts from the relevant institutions and associations.

Table 4.3.8.1.1.- Fuel consumption *(Amounts in TJ_{LHV})*

Category	Fuel	1990	1995	2000	2004	2005	2006	2007	2008
1A3c Railways	Diesel	5.704	4.447	4.171	4.173	4.202	4.180	4.109	3.955
1A3e Compressors	Diesel	38	170	119	93	13	4	4	4
	LPG	269	716	2.042	3.627	4.930	2.799	2.494	2.494
	Total	307	886	2.161	3.720	4.943	2.803	2.498	2.498

Figure 4.3.8.1.1.- Fuel consumption

Railways

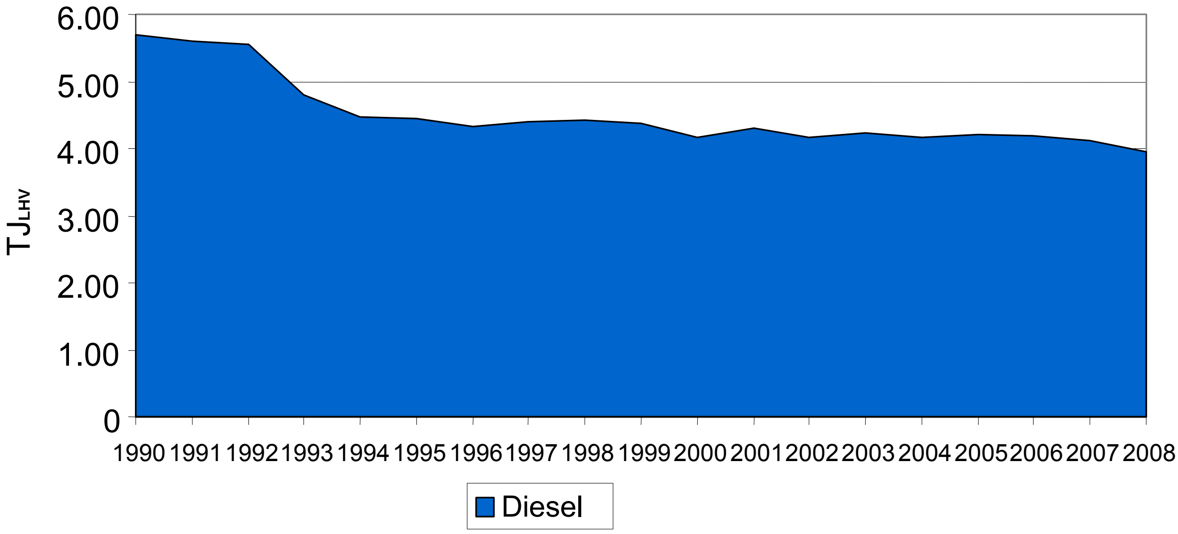
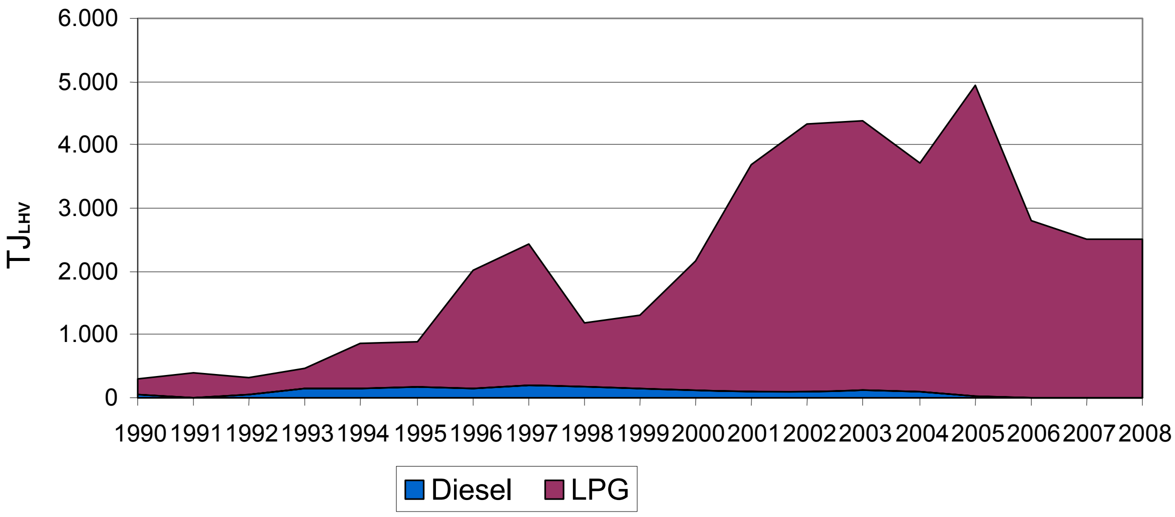


Figure 4.3.8.1.1.- Fuel consumption *(Continued)*

Pipeline compressors



4.3.8.2.- Methodology

4.3.8.2.1.- Advanced methodology

No advanced or country-specific estimation procedures were applied to these activities.

4.3.8.2.2.- Default methodology

The default methodology applied to estimate emissions is essentially that proposed by EMEP/CORINAIR. Mass balance based on the mean annual sulphur content of fuels was used to estimate SO_X.

For the remaining pollutants included in the present report, the default emission factors proposed in the following references were used:

- For railway traffic, the factors applied corresponding to the main pollutants, Cd and PAH, are published in chapter B-810 of EMEP/CORINAIR guidelines. For particulates, the mean European factor for total particulates (PM) proposed for diesel-powered trains in the TRENDS document[45] was applied; the diameter of every particulate emitted was assumed to be under 2.5 microns ($PM_{2.5}$).

[45] "Development of a Database System for the Calculation of Indicators of Environmental Pressure Caused by Transport. Transport and Environment Database System (TRENDS). Detailed Report 3: Railway Module".

- For compressors: Due to the absence of specific factors for these units, those corresponding to engines (for gas-oil) or gas turbines (for LPG) were chosen, subsequently taking similar factors to those corresponding to the two unit types from the following guidance documents: a) EMEP/CORINAIR guidelines, chapter B-112, for main pollutants; b) portmanteau factors for particulate matter within CEPMEIP programme, choosing those corresponding to the "Autoproducers and co-generation of electric power" with medium/high emission level due to the lack of specific factors for this activity; c) OSPARCOM-HELCOM-UNECE[46] for DIOX.

4.3.9.- Combustion in other sectors (1A4)

This category includes emissions derived from combustion in both stationary equipment in commercial, institutional, residential, agricultural activities and mobile machinery used in agriculture and forestry (tractors, walking tractors, harvesters, etc.) and also in fishing fleets. Stationary sources include fixed combustion facilities with relatively low thermal capacity located in these premises and mainly designed to generate heat and, to a much lesser extent, heat and electricity (co-generation) for individual use; whereas mobile sources include equipment self-propelled by means of internal combustion engines used in the above industries and activities.

Every pollutant covered in the present report is estimated for this category. Due to their contribution, it is worth noting particulate emissions of certain gases characteristic of combustion (particularly, CO and NO_X) and those of persistent organic compounds. Broken down by activity and/or sector, emissions mainly come from the residential sector (CO, particulate matter and POPs) and mobile machinery used in agriculture and forestry (NO_X and particulate matter), while the remaining sources were scarcely significant.

As for potentially emitting activities, it is worth mentioning emissions from mobile sources in residential and service sectors, essentially included in categories associated with stationary sources in their respective sectors and labelled as "IE" since mobile source emissions are already taken into account together with stationary sources in the sector[47].

4.3.9.1.- Activity variables

The basic sources of information on activity variables (fuel consumption) have been:

- For commercial, institutional and residential sectors (categories 1A4a and 1A4b), information related to fossil fuels was essentially obtained from the national fuel

[46] "Technical Paper to the OSPARCOM-HELCOM-UNECE Emission Inventory of Heavy Metals and Persistent Organic Pollutants. TNO Institute of Environmental Sciences, Energy Research and Process Innovation. December 18th, 1995.

[47] Since the reference source chosen for the activity variable does not distinguish sectorial consumption by source type (stationary or mobile) and no additional information was available in the inventory to break it down, although consumption from stationary sources clearly prevails in both sectors, total consumption was associated with the said sources, estimating the resulting emissions with factors corresponding to stationary facilities.

balance developed for this Inventory[48], and for biomass have been estimated from information provided by the Institute for the Diversification and Saving of Energy (IDAE).

- For the agriculture, forestry and fishing sector (category 1A4c), estimates have been taken from knowledge of activity patterns and the energy requirements associated with such activity, assuming that practically all fuel used is gas-oil. With regard to information on sub-sector activity patterns (sea fishing, agricultural and forestry machinery), information has been gathered as follows:

  * Sea fishing (1A4ciii): the data contains information on the power of the fishing fleet provided by the Subdirectorate-General for Fishing Fleet Organization and Training at the Ministry of the Environment, Rural and Marine Affairs (MARM) and values for parameters referring to specific average fuel consumption per work unit, number of days of operation a year, hours of operation per day and frequency and duration of stays in port, which have been verified with experts from the sector.

  * Agricultural and forestry machinery (1A4cii): for agricultural machinery, information has been based on that provided by the Sub-Directorate-General for Means of Agricultural Production at the Ministry of Agriculture, Fisheries and Food (MAPA) to evaluate power installed in active vehicles by type of machinery (tractors, combine harvesters or rotovators). Other parameters that play a part in the calculation of fuel consumptions are the number of effective hours/year of each type of machinery and energy requirements per standard hour of operation and per unit of rated power.

    In order to estimate consumptions corresponding to forestry machinery, a similar procedure has been followed. In this case, socio-economic data relating to forestry, such as reforested surface area or the volume of wood harvested, have been selected as base information. These data have been compiled into the publication "Statistical Yearbook" prepared by the MARM and have been complemented by experts from the sector for years when the aforementioned publication was not available. Other complementary basic activity variables, such as the length of prepared forest trails and the surface area of firewalls, have been estimated directly by these experts. These experts have also directly specified such data for other complementary, basic activity variables such as the length of repaired forest tracks and the surface area of firebreaks. These experts have also provided supplementary information regarding the characteristics of machinery by class of operation, such as number of units, mean installed capacity of each unit, pulling or loading performance and specific average fuel consumption, from which the total installed capacity and/or hours of operation by class of operation have been derived.

  * Finally, for stationary combustion in the agricultural sector (engines and other installations), the information considered is that appearing in the national fuel

48 See comments above regarding the integration of different sources of information to estimate this entry for the inventory-specific energy balance.

balance, with the exception of diesel, for which a consumption is estimated that is proportional to the value given for mobile agricultural machinery. The different treatment adopted for stationary combustion in agricultural irrigation engines is worth mentioning as this is based on both diesel consumption ratios per hectare of irrigation as taken from the document "Energy Saving and Efficiency Strategy – E4" for the agricultural sector[49] and the irrigation surface area that appears in the "Statistical Yearbook" by MARM.

Table 4.3.9.1.1 and Figure 4.3.9.1.1 show fuel consumption expressed in energy terms (terajoules of lower heating value, TJ_{LHV}), estimated for the entire category and for each of the sectors under study. With respect to the energy from renewable sources, it should be mentioned that the limited information available about the biomass dedicated to final consumption (i.e. excluding the part consumed for electricity co-generation) has led to the subrogation of the estimates for 1995 for subsequent years, considerably raising the uncertainty associated with these items.

When analyzing the distribution of energy consumption of fuels by social and economic sectors, the prevailing industry is the residential sector, which increased moderately in terms of fuel demand (35.6% in 2008 with respect to 1990), mainly by means of additional supply of natural gas. It is worth noting in this sector the influence of weather on different demand levels, with milder years showing a reduction in growth or even, as in 2006, a net reduction in consumption with regard to the preceding year.

The agriculture, forestry and fishing sectors, which account for 21.7% of total consumption in this category during 2008, are the second fuel energy consumption market within this category and rank first in gas-oil consumption, the clearly prevailing fuel in this sector. Total energy demand in this sector underwent a sustained and moderate increase over the period (18.0% in 2008 with respect to 1990), mainly as a result of the increase in units and consumption of agricultural mobile machinery, the main consuming activity in the sector, and, to a lesser extent, of the demand in stationary agricultural and livestock facilities versus a decrease in activity and consumption for fishing fleets.

With respect to the institutional and commercial sector, its significance in the category as a whole, in energy terms, has notably increased, growing to 20.2% of the total consumption in the category in 2008. The general growth pattern (141.2% in 2008 with respect to 1990) in terms of demand is mainly caused by the marked expansion of natural gas in the energy structure of this sector, both for heat generation and use in co-generation facilities (heat and electricity), together with the more moderate growth of gas-oil in heat production up to 2004.

[49] Working document for "Energy Saving and Efficiency Strategy 2004-2012 of the Agriculture and Fishing Sector", edition July 2003.

Table 4.3.9.1.1.- Fuel consumption *(Amounts in TJ_{LHV})*

Total Other sectors

Type	1990	1995	2000	2004	2005	2006	2007	2008
Liquid	***307,952***	***336,849***	***367,144***	***389,098***	***383,616***	***355,765***	***347,655***	***346,500***
Gasoline	262	264	231	212	224	245	212	212
Kerosene	4,791	2,298	130					
Diesel	190,800	217,276	259,079	290,061	289,435	273,188	267,051	267,798
Residual oil	11,035	25,632	18,893	16,023	13,219	7,972	7,016	6,895
L.P.G.	100,576	90,859	88,485	82,411	80,380	74,002	73,084	71,335
Petroleum coke	488	520	325	390	358	358	293	260
Solid	***28,353***	***15,685***	***7,172***	***6,182***	***6,322***	***6,199***	***6,356***	***6,424***
Hard coal	15,443	12,743	3,519	4,551	4,551	4,551	4,551	4,551
Sub-bituminous coal	924							
Patent fuels	152							
Gas works gas	11,834	2,943	3,652	1,631	1,771	1,648	1,805	1,873
Gases	***23,974***	***53,300***	***113,833***	***177,962***	***195,607***	***188,446***	***204,774***	***212,731***
Natural gas	23,974	53,300	113,833	177,962	195,607	188,446	204,774	212,731
Biomass	***91,783***	***85,365***	***83,817***	***83,674***	***83,674***	***83,674***	***83,881***	***83,691***
Wood/Wood waste	82,455	79,191	78,672	78,672	78,672	78,672	78,672	78,689
Charcoal	8,209	4,735	4,035	4,035	4,035	4,035	4,035	4,035
Other solid biomass	1,118	859	968	968	968	968	968	968
Biogas	0	581	143				207	
Total	**452,062**	**491,200**	**571,965**	**656,916**	**669,219**	**634,085**	**642,666**	**649,346**

Institutional / commercial sector

Type	1990	1995	2000	2004	2005	2006	2007	2008
Liquid	***44,096***	***62,871***	***72,064***	***83,166***	***80,440***	***68,308***	***63,714***	***63,118***
Diesel	26,715	31,160	48,766	62,169	62,003	54,952	50,811	50,074
Residual oil	9,829	22,873	14,000	10,799	8,960	4,615	4,083	4,002
L.P.G.	7,389	8,643	9,135	10,002	9,314	8,579	8,691	8,911
Petroleum coke	163	195	163	195	163	163	130	130
Solid	***2,128***	***1,524***	***2,709***	***1,512***	***1,543***	***1,499***	***1,691***	***1,724***
Hard coal	880	607	1,092	910	910	910	910	910
Sub-bituminous coal	13							
Gas works gas	1,234	917	1,617	602	633	589	780	814
Gases	***7,178***	***12,926***	***29,200***	***48,952***	***60,033***	***58,802***	***63,487***	***64,896***
Natural gas	7,178	12,926	29,200	48,952	60,033	58,802	63,487	64,896
Biomass	***947***	***1,853***	***1,467***	***1,324***	***1,324***	***1,324***	***1,531***	***1,341***
Wood/Wood waste	569	764	796	796	796	796	796	813
Charcoal	378	508	529	529	529	529	529	529
Biogas	0	581	143				207	
Total	**54,348**	**79,173**	**105,440**	**134,954**	**143,341**	**129,933**	**130,423**	**131,081**

Residential sector

Type	1990	1995	2000	2004	2005	2006	2007	2008
Liquid	***146,554***	***151,780***	***167,003***	***172,010***	***169,242***	***151,938***	***147,486***	***145,366***
Diesel	53,424	69,960	87,174	98,665	97,520	86,496	83,316	83,019
Residual oil	603	1,607	3,496	3,697	3,014	2,152	1,808	1,808
L.P.G.	92,202	79,888	76,171	69,454	68,513	63,095	62,199	60,408
Petroleum coke	325	325	163	195	195	195	163	130
Solid	***25,850***	***14,162***	***4,463***	***4,671***	***4,779***	***4,700***	***4,665***	***4,700***
Hard coal	14,563	12,136	2,427	3,641	3,641	3,641	3,641	3,641
Sub-bituminous coal	536							
Patent fuels	152							
Gas works gas	10,600	2,026	2,036	1,030	1,138	1,059	1,024	1,059
Gases	***16,684***	***40,008***	***82,757***	***126,336***	***132,631***	***126,644***	***138,295***	***145,048***
Natural gas	16,684	40,008	82,757	126,336	132,631	126,644	138,295	145,048
Biomass	***89,164***	***83,346***	***82,183***	***82,183***	***82,183***	***82,183***	***82,183***	***82,183***
Wood/Wood waste	81,108	78,349	77,798	77,798	77,798	77,798	77,798	77,798
Charcoal	7,831	4,227	3,506	3,506	3,506	3,506	3,506	3,506
Other solid biomass	226	770	879	879	879	879	879	879
Total	**278,252**	**289,296**	**336,406**	**385,200**	**388,835**	**365,465**	**372,629**	**377,297**

Table 4.3.9.1.1.- Fuel consumption *(Amounts in TJ_{LHV}) (Continued)*

Agriculture / forestry / fishing sector

Type	1990	1995	2000	2004	2005	2006	2007	2008
Liquid	***117,303***	***122,199***	***128,077***	***133,922***	***133,934***	***135,519***	***136,456***	***138,016***
Gasoline	262	264	231	212	224	245	212	212
Kerosene	4,791	2,298	130					
Diesel	110,661	116,156	123,139	129,227	129,912	131,741	132,924	134,704
Residual oil	603	1,152	1,397	1,527	1,246	1,205	1,125	1,085
L.P.G.	985	2,329	3,179	2,955	2,552	2,329	2,194	2,015
Solid s	***375***							
Sub-bituminous coal	375							
Gases	***112***	***366***	***1,876***	***2,674***	***2,942***	***3,001***	***2,992***	***2,786***
Natural gas	112	366	1,876	2,674	2,942	3,001	2,992	2,786
Biomass	***1,672***	***166***	***166***	***166***	***166***	***166***	***166***	***166***
Wood/Wood waste	779	78	78	78	78	78	78	78
Other solid biomass	893	89	89	89	89	89	89	89
Total	**119,461**	**122,731**	**130,119**	**136,762**	**137,042**	**138,687**	**139,614**	**140,968**

Figure 4.3.9.1.1.- Fuel consumption

Total Other sectors

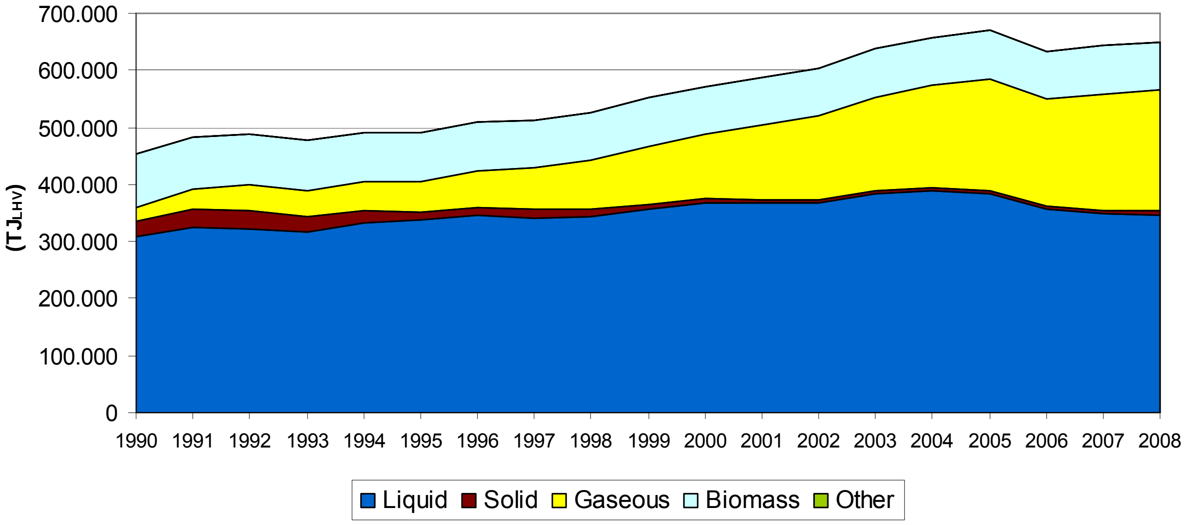
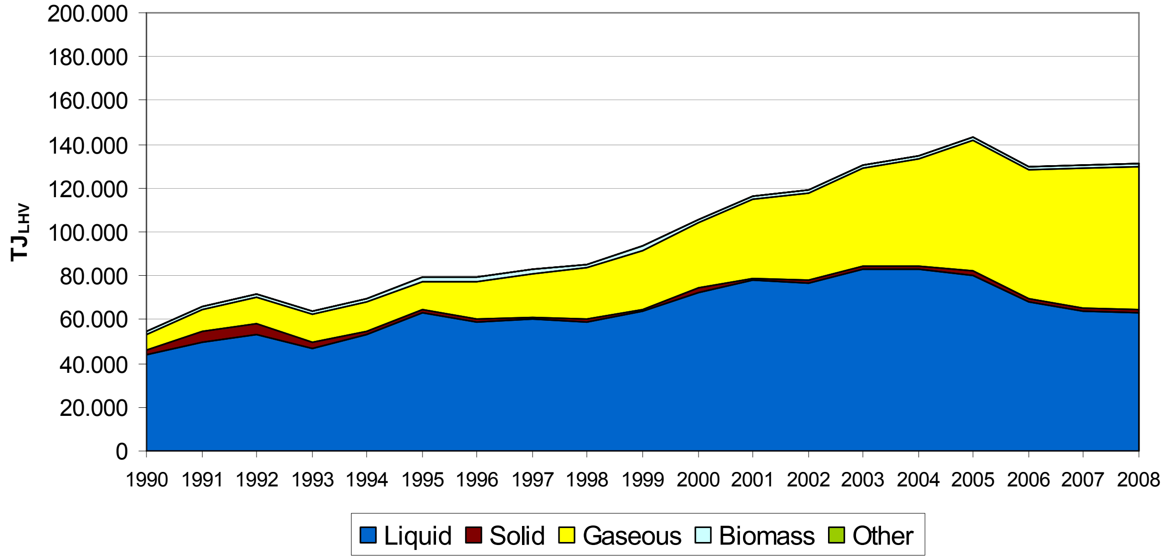


***Figure 4.3.9.1.1.- Fuel consumption** (Continued)*

Institutional / Commercial sector



Residential sector

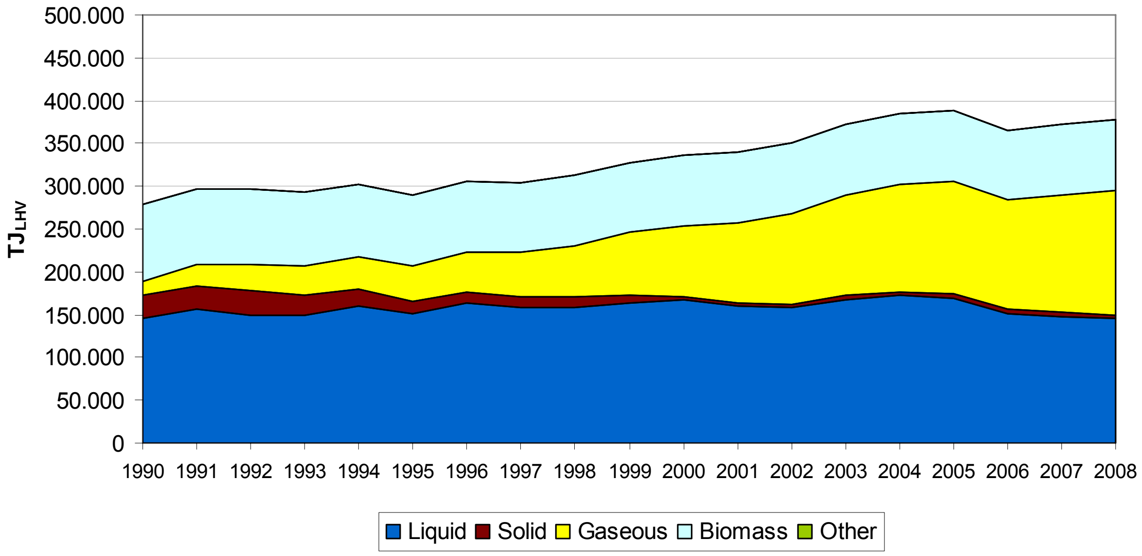


***Figure 4.3.9.1.1.- Fuel consumption** (Continued)*

Agriculture / Forestry / Fishing sector

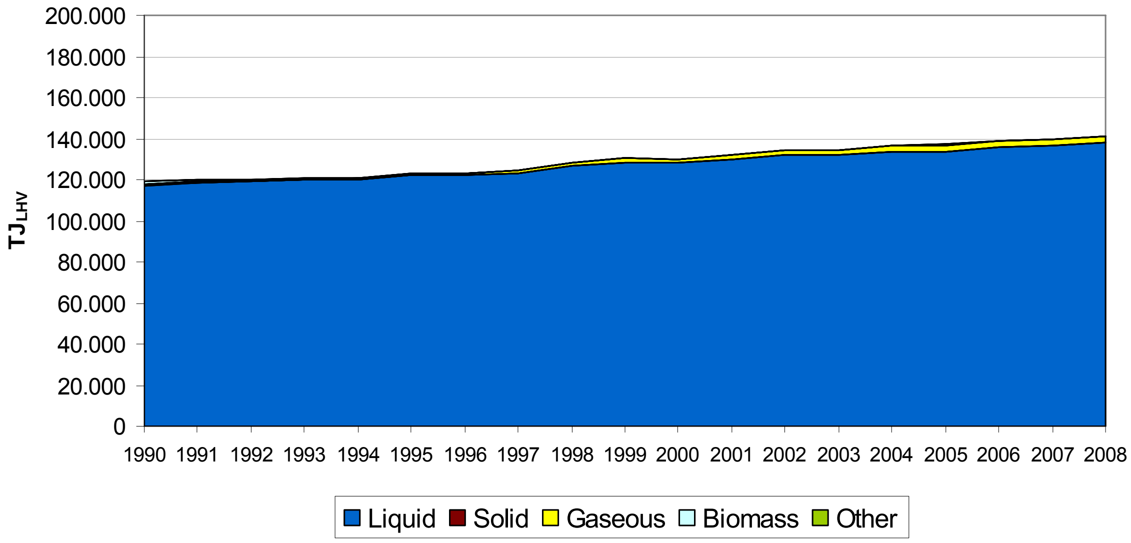


Figure 4.3.9.1.2 shows the distribution of fuel consumption throughout the period inventoried for each category and sector. In terms of the category as a whole, as can be seen, a notable increase is produced in the consumption of natural gas, whose relative contribute went from 5.3% in 1990 to 32.8% in 2008, however, liquid fuels still predominate in energy consumption (53.4% in 2008), despite their loss of relative importance[50]. On the other hand, the use of coal and coal-derived products in this category, which exhibit a significant drop down to residual amounts in the final years of the period, concentrated essentially in the residential sector, decreases in terms of total fuel consumption, going from 6.3% in 1990 down to 1.0% in 2008.

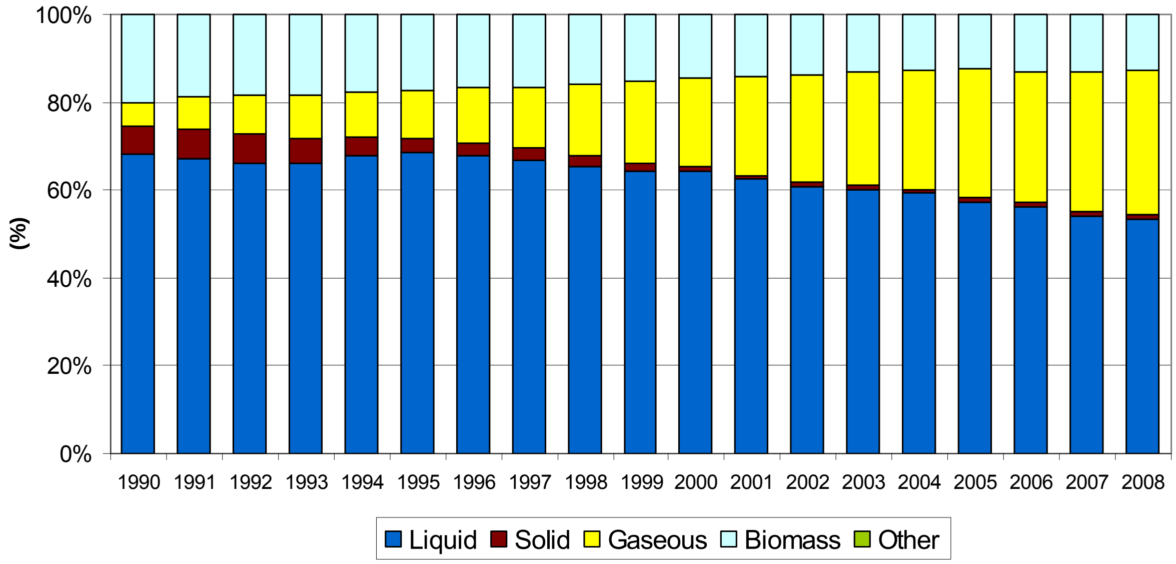
In an analysis by socio-economic sector and with respect to the consumption of fossil energy in the commercial-institutional sector, attention should be drawn to the gradual reduction in the representation by oil-based products, which present a local minimum in 1993 reflecting the economic crisis of that year, which led to a fall in the sector's global energy demand and, more markedly, demand for the residual fuel consumed, and a partial recovery until 1995. From this year on, the more accentuated penetration of natural gas into this sector, replacing, at least in part, the consumption of oil-based products, has caused an increase in the contribution of natural gas to the detriment of these products for the commercial-institutional sector. With respect to the residential sector, the structure of fossil fuels shows an observable similarity with the energy composition in category 1A4 as a whole, although these are lower than the levels of participation by oil-based products, in favour of other types of fuels. Finally, the third diagram in Figure 4.3.9.1.2 shows the predominance mentioned above in oil-based products in the energy demand from the agricultural, forestry

50 This participation of liquid fuels includes fishing activities and mobile agricultural and forestry machinery.

and fishing sector, mainly for gas-oil, as the consumption of other fuels is very marginal (less than 2.5%).

Figure 4.3.9.1.2.- Fuel consumption distribution, based on TJ_{LHV}

Total Other sectors



Institutional / Commercial sector

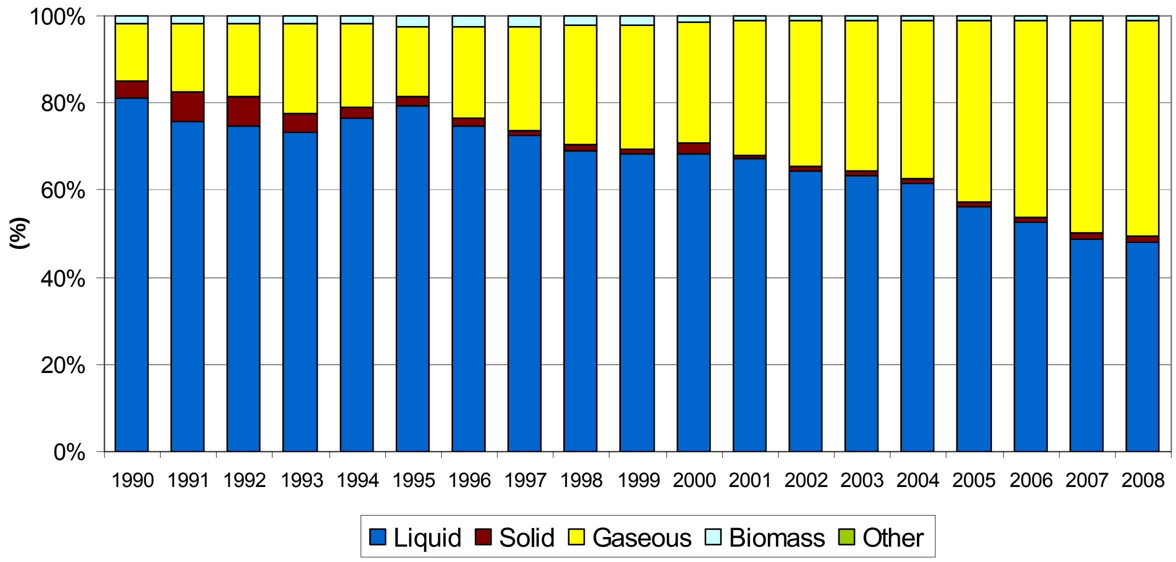
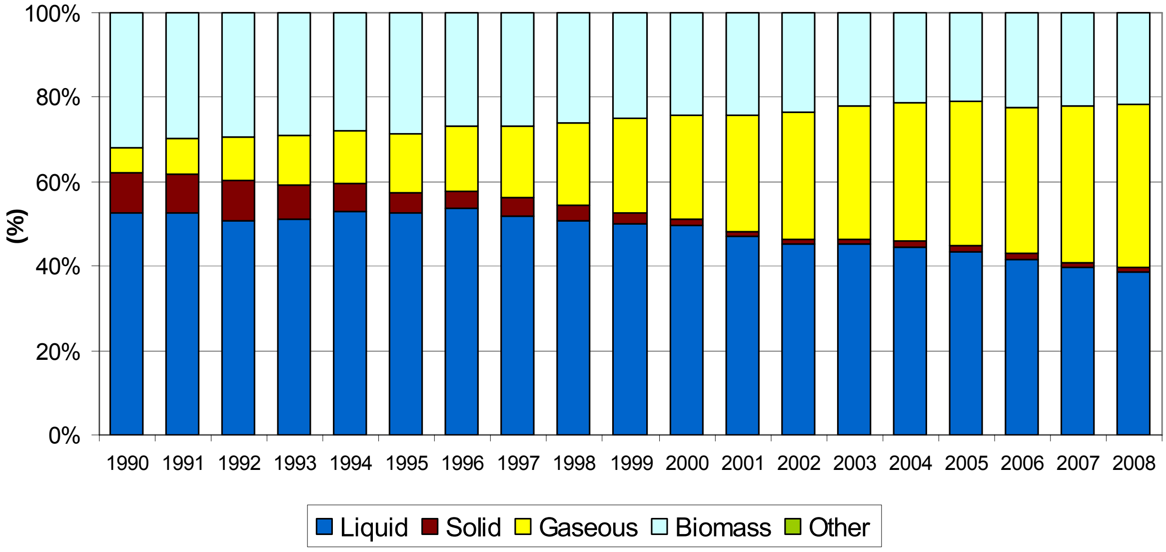
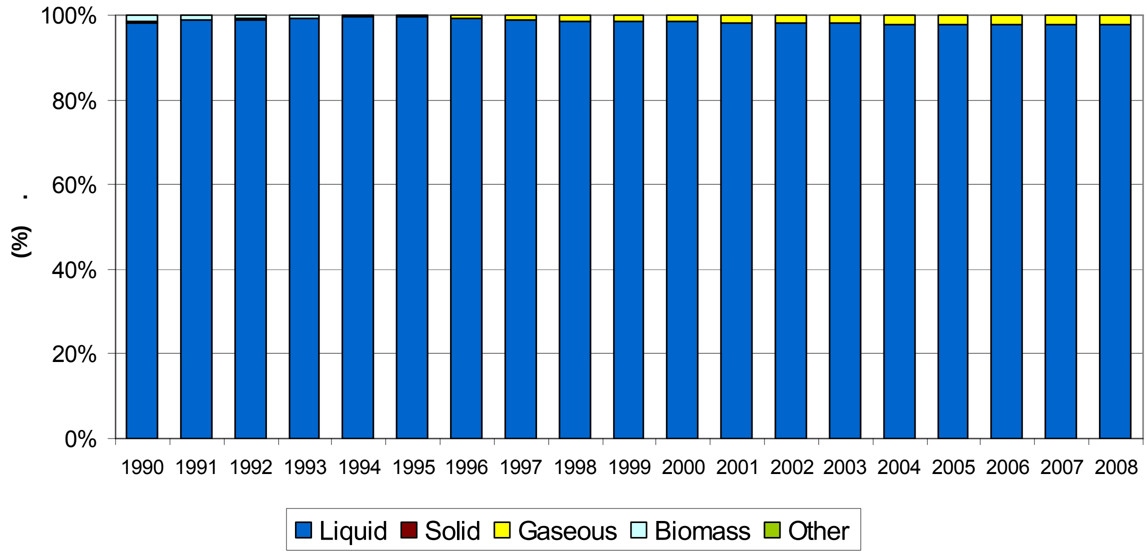


***Figure 4.3.9.1.2. - Fuel consumption distribution, based on TJ_{LHV}** (Continued)*

Residential sector



Agriculture / Forestry / Fishing sector



4.3.9.2.- Methodology

4.3.9.2.1.- Advanced methodology

For stationary engines using natural gas, the emission factors used for NO_X, NMVOC and CO were those obtained from an emissions survey of these pollutants carried out on the basis of the information furnished by the main companies installing this kind of facility.

4.3.9.2.2.- Default methodology

The default methodology applied to estimate emissions is essentially that proposed by EMEP/CORINAIR. Mass balance based on the mean annual sulphur content of fuels was used to estimate SO_X.

For commercial, institutional and residential sectors and stationary combustion in agriculture, the information on default emission factors was obtained from chapters B-111 and B-112 of EMEP/CORINAIR Guidebook, the compilation of particulate factors published by CEPMEIP and the OSPARCOM-HELCOM-UNECE survey[51] for dioxins and furans.

For mobile machinery used in agriculture and forestry, the emission factors applied, except those related to particulate matter, were obtained from chapter B-810 of EMEP/CORINAIR Guidebook. Particulate factors for diesel machinery were derived from the information gathered from the final report entitled "Guidebook on the Estimation of the Emissions of 'Other Mobile and Machinery'. Subparts 'Off-Road Vehicles and Machines', 'Railways' and 'Inland Waterways'" published by Samaras and Zierock for the European Commission, assuming that the diameter of every particulate emitted is lower than 2.5 microns; whereas those corresponding to gasoline equipment used in forestry activities refer to CEPMEIP's database.

With respect to factors used in fisheries, the sources of information used included the "*Marine Exhaust Emissions Research Programme*" survey published by Lloyd's Register of Shipping for NO_X, CO and VOC[52] [53]; CORINAIR handbook (1992) for ammonia; chapter B-842 of EMEP/CORINAIR Guidebook for heavy metals, PAH and dioxins[54]; and for particulates with diameters lower than 2.5 microns, the TRENDS report[55] [56].

4.3.10.- Fugitive emissions from fuels (1B)

This category includes emissions generated during prospection, extraction, storage, transportation, processing or disposal of fossil fuels, coal, oil, oil-derived fuels or natural gas where there is no energy recovery from the fuel. Thus, activities such as flaring of petroleum or natural gas are included here, but not combustion activities intended for the provision of energy in extractive or transformation processes.

---

[51] "Technical Paper to the OSPARCOM-HELCOM-UNECE Emission Inventory of Heavy Metals and Persistent Organic Pollutants. TNO Institute of Environmental Sciences, Energy Research and Process Innovation. December 18th, 1995.

[52] S3-type ships (*barge*) described in this report were used as references.

[53] A 5% methane content is assumed for VOC default speciation.

[54] Metal and dioxin factors were obtained from the August 2007 edition of EMEP/CORINAIR Guidebook, whereas those corresponding to PAH are derived from the May 1998 edition.

[55] "Development of a Database System for the Calculation of Indicators of Environmental Pressure Caused by Transport. Transport and Environment Database System (TRENDS). Detailed Report 2: Maritime and Inland Shipping Modules"

[56] The particulate emission factor used was that corresponding to medium-low speed diesel engines.

The list of potentially emitting activities for one or more pollutants under analysis whose emissions were estimated in the inventory may be grouped depending on the fuel-type used:

a) Coal related (1.B.1):

- Coal extraction and treatment

  Dust emissions associated with production and storage processes in coal berths located in mines or in the respective consumer sectors.[57]

- Transformation of solid fuels

  Fugitive emissions of residual raw gases and powdery materials generated during the opening of doors of coke ovens and coke cooling upon exit were estimated[58]. The main combustion-related pollutants (SO_X, NO_X, NMVOC, NH_3, CO), particulate matter and PAH emissions[59] were estimated for this category.

b) Relative to hydrocarbons (1.B.2):

- Prospection, extraction and transportation of crude oil.

  Evaporative emissions and organic compound (NMVOC) losses during operation in prospection and production platforms[60, 61], and marine terminals, including crude oil supply to refineries, are described here. The activities covered include drilling, extraction, first processing, loading-unloading of tankers, handling and storage in tanks.

  This category includes fugitive emissions associated with the processing or combustion generated by activities in refining plants, excluding those related to combustion processes for energy purposes.

  Of the main emitting sources, the inventory includes the following activities: the processing of oil-derived products, sulphur recovery, and storage and handling of

[57] Due to the absence of information related to the specifically emitted particles, potential metal particle emissions could not be estimated for the inventory.

[58] Other processes associated with this category, such as the production of solid semi-coke, were not included herein, as this activity is not carried out in Spain.

[59] For heavy metals, the chosen reference source (EMEP/CORINAIR Guidebook, first edition, 1996) warns about the possible inclusion of emissions from combustion among the compiled factors (please refer to the comments in this regard in the 2007 edition of the said guidebook, section 8.2 in chapter B-146). In order to avoid double counting, since metal emissions derived from combustion in other categories have already been taken into account in the inventory, the said factors were not applied to this activity.

[60] This category also considers, in addition, the natural gas prospection and drilling platforms because it has been decided, since the classification of the wells drilled is not available by type of hydrocarbon, to count the estimation of the total emissions entirely within the category corresponding to crude oil.

[61] This category contains the total emissions estimated for hydrocarbon prospection-drilling platforms (fugitive emissions, venting or flaring) since the methodological guide provides a single aggregate emission factor.

intermediate and final products in refineries. Regarding the wide range of processes termed as “processing of petroleum-derived products”, the inventory estimates emissions for vacuum distillation, coke calcination and fluid catalytic cracking (FCC) techniques (a regeneration process of catalysts based on the combustion of retained coke).

This category is a SO_X emitting source (by means of sulphur recovery, FCC regeneration and coke calcination) and NMVOC (by storage of derived products and vacuum distillation), their contribution being minimal to particulate emissions, NO_X and CO from FCC regeneration and sulphur recovery.[62]

- Distribution of oil products

  For this category evaporative emissions from hydrocarbons in the distribution network of petroleum-derived products outside the refineries premises were estimated. The potentially emitting activities included in this stage are related to petroleum product transport, storage and supply.

- Fugitive emissions from natural gas

  This category includes hydrocarbon losses during the different stages of the production and supply process: production in extractive facilities (marine or inland platforms), first treatment, loading, transportation and supply to consumer sectors. [63]

- Venting and flaring

  These are considered to be intentional gas losses that, for safety reasons, take place at refining plants or natural gas supply systems, by means of direct gas venting or flaring. [64]

  For this category the main pollutants associated with combustion (CO, NO_X) and particulate matter resulting from flare incineration were estimated, together with NMVOC from gas losses and incineration.

As already mentioned in the Sector Overview, activities related to other solid fuel fugitive emissions (1B1c) and other activities such as geothermal extraction or peat

---

62 Emissions from activities such as regeneration in mobile fluid catalytic cracking or fluidized cracking, in the latter for certain pollutants (NMVOC or NH_3), are considered to be negligible due to the existence of technical abatement units. Furthermore, for other existing sub-processes within this category, such as atmospheric distillation, delayed coking or sweetening of distilled spirits, no emissions were quantified due to the lack of representative emission factors, although they are assumed to be relatively insignificant in certain cases.

63 Fugitive emissions on natural gas prospection and drilling platforms are included in categoría 1B2ai Prospection, extraction and transport of crude oil as it has not been possible to differentiate the basic data by type of hydrocarbon.

64 Emissions due to venting and/or incineration on prospection and drilling platforms have been calculated in category 1B2ai Prospection, extraction and transport of crude oil as the methodological guidebook consulted shows no distinct emission factor by emission source process (fugitive emissions, venting and incineration).

production (1B3) were not taken into account in the inventory due to the absence of any record of this activity in Spain.

Of all pollutants covered in the present report, this category stands out as a moderate emitting source in the inventory for main pollutants (NO_X, NMVOC, SO_X, NH_3 and CO), particulate matter and PAH. With relation to the distribution of emissions within the category, it is worth mentioning the following processes: for PAH and NH_3, the transformation of solid fuels (coal), including all these emissions; for particulate matter, the processes associated with solid fuels (coal or petroleum coke); for NO_X and CO, in general the transformation of solid fuels (coal) and the incineration of gases in refinery flares; in the case of SO_X, sulphur recovery at refineries, regeneration of FCC and incineration through refinery flares; and for NMVOC, the distribution of petroleum-derived products.

4.3.10.1.- Activity variables

Based on activity type, the socio-economic activity variables used to estimate emissions may refer to:

- internal production (of primary or secondary fuels),
- number of facilities,
- amount processed (consumed or stored),
- losses of hydrocarbons (through leaks or venting)

The variables considered are described in detail below, linked to emitting activities and including the list of references used:

- Internal production (gross) of different primary fuels (coal, crude oil and natural gas) represents the socio-economic variable associated with fuel extraction activities.

  The information is provided by the Ministry of Industry, Tourism and Commerce (MITYC) and its “Statistics on hydrocarbon prospection and production”, published by the General Subdirectorate for Hydrocarbons or via the production questionnaire submitted to the Mining General Subdirectorate for inventory purposes.

- Coal stock in bunkers was used to estimate emissions for stored coal.

  Based on the location of coal depots, the information was obtained from the following sources: for coal-fired thermal power plants, the “Report on the exploitation of the electric system” published by Red Eléctrica de España; for mine depots, “Coal statistics” provided by the General Subdirectorate for Energy Planning, MITYC; for those located in steel plants, coke furnaces or other sectors such as residential-commercial industries, from the “Informe Carbunión”. Based on the latter source, and due to the loss of certain data in the final years, the amounts corresponding to the last available year had to be projected.

- The production of metallurgical coke in coke oven furnaces is the activity variable chosen for the opening and extinction of coke oven furnaces.

The activity basically takes place in integrated steel plants whose production is reported by means of individual questionnaires submitted by plants. Data for other sectors are estimated deducting the amounts stated for domestic production figures in statistics or questionnaires published by MITYC ("Estadística de Fabricación de Pasta Coquizable, de Coquerías y de Gas de Horno Alto" or coal questionnaire for the International Energy Agency -IEA- and EUROSTAT).

- The acquisition (imports) of crude oil by refineries is the activity variable for loading-unloading operations of tank vessels and crude oil storage in marine terminals.

  The basic source of information is the "Energy Statistics of OECD countries" published by the International Energy Agency (IEA), supplemented by the questionnaire on oil-derived products (AOS) submitted by the General Subdirectorate for Hydrocarbons at the MITYC to the international bodies IEA and EUROSTAT.

- The number of wells drilled at hydrocarbon exploration-drilling facilities represents the activity variable for the exploration-drilling platforms.

  The data come from the annual publication entitled "Enciclopedia Nacional del Petróleo, Petroquímica y Gas" published by OILGAS.

- The operational characteristics of the different refining activities determine the variables used to estimate emissions in these facilities. Thus, the following variables were taken into account:

  · feeding mass at distillation units, in coke calcinators or FCC regenerator;

  · sulphur production in recovery plants,

  · petroleum products stored by fuel type and tank characteristics or

  · amount of processed crude oil (proxy variable replacing the amounts incinerated in flares)

  · gasoline production (proxy variable replacing the amount dispatched at refining plants)

  The baseline information is provided directly by each plant via questionnaires, supplemented, in the case of gasoline production, with the "Enciclopedia Nacional del Petróleo, Petroquímica y Gas" published by OILGAS in the years prior to the inclusion of such information in the questionnaires submitted to refineries.

- The consumption (sales) of oil-based products acts as a proxy variable when estimating emissions related to handling and transportation activities outside refineries.

  In order to compile this information, the following sources were used: nationwide statistics of sales published by MITYC ("Boletín Estadístico de Hidrocarburos" (Hydrocarbons Statistical Bulletin) published by the Subdirectorate-General for Hydrocarbons and Gas Industry Statistics within the Directorate-General for Energy Planning); the "Energy Statistics of OECD countries" published by IEA, supplemented with the AOS questionnaire developed by the Subdirectorate-General for Hydrocarbons, MITYC; and the annual "Enciclopedia Nacional del Petróleo, Petroquímica y Gas" published by OILGAS.

- Emissions leaked, vented or incinerated in natural gas transport and distribution system facilities.

  With respect to the transportation network, the information, compiled via questionnaires submitted to companies in charge of managing the different facilities, includes annual volumes of natural gas emissions and amounts incinerated per plant (compressor stations, underground depots or regasification plants), natural gas losses in gas pipelines, and the estimation of the gas emitted at metering and regulation stations.

  For the distribution network (pipelines, connections and metering and regulation stations), natural gas losses are estimated based on the structure of the existing pipelines, applying network length factors depending on the type of pipeline material and work pressure on the main distribution line. The length of distribution networks by pipeline type (material*work pressure cross-tab) corresponding to the end of each year is provided by SEDIGAS (Asociación Española del Gas).

4.3.10.2.- Methodology

4.3.10.2.1.- Advanced methodology

Emissions from natural gas transport and distribution network are estimated based on the measurements / estimations of gas volume emitted by the different facilities within the network. For leaks and venting within the network, emission factors for NMVOC associated with natural gas are obtained, at company level, from information submitted by the transport companies relative to mean annual characteristics (molar composition) of the natural gas incorporated into the transport system[65]; additionally, using the same loss factor per unit consumed, secondary contribution for leaks of other hydrocarbons channelled through the distribution network (LPG, air-propane mix or manufactured gases) are calculated based on the estimated annual consumption and the generic content of volatile organic compounds for each of these fuels. With respect to the incineration at gas production facilities, a default estimation procedure is applied based on emission factors proposed in chapter B-926 of EMEP/CORINAIR guidelines and for particulate matter, those of CEPMEIP[66].

Furthermore, it is worth mentioning the methodologies used for regeneration processes of catalysis in fluid catalytic cracking, sulphur recovery or flare incineration, for which the availability of plant-specific information[67] determines the use of more advanced procedures supplemented, to cover the entire activity, with the default methodology. Thus, the lack of estimates for a significant pollutant in certain plants was supplemented by applying activity

---

65 For distribution networks, natural gas characteristics provided by the main operator of the transport network were used.

66 The original CEPMEIP factors, expressed in energy units, were used for the generic combustion of natural gas. To convert volume units, the mean heating value was based on the historical series provided by the main gas transport company.

67 Certain refineries provided measurements and/or estimates of emissions for the following activities and pollutants: i) for FCC regeneration, SO_X, NO_X, CO and TSP; ii) for sulphur recovery, NO_X, CO and TSP; and iii) for flare incineration, usually SO_x, to a lesser extent NO_x, and only in certain cases CO (emissions based on the amounts and characteristics of incinerated gases) and TSP.

variables [68] and emission factors from chapters B-411, B-413 and B-923 of the EMEP/CORINAIR Guidebook[69] or, where these were not available, country-specific factors derived from the information available[70].

In order to estimate SO_X emissions from coke calcination, mass balance was applied to green coke sulphur assuming full oxidation of sulphur during calcination and default characteristics both of green coke (sulphur content) and the process itself (ratio of mass loss for green coke and calcinated coke).

4.3.10.2.2. Default methodology

The default methodology applied to estimate emissions is basically that of EMEP/CORINAIR. Information on default emission factors was obtained from chapters B-146, B-411, B-413, B-551, B-923 and B-926 of EMEP/CORINAIR [71] Guidebook and CORINAIR Manual (1992)[72].

For the compilation of emission factors for non-methane volatile organic compounds in hydrocarbon prospection and extraction operations, the previous source has been complemented by the IPCC 2000 Good Practices Guidelines, which provides methane emission factors for the said activities. Based on these factors, and assuming a speciation of the volatile organic compounds emitted for each type of hydrocarbon (crude oil or natural gas), it has been possible to derive the NMVOC emission factors corresponding to hydrocarbon prospection wells, the extraction of oil at on-shore terminals and the production of natural gas.

For particulate matter, estimates were supplemented with the emission factors proposed by CEPMEIP, more specifically for coal extraction and storage and the opening and extinction of coke furnaces.

---

68 Coke retained in the catalyst, sulphur production or crude oil processed, respectively.

69 Supplemented in the case of FCC regeneration with CITEPA information on particle size published in “Étude sur le méthodes d’évaluation des quantités émises de particules fines (PM_{10} et inférieures) primaires et secondaires pour tous les secteurs d’activité en vue des inventaires”. Final report. July 2002, or, for the case of vacuum distillation, assuming a speciation percentage of 99% for VOC according to experts’ judgement (99% NMVOC content).

70 This is the case for CO emission factor in FCC regeneration and TSP from incineration.

71 With regard to the storage of oil-derived products, the NMVOC factors for the various fuel groups were estimated from the EMEP/CORINAIR Guidebook factors for the storage of petrol, taking into account the different volatility indexes of each oil-derived product in comparison with the volatility index of petrol (mean values obtained through in-house estimation using the data provided by the refineries). The original emission factors of SO_X, NO_X, CO and NH_3 for the coke oven door leakage and extinction activity, in terms of the coal load, are expressed in relation to the amount of metallurgic coke produced, assuming that coke produced amounts to 80% of coking coal load (percentage derived from the information provided by the integrated iron and steel plants).

72 Reference source considered for estimating the NMVOC emissions from extraction, first treatment and loading of liquid and gaseous fuels at marine terminales (included in category 1B2ai) and from distribution activities relating to liquid fuels except gasoline (category 1B2av).

For PAH factors, the “Atmospheric Emission Inventory Guidelines for Persistent Organic Pollutants (POPs)” was used as an additional reference to estimate specifically the emissions from the opening and extinction of coke ovens.

4.5.- References

- “Anuario de Estadística”. Ministry of the Environment, Rural and Marine Affairs (MARM).
- CARBUNION. “Informe anual”
- CEPMEIP. Co-ordinated European Programme on Particulate Matter Emission Inventories, Projections and Guidance.
- CIEMAT. “Análisis de Compuestos Orgánicos Persistentes y elaboración de inventarios integrados en su emisión a la atmósfera, efluentes y suelos. Volumen II Actividades y conclusiones específicas en el sector cementero”.
- CIEMAT (Centre for Research into Energy, Environment and Technologies). Estadísticas de base de consumos y características de combustibles y emisiones estimadas en centrales térmicas (1997-2002).
- CITEPA. “Etude sur le méthodes d’évaluation des quantités émises de particules fines (PM10 et inférieures) primaires et secondaires pour tous les secteurs d’activitié en vue des inventaires”. Final Report. July, 2002.
- “Compilation of emission factors for persistent organic pollution. A case study of emission estimates in the Czech and Slovak Republics”. Holoubek I. et al. Prepared for External Affairs Canada. March, 1993.
- CONCAWE (1997). “Motor vehicle emission regulations and fuel specifications: part 2 detailed information and historic review (1970-1996)”.
- CONCAWE (2001). “Motor vehicle emission regulations and fuel specifications: parts 1 and 2 detailed information and historic review (1996-2000)”.
- COPERT III. (2000). “Computer programme to calculate emissions from road transport”. Technical Report no. 49. European Environment Agency. November 2000.
- Dirección General de Aviación Civil. “*Tráfico comercial en los aeropuertos españoles”*. Madrid: Ministry of Public Works, Directorate-General for Civil Aviation.
- Directorate-General for Traffic. “*Anuario estadístico general”*. Madrid: DGT, 1990-2008.
- EMEP/EEA 2009. “Air Pollutant Emission Inventory Guidebook”. UNECE-Convention on long-range transboundary air pollution & European Environmental Agency.
- “Energy Balance Sheets”. Eurostat. Luxembourg: Office des publications officielles des Communautés Européennes.
- EPA. Series AP-42 Manuals, various editions, from the United States Environmental Protection Agency.

- "Energy Statistics of OECD Countries". International Energy Agency (IEA). OECD, Paris.

- "Experiences with the heavy metals inventory in Slovakia". Economic Comission for Europe. Convention on Long-Range Transboundary Air Pollution. Task Force on Emission Inventories. March 1996, Oxford.

- "*Guía de Mejores Técnicas Disponibles en España de fabricación de cemento*". Madrid: Ministry of the Environment, Publications Centre, 2003.

- Holoubek I. et al. (1993). "Compilation of emission factors for persistent organic pollutants. A case study of emission estimates in the Czech and Slovak Republics". Prepared for External Affairs Canada. Masaryk University, Axys Environmental Consulting. March, 1993.

- ICAO Aircraft Type Designators.

- "*ICAO engine exhaust emissions data bank"*. Montreal: ICAO (International Civil Aviation Organization), 1995.

- Institute for Energy Diversification and Savings (IDAE). "*Estrategia de Ahorro y Eficiencia Energética 2004-2012: Sector Agricultura y Pesca*". IDAE, 2003

- IPPC. Integrated Pollution Prevention and Control. "Reference Document on Best Available Techniques in the Non Ferrous Metals Industries". December 2001.

- IPPC. Integrated Pollution Prevention and Control. "Reference Document on Best Available Techniques in the Cement and Lime Manufacturing Industries". Draft September 2007".

- Libro Guía EMEP/CORINAIR (1996). "Atmospheric Emission Inventory Guidebook". First Edition. February 1996. UNECE-convention on long-range transboundary air pollution & European Environmental Agency.

- EMEP/CORINAIR Guidebook. "Atmospheric Emission Inventory Guidebook". Second Edition. September 1999. UNECE-convention on long-range transboundary air pollution & European Environmental Agency.

- EMEP/CORINAIR Guidebook. "Atmospheric Emission Inventory Guidebook". Third Edition. Updated to December 2006. UNECE-Convention on long-range transboundary air pollution & European Environmental Agency.

- EMEP/CORINAIR Guidebook. "Atmospheric Emission Inventory Guidebook". Third Edition. Updated to December 2007. UNECE-Convention on long-range transboundary air pollution & European Environmental Agency.

- "*Los transportes y los servicios postales"*. Madrid: Ministry of Public Works.

- CORINAIR Manual (1992). "Default Emission Factors Handbook". Second Edition. Edited by CITEPA for DG-XI CEC.

- IPCC Reference Manual. “Greenhouse Gas Inventory Reference Manual”, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. IPCC-OECD-IEA. 1997.

- “*Marine Exhaust Emissions Research Programme*”. Lloyd’s Register of Shipping

- OFICO (Office for Electricity Compensations). Estadísticas de base de consumos y características de combustibles (1990-1994) y emisiones estimadas en centrales térmicas (1990-1996).

- OILGAS. “*Enciclopedia nacional del petróleo, petroquímica y gas”*. Madrid: Technical Headquarters.

- OSPARCOM-HELCOM-UNECE (1995). “Technical Paper to the OSPARCOM-HELCOM-UNECE Emission Inventory of Heavy Metals and Persistent Organic Pollutants”. TNO Institute of Environmental Sciences, Energy Research and Process Innovation. December 18th, 1995.

- PARCOM-ATMOS (1992). “Emission Factors Manual. PARCOM-ATMOS. Emission factors for air pollutants. 1992”. P.F.J. van der Most and C. Veldt, eds., TNO Environmental and Energy Research, TNO Rept. 92-235, Apeldoorn, the Netherlands.

- Parma, Zdenek et al. “*Atmospheric emission inventory guidelines for persistent organic pollutants (POPs)*”. Praga, 1995.

- Red Eléctrica de España (REE). “*Informe de explotación del sistema eléctrico”*. Madrid: REE

- Samaras, Z.; Zierock, K.H. “*Guidebook on the estimation of the emissions of ‘other mobile machinery’: Subparts ‘off-road vehicles and machines’, ’railways’ and ‘inland waterways’ in the European Union”*. 1994

- Subdirectorate-General for Hydrocarbons. “*Estadísticas de consumo de productos petrolíferos*”. Madrid: Ministry of Industry, Trade and Tourism, Subdirectorate-General for Hydrocarbons.

- Subdirectorate-General for Hydrocarbons**. “*Estadísticas de prospección y producción de hidrocarburos*”. Madrid:** Ministry of Industry, Trade and Tourism**,** Subdirectorate-General for Hydrocarbons**.**

- Subdirectorate-General for Energy **Planning. “*Estadísticas del carbón*”. Madrid:** Ministry of Industry, Trade and Tourism**,** Subdirectorate-General for Energy **Planning.**

- Subdirectorate-General for Energy **Planning**. “*Estadística de fabricación de pasta coquizable, de coquerías y de gas de horno alto*”. Madrid: Ministry of Industry, Trade and Tourism, Subdirectorate-General for Energy **Planning**.

- Subdirectorate-General for Energy **Planning.** “*Estadísticas de industrias del gas*”. Madrid: Ministry of Industry, Trade and Tourism**,** Subdirectorate-General for Energy **Planning.**

- UNESA/ENDESA/IBERDROLA/CIEMAT. “Emisiones de Metales Pesados en las Centrales Térmicas de Endesa”. Heavy Metals Modelling Group (GMM). August 1998.

5.- INDUSTRIAL PROCESSES

Chapter updated in July 2010

5.1.- Sector analysis

The present chapter describes the set of activities related with industrial processes (or parts of these processes) not related to combustion. These processes may involve energy requirements satisfied by means of heat transfer from the combustion processes analyzed in chapter 4. Thus, the emissions analyzed here do not include the contribution of emissions associated with the use of fuels.

The list of NFR nomenclature categories included in this sector is as follows:

- 2.A: Mineral products
- 2.B: Chemical industry
- 2.C: Metal production
- 2.D: Other production
- 2.E: Production of persistent organic pollutants (POPs)
- 2.F: Consumption of POPs and heavy metals
- 2.G: Other.

The emissions for this sector are mainly related to metal production and chemical industry processes, except for those corresponding to NMVOC with a greater incidence of category 2D, which include fermentation activities in the food processing industry.

5.1.1.- NO_X

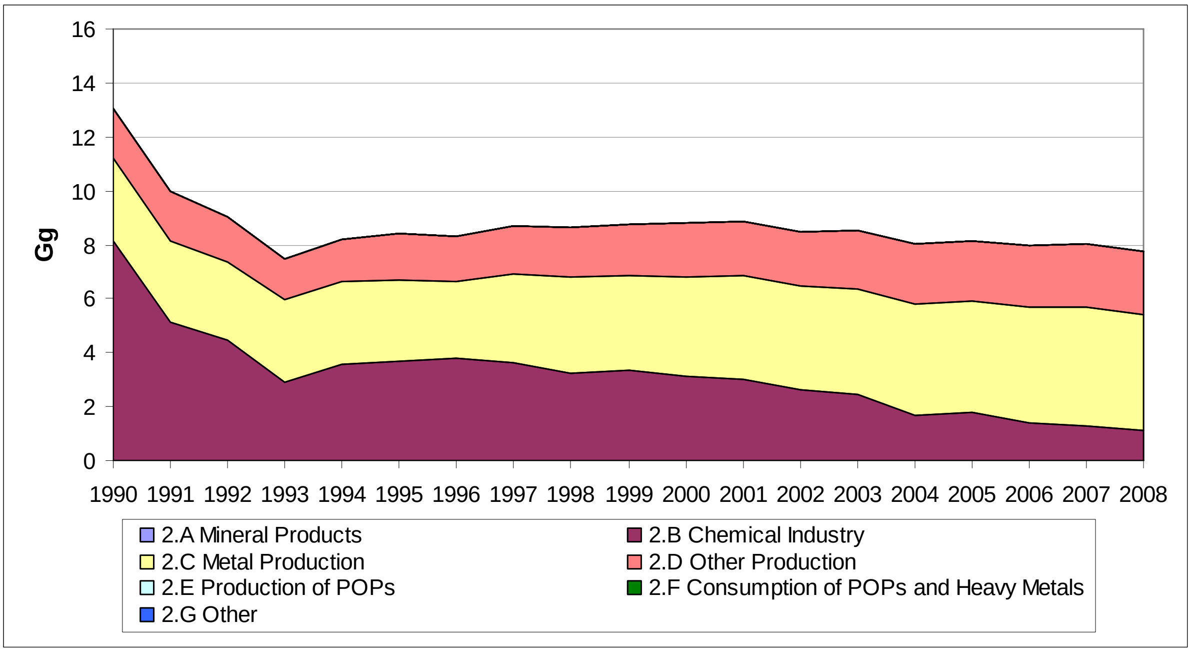
NO_X emissions in this sector shown in table 5.1.1.1 are scarcely relevant in the inventory and are mainly related to a limited number of activities, particularly those of steel production in electric furnaces, the production of nitric acid and ammonia, and the manufacturing of paper pulp. The whole sector has witnessed a reduction in NO_X emissions, from 13.0 Gg in 1990 to 7.8 Gg in 2008.

***Table 5.1.1.1.- NO_X emissions** (Amounts in Gg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
2.A Mineral products	-	-	-	-	-	-	-	-
2.B Chemical industry	8.5	3.7	3.1	1.7	1.8	1.4	1.3	1.1
2.C Metal production	3.0	3.0	3.7	4.1	4.2	4.3	4.4	4.3
2.D Other industries	1.8	1.7	2.0	2.2	2.2	2.3	2.4	2.3
2.E Production of POPs	-	-	-	-	-	-	-	-
2.F Consumption of POPs and heavy metals	-	-	-	-	-	-	-	-
2.G Others	-	-	-	-	-	-	-	-
Industrial Processes	**13.0**	**8.4**	**8.8**	**8.0**	**8.1**	**8.0**	**8.0**	**7.8**

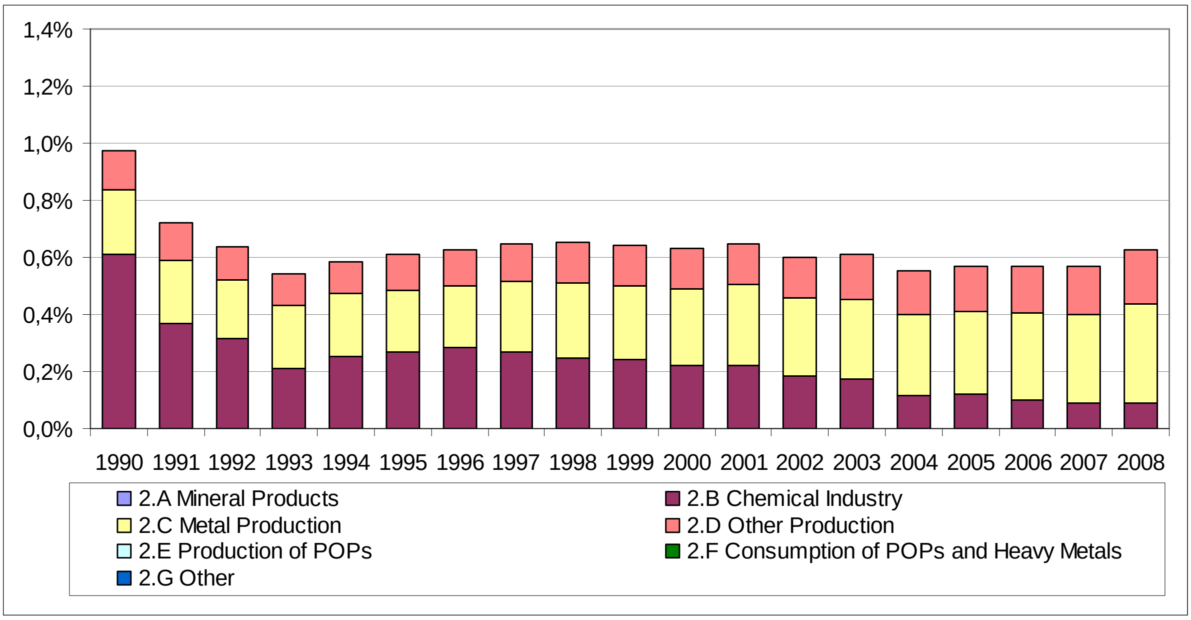
Figure 5.1.1.1 shows the evolution of NO_X emissions in the inventory period. The figure shows that this evolution is clearly caused by activities in the chemical industry and reflect the gradual closure of manufacturing plants for nitric acid (from 14 plants in 1990 to barely 4 in 2008) and ammonia (4 plants in 1990 and 2 in 2008). As for the remaining categories, the growth trend is a consequence of the production levels associated with the activities falling into the above categories.

Figure 5.1.1.1.- Evolution of NO_x emissions by category



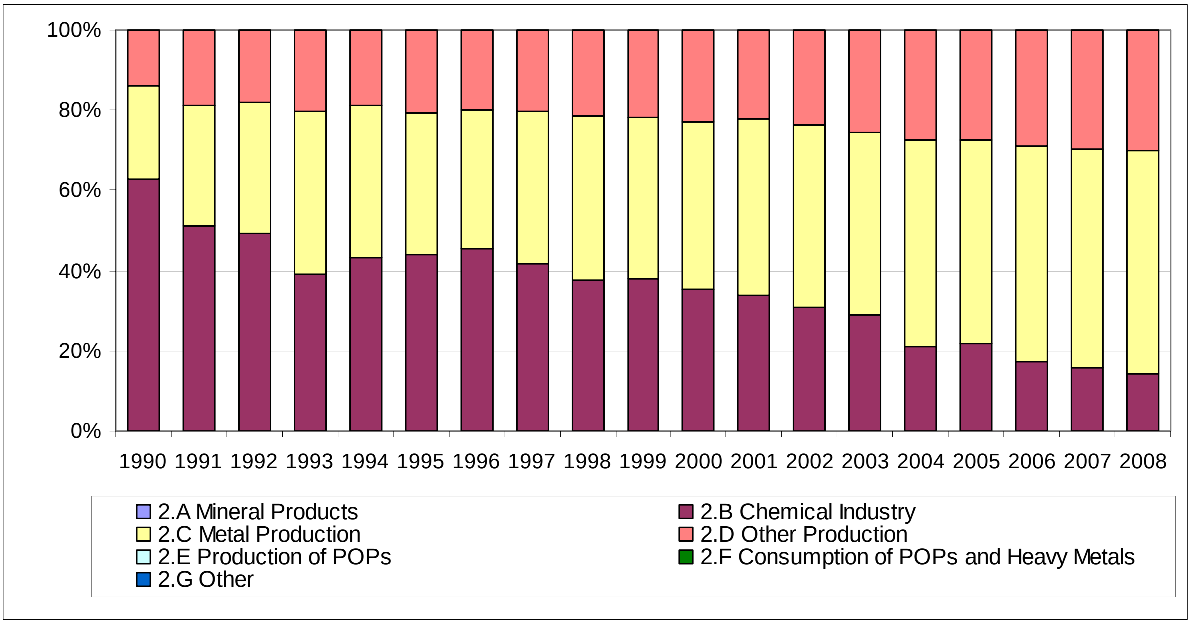
Regarding the share of NO_X emissions for this sector in the inventory as a whole, figure 5.1.1.2 shows its scant relevance, under 1 per cent of the total for all years (except for 1990), with a relatively stable trend in all years, when the progressive marked reduction in the production of nitric acid considerably affected the contribution of this sector to the whole of the inventory.

Figure 5.1.1.2.- Percentage of NO_X emissions by category with respect to the inventory total



Regarding the distribution of emissions among the sector's categories, figure 5.1.1.3 reveals a progressive reduction in chemical industry processes as a consequence of the lower activity levels throughout the inventory period together with the increase in metal production, which led to its greater share in this sector and a more moderate increase in the share of the remaining industries.

Figure 5.1.1.3.- Percentage of NO_X emissions by category with respect to the sector total



As for NO_X, the industrial processes sector as a whole is the key source for this trend in 1991-2003 and 2005. Table 5.1.1.2 shows the contribution of emissions to the levels and trends, the order number for this category in the list of key sources[1], as well as the absolute values, all referring to 2008.

Table 5.1.1.2.- NO_X key sources: Level and Trend contribution

Activity		NO_X (Gg) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	Description		%	Key source	Rank	%	Key source	Rank
2	Industrial processes	7.8	0.6	NO	14	0.4	NO	11

5.1.2.- NMVOC

NMVOC emissions from industrial processes mainly result from fermentation processes in the food processing industry and the manufacturing of chemical organic products. Table 5.1.2.1 shows NMVOC emissions by category in this sector. According to the available data, NMVOC emissions for this sector increased by 6% in 2008 with respect to 1990, from 56.9 Gg in 1990 to 60.2 Gg in 2008.

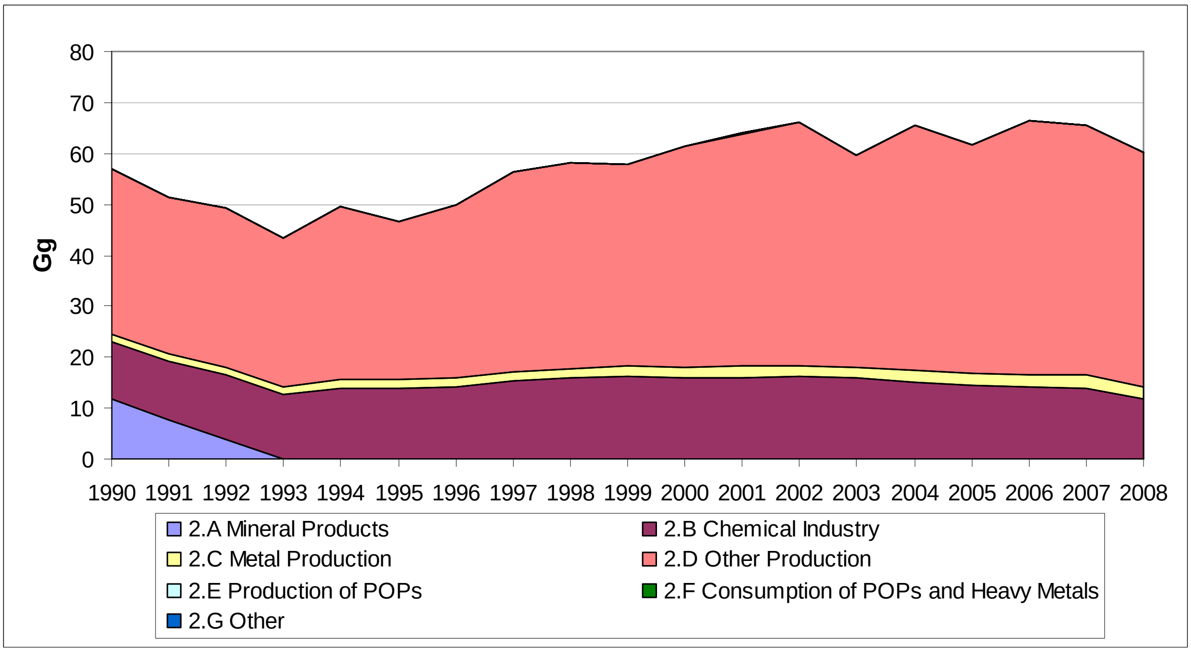
***Table 5.1.2.1.- NMVOC emissions** (Amounts in Gg)*

Category	**1990**	**1995**	**2000**	**2004**	**2005**	**2006**	**2007**	**2008**
2.A Mineral products	11.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.B Chemical industry	11.4	14.0	15.9	15.1	14.4	14.2	14.0	11.9
2.C Metal production	1.6	1.7	2.1	2.4	2.3	2.4	2.4	2.4
2.D Other industries	32.3	31.0	43.3	48.0	44.9	49.7	49.2	45.9
2.E Production of POPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.F Consumption of POPs and heavy metals	-	-	-	-	-	-	-	-
2.G Others	-	-	-	-	-	-	-	-
Industrial processes	**56.9**	**46.7**	**61.3**	**65.5**	**61.6**	**66.3**	**65.6**	**60.2**

Figure 5.1.2.1 shows the evolution of NMVOC emissions throughout the inventory period. The trend in emissions is mainly determined by category 2D (Other industries) which includes processes in the food processing industry, since emissions in category 2B (Chemical Industry) show greater stability. However, it is worth mentioning the influence of category 2A (Mineral products) in 1990-1993 due to the activity of road surfacing with asphalt using fluidized bed (cutback), a method which ceased to be used since 1994.

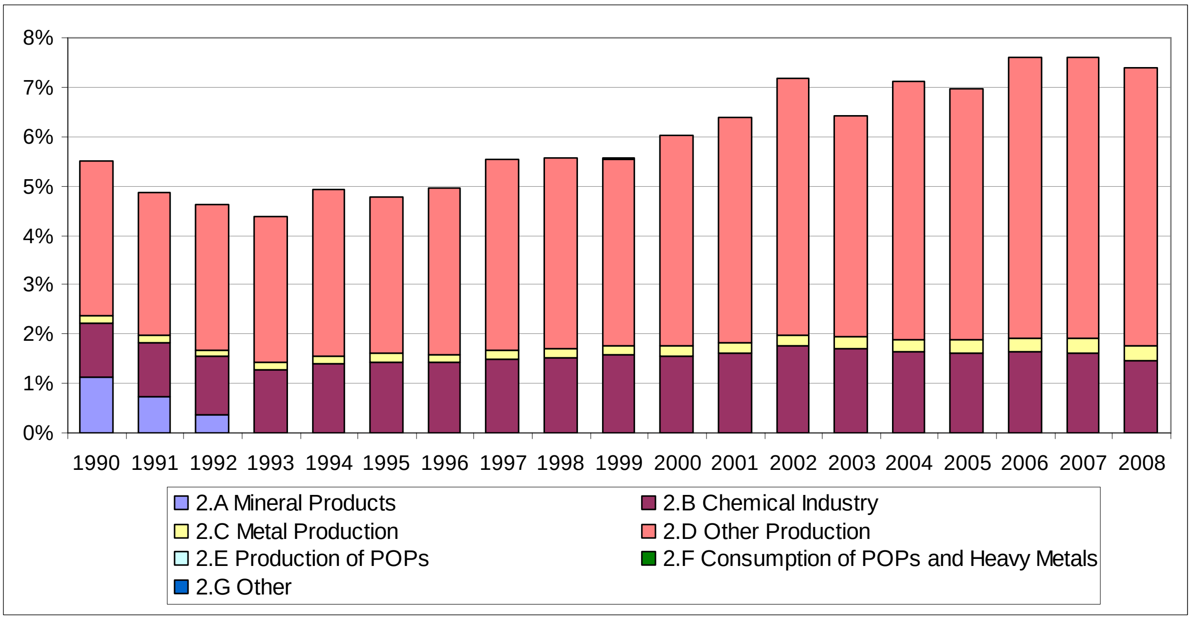
[1] Ranking determined by the contribution of the emissions in the category to the level or the trend.

Figure 5.1.2.1.-Evolution of NMVOC emissions by category



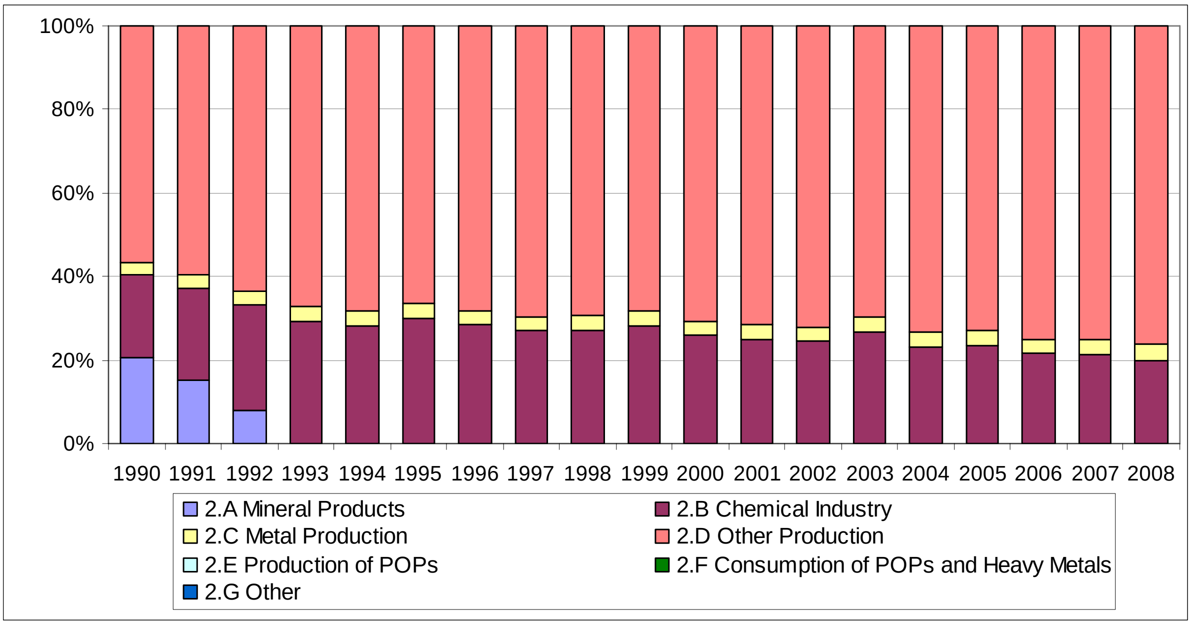
According to figure 5.1.2.2, NMVOC emissions represented 7.4% of all emissions in the inventory in 2008, implying an increase in the contribution with respect to 1990, when these represented 5.5% of the total. Therefore, this is a less relevant sector in the evolution of total NMVOC emissions.

Figure 5.1.2.2.- Percentage of NMVOC emissions by category with respect to the inventory total



With regard to the distribution of emissions among the sector categories, figure 5.1.2.3 shows that the main contribution corresponds to activities in category 2D (Other industries) including fermentation processes in the food processing industry, with a share around 75% in the final years of the period analyzed, followed by category 2B (Chemical industry) and lastly by category 2C (Metal Production) with shares below 5%. As already mentioned the contribution of is virtually marginal except, as already mentioned, for the period 1990-1992, with a significant contribution of over 20% in 1990 and a progressive reduction up to 1993. From this year on, its contribution is lower than 0.02%.

Figure 5.1.2.3.- Percentage of NMVOC emissions by category with respect to the sector total



With regards to NMVOC for this sector, the following key sources were identified for the 1990-2008 period:

- Road paving with asphalt (2A6) by its emission level in 1990 and by its trend in the years 1991-2008.

- Chemical industry (2B) by its emission level in the years 1991-2008, and by its trend in the years 1993-2004.

- Other industries (2D) by its emission level throughout the 1990-2008 period and by its trend in the years 1991-1994 and 1996-2008.

Table 5.1.2.2 below summarizes the contribution of emissions to levels and trends for the key NMVOC categories in this sector, the order number for the category in relation to key sources[2], as well as the absolute value, all referring to 2008.

---

2 Ranking determined by the contribution of the emissions in the category to the level or the trend.

Table 5.1.2.2.- NMVOC key sources: Level and Trend contribution

Activity		NMVOC (Gg) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	Description		%	Key source	Rank	%	Key source	Rank
2A6	Road paving with asphalt	0.002	0.0003	NO	29	1.8	YES	10
2B	Chemical industry	11.9	1.5	YES	15	0.6	NO	18
2D	Other industries	45.9	5.6	YES	5	4.1	YES	7

5.1.3.- SO_X

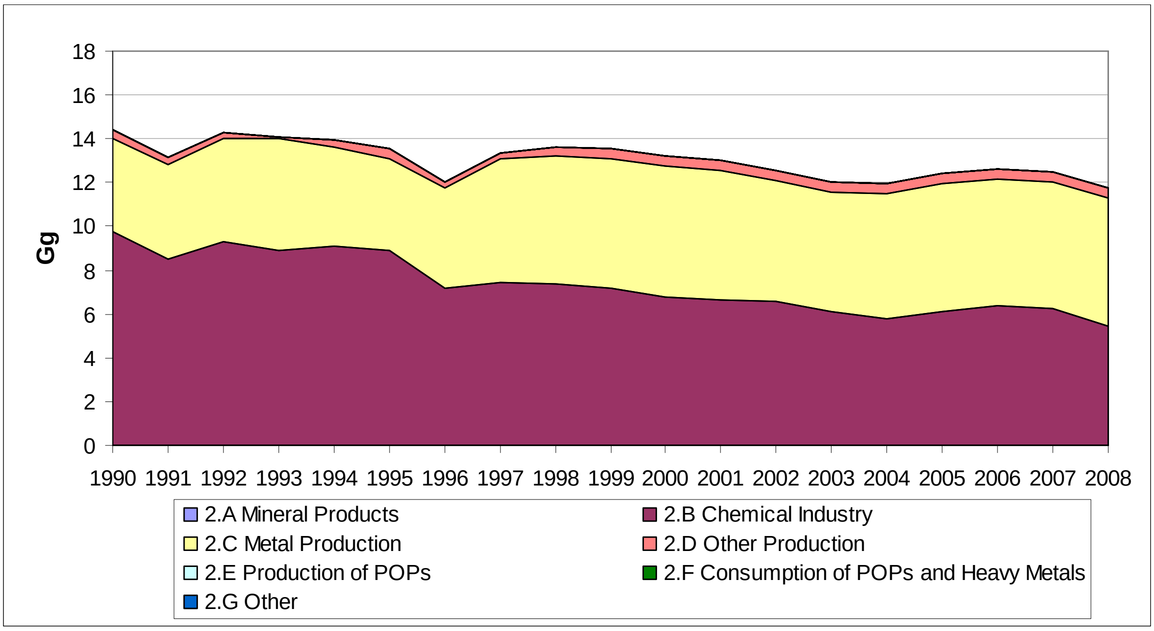
SO_X emissions from industrial processes have little incidence on the inventory as a whole, their origin being certain processes in the chemical industry, metal production and paper pulp production. Table 5.1.3.1 shows SO_X emissions by category in this sector. According to the available data, these emissions have dropped by 18.3% in 2008 with respect to 1990, going from 14.4 Gg in 1990 to 11.8 Gg in 2008.

Table 5.1.3.1.- SO_X emissions *(Amounts in Gg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
2.A Mineral products	-	-	-	-	-	-	-	-
2.B Chemical industry	9.8	8.9	6.8	5.8	6.1	6.4	6.3	5.5
2.C Metal production	4.3	4.2	6.0	5.7	5.8	5.8	5.8	5.9
2.D Other industries	0.4	0.4	0.5	0.5	0.5	0.5	0.4	0.5
2.E Production of POPs	-	-	-	-	-	-	-	-
2.F Consumption of POPs and heavy metals	-	-	-	-	-	-	-	-
2.G Others	-	-	-	-	-	-	-	-
Industrial processes	**14.4**	**13.5**	**13.2**	**12.0**	**12.4**	**12.6**	**12.5**	**11.8**

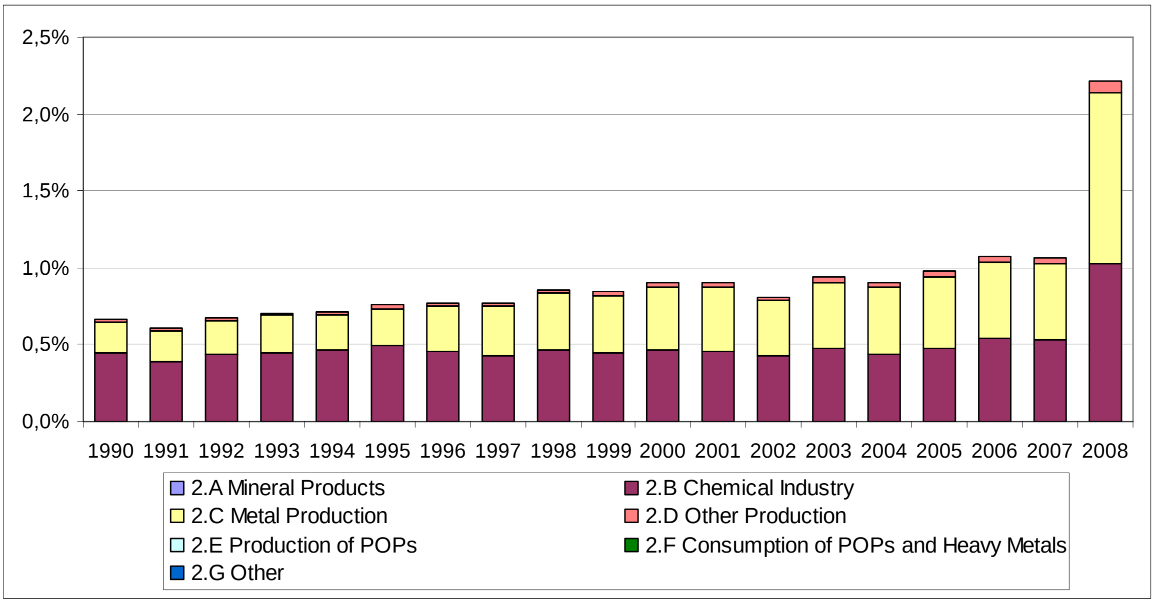
Figure 5.1.3.1 shows the evolution of SO_X emissions throughout the inventory period. The trend of emissions is mainly determined by category 2B (Chemical industry), with the primary influence corresponding to the sulphuric acid production activity, both in terms of production levels and technological improvement of the processes used, followed by category 2C (Metal production) where primary aluminium production and steel production activities in electric furnace shops have a greater relevance, whereas category 2D (Other industries) have a marginal incidence in the evolution of SO_X emissions.

Figure 5.1.3.1.- Evolution of SO_X emissions by category



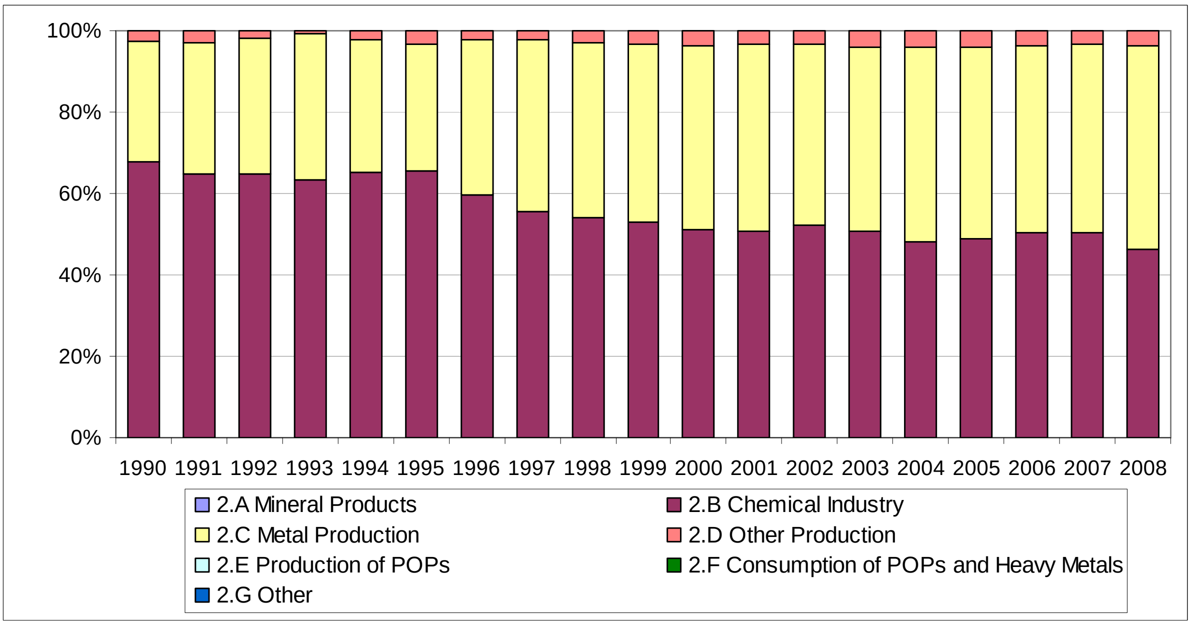
As for the share of SO_X emissions for this sector in the inventory as a whole, figure 5.1.3.2 shows that its relevance is small, remaining under 1% for the entire period, with the exception of 2006 and 2007, when its share amounts to approximately 1.1%, growing in the year 2008 up to 2.2% as a result of the sharp fall in emissions for the energy sector (more specifically in public service thermal plants), which explains the greater weighting of all other sectors. The trend in terms of share is therefore slightly upwards until 2007, with the already described increase in 2008.

Figure 5.1.3.2.- Percentage of SO_X emissions by category with respect to the inventory total



Regarding the distribution of emissions among the sector categories, figure 5.1.3.3 shows the progressive reduction of processes for the chemical industry marked by the evolution of SO_X in the sulphuric acid manufacturing activity, in combination with the increase in metal production, which increases its share in this sector, with the remaining industries showing a more moderate increase within the reduced share in the sector.

Figure 5.1.3.3.- Percentage of SO_X emissions by category with respect to the sector total



With regards to SO_X for this sector, the following key sources were identified for the 1990-2008 period:

- Metal production (2C) by its trend in the years 1998 and 2000-2008.

Table 5.1.3.2 presents for the contribution of the emissions to the level and trend, the category's ranking in relation to the key sources [3], as well as the absolute values, all referred to 2008.

Table 5.1.3.2.- SO_X key sources: Level and Trend contribution

Activity		SO_x (Gg) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	Description		%	Key source	Rank	%	Key source	Rank
2C	Metal Production	5.9	1.1	NO	14	1.3	YES	10

[3] Ranking determined by the contribution of the emissions in the category to the level or the trend.

5.1.4.- NH_3

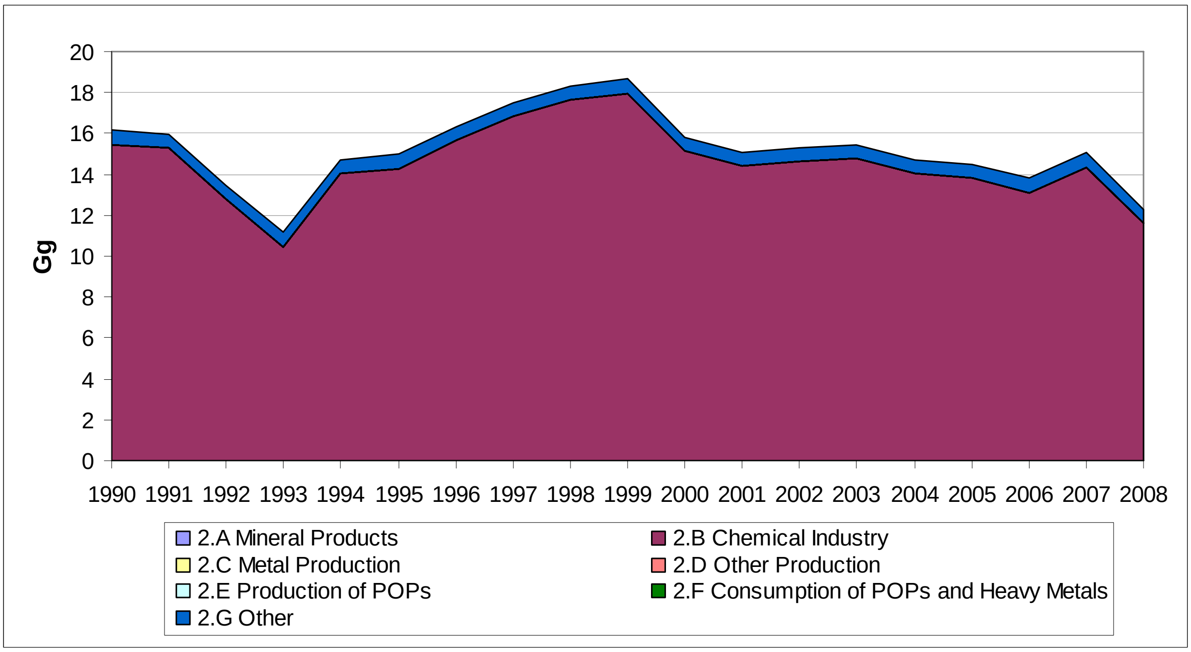
NH_3 emissions from industrial processes are mainly associated with the production of fertilizers in the chemical industry, with a small contribution from the use of ammonia as cooler. Table 5.1.4.1 includes NH_3 emissions by category in this sector. According to the available data, these emissions decreased by 24% in 2008 with respect to 1990, going from 16.2 Gg in 1990 to 12.3 Gg in 2008.

Table 5.1.4.1.- NH_3 emissions *(Amounts in Gg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
2.A Mineral products	-	-	-	-	-	-	-	-
2.B Chemical industry	15.5	14.3	15.1	14.0	13.8	13.1	14.4	11.6
2.C Metal production	-	-	-	-	-	-	-	-
2.D Other industries	-	-	-	-	-	-	-	-
2.E Production of POPs	-	-	-	-	-	-	-	-
2.F Consumption of POPs and heavy metals	-	-	-	-	-	-	-	-
2.G Others	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Industrial processes	**16.2**	**15.0**	**15.8**	**14.7**	**14.5**	**13.8**	**15.1**	**12.3**

Figure 5.1.4.1 shows the evolution of NH_3 emissions throughout the inventory period. The trend for emissions is determined by fertilizer manufacturing processes included under category 2B (Chemical industry), since the evolution of category 2G (Other) remains constant.

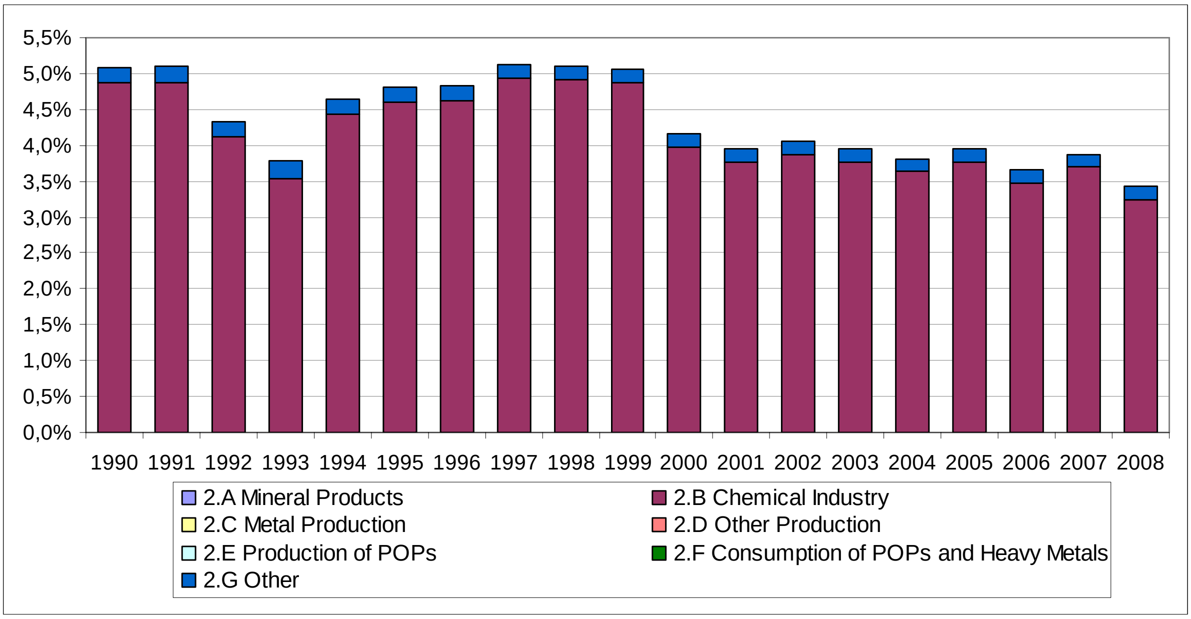
Figure 5.1.4.1.- Evolution of NH_3 by category



The share of NH_3 emissions for this sector in the inventory as a whole, as shown in figure 5.1.4.2, stands below 5.5% throughout the inventory period, with rises and falls in the corresponding share, although it is worth noting the reduction during 2000 and its relative

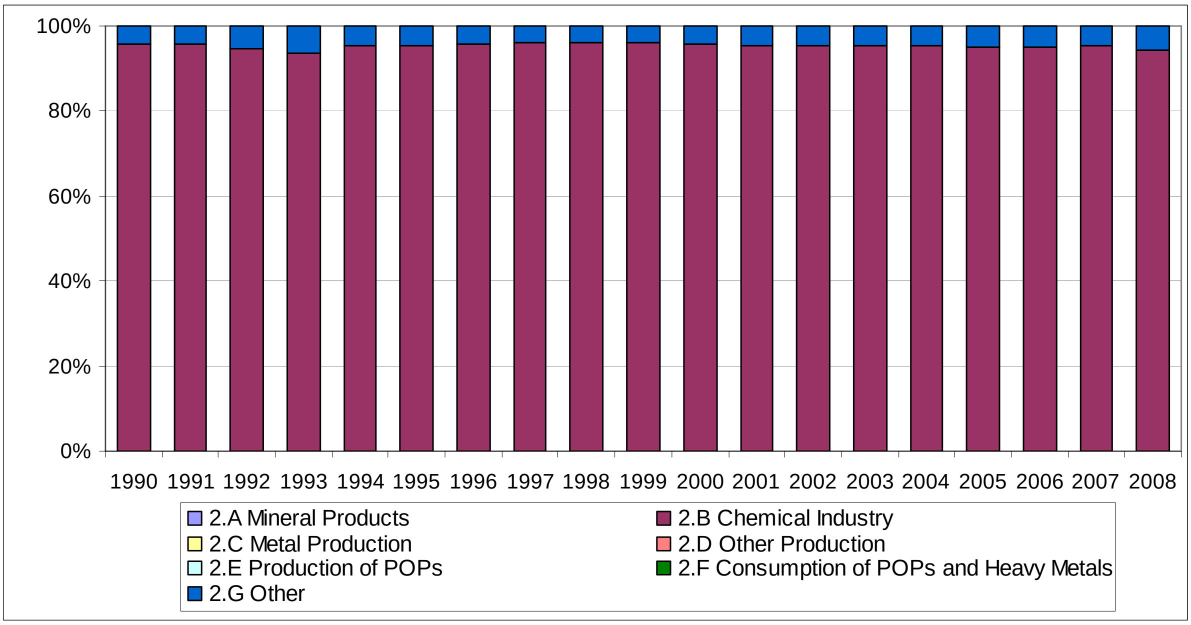
stability starting that year, reflecting the evolution in the production of the different types of fertilizers for that period.

Figure 5.1.4.2.- Percentage of NH_3 emissions by category with respect to the inventory total



As for the distribution of emissions among the categories in this sector, figure 5.1.4.3 shows that the chemical industry is the main source for NH_3 emissions in this sector, with a contribution amounting to approximately 95%.

Figure 5.1.4.3.- Percentage of NH_3 by category with respect to the sector total



With regards to NH_3 for this sector, the following key sources were identified for the 1990-2008 period:

- Chemical industry (2B) by its emission level throughout the 1990-2008 period and by its trend in the years 1992-1996 and 2000-2008.

Table 5.1.4.2 presents for the contribution of the emissions to the level and trend, the category's ranking in relation to the key sources [4], as well as the absolute values, all referred to 2008.

Table 5.1.4.2.- NH_3 key sources: Level and Trend contribution

Activity		NH_3 (Gg) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	Description		%	Key source	Rank	%	Key source	Rank
2B	Chemical industry	11.6	3.2	YES	3	11.5	YES	3

5.1.5.- CO

CO emissions from industrial processes are a significant source within the inventory and are essentially generated in metal production processes, with considerably lower contributions from the chemical industry and virtually marginal contributions from the remaining industries. Table 5.1.5.1 shows the said emissions by category for this sector. According to the available data, CO emissions in this sector increased by 44.6% in 2008 with respect to 1990, going from 298.1 Gigagrammes (Gg) in 1990 to 431.0 Gg in 2008.

Table 5.1.5.1.- CO emissions *(Amounts in Gg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
2.A Mineral products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.B Chemical industry	8.5	8.6	7.6	7.6	7.6	7.7	7.6	9.1
2.C Metal production	289.7	284.3	353.9	398.9	404.6	401.1	423.2	421.9
2.D Other industries	-	0.0	0.0	0.0				
2.E Production of POPs	-	-	-	-	-	-	-	-
2.F Consumption of POPs and heavy metals	-	-	-	-	-	-	-	-
2.G Others	-	-	-	-	-	-	-	-
Industrial processes	**298.1**	**292.9**	**361.5**	**406.5**	**412.2**	**408.8**	**430.7**	**431.0**

Figure 5.1.5.1 shows the evolution of CO emissions throughout the inventory period. The trend for emissions is clearly dominated by category 2C (Metal production), following a generally growing evolution with drops in the 1990-1992 and 1994-1996 periods as a consequence of the reduction in production and final closure of an integrated steel plant together with a decrease in the production of ferro-alloy, and a mild decrease in 1999 as a result of the drop in the production of ferro-alloy.

4 Ranking determined by the contribution of the emissions in the category to the level or the trend.

Figure 5.1.5.1.- Evolution of CO emissions by category

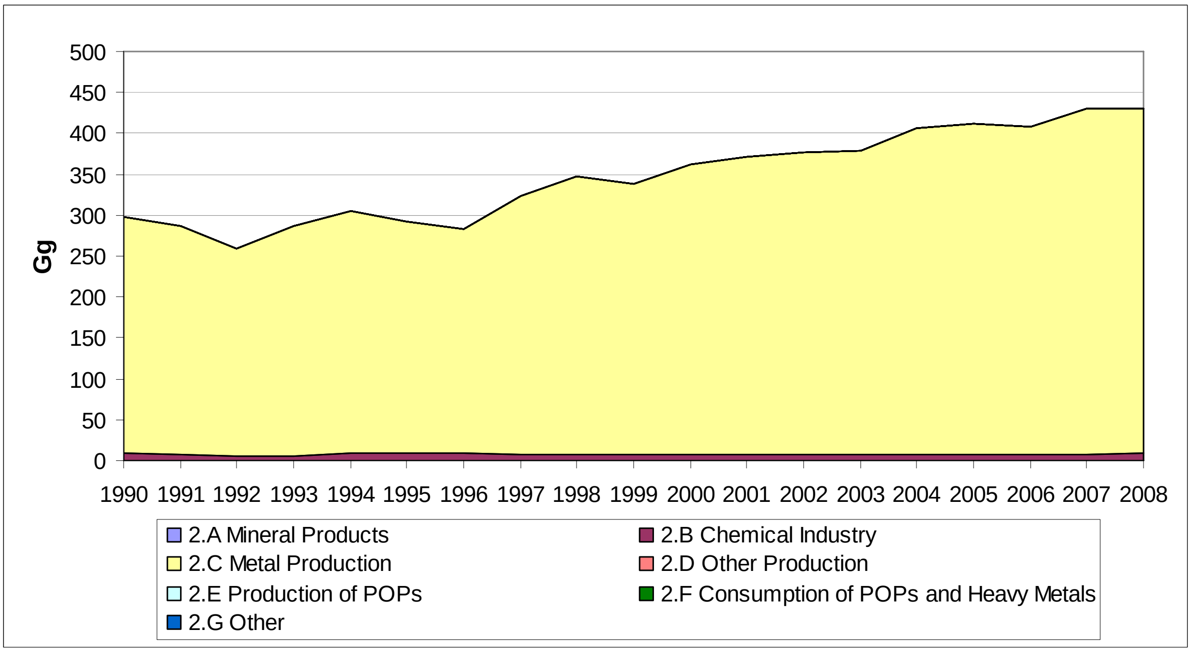
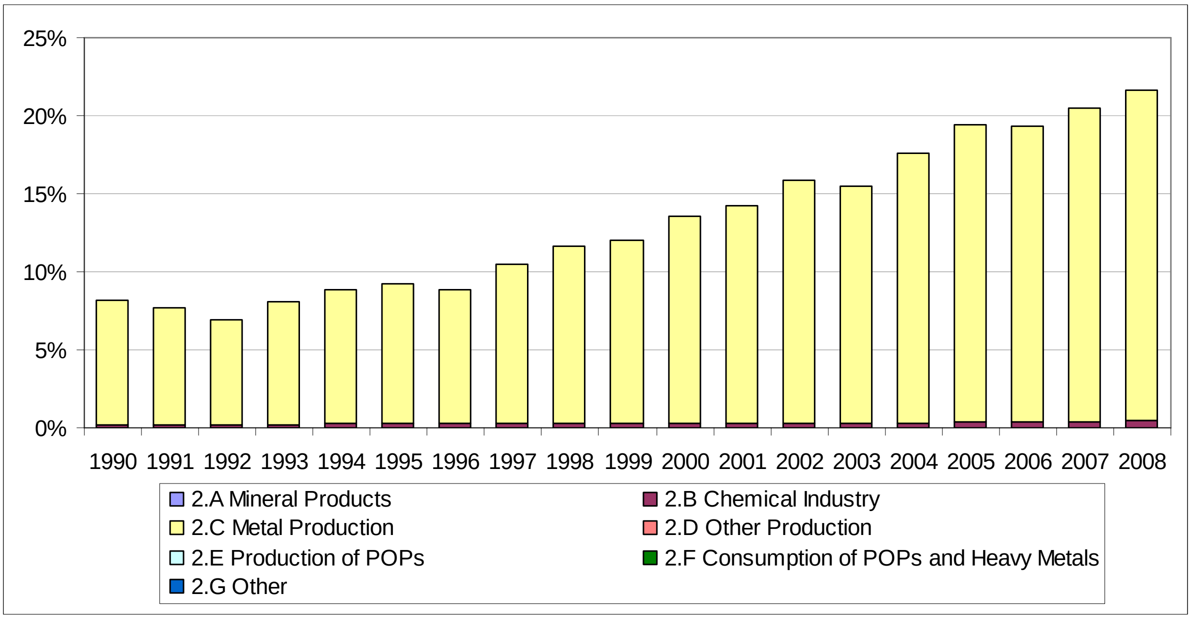


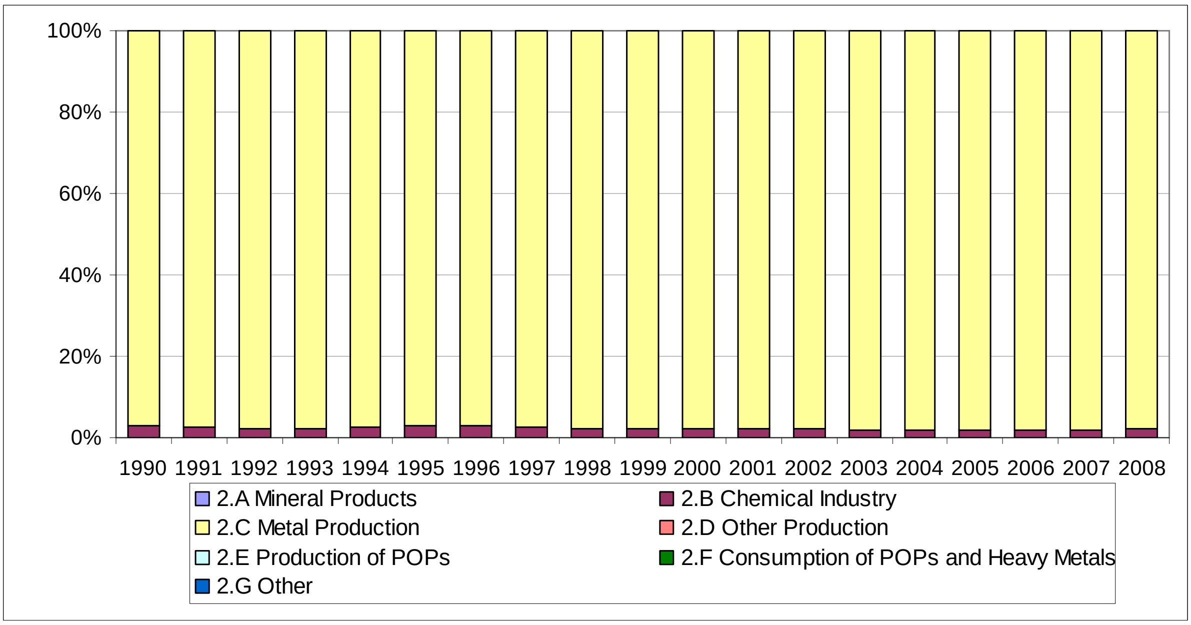
Figure 5.1.5.2 shows that CO emissions in 2008 accounted for 21.6% of the total emissions in the inventory, which implies a considerable increase in the contribution with respect to 1990, when these represented 8.2% of the total.

Figure 5.1.5.2.- Percentage of CO emissions by category with respect to the inventory total



Regarding the distribution of emissions among the sector categories, shown in figure 5.1.5.3, the main contribution corresponds, as already noted, to activities under category 2C (Metal production), with a share above 97% throughout the inventory period; it is followed by category 2B (Chemical industry), which accounts for virtually the remaining contribution to CO emissions in this sector, the share of the remaining categories being insignificant or nil.

Figure 5.1.5.3.- Percentage of CO emissions by category with respect to the sector total



With regards to CO for this sector, the following key sources were identified for the 1990-2008 period:

- Metal production (2C) by its emission level throughout the 1990-2008 period and by its trend in the years 1991-1992 and 1994-2008.

- Industrial processes except metal production (2-2C) by its trend in 1991.

Table 5.1.5.2 presents for the contribution of the emissions to the level and trend, the category's ranking in relation to the key sources [5], as well as the absolute values, all referred to 2008.

5 Ranking determined by the contribution of the emissions in the category to the level or the trend.

Table 5.1.5.2.- CO key sources: Level and Trend contribution

Activity		CO (Gg) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	Description		%	Key source	Rank	%	Key source	Rank
2C	Metal Production	421.9	21.1	YES	2	16.2	YES	2
2-2C	Industrial processes – Others	9.1	0.5	NO	13	0.3	NO	15

5.1.6.- $PM_{2.5}$

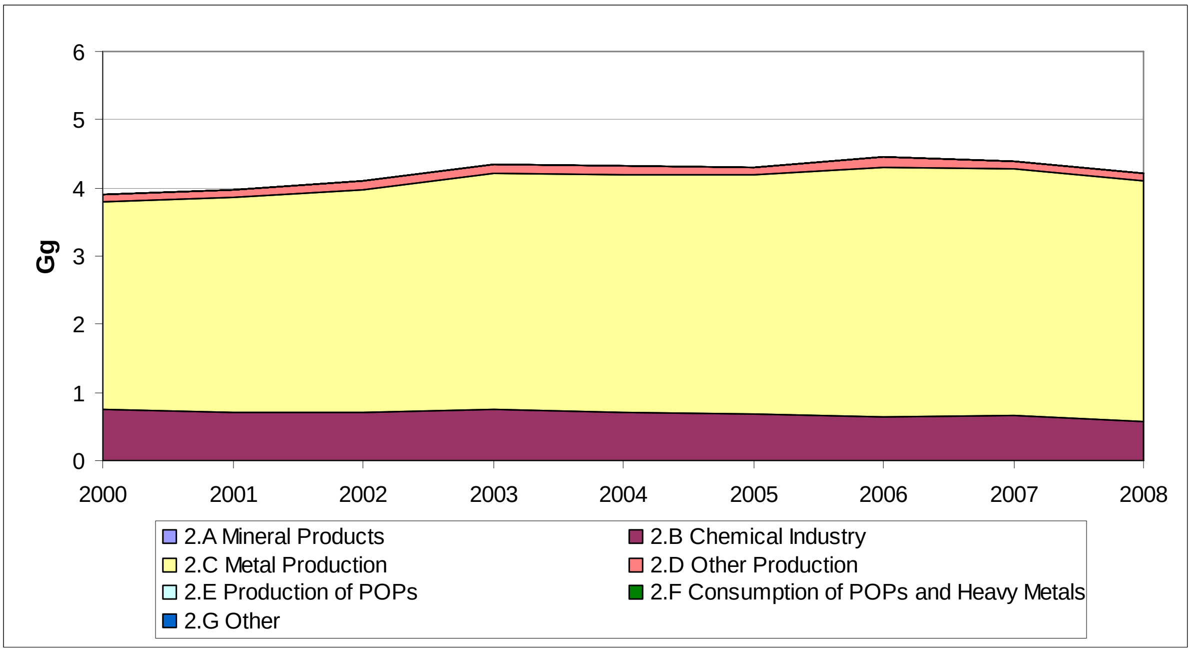
$PM_{2.5}$ emissions in this sector have a smaller incidence in the inventory as a whole, since they account for less than 4% of the total inventory. Table 5.1.6.1 shows emissions by category in this sector. According to the available data, there was an increase of 8.3% in 2008 with respect to 1990, going from 3.9 Gg in 1990 to 4.2 Gg in 2008.

Table 5.1.6.1.- $PM_{2.5}$ emissions *(Amounts in Gg)*

Category	2000	2004	2005	2006	2007	2008
2.A Mineral products	-	-	-	-	-	-
2.B Chemical industry	0.8	0.7	0.7	0.6	0.7	0.6
2.C Metal production	3.0	3.5	3.5	3.7	3.6	3.5
2.D Other industries	0.1	0.1	0.1	0.1	0.1	0.1
2.E Production of POPs	-	-	-	-	-	-
2.F Consumption of POPs and heavy metals	-	-	-	-	-	-
2.G Others	-	-	-	-	-	-
Industrial processes	**3.9**	**4.3**	**4.3**	**4.4**	**4.4**	**4.2**

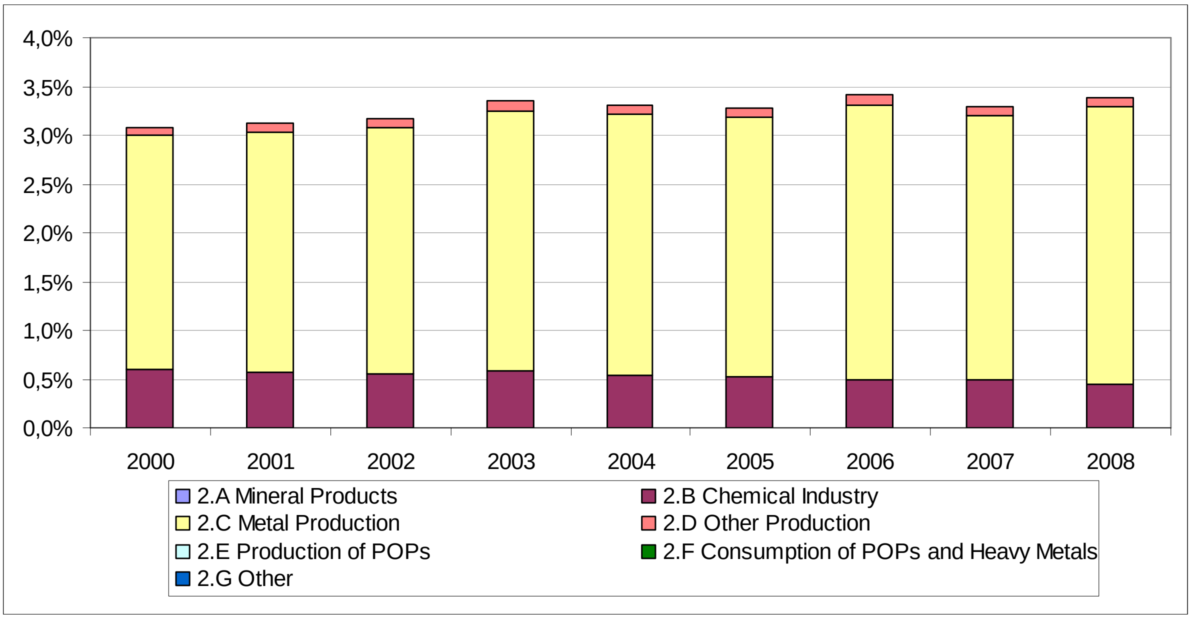
Figure 5.1.6.1 shows the evolution for $PM_{2.5}$ emissions since 2000. According to the available data, these emissions are relatively stable, with category 2C (Metal production) having the greatest incidence in this evolution, and more specifically steel production in electric furnaces and the production of primary aluminium.

Figure 5.1.6.1.- Evolution of $PM_{2.5}$ emissions by category



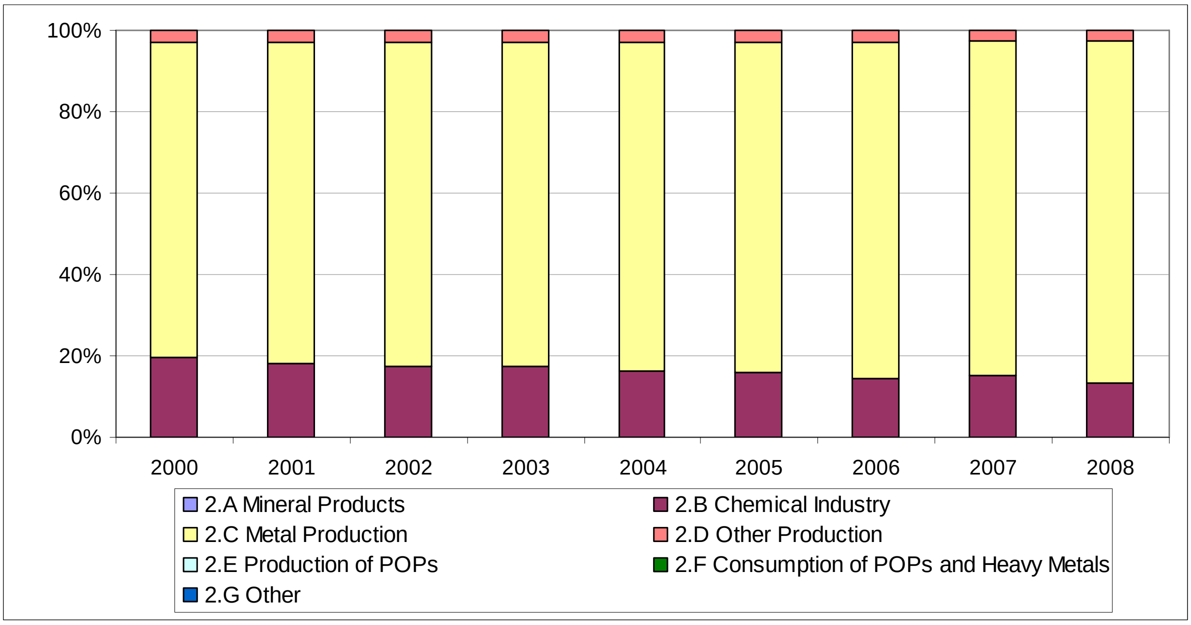
As already mentioned, and shown in figure 5.1.6.2, the sector contribution to total $PM_{2.5}$ emissions in the inventory is below 4%, with slight upward or downward variations during the period under study.

Figure 5.1.6.2.- Percentage of $PM_{2.5}$ emissions by category with respect to the inventory total



Regarding the distribution of emissions among the categories in this sector, figure 5.1.6.3 shows that the main contribution corresponds to activities under category 2C (Metal production), since they account for approximately 80% of $PM_{2.5}$ emissions in the sector, followed by category 2B (Chemical industry) with shares ranging from 13% to 20%, and finally by category 2D (Other industries), and more specifically the paper pulp manufacturing activity, whose share stands at around 3%.

Figure 5.1.6.3.- Percentage of $PM_{2.5}$ emissions by category with respect to the sector total



With regards to $PM_{2.5}$ for this sector, the following key sources were identified for the 2000-2008 period:

- Metal production (2C) by its trend in the years 2001-2008.

Table 5.1.6.2 presents for the contribution of the emissions to the level and trend, the category's ranking in relation to the key sources [6], as well as the absolute values, all referred to 2008.

Table 5.1.6.2.- $PM_{2.5}$ key sources: Level and Trend contribution

Activity		$PM_{2.5}$ (Gg) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	Description		%	Key source	Rank	%	Key source	Rank
2C	Metal production	3.5	2.8	NO	6	3.0	YES	5

6 Ranking determined by the contribution of the emissions in the category to the level or the trend.

5.1.7.- PM_{10}

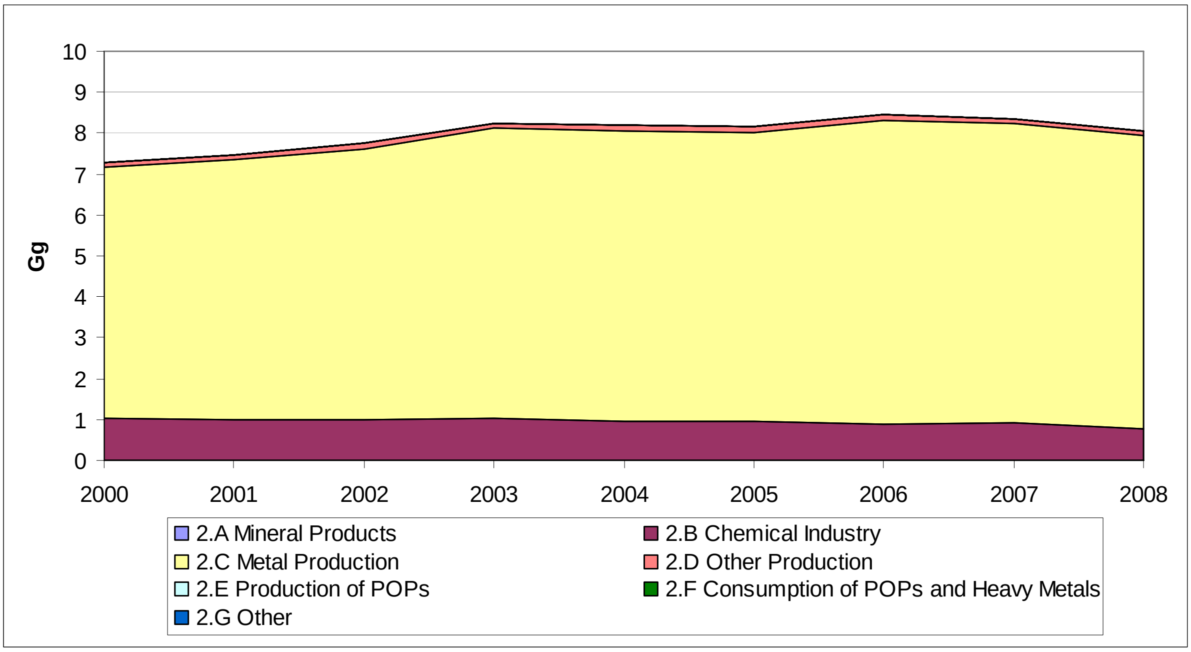
PM_{10} emissions in this sector have a lower incidence in the inventory as a whole, since they account for less than 5.5% of the total inventory. Table 5.1.7.1 shows these emissions in this sector by category. According to the available data, there was an increase of 10.7% in 2008 with respect to 1990, going from 7.3 Gg in 1990 to 8.1 Gg in 2008.

***Table 5.1.7.1.- PM_{10} emissions** (Amounts in Gg)*

Category	2000	2004	2005	2006	2007	2008
2.A Mineral products	-	-	-	-	-	-
2.B Chemical industry	1.0	1.0	1.0	0.9	0.9	0.8
2.C Metal production	6.1	7.1	7.1	7.4	7.3	7.2
2.D Other industries	0.1	0.1	0.1	0.1	0.1	0.1
2.E Production of POPs	-	-	-	-	-	-
2.F Consumption of POPs and heavy metals	-	-	-	-	-	-
2.G Others	-	-	-	-	-	-
Industrial processes	**7.3**	**8.2**	**8.2**	**8.5**	**8.4**	**8.1**

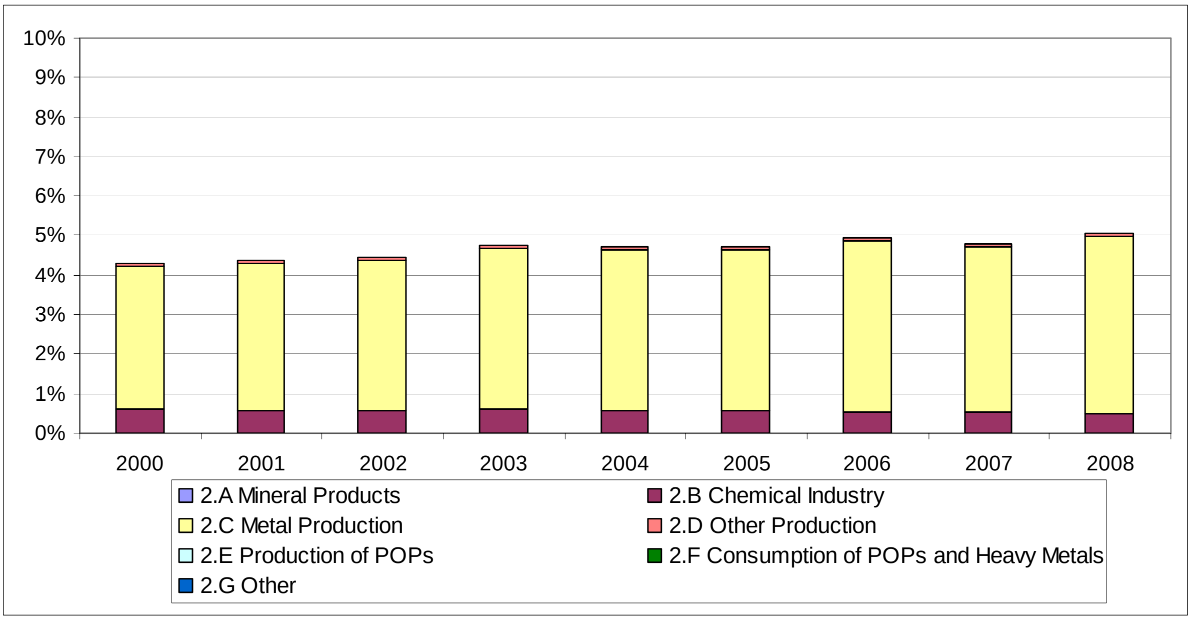
Figure 5.1.7.1 shows the evolution of PM_{10} emissions starting in 2000. According to the available data, these emissions are relatively stable, with category 2C (Metal production) having the greatest incidence in such evolution, and more specifically steel production in electric furnaces and the production of primary aluminium.

Figure 5.1.7.1.- Evolution of PM_{10} emissions by category



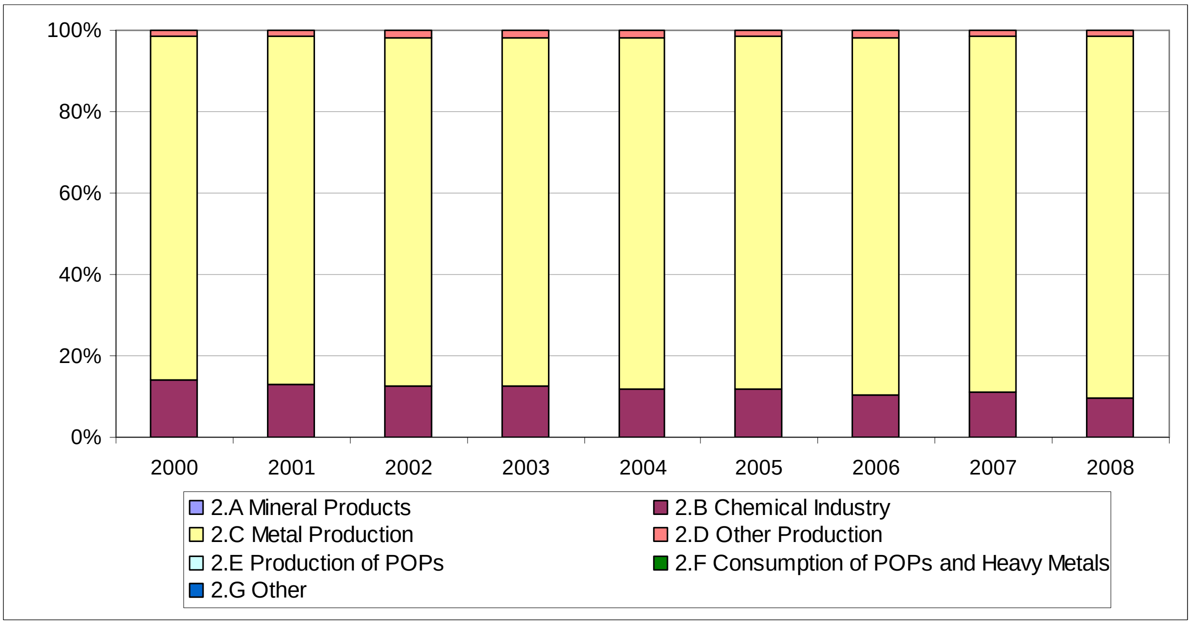
As already noted, and shown in figure 5.1.7.2, the contribution of the sector to total PM_{10} emissions in the inventory is below 5.5%, with slight upward or downward variations during the period under study.

Figure 5.1.7.2.- Percentage of PM_{10} emissions by category with respect to the inventory total



As for the distribution of emissions among the sector categories, figure 5.1.7.3 shows that the main contribution corresponds to the activities under category 2C (Metal production), which account for between 80% and 90% of PM_{10} emissions in the sector, followed by category 2B (Chemical industry) with shares ranging from 10% to 15%, and finally by category 2D (Other industries), and more specifically the paper pulp manufacturing activity, whose share stands at less than 2%.

Figure 5.1.7.3.- Percentage of PM_{10} emissions by category with respect to the sector total



With regards to PM_{10} for this sector, the following key sources were identified for the 2000-2008 period:

- Metal production (2C) by its emission level throughout the 2000-2008 period and by its trend in the years 2001-2008.

Table 5.1.7.2 presents for the contribution of the emissions to the level and trend, the category's ranking in relation to the key sources [7], as well as the absolute values, all referred to 2008.

Table 5.1.7.2.- PM_{10} key sources: Level and Trend contribution

Activity		PM_{10} (Gg) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	Description		%	Key source	Rank	%	Key source	Rank
2C	Metal Production	7.2	4.5	YES	6	4.4	YES	5

5.1.8.- TSP

TSP emissions in this sector have a lower incidence in the inventory as a whole, as they amount to less than 5% of the whole inventory. Table 5.1.8.1 shows these emissions by category in this sector. According to the available data, there was an increase of 9.1% in 2008 with respect to 1990, going from 9.0 Gg in 1990 to 9.8 Gg in 2008.

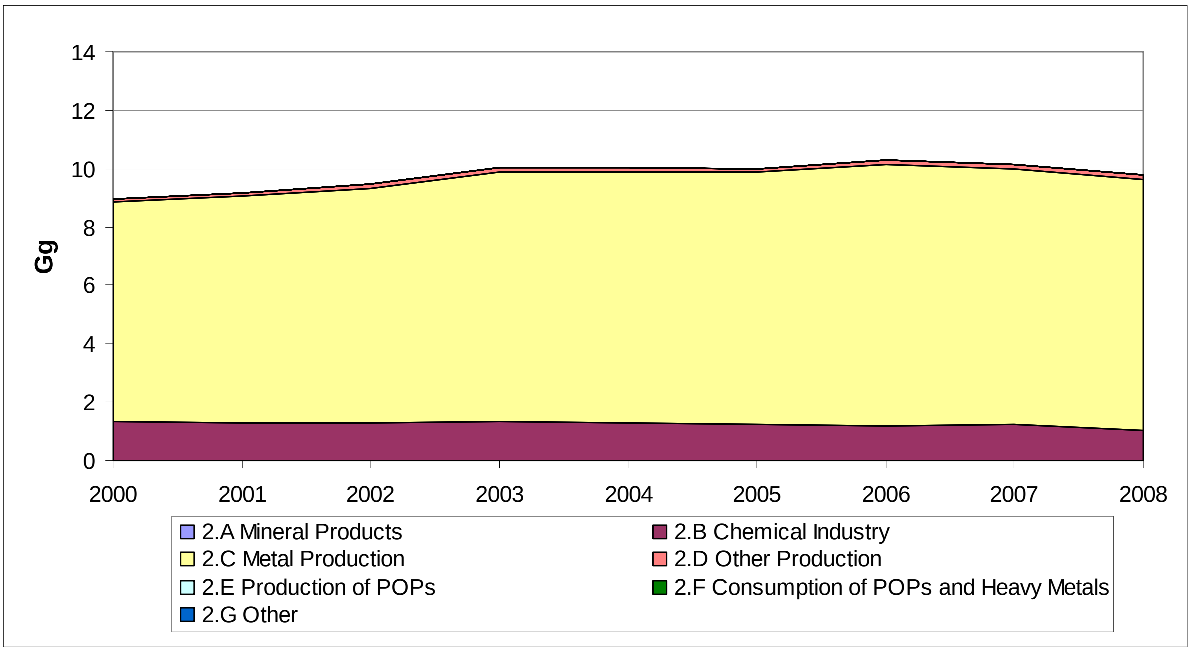
***Table 5.1.8.1.- TSP Emissions** (Amounts in Gg)*

Category	2000	2004	2005	2006	2007	2008
2.A Mineral products	-	-	-	-	-	-
2.B Chemical industry	1.3	1.3	1.3	1.2	1.2	1.0
2.C Metal production	7.5	8.6	8.6	9.0	8.8	8.6
2.D Other industries	0.1	0.1	0.1	0.2	0.1	0.1
2.E Production of POPs	-	-	-	-	-	-
2.F Consumption of POPs and heavy metals	-	-	-	-	-	-
2.G Others	-	-	-	-	-	-
Industrial Processes	**9.0**	**10.0**	**10.0**	**10.3**	**10.1**	**9.8**

Figure 5.1.8.1 shows the evolution of TSP emissions since 2000. According to the available data, these emissions were relatively stable, with category 2C (Metal production) having a greater incidence in this evolution, and more specifically steel production in electric furnaces and the production of primary aluminium.

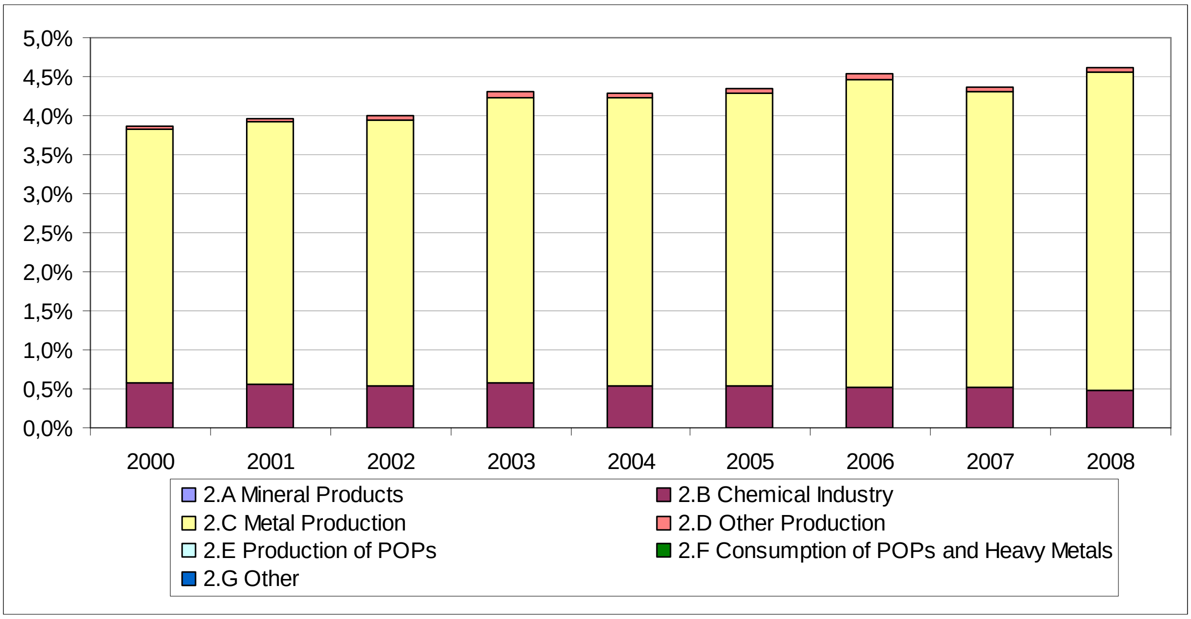
[7] Ranking determined by the contribution of the emissions in the category to the level or the trend.

Figure 5.1.8.1.- Evolution of TSP emissions by category



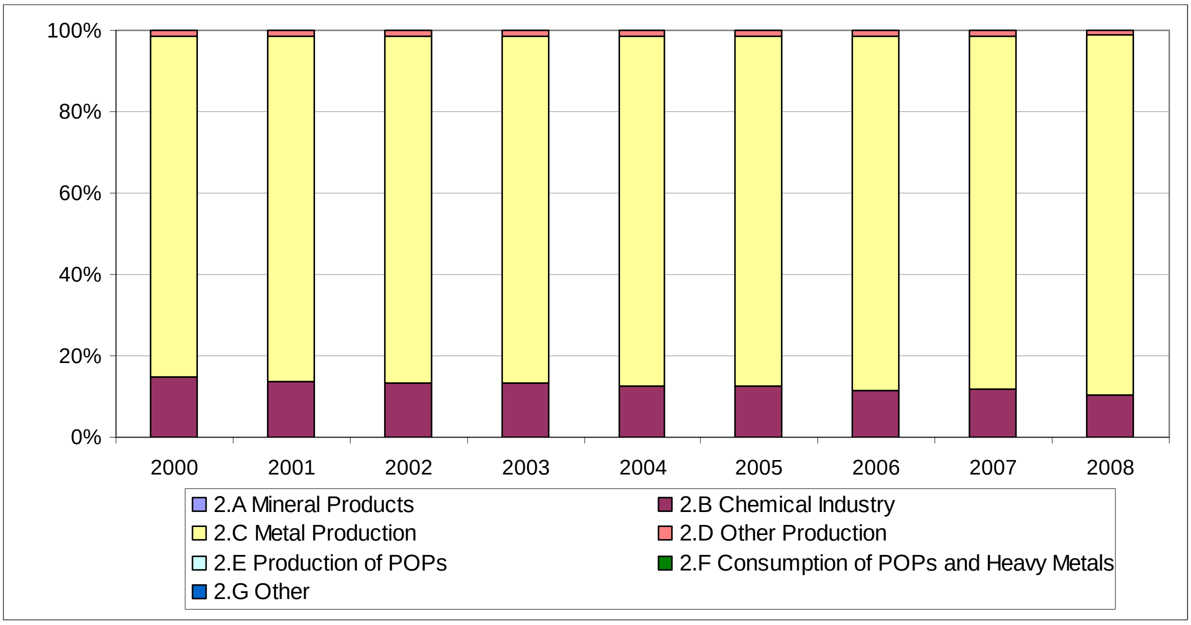
As already noted and shown in figure 5.1.8.2, the sector's contribution to total TSP emissions in the inventory is lower than 5%, with slight upward or downward variations during the period under study.

Figure 5.1.8.2.- Percentage of TSP emissions by category with respect to the inventory total



Regarding the distribution of emissions among the sector categories, figure 5.1.8.3 shows that the main contribution corresponds to activities under category 2C (Metal production) since they account for between 80% and 90% of TSP emissions in the sector, followed by category 2B (Chemical industry) with shares ranging from 10% to 15%, and finally by category 2D (Other industries), and more specifically the paper pulp manufacturing activity, with shares below 1.5%.

Figure 5.1.8.3.- Percentage of TSP emissions by category with respect to the sector total



With regards to TSP for this sector, the following key sources were identified for the 2000-2008 period:

- Metal production (2C) by its emission level throughout the 2000-2008 period and by its trend in the years 2001-2008.

Table 5.1.8.2 presents for the contribution of the emissions to the level and trend, the category's ranking in relation to the key sources [8], as well as the absolute values, all referred to 2008.

Table 5.1.8.2.- TSP key sources: Level and Trend contribution

Activity		TSP (Gg) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	Description		%	Key source	Rank	%	Key source	Rank
2C	Metal Production	8.6	4.1	YES	7	3.5	YES	6

8 Ranking determined by the contribution of the emissions in the category to the level or the trend.

5.1.9.- Pb

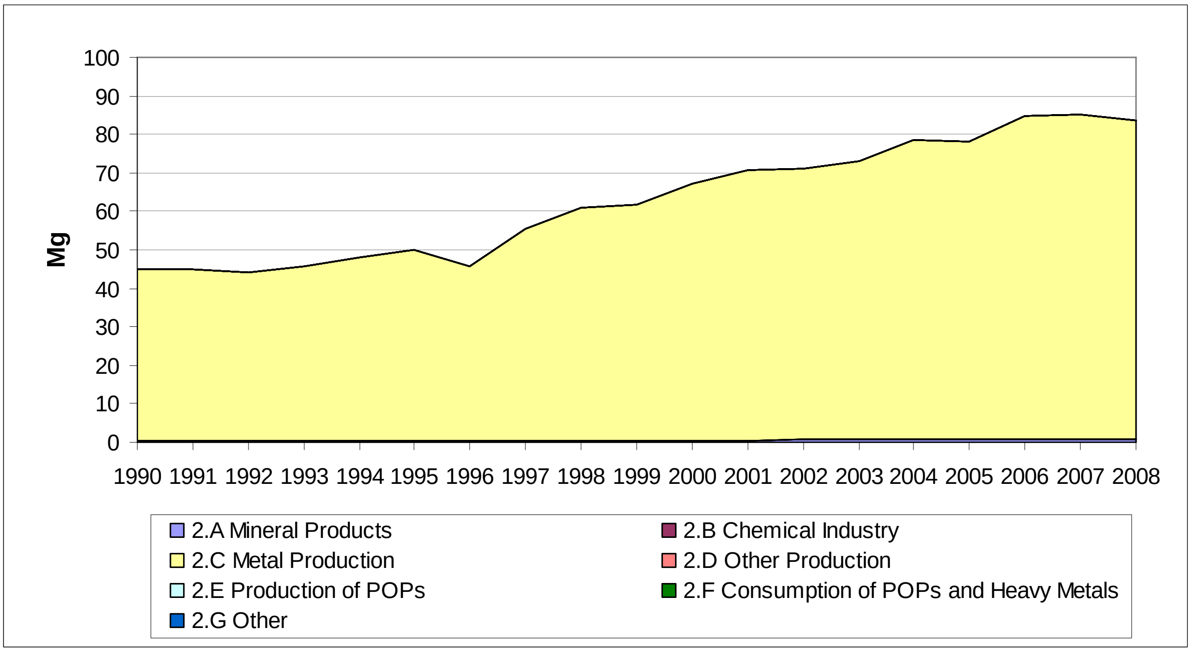
Pb emissions in this sector, shown in Table 5.1.9.1, are mainly generated by the metal production industry, with those produced in electric furnace shops being particularly relevant, while the remaining emissions correspond to the manufacture of lead batteries. According to the available data, the whole sector witnessed an increase in Pb emissions, going from 44.8 Mg in 1990 to 83.6 Mg in 2008.

***Table 5.1.9.1.- Pb emissions** (Amounts in Mg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
2.A Mineral products	0.3	0.4	0.5	0.7	0.7	0.7	0.7	0.7
2.B Chemical industry	-	-	-	-	-	-	-	-
2.C Metal production	44.5	49.4	66.6	78.0	77.6	84.1	84.5	82.9
2.D Other industries	-	-	-	-	-	-	-	-
2.E Production of POPs	-	-	-	-	-	-	-	-
2.F Consumption of POPs and heavy metals	-	-	-	-	-	-	-	-
2.G Others	-	-	-	-	-	-	-	-
Industrial Processes	**44.8**	**49.8**	**67.2**	**78.6**	**78.3**	**84.7**	**85.2**	**83.6**

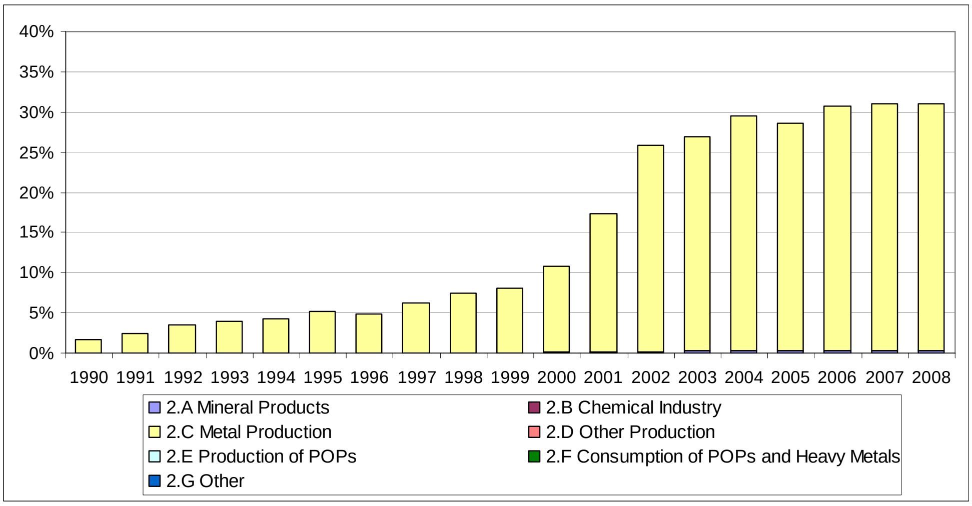
Figure 5.1.9.1 shows the evolution of Pb emissions during the inventory period. According to this figure, the evolution is clearly determined by activities within category 2C (Metal production), and more specifically by steel production activities in electric furnace shops, while those generated in other sector categories were marginal or non-existent. The trend in this sector is clearly growing, with the exception of 1996, when steel manufacturing in electric furnaces decreased, with an increase of 86.7% during 2008 with respect to 1990.

Figure 5.1.9.1.- Evolution of Pb emissions by category



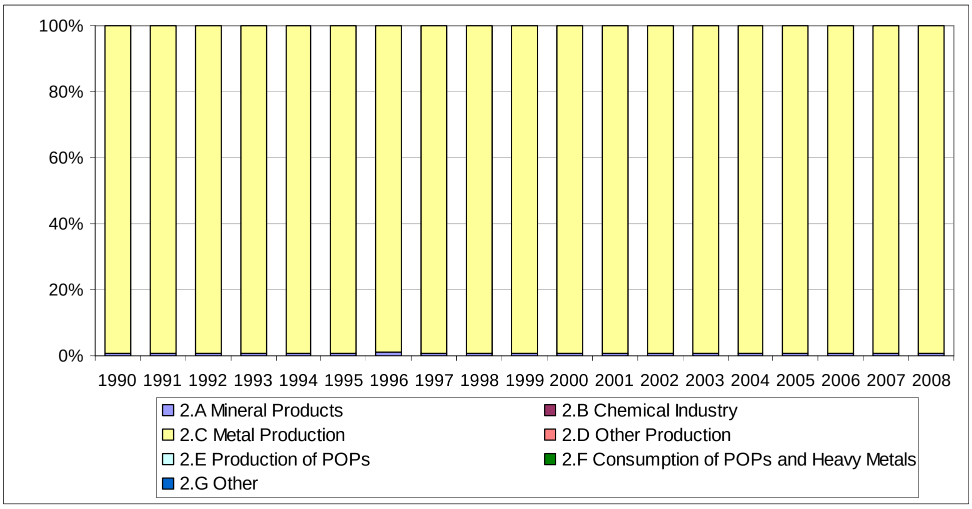
As shown in figure 5.1.9.2, the share of Pb emissions for this sector in the inventory as a whole reveals a growing evolution with a marked increase during the 1999-2004 period followed by a greater stability starting during 2004, from 1.6% of total emissions in 1990 to a 31.0% share during 2008. This results from the progressive reduction and disappearance in 2002 of unleaded gasoline consumption in road transport, which translates into Pb emissions and notably influences the contribution of emissions for this pollutant in the remaining sectors.

Figure 5.1.9.2.- Percentage of Pb emissions by category with respect to the inventory total



As for the distribution of Pb emissions among the sector categories, figure 5.1.9.3 shows 2C (Metal production) to be the prevailing category, with shares over 99% throughout the inventory period. Category 2A (Mineral products) together with emissions generated by the manufacturing of lead batteries make up the remaining emissions for this sector, although their share has a marginal presence in the sector as a whole.

Figure 5.1.9.3.- Percentage of Pb emissions by category with respect to the sector total



With regards to Pb for this sector, the following key sources were identified for the 1990-2008 period:

- Metal production (2C) by its emission level in the years 1992-2008 and by its trend in the years 1991-2008.

Table 5.1.9.2 presents for the contribution of the emissions to the level and trend, the category's ranking in relation to the key sources [9], as well as the absolute values, all referred to 2008.

Table 5.1.9.2.- Pb key sources: Level and Trend contribution

Activity		Pb (Mg) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	Description		%	Key source	Rank	%	Key source	Rank
2C	Metal production	82.9	30.7	YES	2	17.5	YES	3

5.1.10.- Cd

As shown in table 5.1.10.1, Cd emissions in this sector are mostly generated by the metal industry, with those generated in electric furnace shops being particularly relevant. According to the available data, the whole sector witnessed an increase in Cd emissions, which went from 2.3 Mg in 1990 to 4.4 Mg in 2008.

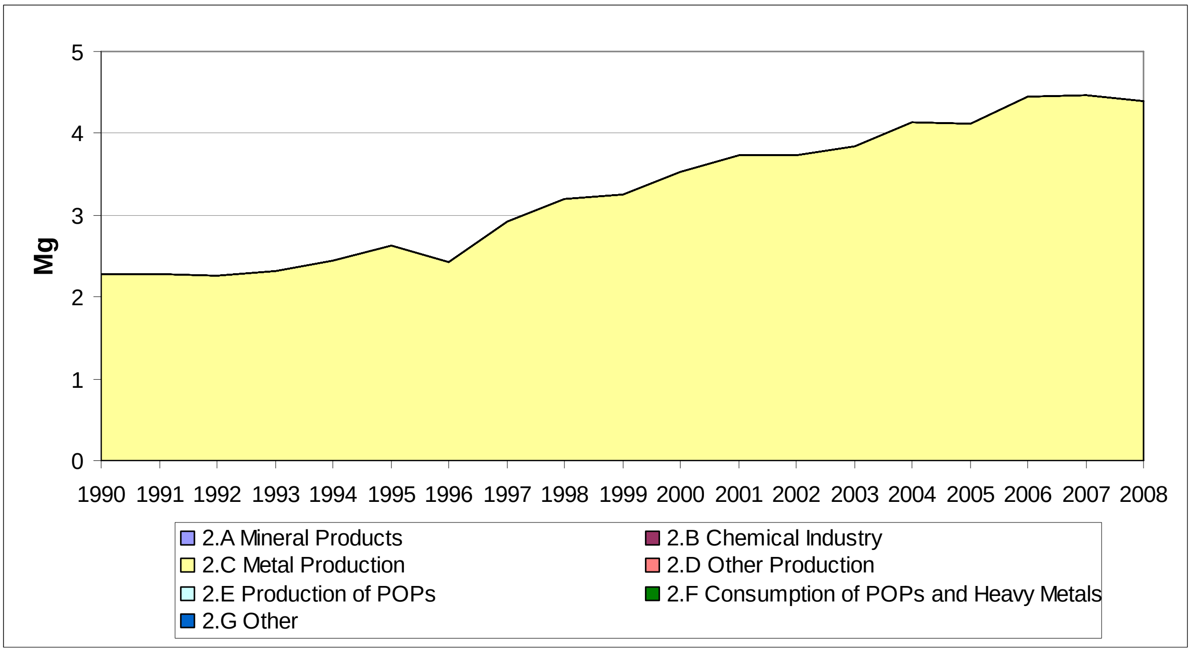
Table 5.1.10.1.- Cd emissions (Amounts in Mg)

Category	1990	1995	2000	2004	2005	2006	2007	2008
2.A Mineral products	0.0	0.0	0.0	-	-	-	-	-
2.B Chemical industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.C Metal production	2.3	2.6	3.5	4.1	4.1	4.4	4.5	4.4
2.D Other industries	-	-	-	-	-	-	-	-
2.E Production of POPs	-	-	-	-	-	-	-	-
2.F Consumption of POPs and heavy metals	-	-	-	-	-	-	-	-
2.G Others	-	-	-	-	-	-	-	-
Industrial Processes	**2.3**	**2.6**	**3.5**	**4.1**	**4.1**	**4.4**	**4.5**	**4.4**

Figure 5.1.10.1 shows the evolution of Cd emissions during the inventory period. According to the available data, the evolution is clearly determined by activities under category 2C (Metal production), and more specifically by steel production activity in electric furnace shops, while those produced by other sector categories were marginal or non-existent. The trend in this sector is clearly growing, with the exception of 1996, when steel manufacturing in electric furnaces decreased, and an increase of 91.9% in 2008 with respect to 1990.

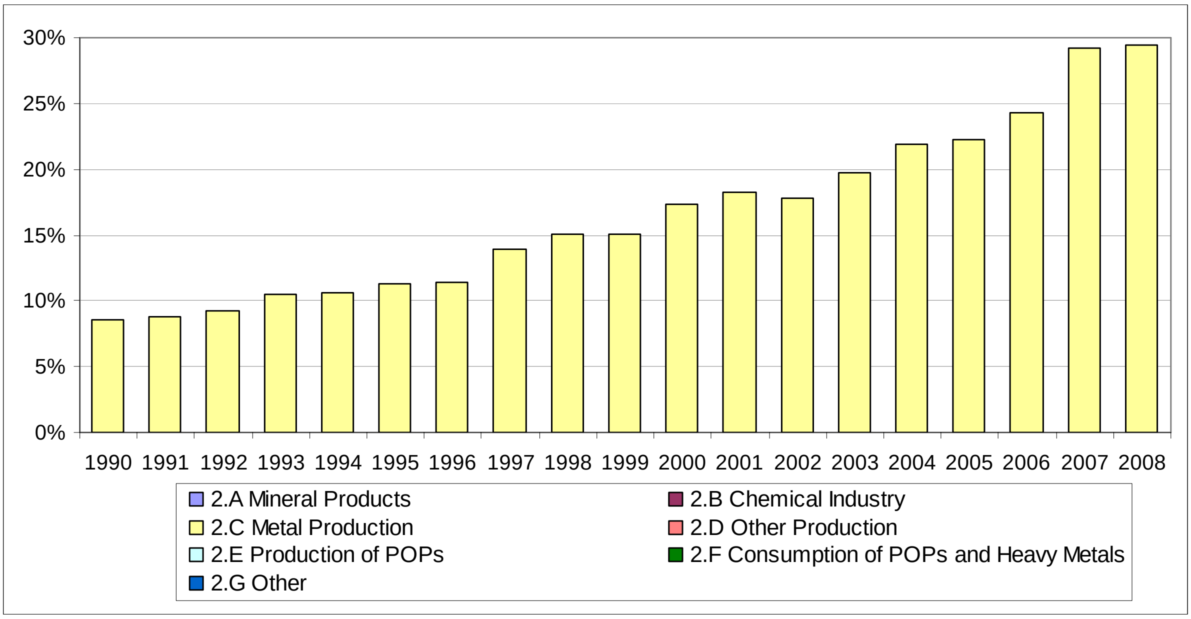
[9] Ranking determined by the contribution of the emissions in the category to the level or the trend.

Figure 5.1.10.1.- Evolution of Cd emissions by category



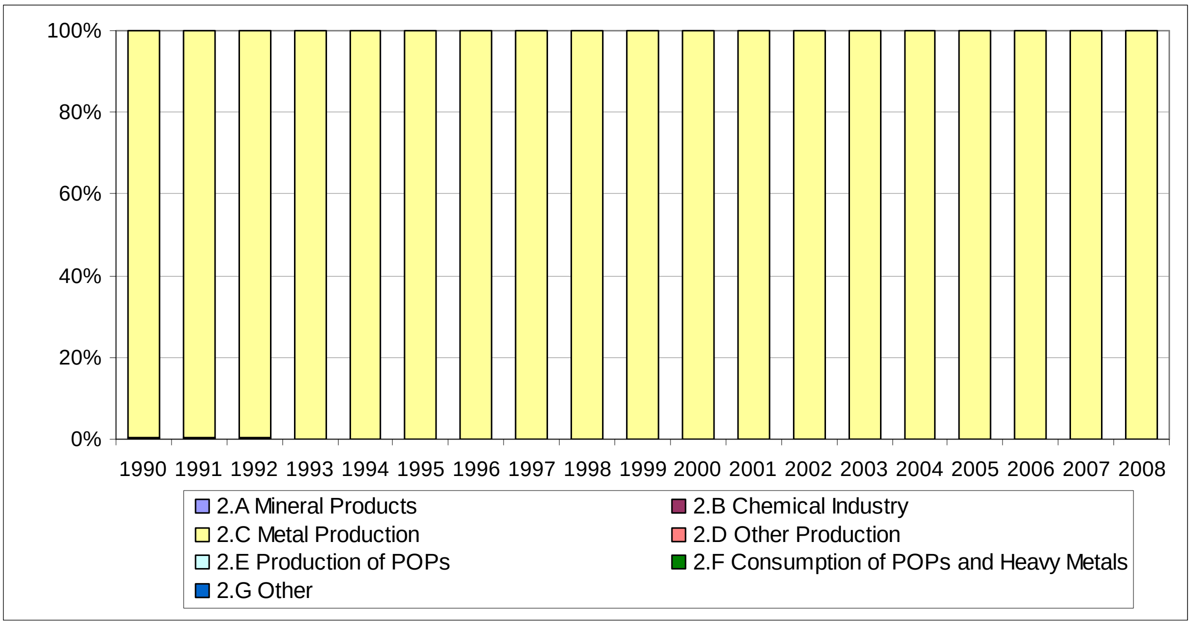
As shown in figure 5.1.10.2, the share of Cd emissions for this sector in the inventory as a whole also presents an upward trend, going from 8.5% of total emissions in 1990 to a 29.5% share in 2008.

Figure 5.1.10.2.- Percentage of Cd emissions by category with respect to the inventory total



According to Figure 5.1.10.3, the distribution by categories within this sector is led by category 2C (Metal production) with shares over 99.7% throughout the inventory period. Category 2A (Mineral products) with emissions generated by the manufacturing of Ni-Cd batteries, and category 2B (Chemical industry) whose emissions result from the manufacturing of phosphate fertilizers have a minimal share in the sector.

Figure 5.1.10.3.- Percentage of Cd emissions by category in relation to sector's total



With regards to Cd for this sector, the following key sources were identified for the 1990-2008 period:

- Metal production (2C) by its emission level throughout the 1990-2008 period and by its trend in the years 1991-2008.

Table 5.1.10.2 presents for the contribution of the emissions to the level and trend, the category's ranking in relation to the key sources [10], as well as the absolute values, all referred to 2008.

Table 5.1.10.2.- Cd key sources: Level and Trend contribution

Activity		Cd (Mg) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	**Description**		**%**	**Key source**	**Rank**	**%**	**Key source**	**Rank**
2C	Metal production	4.4	29.5	YES	2	31.5	YES	2

[10] Ranking determined by the contribution of the emissions in the category to the level or the trend.

5.1.11.- Hg

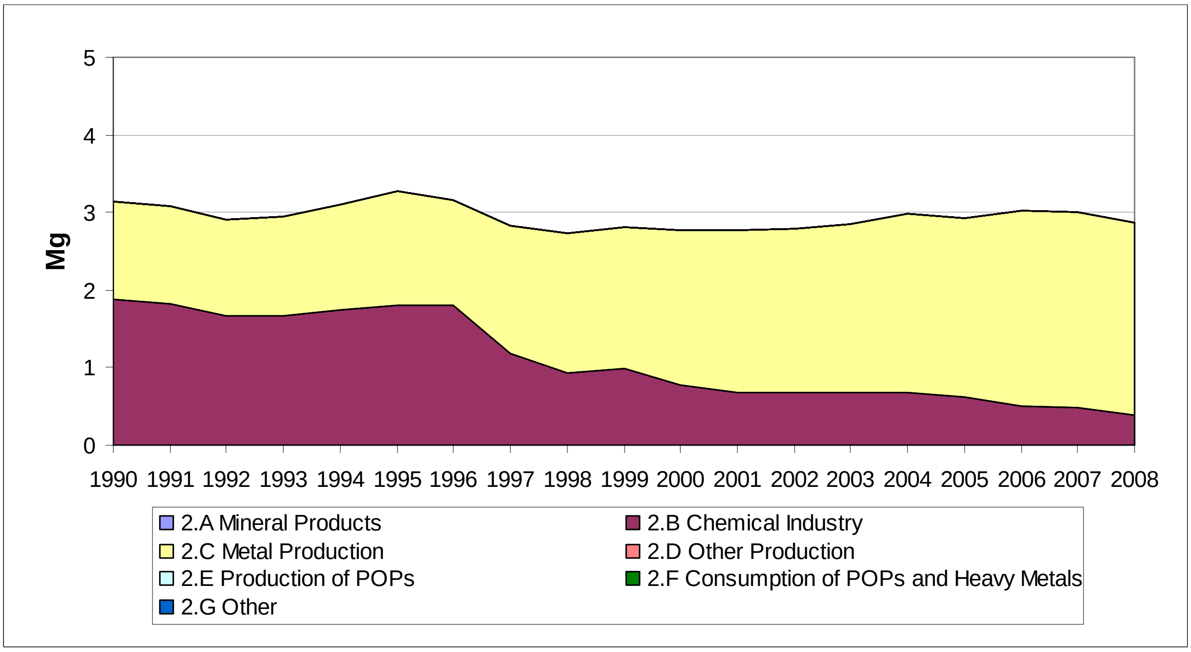
As shown in Table 5.1.11.1, Hg emissions in this sector are particularly significant in the inventory as a whole and mainly result from activities related to steel production in electric furnace shops and the manufacturing of chlorine. According to the available data, emission levels are similar when comparing the years 1990 and 2008, with 3.1 Mg in 1990 and 2.9 Mg in 2008.

Table 5.1.11.1.- Hg emissions (Amounts in Mg)

Category	1990	1995	2000	2004	2005	2006	2007	2008
2.A Mineral products	-	-	-	-	-	-	-	-
2.B Chemical industry	1.9	1.8	0.8	0.7	0.6	0.5	0.5	0.4
2.C Metal production	1.3	1.5	2.0	2.3	2.3	2.5	2.5	2.5
2.D Other industries	-	-	-	-	-	-	-	-
2.E Production of POPs	-	-	-	-	-	-	-	-
2.F Consumption of POPs and heavy metals	-	-	-	-	-	-	-	-
2.G Others	-	-	-	-	-	-	-	-
Industrial processes	**3.1**	**3.3**	**2.8**	**3.0**	**2.9**	**3.0**	**3.0**	**2.9**

Figure 5.1.11.1 shows the evolution of Hg emissions during the inventory period. This evolution is determined by category 2B (Chemical industry), which witnessed a decrease in emissions as a consequence of technological improvements in the chlorine manufacturing activity and by category 2C (Metal production), with a growing evolution of emissions reflecting the increased production in electric furnace shops.

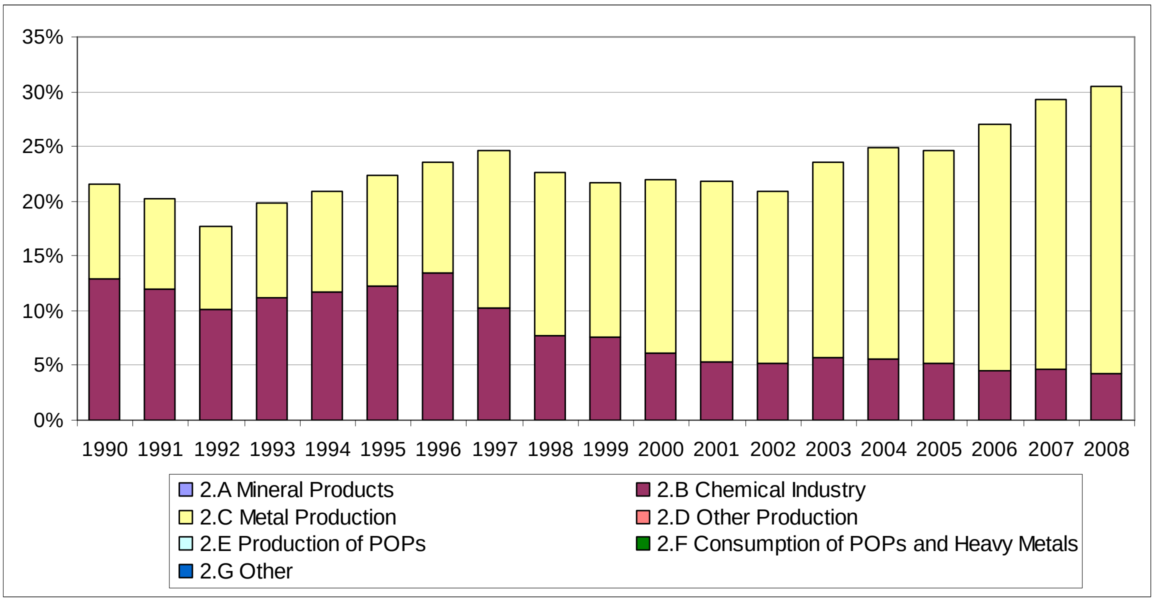
Figure 5.1.11.1.- Evolution of Hg emissions by category



This sector is particularly significant in all Hg emissions of the inventory, amounting to 30.5% of total emissions in 2008. As shown in Figure 5.1.11.2, the share is characterized by

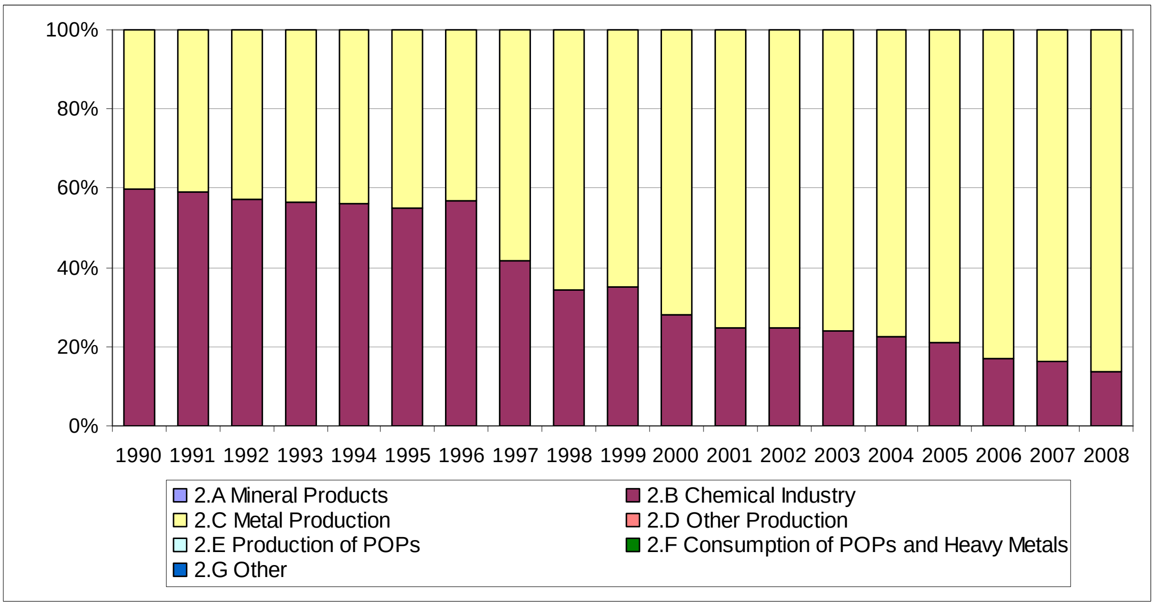
rises and falls throughout the inventory period, although a growing evolution has been observed in the past few years.

Figure 5.1.11.2.- Percentage of Hg emissions by category with respect to the inventory total



The evolution of the two categories above also translates into Hg emissions shares in the sector. As shown in figure 5.1.11.3, the decrease in category 2B (Chemical industry) with a 2008 share of 13.8% is offset by the increased contribution of metal production, which accounts for 86.2% of the sector emissions in 2008.

Figure 5.1.11.3.- Percentage of Hg emissions by category in relation to sector's total



With regards to Hg for this sector, the following key sources were identified for the 1990-2008 period:

- Chemical industry (2B) by its emission level throughout the 1990-2008 period and by its trend in the years 1991-1994 y 1997-2008.

- Metal production (2C) by its emission level throughout the 1990-2008 period and by its trend in the years 1992 and 1994-2008.

Table 5.1.11.2 presents for the contribution of the emissions to the level and trend, the category's ranking in relation to the key sources [11], as well as the absolute values, all referred to 2008.

Table 5.1.11.2.- Hg Key sources: Level and Trend contribution

Activity		Hg (Mg) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	Description		%	Key source	Rank	%	Key source	Rank
2B	Chemical industry	0.4	4.2	YES	4	16.7	YES	3
2C	Metal production	2.5	26.3	YES	2	33.8	YES	1

5.1.12.- DIOX

Dioxin emissions (DIOX) are generated in this sector by a single activity, steel production in electric furnace shops, included under category 2C (Metal production). Table 5.1.12.1 shows emissions for this pollutant, which rose from 14.7 g-I Teq in 1990 to 29.0 g-I Teq in 2008.

Table 5.1.12.1.- DIOX emissions *(Amounts in g I-Teq)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
2.A Mineral products	-	-	-	-	-	-	-	-
2.B Chemical industry	-	-	-	-	-	-	-	-
2.C Metal production	14.7	17.3	23.3	27.3	27.1	29.4	29.6	29.0
2.D Other industries	-	-	-	-	-	-	-	-
2.E Production of POPs	-	-	-	-	-	-	-	-
2.F Consumption of POPs and heavy metals	-	-	-	-	-	-	-	-
2.G Others	-	-	-	-	-	-	-	-
Industrial processes	**14.7**	**17.3**	**23.3**	**27.3**	**27.1**	**29.4**	**29.6**	**29.0**

Figure 5.1.12.1 shows the evolution of DIOX emissions for this sector, also associated with steel production in electric furnace shops. Production in electric furnace shops increased throughout the inventory period while oxygen steelmaking decreased.

[11] Ranking determined by the contribution of the emissions in the category to the level or the trend.

Figure 5.1.12.1.- Evolution of DIOX emissions by category

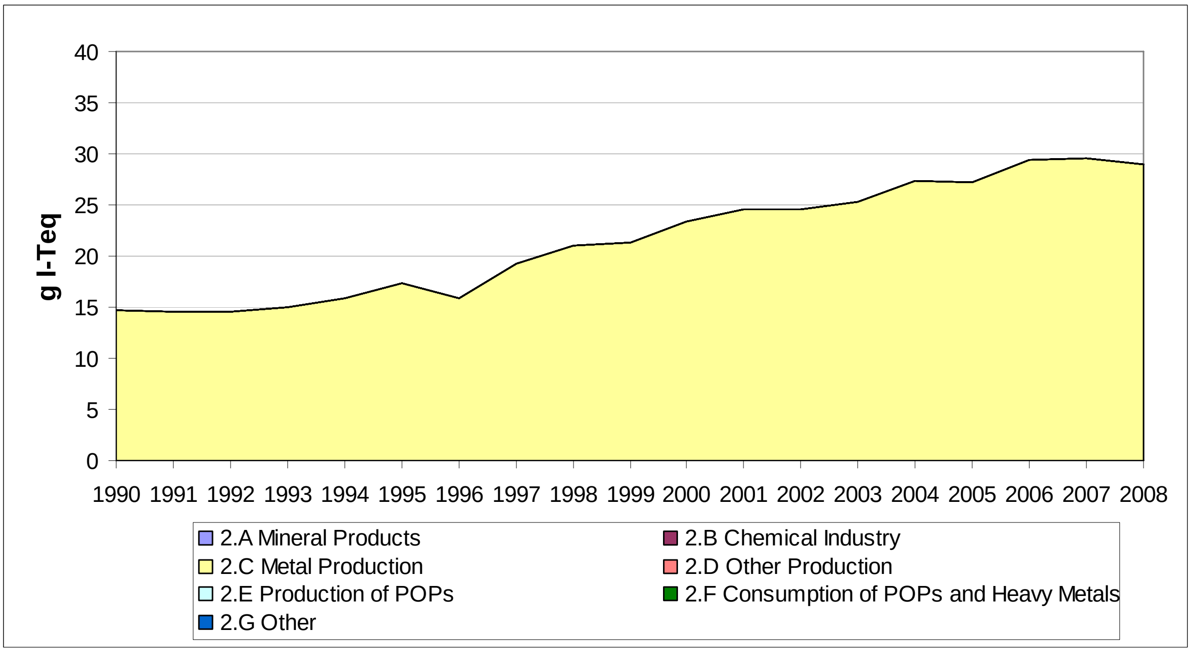
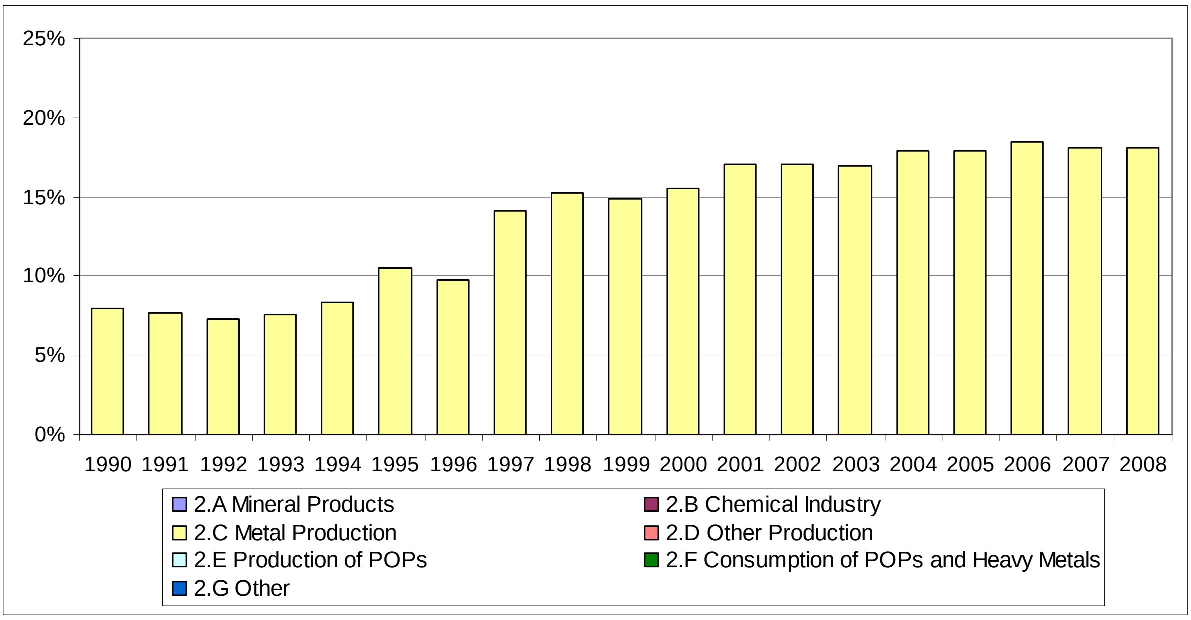


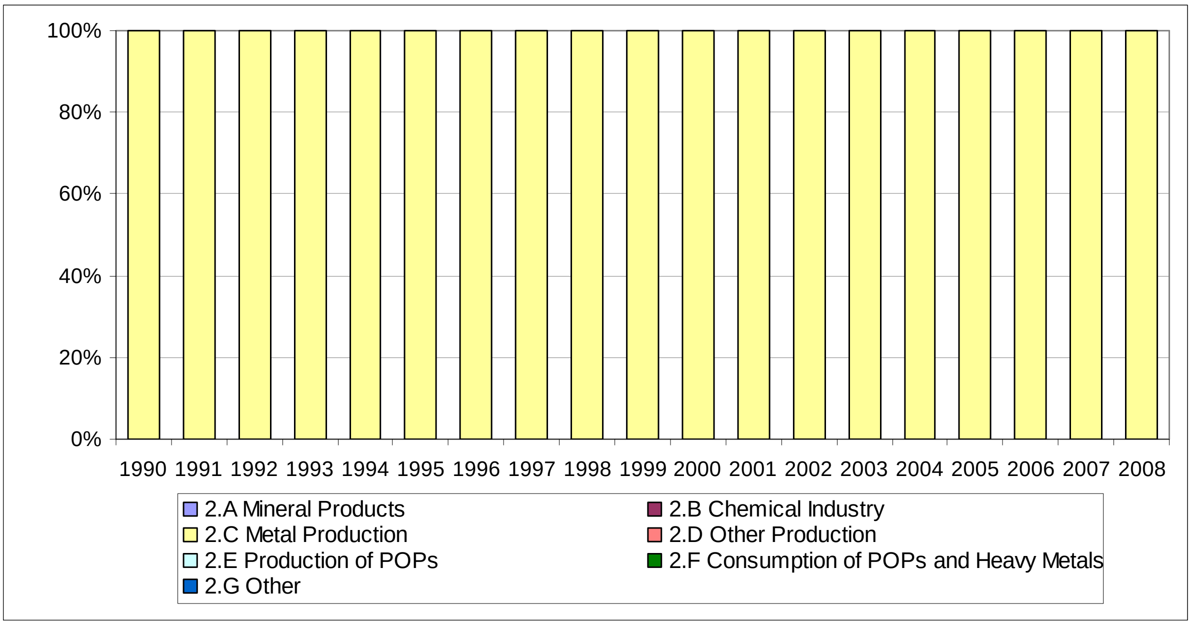
Figure 5.1.12.2 shows the specific significance of this sector with regard to total DIOX emissions in the inventory, with an increase in its share from 7.9% in 1990 to 18.1% in 2008.

Figure 5.1.12.2.- Percentage of DIOX emissions by category with respect to the inventory total



As already noted, DIOX emissions in this sector are included under category 2C (Metal production), which accounts for 100% of sector emissions, as shown in figure 5.1.12.3.

Figure 5.1.12.3.- Percentage of DIOX emissions by category in relation to sector's total



With regards to dioxins for this sector, the following key sources were identified for the 1990-2008 period:

- Metal production (2C) by its emission level throughout the 1990-2008 period and by its trend in the years 1991-1992 y 1994-2008.

Table 5.1.12.2 presents for the contribution of the emissions to the level and trend, the category's ranking in relation to the key sources [12], as well as the absolute values, all referred to 2008.

Table 5.1.12.2.- DIOX key sources: Level and Trend contribution

Activity		DIOX (g-I Teq) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	**Description**		**%**	**Key source**	**Rank**	**%**	**Key source**	**Rank**
2C	Metal production	29.0	18.1	YES	3	15.6	YES	4

5.1.13.- PAH

As shown in table 5.1.13.1, virtually all PAH emissions in this sector are generated by metal production, the main sources being the manufacturing of primary aluminium, the casting of pig iron and the production of ferro-alloy. During 2008, PAH emissions in the sector amounted to 48.5 Mg, representing a small decrease with respect to the 48.6 Mg for 1990.

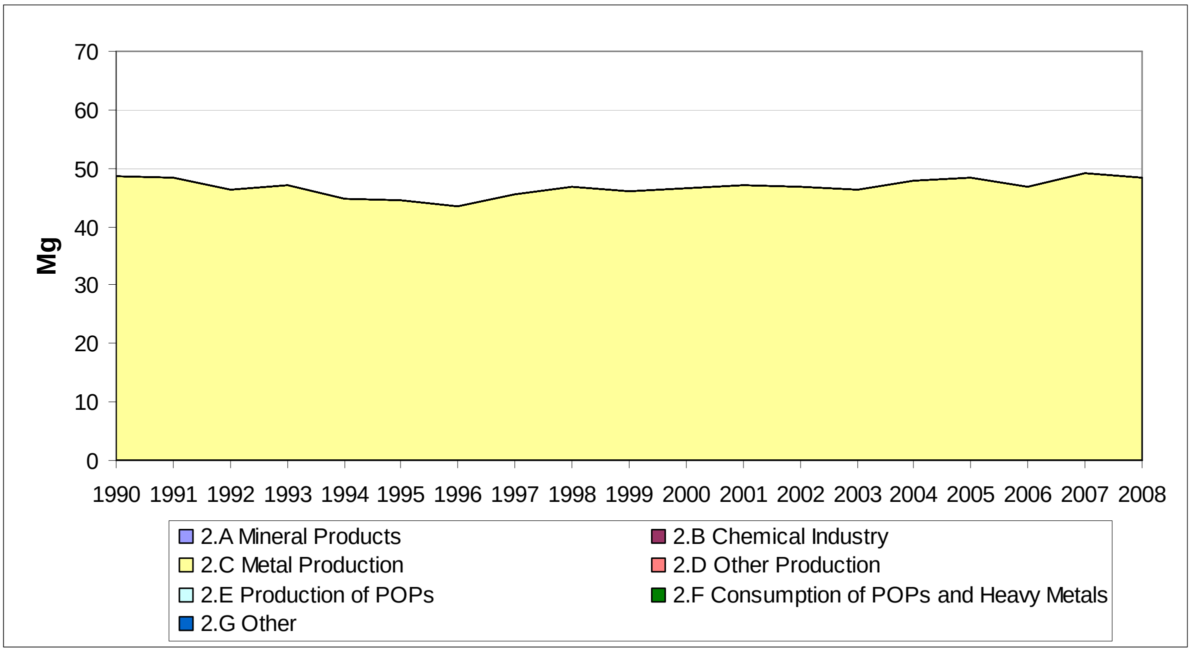
[12] Ranking determined by the contribution of the emissions in the category to the level or the trend.

Table 5.1.13.1.- PAH emissions (Amounts in Mg)

Category	1990	1995	2000	2004	2005	2006	2007	2008
2.A Mineral products	-	-	-	-	-	-	-	-
2.B Chemical industry	-	-	-	-	-	-	-	-
2.C Metal production	48.6	44.6	46.6	47.8	48.5	46.7	49.1	48.5
2.D Other industries	-	-	-	-	-	-	-	-
2.E Production of POPs	-	-	-	-	-	-	-	-
2.F Consumption of POPs and heavy metals	-	-	-	-	-	-	-	-
2.G Others	-	-	-	-	-	-	-	-
Industrial processes	**48.8**	**44.8**	**46.7**	**48.0**	**48.6**	**46.9**	**49.2**	**48.5**

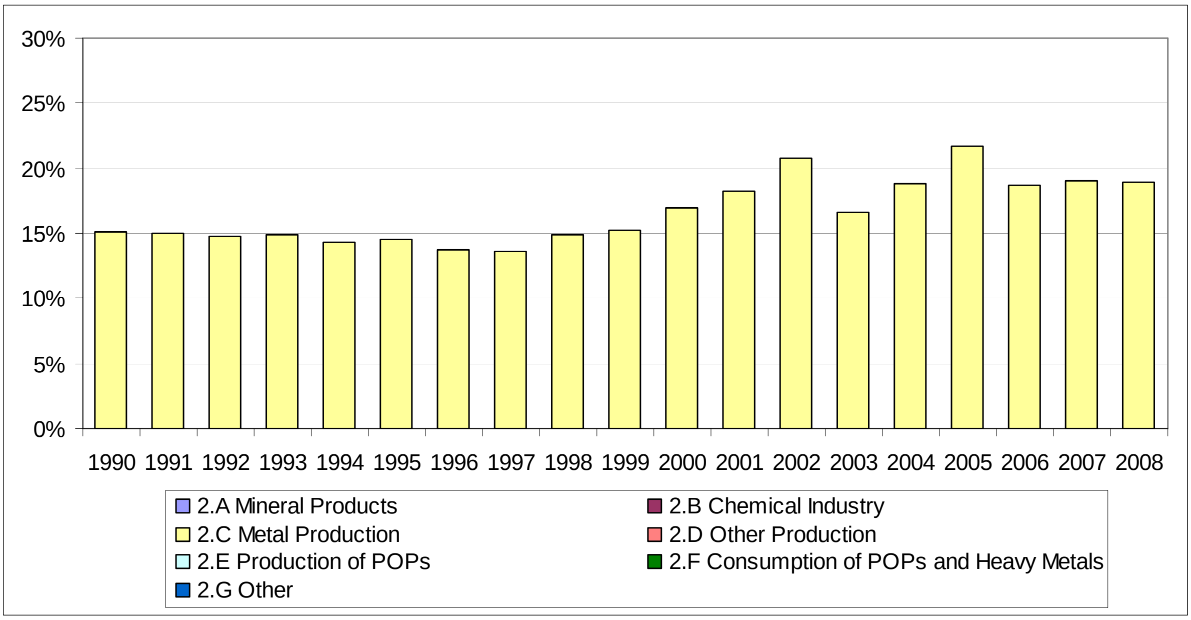
The evolution of PAH emissions for this sector was relatively stable throughout the inventory period, as shown in Figure 5.1.13.1. This trend is marked by the increase in the production of primary aluminium and ferro-alloy, offset by the decrease in emissions in the production of pig iron as a consequence of a reduced oxygen steel production in integrated steel plants.

Figure 5.1.13.1.- Evolution of PAH emissions by category



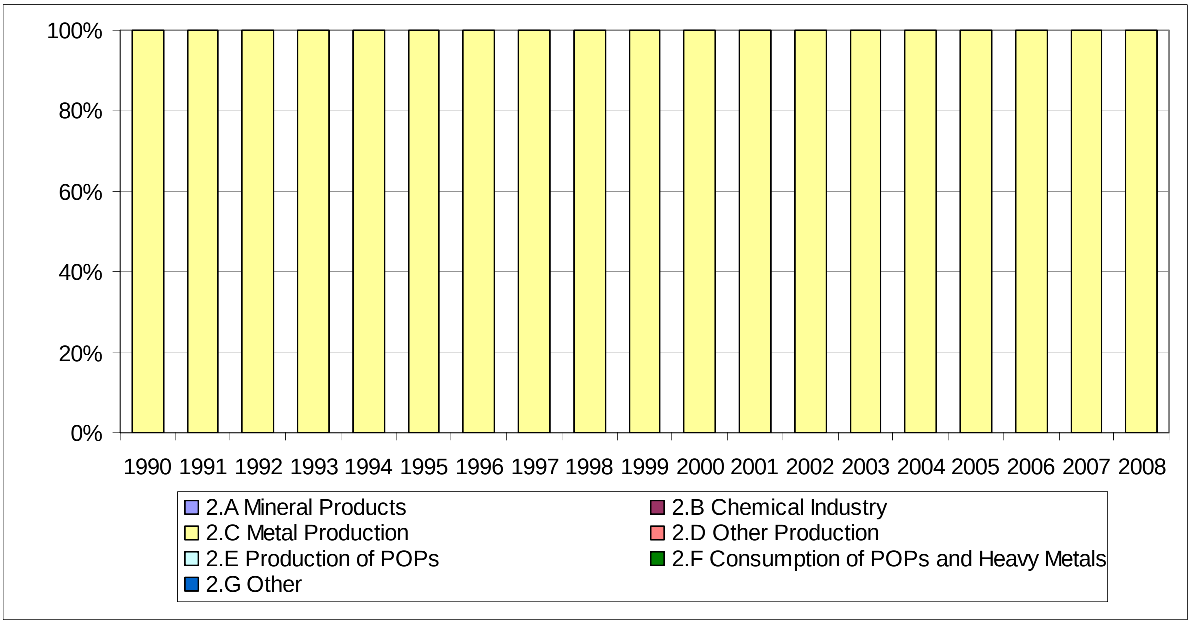
As shown in Figure 5.1.13.2, this sector has a relevant share in the inventory as a whole with a maximum of 21.7% in 2005 and a minimum of 13.6% during 1997.

Figure 5.1.13.2.- Percentage of PAH emissions by category with respect to the inventory total



As already pointed out, PAH emissions for this sector fall under category 2C (Metal Production). Consequently, this category accounts for 100% of sector emissions, as illustrated in Figure 5.1.13.3.

Figure 5.1.13.3.- Percentage of PAH emissions with respect to the sector total



With regards to PAH for this sector, the following key sources were identified for the 1990-2008 period:

- Metal production (2C) by its emission level throughout the 1990-2008 period and by its trend in the years 1991-1998 and 2000-2008.

Table 5.1.13.2 presents for the contribution of the emissions to the level and trend, the category's ranking in relation to the key sources [13], as well as the absolute values, all referred to 2008.

Table 5.1.13.2.- PAH key sources: Level and Trend contribution

Activity		PAH (Mg) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	**Description**		**%**	**Key source**	**Rank**	**%**	**Key source**	**Rank**
2C	Metal production	48.5	18.9	YES	3	13.0	YES	3

5.3.- Analysis by key categories

The following section describes in detail the key sources for this sector.

5.3.1.- Road paving with asphalt (2A6)

The bituminous mix with which the roads generally are asphalted consists of an arid combination (gravel, stones or refined metal subproducts) mixed with an asphaltic ligament (asphaltic cement or liquid asphalt). The asphaltic cement is semi-solid and must be heated so as to form the bituminous mix (hot mix), whereas the liquid asphalts, that may by of the fluidified type (cutback) or emulsified, do not need a prior heating. Regarding the emulsions, resides the emulsified mixes, it must be pointed out that emulsions also are prepared to be used as such without being mixed with arids.

In this category are described the emissions of the liquid asphalts, since the emissions produced in the preparation of the bituminous mixtures in the heat (hot mix) have been included in the 1A2f category.

5.3.1.1.- Activity variables

As a starting point this activity takes into consideration the production of the different types of bituminous mixtures:

- fluidized mixtures (cutback)
- bituminous mixtures in cold (emulsions)
- emulsions without mixture.

As far as the fluidized mixtures, according to the information facilitated by ASEFMA (Spanish Association of Bituminous Mixture Factories), its use was already very limited and

[13] Ranking determined by the contribution of the emissions in the category to the level or the trend.

disappeared in during the 90s. In order to show the small influence of this type of mixtures (cutback), and lacking a better information, it has come to consider them as a small percentage of the hot bituminous mix production[14]. Thus, specifically on the basis of ASEFMA expert opinion, the following percentages have been used: 1990 (3%), 1991 (2%) and 1992 (1%), this year being the last year when manufacturing it.

For the bituminous mixtures in cold, it is information, for the years 2004, 2005, 2006 and 2007, in the table "Cold Bituminous Mixes" coming from the publication "Asphalt in Figures 2006" of EAPA (European Asphalt Pavement Association). In order to construct the homogenous temporary series 1990-2007, it has been considered, in agreement with the information of the ASEFMA experts, that in 1990 the amount was double than in 2005 and, by interpolation between 1990 and 2004, the rest of the years have been estimated. In 2008, no updated EAPA information was available. Production figures for this year were estimated applying the 2008/2007 variation rate for "*Bituminous mixtures based on natural asphalt, on natural bitumen, on petroleum bitumen, on mineral tar or on mineral tar pitch (for example, bituminous mastics, cut-backs)*" (listed in INE's Industrial Products Survey) to 2007 production figures.

Finally, to construct the temporary series of the emulsions without mixture it was considered as starting point the information that appeared reflected in page 170 of the extraordinary publication of " Highways" ("Carreteras"), number 155/Sep-Oct 07. This data reflects the consumption of total emulsions in 2005 (0,233 million tons). Considering, according to the information of ASEFMA experts, that 50% of the bituminous mixtures in cold is formed by emulsions, it is possible to obtained the amount of generated emulsions that were not used for mixtures but as emulsions without mixture (0,056 million tons) From that information in the year 2005, the ratio of (0,16) is obtained that supposes the emulsions without mixture on the bituminous mixtures in cold. That ratio is assumed to be constant for all the years and applying it on the temporary series of the bituminous mixtures in cold already obtained, it allows considering the production of emulsions without mixture.

Once calculated the final product of the bituminous mixtures for the three varieties: fluidized mixtures, cold bituminous mixtures and emulsions without mixture, starting with these varieties the amount of bitumen that is being incorporated is to be calculated, since the bitumen is going to be the activity variable on which the NMVOC factors will be applied later. In agreement with the information facilitated by the experts of ASEFMA, the bitumen contents of the three varieties of bituminous mixtures before referred to, are the following:

- 5% for the fluidized mixtures (cutback)
- 30% for the bituminous mixtures in cold

---

[14] The data relative to hot mix asphalt for the years 2004-2007 were obtained from "Asphalt in Figures" published by EAPA (European Asphalt Pavement Association); for 1990, out of total domestic asphalt production according to the OILGAS Encyclopaedia, 80% was destined to road surfacing, which in turn uses asphalt cement in 80% of cases. For the remaining years (1991-2003), hot mix asphalt production data were estimated by interpolating the 1990 and 2004 data. In 2008, no updated EAPA information was available. Production figures for this year were estimated applying the 2008/2007 variation rate for "*Bituminous mixtures based on natural asphalt, on natural bitumen, on petroleum bitumen, on mineral tar or on mineral tar pitch (for example, bituminous mastics, cut-backs)*" (listed in INE's Industrial Products Survey) to 2007 production figures.

- 60% for the emulsions without mixture

5.3.1.2.- Methodology

5.3.1.2.1.- Advanced Methodology

No specific estimation methodology was designed for this category.

5.3.1.2.2.- Default methodology

The default methodology applied to estimate emissions is that of EMEP/CORINAIR. The emission factors for NMVOC, the only pollutant taken into account for this activity, were obtained from the sources listed below. For fluidized cutback, chapter B4611, table 6, from the EMEP/CORINAIR Guidebook, considering this to be fast-curing with 45% in thinner volume. For cold mix asphalt and emulsions (non-mix), the emission factors taken into account were obtained from chapter B4611, tables 2 and 3, in the EMEP/CORINAIR Guidebook, assuming the plants use diesel oil and do not implement pollutant emissions abatement techniques.

5.3.2.- Chemical industry (2B)

This category includes processes for both organic and inorganic chemical industries. It is worth mentioning the production of sulphuric acid due to its SO_X emissions; nitric acid, ammonia and several kinds of ammonium fertilizers due to their NH_3 emissions; the production of chlorine due to its Hg emissions; and organic chemical industry processes due to their NMVOC emissions.

5.3.2.1.- Activity variables

The production of each chemical is used as an activity variable, with the exception of chlorine manufacturing, for which production capacity is used as the activity variable. Depending on the activity, information was compiled by means of questionnaires submitted by the production plants, generic statistics or data provided by associations or public entities. More specifically, the main sources of information were:

- Information compiled at production centres. Such is the case of sulphuric acid and nitric acid manufacturing for 1990 (in the case of sulphuric acid, direct data was available since 2000 from the facilities located in non-ferrous metal plants); the manufacturing of ammonia; urea manufacturing; calcium carbide manufacture (since 2005); silicon carbide manufacture; chlorine manufacture (since 2005); PVC manufacture.

- Information provided by the Ministry of Industry, Tourism and Trade (MITYC).

- Information provided by business associations such as the Spanish Chemical Industry Federation (FEIQUE), Spanish Confederation of Plastics Businesses (ANAIP) or Spanish Chlorine Producers Association (ANE).

- Publications such as "La Industria química en España", "Los Plásticos en España" and "Anuario de Ingeniería Química" (see section 5.5. on references).

5.3.2.2.- Methodology

5.3.2.2.1.- Advanced methodology

For certain activities, plant-specific or process-specific emissions were available to estimate the associated emissions. These activities are detailed below:

- Sulphuric acid manufacturing: SO_X emission factors by plant and process type were obtained from information on emissions provided by plants and referring to 1990.
- Nitric acid manufacturing: NO_X emission factors by plant and process type were obtained from information on emissions provided by plants and referring to 1990, as well as information on NO_X and NH_3 measurements and emissions abatement techniques supplied for 2008 via individual questionnaires by nitric acid manufacturing plants. Default emission factors were used only for those plants and years which could not provide this type of information.
- Ammonia manufacturing: Emission factors by plant and process type were obtained from information on emissions provided by plants and referring to 1990. Default emission factors were used only for those plants which could not provide this type of information.
- Ammonium nitrate manufacturing: The estimation of NH_3 emissions was based on the implicit factor inferred from the emissions measured and provided by one of the production plants for 1990.
- Urea manufacturing: NH_3 emission factors by plant were inferred from the information on the emissions measured and provided by plants and referring to 1990. Default emission factors were used for only one plant that was unable to provide this type of information.
- Chlorine production: For the years 1998-2004 Hg emission factors (given in terms of production capacity) have been obtained from "Mercury Losses from the Chlor-Alkali Industry 2004" of the OSPAR Comission, and from the questionnaires submitted by the plants from 2005 on. It is interesting to note that the information provided by the plant comes as a result of the Volunteer Agreement for the environmental protection and control of emissions of the Spanish chlor-alkali industry.

5.3.2.2.2.- Default methodology

The default methodology applied to estimate emissions is essentially that of EMEP/CORINAIR. However, in certain cases other references were used to estimate emissions whenever the EMEP/CORINAIR guidelines did not suggest an emission factor. More specifically, the references used to obtain default emission factors were as follows:

- The EMEP/CORINAIR Guidebook, chapters B-441, B-442 and B-451 to B-4521.
- The CORINAIR Manual (1992).

- CEPMEIP. Co-ordinated European Programme on Particulate Matter Emission Inventories, Projections and Guidance. This reference was used to estimate particle emissions (TSP, PM_{10} and $PM_{2.5}$).
- The IPCC Reference Manual (1996).
- PARCOM-ATMOS (1992), specifically for heavy metals and persistent organic compound emissions.
- BREF published by the IPCC for the estimation of NMVOC emissions in the manufacturing of PVC.

5.3.3.- Metal production (2C)

This category includes non-combustion production processes for the iron and steel industries and non-ferrous metal production. The main activities considered are pig iron casting, steel production, steel rolling processes, the production of primary aluminium and the manufacturing of ferro-alloy. It also includes an activity that, although not specifically a combustion one, is directly related to the furnaces used, namely the charging of furnaces, a process generating fugitive emissions always difficult to control. Finally, emissions that result from gas flaring at integral metal production plants and do not imply the exploitation of energy.

5.3.3.1.- Activity variables

The activity variables used are the different productions taking place for each of the activities considered. The information sources relative to these variables are listed below:

- Pig iron production: the information was compiled by means of individual questionnaires submitted to integral metal production plants.

- Steel production: Basic oxygen steel production has been taken have been provided through questionnaires completed by each of the integrated iron and steelworks plants; as for the production of arc-furnace steel, the information of production has been taken have been taken, for the year 1990, from the “Informe sobre la Industria Española” for the years 1991-1993 from information supplied by the Ministry of Industry, Tourism and Trade (MITYC), and from 1994 on the information has been supplied by the Union of Iron and Steel Companies (UNESID).

- Finished rolled products: the information sources were the same used for steel production.

- Primary aluminium production: the information was compiled by means of individual questionnaires submitted to production plants.

- Ferro-alloy production: the information was compiled by means of individual questionnaires submitted to production plants.

- Flares used in steel production: the information related to incineration gases (gas coke, blast furnace gas, steel plant gas) was provided by steel production plants by means of questionnaires.

5.3.3.2.- Methodology

5.3.3.2.1.- Advanced methodology

Since most data on the activities falling under this category were obtained via individual plant questionnaires, information on pollutant emissions was available and used instead of estimations by applying default emission factors. In other cases, sectorial studies were available for more reliable estimations of emissions than the use of default methodologies. The following cases used these estimation methodologies:

- Blast furnace charging: For heavy metals the estimation of the emissions has been limited to the application of the factors derived from measurements effected in 2003 at the only plant currently conducting this process (these emissions are limited to Cd and Zn). As for particles, the measured emissions provided by the plant itself have been available from 2003 on for PM_{10} and TSP. For these years, the $PM_{2.5}$ emissions have been estimated by applying to the measured PM_{10} figures the ratios derived from the data on emission factors proposed by the CEPMEIP for the ration between the $PM_{2.5}$ and PM_{10} emissions; for the period 2000-2002, on the other hand, the implicit emission factors obtained per tonne of pig iron in 2003 have been applied.
- Pig iron tapping: For 2003 it has been possible to obtain the measured emissions of SO_2, heavy metals, PM_{10} and TSP at the only plant currently conducting this process. As to SO_2 and the heavy metals, the emissions for 2004-2008 have been estimated by using the implicit emission factors per tonne of pig iron produced derived from the emissions measured in 2003, this being the reason for the differences observed in terms of pollutant emissions for the period 1990-2002 (estimated by applying default emission factors to all plants) and those estimated from 2003 onwards. The same procedure has been used to estimate the PM_{10} and TSP emissions (in these cases for 2000-2002 and 2004 and subsequent years). Also, the $PM_{2.5}$ emissions have been made by applying to the measured PM_{10} figures the ratios derived from the data on the emission factors proposed by the CEPMEIP regarding the ratio of $PM_{2.5}$ with respect to PM_{10}.
- Basic oxygen furnace steel: For 2003, data on measured emissions have been available for a wide variety of pollutants in the two plants currently operating with this method of steel production. At these plants, the emission factors resulting from the measured emissions in 2003 have been applied for the other years, complemented by the default emission factors to estimate the emissions of those pollutants for which no measurements were available, with the exception of the $PM_{2.5}$ emissions, which have been calculated by applying to the PM_{10} measured data the ratio derived from the information on emission factors proposed by the CEPMEIP regarding the relationship between $PM_{2.5}$ emissions and PM_{10} emissions.
- For heavy metals y electric furnace steel plants, with the exception of As and Ni, the data has been used that appears in the report drawn up for the “Entorno” Foundation on the sector that groups together SIDERINSA-UNESID by the engineering company called “Idom”, and to which access was provided through the UNESID. Specifically speaking, the following parameters have been taken into account:

- Average concentration of particles emitted in the fusion: 10 mg/m^{3}N, which are assumed to be equivalent to 200 g/t of product, from which a conversion factor of 20 m^{3}N/kg of steel is deduced.

- Values of the concentrations of metals contained in the particles emitted in the fusion assumed by the Inventory Task Force within the ranges of values that appear in the aforesaid report (all of which are expressed in μg/m^{3}N): Cd = 15; Cr = 7.5; Cu = 20; Hg = 8.5; Pb = 285; Zn = 1,100. The above values have been converted back to mg/t using the conversion factor indicated above.

- Primary aluminium production: SO_2 and TSP emission measurements were available for each plant. Those years for which no information was available, the plant-specific implicit factor corresponding to the closest year for which information was available was applied. In addition to this, $PM_{2.5}$ and PM_{10} emissions have been estimated by applying to the measured TSP figures the ratios deriving from the data on emission factors proposed by CEPMEIP for the relationship between $PM_{2.5}$ and PM_{10} emissions and TSP (assuming the closest emission level at each centre).

5.3.3.2.2.- Default methodology

The default methodology applied for the estimation of emissions is essentially that of EMEP/CORINAIR. However, in certain cases other references were used to estimate emissions whenever the EMEP/CORINAIR guidelines did not suggest any emission factors. More specifically, the references used to obtain default emission factors were as follows:

- EMEP/CORINAIR Guidebook, chapters B-423, B-424, B-426, B-427, B428 and B-431.
- CORINAIR Manual (1992).
- CEPMEIP. Co-ordinated European Programme on Particulate Matter Emission Inventories, Projections and Guidance. This reference was used to estimate particle emissions (TSP, PM_{10} and $PM_{2.5}$), assuming emission levels according to plant conditions.
- The IPCC Reference Manual for the estimation of CO emissions in furnace charging, and SO_X, NO_X, NMVOC and CO emissions in pig iron tapping.
- "Experiences With The Heavy Metals Inventory in Slovakia" to estimate heavy metal emissions in the manufacturing of ferro-alloy (information was only available for the manufacturing of ferro-manganese).
- Holoubek I. et al. (1993) for the estimation of PAH emissions in ferro-alloys. The emission factor was applied to all types of ferro-alloys, since no differentiating source is specifically stated for each product type.

5.3.4.- Other industries (2D)

This category contains information for other relevant industries in pollutant emissions, particularly NMVOC emissions. It includes the different methods used in the manufacturing of paper pulp and paper board; fermentation processes in the food and beverage processing industry (bread, biscuits, sugar, coffee roasting, wine, liqueurs); and wood processing

activities, although no emissions could be estimated for this activity as no information was available for the activity variable.

5.3.4.1.- Activity variables

The activity variables used to estimate emissions refer to the production of different product types manufactured in the activities falling under this category. The information sources used to obtain these variables are listed below:

- Chipboard production: The information has been taken, for the years 1990 and 1997-2001, from the “Informe Anual” by the Spanish Association of Pulp and Paper Manufacturers (ASPAPEL), and for the years 1991-1996 it has been supplied by the Sub-Directorate General for Basic and Processing Industries at the Ministry of Industry and Energy; for 2002-2006, the figures have been provided directly by ASPAPEL; for 2007 an estimation was obtained by applying to the 2006 production the 2007/2006 year-on-year variation found in ASPAPEL´s 2007 Statistical Report for the joint production of paper and chipboard; whereas for the year 2008 estimates were performed applying the 2008/2007 variation rate for paper and board production to the 2007 estimated production [15].

- Paper pulp production: the information on the production of different paper pulp types was gathered by means of individual questionnaires submitted to production plants.

- Manufacture of bread and other food products:

    - *Bread*: The information has been taken from the publication “La Alimentación en España” which is published by the Ministry of Environment and Rural and Marine Affairs (MARM), using the amounts of bread purchased in each year. For the period 1996-2008, the data have been estimated by the Inventory Working Group based on the figures in the Spanish National Statistics Institute (INE) Industrial Survey, since it was not possible to make use of information for this period in the aforesaid MARM publication.

    - *Biscuits*: The activity variable is identified with the production of “Biscuits” from sector 53 of the “Encuesta Industrial” up until the year 1992, and with the production of “Biscuits and sweet cakes” and “Other types of biscuits” from sector 10 as from the year 1993. Due to the methodological change introduced in this source as from the year 1993, and so as to maintain the homogeneous nature of the data, for the years 1990-1992 the production of cakes has been added to that for the production of biscuits, according to data supplied by the INE itself.

    - *Sugar*: The activity variable is identified with the production of “cane and beet sugar (refined and unrefined)” from 54 of the INE’s Industrial Survey up to the year 1992, and with the production of “unrefined sugar”, “refined sugar ” and “sugar with flavours or colorants” from sector 11 as from the year 1993.

[15] Paper and board production figures for 2007 were obtained from ASPAPEL’s 2007 Statistical Report, whereas 2008 figures were based on IDE Magazine on Packaging, as no ASPAPEL statistical report was available for 2008.

- *Coffee roasting*: The activity variable is identified with the “production of ground coffee and coffee extracts” from sector 57 in the INE’s Industrial Survey up to the year 1992, and with the production of “Roasted coffee” from sector 13 as from the year 1993.

- Wine production: the information on the production of different types of wine was obtained from the Statistical Yearbook of the Ministry of Environment and Rural and Marine Affairs (MARM) (see references), except for 2008, for which the corresponding estimation was based on the 2007 production data, increased on the basis of the ratio obtained between 2007 and 2008 in the figures published by the INE´s Industrial Survey.

- Manufacture of beer: The information on this variable has been taken from the publication “Estudio sobre la Posición Competitiva del Sector de Alimentación y Bebidas en España. Sector de la Cerveza y Malta de Cerveza” from the Ministry of Agriculture, Food and Fisheries (MAPA)[16] for the year 1990; from data supplied by the Brewers of Spain (named National Association of Brewers (ANFACE) until 1995) for the years 1991-2003; and for 2004-2008, since no production figures were available, an estimation has been made by applying to the production of 2003 the variation rate of the productions of 2004-2008 as opposed to 2003 included in the INE’s Industrial Survey.

- Spirits: The information on the said variable, has been taken from different sources. For the years 1990 and 1991, form the publication “Estudio sobre la posición competitiva del sector de alimentación y bebida en España. Sector de Alcoholes Etílicos de Fermentación” from the MAPA; and for the years 1992, 1993 and 1995, from the “Informe sobre la Industria Española”. In the year 1993 only the total production was available and not broken down by types of liquors, although it is stated that the production of brandy experienced a drop of 40% and that of whisky a drop of 4%, hence these percentages have been applied to the data for 1992, with the rest being obtained from the difference. For 1994, 1996 and the following years, since no data on production are available, increase coefficients have been applied to the preceding years obtained on the basis of the information that is presented in the INE’s Industrial Survey.

5.3.4.2.- Methodology

5.3.4.2.1.- Advanced methodology

For the manufacturing of paper pulp, SO_X, NO_X, TSP and CO emissions measurements were available at certain plants. In such cases, the emissions provided were verified and entered into the database for the corresponding point sources.

[16] The above document was edited by the then Ministry of Agriculture, Food and Fisheries, currently the Ministry of the Environment and Rural and Marine Affairs.

5.3.4.2.2.- Default methodology

The default methodology applied to estimate emissions is that of EMEP/CORINAIR. The information related to default emission factors was obtained from chapters B-643, B-646 and B-647 of the EMEP/CORINAIR Guidebook and the CORINAIR Manual (1992).

- Chipboard production: For the NMVOC, the factor used is that proposed in Part 6, Heading 4.6, of the CORINAIR Manual.

- Producción de cartón: Para los NMVOC, se ha utilizado el factor propuesto en la parte 6, epígrafe 4.6, del Manual CORINAIR.

- Paper pulp production: whenever no information was available for emissions measured and provided by means of questionnaires, the default emission factors were used. Based on the type of pulp manufactured, the information sources for those factors were as follows:

  For kraft paper pulp, The source of information for the factors in the Table is the CORINAIR Manual, in Table 9.3.1 of Part 1 (process "*Smelt dissolving tank*") for the SO_X and the NO_X, and Part 6, Heading 4.6, for the NMVOC. For these three pollutants it has been decided to keep the source of information stated, which was already used in the previous edition of the Inventory, with preference over the EMEP/CORINAIR Guidebook, in which the factors for these three pollutants also appear, taking into account the difficulty in defining which processes the factors refer to, and therefore, in associating them to the pertinent socio-economic variables. For particles, the default emission factors proposed by CITEPA have been taken when the plants themselves did not provide measured TSP emissions, whereas when such data were provided, the TSP emissions have been taken and the emissions of $PM_{2.5}$ and PM_{10} by applying to these TSP emissions the ratios derived from the $PM_{2.5}$ and PM_{10} emission factors with respect to the TSP emission factor.

  For paper pulp (bisulphite process) the data sources for the factors are: the EMEP/CORINAIR Guidebook for SO_2 (chapter B463, Table 3), NO_X (chapter B463, Table 4) and NMVOC (chapter B463, page B463-7); for particulate matter, the CITEPA default factors have been taken for PST and PM_{10} and an estimate was made for the emission factor for $PM_{2.5}$ depending on the ratio derived from the $PM_{2.5}$ emission factor with respect to the PM_{10} factor.

- Manufacture of bread and other food products: The emission factors used to estimate the emissions are those proposed in the EMEP/CORINAIR Guidebook (Chapter B465, Table 8.2).

- Wine: The emission factors used in order to estimate the emissions are those proposed in Table 8.2 of Chapter B466 in the EMEP/CORINAIR Guidebook

- Manufacture of beer: The emission factor of NMVOC has been taken from Table 10.1.3.2 in Part 1 of the CORINAIR Manual. In the EMEP/CORINAIR Guidebook (Chapter B466, Table 8.2) a higher factor is stated (35 g/hl), which, however has not been considered since it does not have a quality label higher than the factor from CORINAIR Manual and which had already been used in previous editions of the Inventory.

- Spirits: The emission factors used to estimate the emissions are those proposed in the EMEP/CORINAIR Guidebook (Chapter B466, Table 8.2).

5.4.- Other sources

Some of the main categories that are not key sources in the inventory but are nevertheless included under the industrial processes heading are listed below.

- Category 2A5 (Asphalt Roofing), NMVOC and CO emissions were obtained using default emission factors.

- Category 2A7d (Other mineral products) included the estimation of metal emissions in the activity of battery manufacturing (lead and nickel-cadmium), carried out by applying default emission factors (PARCOM-ATMOS 1992)

- Category 2E (Production of persistent organic compounds, POP), which in the inventory are restricted throughout the inventory period to the production of tetrachloromethane (TCM), trichloroethylene (TRI) and perchloroethylene (PER). The estimation of POP emissions was carried out by using default emission factors (mostly from PARCOM-ATMOS 1992), calculating as well the emissions of both POP and NMVOC.

- Category 2G (Others) included NH_3 emissions resulting from the use of this compound as a coolant, mainly at industrial facilities. To estimate emissions, total annual consumption was assumed to be released into the atmosphere ultimately.

5.5.- References

- “Statistical Yearbook.” Departmental Secretariat. Ministry of the Environment and Rural and Marine Affairs (MARM.) This publication replaces the Food Statistical Yearbook published in the past by the Ministry of Agriculture, Food and Fisheries.

- “Anuario de Estadística Agroalimentaria”. Ministerio de Agricultura, Pesca y Alimentación (MAPA). This document has been renamed Statistical Yearbook and is published by the Ministry of the Environment and Rural and Marine Affairs (MARM.)

- “Anuario de Ingeniería Química”. Madrid: Ingeniería Química, Alcion Ingeniería Química, Red Busines Information.

- Asociación Española de la Carretera (AEC). *Carreteras*, nº 155 (sept.-oct. 2007)

- “Asphalt in figures”. European Asphalt Pavement Association (EAPA).). Belgium EAPA.

- “Atmospheric Emission Inventory Guidelines for Persistent Organic Pollutants (POPs)”. Prague, The Czech Republic, July, 1995.

- CEPMEIP. Co-ordinated European Programme on Particulate Matter Emission Inventories, Projections and Guidance.

- CITEPA. “Etude sur le méthodes d’évaluation des quantités émises de particules fines (PM10 et inférieures) primaires et secondaires pour tous les secteurs d’activité en vue des inventaires”. Rapport final. Juillet 2002.

- EMEP/EEA 2009. “Air Pollutant Emission Inventory Guidebook”. UNECE-Convention on long-range transboundary air pollution & European Environmental Agency.

- EMEP/CORINAIR Emission Inventory Guidebook 2006: Technical report No. 30. 3rd ed. Copenhagen: European Environmental Agency, 2006

- Enciclopedia OILGAS. “Enciclopedia Nacional del Petróleo, Petroquímica y Gas”. Sede Técnica, S.A.

- “Encuesta Industrial”. Spanish National Statistics Institute (INE).

- “Estudio sobre la Posición Competitiva del Sector de Alimentación y Bebidas en España. Sector de la Cerveza y Malta de Cerveza”. Ministerio de Agricultura, Pesca y Alimentación (MAPA).

- “Estudio sobre la posición competitiva del sector de alimentación y bebida en España. Sector de Alcoholes Etílicos de Fermentación”. Ministerio de Agricultura, Pesca y Alimentación (MAPA).

- “Experiences With The Heavy Metals Inventory in Slovakia”. Oxford: Economic Commission for Europe, Convention on Long-Range Transboundary Air Pollution, 1996.

- Holoubek I. et al. (1993). “Compilation of emission factors for persistent organic pollutants. A case study of emission estimates in the Czech and Slovak Republics”. Prepared for External Affairs Canada. Masaryk University, Axys Environmental Consulting. March, 1993.

- IDOM Ingeniería y Consultoría. “Plantas siderúrgica de referencia medioambiental”*:* Siderinsa-UNESID. IDOM, 1998

- “Informe Anual”. Asociación de Fabricantes de Papel y Pasta de Papel (ASPAPEL).

- “Informe Estadístico 2007”. Asociación de Fabricantes de Papel y Pasta de Papel (ASPAPEL). Madrid: ASPAPEL, 2008.

- “Informe sobre la Industria Española”. Madrid: Ministerio de Industria y Energía, Centro de Publicaciones.

- IPPC. Integrated Pollution Prevention and Control. “Draft Reference Document on Best Available Techniques in the Production of Polymers”. Draft April 2005.

- “La Alimentación en España”. Ministerio de Agricultura, Pesca y Alimentación (MAPA).

- “La Industria Química en España”. Ministerio de Industria y Energía (MINER), actualmente Ministerio de Industria, Turismo y Comercio (MITYC).

- EMEP/CORINAIR Guide Book (1996). “Atmospheric Emission Inventory Guidebook”. First Edition. February 1996. UNECE-convention on long-range transboundary air pollution & European Environmental Agency.
- EMEP/CORINAIR Guidebook. “Atmospheric Emission Inventory Guidebook”. Second Edition. September 1999. UNECE-convention on long-range transboundary air pollution & European Environmental Agency.
- EMEP/CORINAIR Guidebook. “Atmospheric Emission Inventory Guidebook”. Third Edition. Updated to December 2006. UNECE-Convention on long-range transboundary air pollution & European Environmental Agency.
- EMEP/CORINAIR Guidebook. “Atmospheric Emission Inventory Guidebook”. Third Edition. Updated to December 2007. UNECE-Convention on long-range transboundary air pollution & European Environmental Agency.
- CORINAIR Manual (1992). “Default Emission Factors Handbook”. Second Edition. Edited by CITEPA for DG-XI CEC.
- “Los Plásticos en España”. Confederación Española de Empresarios de Plásticos (ANAIP)
- IPCC Reference Manual. “Greenhouse Gas Inventory Reference Manual”, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. IPCC-OECD-IEA. 1997.
- “Mercury Losses from the Chlor-Alkali Industry in 2004”. OSPAR Commission, 2006.
- PARCOM-ATMOS (1992). “Emission Factors Manual. PARCOM-ATMOS. Emission factors for air pollutants. 1992”. P.F.J. van der Most and C. Veldt, eds., TNO Environmental and Energy Research, TNO Rept. 92-235, Apeldoorn, the Netherlands.
- U.S. EPA, 1995 (“Compilation of Air Pollutant Emission Factors. Volume I: Stationary Point and Area Sources”. AP-42. 5th Edition. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.
- UNECE-CLRTAP (1997). Draft BAT Background Document. Task Force on the Assessment of Abatement Options/Techniques for Volatile Organic Compounds. French-German Institute for Environmental Research. University of Karlsruhe, Germany. November 1997.

6.- SOLVENT AND OTHER PRODUCT USE

Chapter updated in July 2010

6.1.- Sector analysis

Emissions generated by a wide range of production and consumption processes applying organic solvents are examined for the present sector. Although relatively heterogeneous, the list of activities under consideration is divided into the following NFR nomenclature categories in an attempt to provide a more uniform structure for the activities under consideration:

- 3.A: Paint application
- 3.B: Degreasing and dry cleaning
- 3.C: Chemical products, manufacture and processing
- 3.D: Other use of solvents and other products (including products containing heavy metals and POPs).

Emissions in this sector are essentially characterized by their contribution to the inventory categories corresponding to Non-Methane Volatile Organic Compounds (NMVOC), the emissions of the remaining pollutants being non-existent or marginal. In general, an initially decreasing trend in emissions is observed from 1990 to 1993, mainly due to the drop in the economic cycle and this translates more specifically into paint consumption, followed by a sustained growth period and subsequent relative stabilization with a significant fall in 2008as a consequence of both the reduction in the organic compounds in the products used and improved product application and effluent management as well as the economic recession in 2007-2008.

6.1.1.- NMVOC

Emissions associated with the use of solvents and other products are one of the main sources of NMVOC emissions. Table 6.1.1.1 shows NMVOC emissions by category in this sector. According to the available data, NMVOC emissions for this sector increased by 17.7% in 2008 with respect to 1990, going from 395.6 Gigagrammes (Gg) in 1990 to 465.8 Gg in 2008.

Table 6.1.1.1.- NMVOC emissions *(Amounts in Gg)*

Category	**1990**	**1995**	**2000**	**2004**	**2005**	**2006**	**2007**	**2008**
3.A Paint application	172.5	148.1	195.8	202.0	193.2	191.6	193.5	172.4
3.B Degreasing and dry cleaning	42.0	30.6	30.4	26.6	26.0	26.0	26.1	26.1
3.C Chemical products manufacture and processing	67.7	70.5	93.0	102.5	104.6	104.7	104.4	100.6
3.D Other use of solvents and other products	113.5	115.1	167.4	169.9	176.6	168.3	167.7	166.7
Total solvent and other product use	**395.6**	**364.4**	**486.7**	**501.0**	**500.4**	**490.6**	**491.7**	**465.8**

Figure 6.1.1.1 shows the evolution of NMVOC emissions throughout the inventory period. The trend in emissions is determined, in order of importance, by categories 3A (Paint Application), 3D (Other use of solvents and other products) including products containing HMs and POPs), 3C (Chemical Products, Manufacture and Processing) and 3B (Degreasing and Dry Cleaning.) According to the available data, paint application activities (category 3A) show a decrease in NMVOC emissions during the period 1990-1993 as a consequence of the drop in paint consumption during the same period, followed by a subsequent sustained increase until 2003, followed by the decrease and subsequent stabilization between 2004 and 2007, ending with a significant fall in 2008 due to the smaller consumption of paint in this year. However, the increase in consumption is offset by the decrease in the amount of volatile organic compounds in paint (greater use of water-based paints instead of solvent-based paints), with a clear impact on NMVOC emissions, resulting in decreased emissions despite the greater use of paint, with the exception of the decline in consumption in 2008. As for the evolution of the other prevailing category in this sector (3D), a relatively stable pattern is observed between 1990 and 1997, followed by an increase during the period 1998-2000, with subsequent fluctuations starting in 2000. This trend is basically the consequence of variations in the application of glue and adhesive, the activity contributing most NMVOC emissions in category 3D. The evolution of the remaining categories in this sector is more stable, with a generally upward trend in emissions generated by Chemical Products, Manufacture and Processing (category 3C) and a decrease in Degreasing and Dry Cleaning processes, although their smaller contribution to emissions translates into a lower relative weight of the impact of such variations for the whole sector.

Figure 6.1.1.1.- Evolution of NMVOC emissions by category

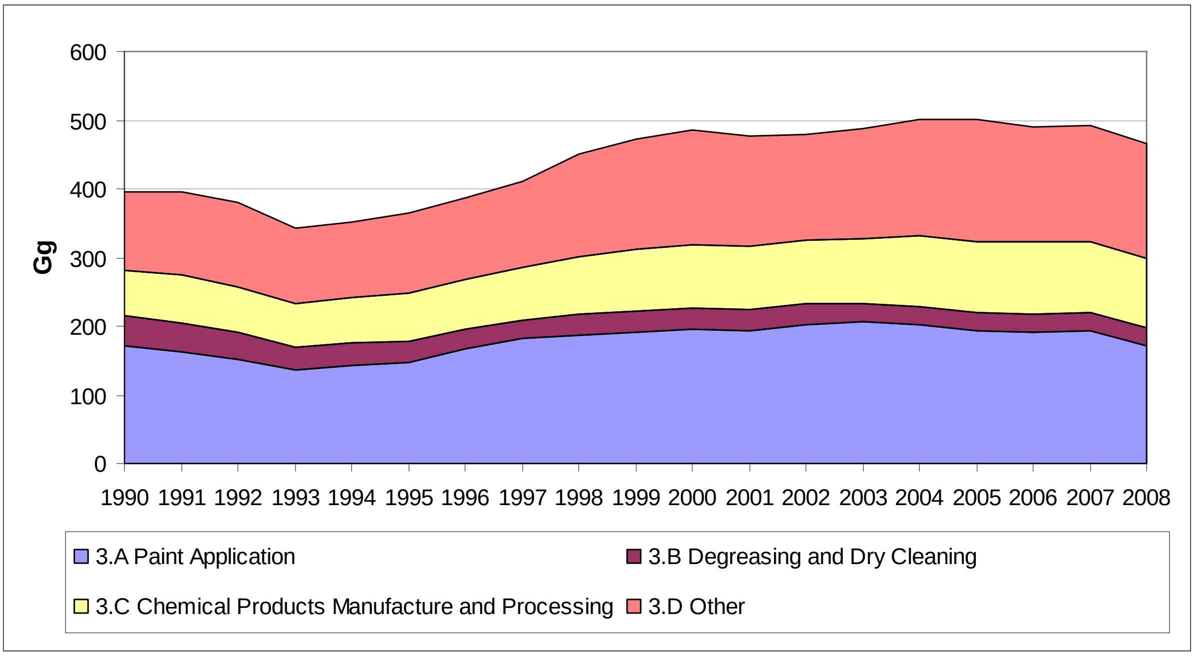
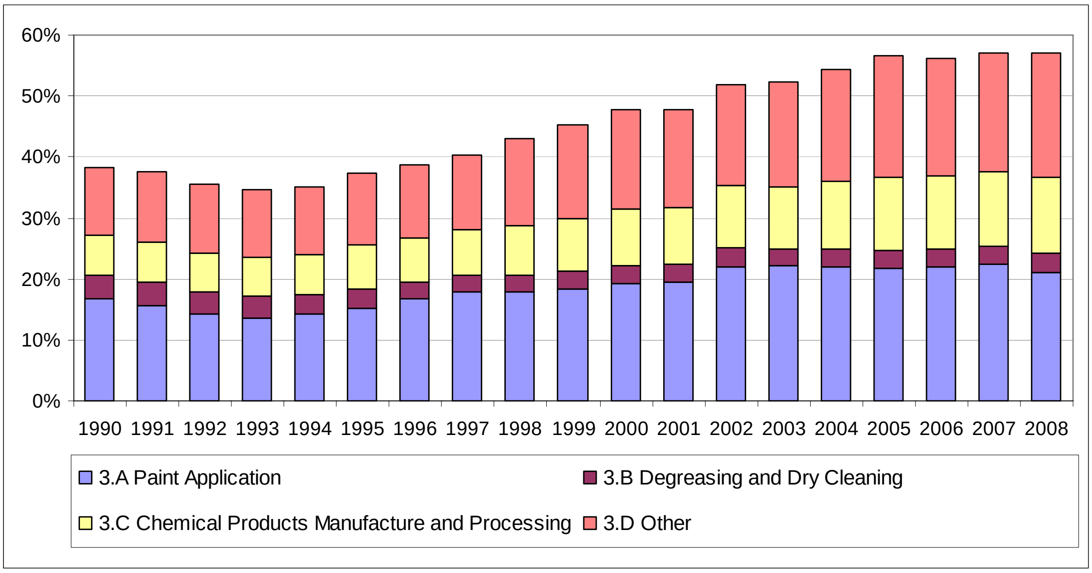


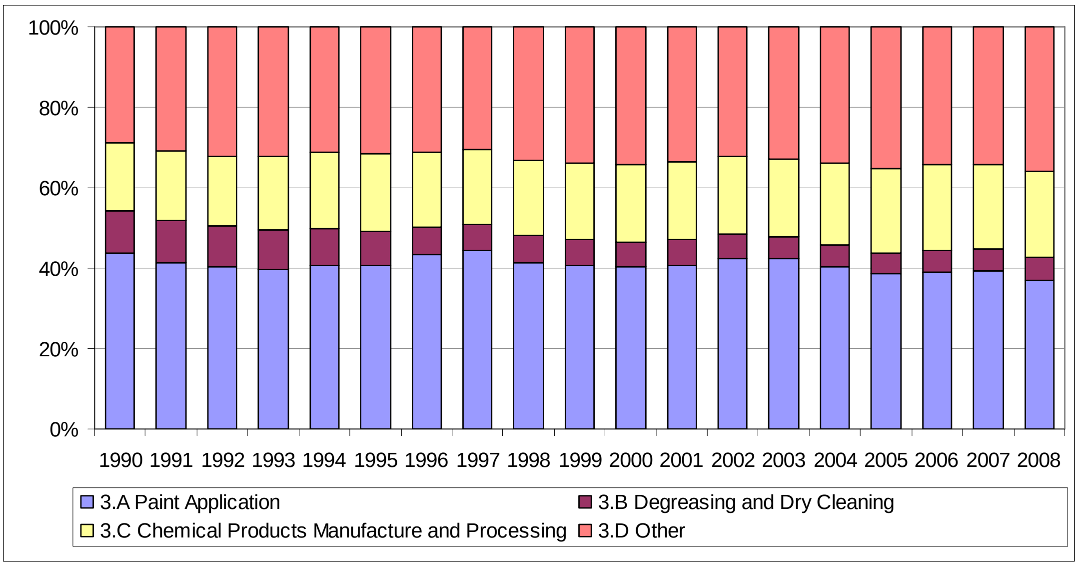
Figure 6.1.1.2 shows that NMVOC emissions in 2008 accounted for 57.1% of total emissions in the inventory, representing a greater contribution with respect to 1990, when they accounted for 38.2% of total emissions. Therefore, this is a particularly relevant sector in the evolution of total NMVOC emissions.

Figure 6.1.1.2.- Percentage of NMVOC emissions by category with respect to the inventory total



Regarding the distribution of emissions among the sector categories, Figure 6.1.1.3 shows that the main contribution corresponded to activities in category 3A (Paint application), whose share amounts to 40% throughout the inventory period; it is followed by category 3D (Other use of solvents and other products), whose contribution exceeds 30% (35.8% in 2008); category 3C (Chemical Products, Manufacture and Processing) ranked third, its relative importance within the sector growing moderately throughout the inventory period up to 21.6% in 2008; and finally category 3B (Degreasing and Dry Cleaning) with a moderately decreasing trend with contributions slightly above 5% in the final years of the series.

Figure 6.1.1.3.- Percentage of NMVOC emissions by category with respect to the sector total



With regards to NMVOC for this sector, the following key sources were identified for the 1990-2008 period:

- Paint application (3A) by its emission level throughout the 1990-2008 period and by its trend in the years 1991-1995 and 1997-2008.

- Degreasing and dry cleaning (3B) by its emission level throughout the 1990-2008 period and by its trend in the years 1991-2008.

- Chemical products, manufacture and processing (3C) by its emission level throughout the 1990-2008 period and by its trend in the years 1992-2008.

- Other use of solvents and other products (including products containing heavy metals and POPs) (3D) by its emission level throughout the 1990-2008 period and by its trend in the years 1991-1993 and 1995-2008.

As a summary of the foregoing information Table 6.1.1.2 below presents, for the NNMVOC key categories in this sector, the contribution of the emissions to the level and trend, and the category's ranking in relation to the key sources[1], as well as the absolute values, all referred to 2007.

Table 6.1.1.2.- NMVOC key sources: Level and Trend contribution

Activity		NMVOC (Gg) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	Description		%	Key source	Rank	%	Key source	Rank
3A	Paint application	172.4	21.1	YES	1	7.4	YES	5
3B	Degreasing and dry cleaning	26.1	3.2	YES	10	1.4	YES	14
3C	Chemical products, manufacture and processing	100.6	12.3	YES	3	9.5	YES	4
3D	Other use of solvents and other products	166.7	20.4	YES	2	15.6	YES	2

6.1.2.- PAH

As shown in Table 6.1.2.1, PAH emissions in this sector are limited to wood preservation and result from the use of creosote as wood preservative. According to the available data, PAH emissions for this sector increased by 428.6% in 2008 with respect to 1990, going from 0.9 kg in 1990 to 3.8 kg in 2008.

[1] Ranking determined by the contribution of the emissions in the category to the level or the trend.

***Table 6.1.2.1.- PAH emissions** (Amounts in kg)*

Category	1990	1995	2000	2003	2004	2005	2006	2007
3.A Paint application	-	-	-	-	-	-	-	-
3.B Degreasing and dry cleaning	-	-	-	-	-	-	-	-
3.C Chemical products, manufacture and processing	-	-	-	-	-	-	-	-
3.D Other use of solvents and other products	0,9	0,6	0,3	0,5	0,6	0,6	0,7	3,8
Total solvent and other product use	**0,9**	**0,6**	**0,3**	**0,5**	**0,6**	**0,6**	**0,7**	**3,8**

Figure 6.1.2.1 shows the evolution of PAH emissions throughout the inventory period. According to the available data, emissions went through a downward trend until 2000, followed by a moderate increase during the period 2001-2006, with a final marked increase in 2007 caused by the greater use of creosote in wood preservation which in turn reduced the consumption of other organic solvents.

Figure 6.1.2.1.- Evolution of PAH emissions by category

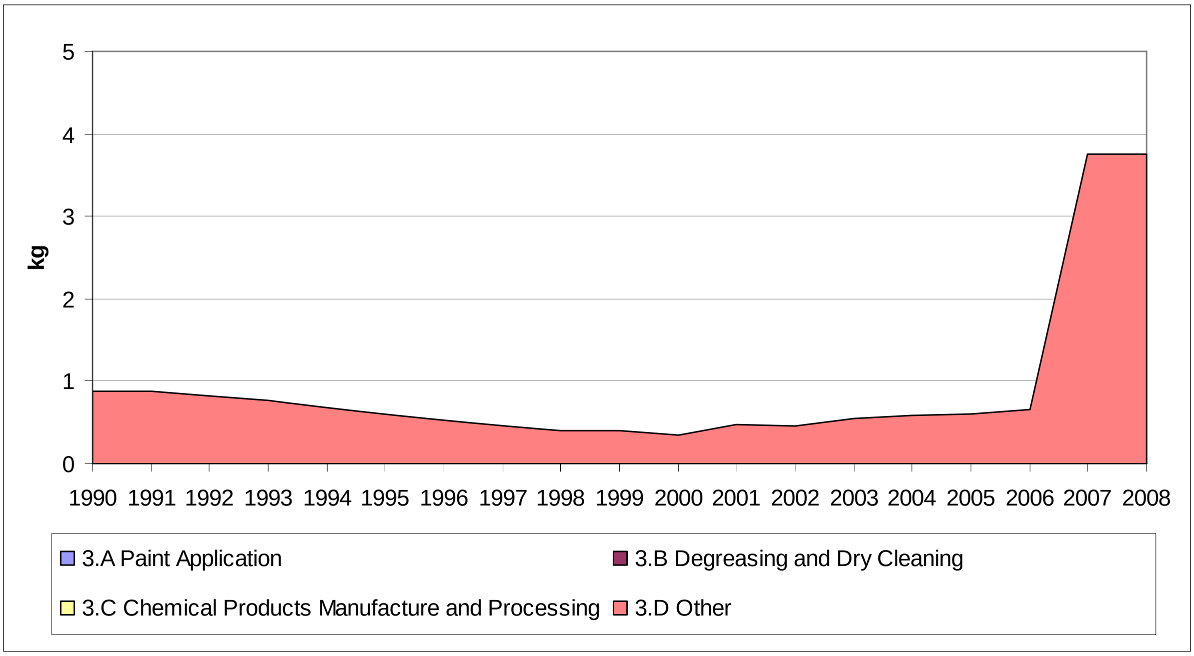
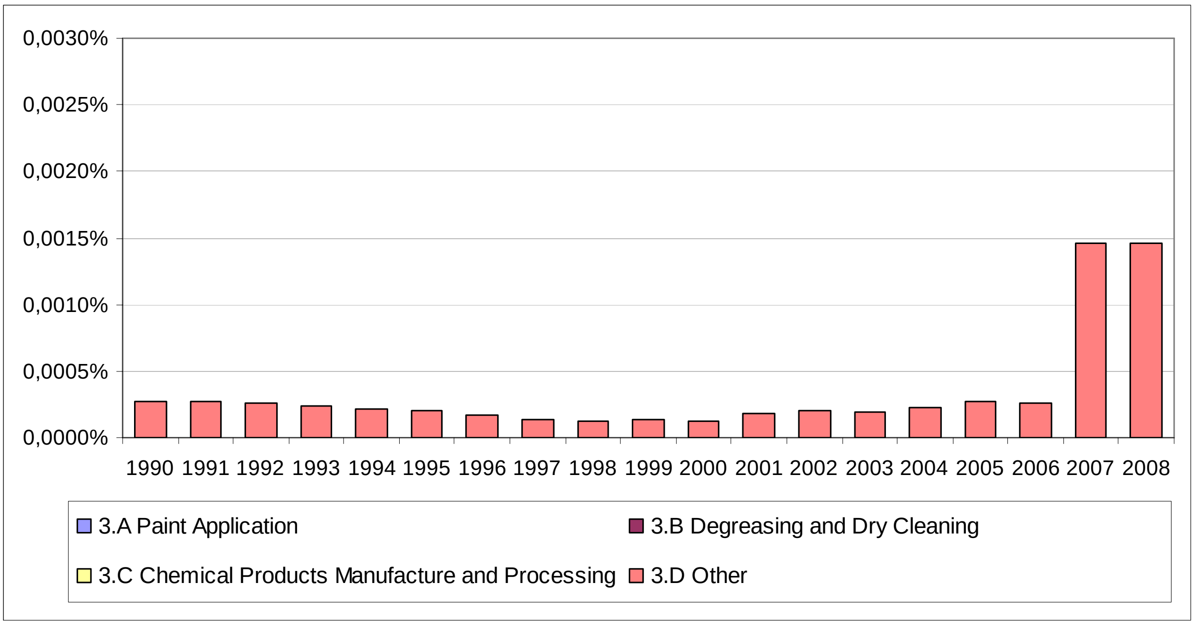


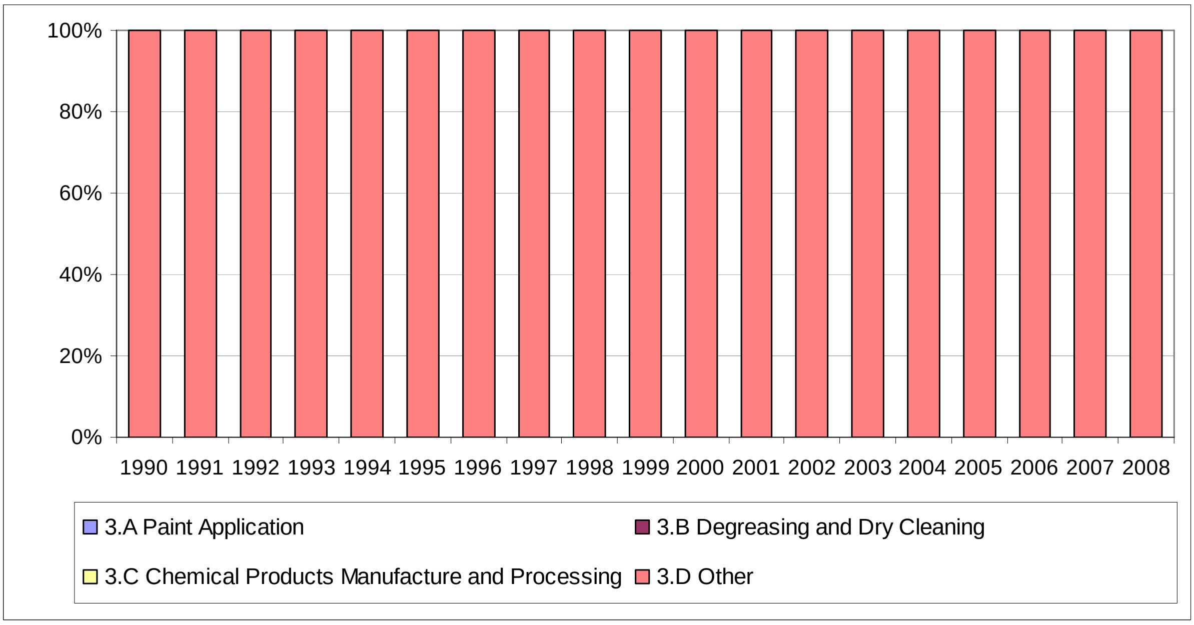
Figure 6.1.2.2 reveals that PAH emissions in this sector have a marginal impact with respect to the total inventory.

Figure 6.1.2.2.- Percentage of PAH emissions by category with respect to the inventory total



Regarding the distribution of emissions among the sector categories illustrated by Figure 6.1.2.3, the whole contribution corresponds to category 3D (Other use of solvents and other products), which includes wood preservation activities.

Figure 6.1.2.3.- Percentage of PAH emissions by category with respect to the sector total



Due to their scant relevance for this sector, PAH emissions are not considered key sources in terms of levels or trends.

6.3.- Analysis by key categories

Key sources for this sector are analyzed in detail below.

6.3.1.- Paint application (3A)

Surface coating or painting consists in the application of protective or decorative materials in liquid or powder form onto the prepared surfaces. These coatings are normally done with general organic solvent type paints, varnishes, lacquers or also with water-thinned paints. The emission of Non-Methane Volatile Organic Compounds (NMVOC) takes place through the evaporation of the organic solvent used to thin the paints or for cleaning purposes. The amount of organic solvents consumed and not recovered or eliminated can, in principle, be regarded as emissions. The main factor determining these emissions is the amount of volatile material required by the paint. Conventional paints contain approximately 50% of dry matter and another 50% of organic solvents, whereas paint with a high solid content and water-borne paints contain a smaller proportion, less than 30%, of organic solvents. Following the application of the surface coating using one of the many techniques available, the surface is dried with hot air to eliminate the volatile solvents on the treated surface.

6.3.1.1.- Activity variables

The basic sources of data about the application of paint making up the activity variables of the present category are as follows:

- Spanish Association of Paint and Printing Dye Manufacturers (ASEFAPI).
- Questionnaires filled in by the vehicle manufacturing factories
- Vehicle building statistics (MITYC)
- European Council of the Paint, Printing Ink and Artists‘ Colours Industry (CEPE)

An additional source consulted was the specific analysis of the “Encuesta Industrial” requested for the purpose by the Directorate-General for Environmental Quality and Assessment. The data in this source were used to verify the data provided by the data sources mentioned above.

The activities of “*Paint application: construction and buildings*” and “*Paint application. Domestic Use*” are worth highlighting. Information related to these activities was obtained from CEPE[2] for the years 1990, 2000 and 2010 regarding the distribution of consumption by

[2] This information was sent to the General Sub-directorate for Air Quality and Industrial Environment by the parties responsible for the IIASA (International Institute for Applied Systems Analysis) within the framework of the bilateral consultations established with the latter organization for the revision of the Ceilings Directive.

paint type and VOC content for each type. Based on this information, the Inventory working team estimated the corresponding values throughout the period under analysis by means of quadratic interpolation procedures, finally obtaining for each year an emission factor per kg of paint used which reflects the evolution of VOC contents in paint.

6.3.1.2.- Methodology

6.3.1.2.1.- Advanced methodology

Firstly, it is worth mentioning the case of vehicle manufacturing plants, subjected to plant-specific treatment to gather information on the amounts of concentrate and solvent used and their VOC content during the different stages of paint lines in the production process, as well as recovery and disposal processes implemented at each centre, so as to estimate emissions by means of mass balance. Table 6.3.1.2.1.1 shows the form for requesting the information needed to perform this mass balance.

Table 6.3.1.2.1.1.- VOC application questionnaire for vehicle plants

PROCESS	CONCENTRATE		SOLVENT		DISSOLUTION		TOTAL VOC
	kg	% VOC	kg	% VOC	kg	% VOC	kg
1.- Paint application							
Cataphoresis							
PVC Products (mastics)							
Priming							
Lacquer							
Refinishing							
Protective waxes							
± Adjustments							
2.- Degreasing and industrial cleaning							
Metal degreasing							
Other industrial cleaning							
Total manufacturing (1 + 2)							
3. Maintenance							
TOTAL CONSUMPTION (1 + 2 + 3):							
Recovery (recycling)							
Disposal (incineration)							
Dispatch to external treatment							
EMISSION							

Advanced estimation procedures have been applied to other activities, such as "*Paint application: construction and buildings*" and "*Paint application. Domestic use*". For these activities, information has been made available by the CEPE for 1990, 2000 and 2010 regarding the distribution of the consumption figures by type of paint and VOC contents for each type. On the basis of this information, the Inventory Working Party has drawn up an estimate of the corresponding values throughout the period analyzed using quadratic interpolation procedures, before finally obtaining an emission factor per kg of paint used each

year reflecting the evolution in the VOC contents of the paint. In addition, the emissions corresponding to the use of solvents for equipment-cleaning are estimated separately in these activities. Table 6.3.1.2.1.2 presents annualized NMVOC emission factors for paint consumption in these activities.

Table 6.3.1.2.1.2.- NMVOC emission factors

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
179.63/B	167.2/B	158.62/B	150.05/B	141.44/B	133.01/B	124.66/B	116.6/B	108.75/B	101.27/B

2000	2001	2002	2003	2004	2005	2006	2007	2008
96.13/B	87.36/B	80.99/B	75.11/B	69.62/B	64.66/B	60.09/B	56.05/B	52.41/B

6.3.1.2.2.- Default methodology

The default methodology applied to estimate NMVOC emissions is essentially that of EMEP/CORINAIR. As for emission factors, the methodology used seeks to quantify NMVOC contents in solvents and other products containing such substances. Whenever applicable, reduction coefficients corresponding to the different application and abatement techniques for the resulting emissions are added in.

As for NMVOC, the data on the default emission factors have been taken from Table 8.1, chapter B-610 of the EMEP/CORINAIR Guidebook. In those cases were the data on factors provide various options for a single activity, the Inventory working party has selected that factor which according to the references indicated was considered to be most representative as a mean factor for the activity. The factors finally selected are shown in Table 6.3.1.2.2.1 below.

Table 6.3.1.2.2.1.- NMVOC emission factors

ACTIVITY	EMISSION FACTOR		
	VALUE/LABEL	UNIT	SOURCE (*)
MANUFACTURE OF AUTOMOBILES	315/C	g/kg	EP
CAR REPAIRING	665/D	g/kg	LG-B610
CONSTRUCTION AND BUILDINGS			
Paint	(1)	g/kg	
Solvent cleaning	1.000/A	g/kg	(2)
DOMESTIC USE			
Paint	(1)	g/kg	
Solvent cleaning	1.000/A	g/kg	(2)
COIL COATING	50/D	g/kg	LG-B610
BOAT BUILDING	500/D	g/kg	LG-B610
WOOD	270/D	g/kg	LG-B610
OTHER INDUSTRIAL PAINT APPLICATION			
Metalgraphic	488/D	g/kg	LG-B610
General	488/D	g/kg	LG-B610
OTHER NON INDUSTRIAL PAINT APPLICATION	500/D	g/kg	LG-B610

(*) EP: Own estimate
LG-Cap.: EMEP/CORINAIR Guide Book, chapter Cap.).
(1) See Table 6.3.1.2.1.2
(2) It is assumed that the amount of solvent is emitted in its entirety.

As an additional clarification of the methodology used to obtain the emission factors indicated in Table 6.3.1.2.2.1, in those cases where they are not directly extracted from the reference indicated, the following commentaries by activity is effected.

- Manufacture of automobiles: For Area Sources[3], the factor indicated has been deduced on the basis of the data available in the questionnaires sent by the vehicle manufacturing plants.

- Coil coating: An intermediate value from the range 10-200 g/kg of paint has been assumed, depending on the emissions abatement techniques indicated in the source.

- Boat building: An intermediate value from the range 338-750 g/kg of paint has been assumed, depending on the emissions abatement techniques indicated in the source.

- Other non industrial paint application: An intermediate value from the range 333-740 g/kg of paint has been assumed, depending on the emissions abatement techniques indicated in the source.

6.3.2.- Degreasing and dry cleaning (3B)

This category considers the emissions of pollutants into the atmosphere from cleaning and degreasing activities involving organic solvents. Some of these are simple derivatives of oil-based hydrocarbons while others are halogenated organic compounds which are classified where appropriate in the category of persistent organic pollutants.

In this category, the estimation of emissions has been made for the following activities:

- Metal degreasing
- Dry cleaning
- Other industrial cleaning

In the case of the other industrial cleaning activity, this is a remainder heading intended to include emissions not assessed in other items and so it has been possible to estimate the emissions on the basis of the information provided by automobile manufacturing centres. On the other hand, no emissions could be estimated for the manufacture of electronic components due to the lack of verified information on the effective use of solvents in this activity.

6.3.2.1.- Activity variables

Primary information regarding solvent consumption for metal degreasing activities was provided by the Spanish Chemical Industry Federation (FEIQUE), in addition to small amounts compiled via questionnaires completed by vehicle manufacturing plants. However, the final activity variable used was the number of employees in sectors 7 ("Metal products and machinery") and 8 (Transport material) from the "National Income and Provincial Distribution in Spain" report published by the BBVA Foundation, since the NMVOC emission factor applied for estimation purposes depends on this variable.

[3] For plants treated as point sources the calculation of the emissions has been derived directly from the analysis of the questionnaires supplied by the own plants.

As for dry cleaning, according to the EMEP/CORINAIR guidelines (see section 9, chapter B622), 90% of emissions for this activity were made up of perchloroethylene (PER). Consumption data for this compound was provided by FEIQUE, total solvent consumption being estimated by applying a 100/90 scaling factor to the reported PER consumption.

6.3.2.2.- Methodology

6.3.2.2.1.- Advanced methodology

For dry cleaning activities, both PER and complementary organic solvent components were assumed to be released into the atmosphere, thus obtaining annual implicit emission factors per inhabitant that are considerably lower than the default factor suggested by EMEP/CORINAIR Guidebook.

Additionally, the estimation of NMVOC emissions for small amounts for surface cleaning in vehicle manufacturing plants was carried out by means of mass balance (see heading 6.3.1.2.1).

6.3.2.2.2.- Default methodology

The default methodology applied to estimate emissions for metal degreasing activities is that of EMEP/CORINAIR, applying the default emission factor proposed in the CORINAIR Manual (1992) of 42,300 g of NMVOC/employee[4]

6.3.3.- Chemical products, manufacture and processing (3C)

This category includes a series of activities relating to the manufacture, processing or application of chemicals incorporating organic solvents. These activities can be grouped into the following three blocks:

1) Processing:
   - Polyester processing
   - Polyvinylchloride processing
   - Polyurethane processing
   - Polystyrene foam processing
   - Rubber processing.

These activities have already been considered, as far as their manufacture is concerned, in chapter 5 Industrial Processes. Here they are considered from the viewpoint of their application in other manufacturing processes or in consumption activities.

[4] This factor was obtained as a result of assuming a consumption of 47 kg of solvent per employee and an NMVOC emissions ratio of 90%, taken from Manual CORINAIR 1992, part 1, section 18, Table 18.1.

2) Manufacturing:

- Pharmaceutical products manufacturing
- Paints manufacturing
- Inks manufacturing
- Glues manufacturing
- Pharmaceutical products manufacturing
- Asphalt Blowing
- Adhesive, magnetic tapes, films and photographs manufacturing.

These activities are analysed here from the standpoint of the emissions generated by their manufacture. Paints, inks, glues and adhesives all share the fact that they incorporate as a vehicle organic solvents in order to facilitate the application of the film elements, colour pigments or adherents in their respective products. These organic solvents are what give rise to emissions when they evaporate. The manufacture of pharmaceuticals, on the other hand, uses volatile organic compounds both as active ingredients and also as solvents for other major products. Asphalt blowing is the process by which a current of air is introduced into a flow of hot asphalt in order to raise the temperature at which the asphalt will soften. The resulting product is mainly used as waterproofing for outdoor surfaces (roofs and façades). The blowing process takes place in distillation pots either in the refineries themselves or in specific blowing plants or at external covering material factories.

3) Others:

- Textile finishing processes
- Leather tanning

Estas dos actividades tienen en común que constituyen sólo una fase del proceso de producción integral del sector correspondiente (producción textil y de artículos de cuero), si bien, aunque constituyen una parte del ciclo de producción, en ellas se realizan procesos que son significativos desde el punto de vista de sus emisiones a la atmósfera. En los procesos de acabado textil se utilizan disolventes con una alta proporción de NMVOC, que se volatilizan durante la aplicación del disolvente a los productos textiles tratados. En el caso del curtimiento de cuero, los disolventes orgánicos se utilizan para el desengrasado, tratamiento y acabado de los cueros como materia prima para la fabricación artículos de este material.

These two activities share the fact that they up form only one part of that process for manufacturing in their corresponding sectors (textile production and leather goods) as, although they constitute part of the production cycle their activities include processes which are significant from the point of view of air pollution. In the textile finishing processes solvents are used with a high proportion of NMVOC which volatilise during the application of solvents to the textile products being treated. In the case of leather tanning, the organic solvents are used for degreasing, preparing and finishing the hides as the raw material for the manufacture of leather goods.

6.3.3.1.- Activity variables

By types of activity, the socio-economic activity variables used to estimate emissions can refer to:

- Domestic production or the amount treated (consumed),
- Number of people occupied in the sector (employees)

For the emission sources in this category, a vast proportion of the data on activity variables comes from the corresponding business associations, among which the following should be identified: the Spanish Confederation of Plastics Businesses (ANAIP); Technical Association of Applied Polyurethane (ATEPA); National Association for Expanded Polystyrene (ANAPE); Industry Association of Rigid Polyurethane (IPUR); National Consortium of Rubber Manufacturers (COFACO); Spanish Tanner Council; National Federation for Textile Finishers, Printers and Dyers. Likewise, in the case of some activities, general statistical information such as population was obtained from the Spanish National Statistics Institute (INE), the Industrial Survey (INE), the publication entitled “The Chemical Industry in Spain” from the Ministry of Industry, Tourism and Trade (MITYC), or the publication entitled “Fur and Leather Yearbook” from the Spanish Fur and Leather Council.

6.3.3.2.- Methodology

6.3.3.2.1.- Advanced methodology

In the case of textile finishing processes, the emission factor has been deduced through the following procedure. According to the survey entitled “Valoración del Borrador de la Directiva Europea de COV’s …” (Assessment of the Draft European Directive on VOCs) (please refer to the Bibliography), in 1993 the textile finishing sub-sector represented emissions of approximately 41.000 tonnes of NMVOC in the entire European Union. On the other hand, data are available for 1998 on the number of employees in the whole of the textile sector (information provided by the Office of the Secretary-General of the National Federation for Textile Finishers, Printers and Dyers, referring to the CITYC/EURATEX/OETH source), both in Europe (2.348.000 employees) and in Spain (273.500 employees). By dividing the number of employees in Europe in the whole of the textile sector by the proportion obtained (15,194) for the number of employees in Spain in the textile sector as a whole in proportion to the sub-sector for textile finishing (273.500/18.000=15,194), an estimate is obtained for the number of employees in the textile finishing sub-sector in Europe (154.530 employees). Using this initial datum, and the emissions available for NMVOC, an emissions factor of 265 kg of NMVOC/employee is deduced for Europe, and this is the factor applied in order to estimate the emissions in Spain.

6.3.3.2.2.- Default methodology

The default methodology applied to estimate emissions is essentially that of EMEP/CORINAIR. Information on default emission factors was collected from chapters B-633 and B-6310 of the EMEP/CORINAIR Guidebook and CORINAIR Manual (1992). UNECE-CLRTAP emission factors have also been used (please see the bibliographic

references in heading 6.5), more specifically applied to the activities of *“Rubber processing”* and *“Pharmaceutical products manufacturing”*.

With regard to NMVOC, Table 6.3.3.2.2.1 lists for each of the activities in this category the emission factors used to estimate the emissions. Together with the value, quality label and unit of measurement of each factor, the source from which it has been taken is also indicated.

Table 6.3.3.2.2.1.- NMVOC emission factors

ACTIVIDAD	EMISSION FACTOR		
	VALUE/LABEL	UNIT	SOURCE (*)
POLYESTER PROCESSING	25,000/E	g/t	EP-M-6-6
POLYVINYLCHLORIDE PROCESSING	40,000/D	g/t	M-6-6
POLYURETHANE PROCESSING			
Flexible foam	120,000/D	g/t	LG-B633
Rigid foam. Construction	0/C	g/t	EP
Rigid foam. Others	120,000/D	g/t	LG-B633
Semi-rigid foam	120,000/D	g/t	LG-B633
Integral Polyurethane	120,000/D	g/t	LG-B633
POLYSTYRENE FOAM PROCESSING	60,000/C	g/t	LG-B633
RUBBER PROCESSING			
No tyres	8,000/D	g/t	UC-7.4.3.2
Tyres	10,000/D	g/t	UC-7.4.3.2
PHARMACEUTICAL PRODUCTS MANUFACTURING	91,700/E	g/EMP	UC-7.4.3.3
PAINTS MANUFACTURING	15,000/E	g/t	M-6-6
INKS MANUFACTURING	30,000/D	g/t	M-6-6
GLUES MANUFACTURING	20,000/E	g/t	M-6-6
ASPHALT BLOWING	540/D	g/t	LG-B6310
ADHESIVE, MAGNETIC TAPES, FILMS AND PHOTOGRAPHS MANUFACTURING	60,000/E	g/t	EP-M-6-6
LEATHER TANNING	188/D	g/m^2	Doc. Tec.

(*) EMP: Nº of employees.
(**) EP: Own estimate
M-i-j: CORINAIR Manueal 1992, part i, section j
LG-Cap.: EMEP/CORINAIR Guide Book, chapter Cap.
UC-Cap: UNECE-CLRTAP (1997), chapter Cap.
Doc. Tec.: Technical Document (version dated 31/5/95) drafted by CORINAIR experts from Italy as the provisional chapter for the EMEP/CORINAIR Guide Book (1996), but which was finally not included in the published version.

As an additional clarification of the methodology used to obtain the emission factors indicated in Table 6.3.3.2.2.1, in those cases where they are not directly extracted from the reference given, the following comments are indicated for the different activities.

- Polyester processing: The value chosen is the average of the values corresponding to: 1) “Manual lay-up” (40.000 g/t of polyester resin); and 2) “closed system moulding” (10.000 g/t of polyester resin). Both factors had “B” quality label but it has been thought that the most representative label for application to the Spanish inventory may be “E” (the factor is applied to treated polyester and not to polyester resins as the reference indicates).

- Rubber processing: For the handling of the non-tyre rubber products, the value chosen is a weighted average of those indicated in the original data source, with 90% applied to the value of 8,45 g/kg corresponding to processes without emissions abatement, and 10% applied to the value of 4,23 g/kg corresponding to processes with unspecified

primary abatement measures. In all cases it is assumed that the plants are of small size, with a production of less than 240 tonnes/year.

- Pharmaceutical products manufacturing: It is assumed that, for the values proposed in the original source, the situation in Spain corresponds to small or medium-sized plants, with primary emission abatement measures (use of 95% of water-soluble solvents (alcohols) and 5% of non-halogenated solvents, in combination with good maintenance practices) and with secondary emission abatement techniques (thermal or catalytic incineration, condensation or adsorption).

- Asphalt blowing: The value chosen has been taken from the "*Uncontrolled*" option in Table 3 from chapter B-6310 of the EMEP/CORINAIR Guidebook.

- Adhesive, magnetic tapes, films and photographs manufacturing: The value indicated in the source is 60 g/m2, which has been assimilated by the Inventory working party to 60 g/kg, in other words 60.000 g/t.

6.3.4.- Other use of solvents and other products (including products containing heavy metals and POPs) (3D)

This is a miscellaneous category, including the following activities which all have the common characteristic for the purposes of the Inventory of using organic solvents:

- Glass wool enduction.
- Mineral wool enduction.
- Printing industry.
- Fat, edible and non-edible oil extraction.
- Application of glues and adhesives.
- Preservation of wood.
- Underseal treatment and conservation of vehicles.
- Domestic solvent use (other than paint application).
- Vehicle dewaxing.
- Domestic use of pharmaceutical products.
- Others (Preservation of seeds, etc.).

The first two activities include the emissions from the evaporation of solvents in coating operations for both thermal and acoustic installation carried out respectively with glass wool and mineral wool.

In the printing industry the following activities are included: printing of newspapers, magazines and books; printing of paper, cardboard, plastic or metal packaging; and decoration activities. The most common techniques are: offset, rotogravure and flexography, plate printing and bromide printing. The emissions are caused by the evaporation of solvents,

mainly during the drying and cleaning phases as well as in the storage and manipulation of the raw material containing organic solvents.

The extraction of facts and oils (who edible and non-edible oils) us from oil bearing seeds is carried out either by mechanical processes or by using solvents and sometimes by a combination of both procedure. When solvents are used, the seeds may be subjected to repeated treatment and the solvent is recovered, filtered and recycled in each process. The final waste from the seed is dried and often used as animal feed. The NMVOC emissions come from the part of the solvents used and not recycled and those emanating from the seed waste.

The application of glues and adhesives in manufacturing and consumption processes, and the domestic use of solvents provide the complement in usage terms for the corresponding manufacturing activities listed in category 3C above.

Preservation of wood includes the processes of impregnation/immersion of wood with/in chemical compounds for protection purposes. One of the compounds most commonly used is creosote: the emissions come from the evaporation of their organic solvents and the volatile compounds in creosote.

The activities of underseal (for protection) and dewaxing vehicles (for presentation prior to sale), carried out respectively by the manufacturers and by the dealers, are also included in this sub-group on the use organic solvents.

6.3.4.1.- Activity variables

Depending on the type of activity, the socio-economic datum used to carry out the estimates may refer to:

- Internal production or amount processed (consumed),
- Number of people occupied in the sector,
- Number of inhabitants,
- Consumption of solvents used,
- Number of vehicles manufactured,
- Number of vehicles imported.

For the emission sources in this category, a vast proportion of the data on activity variables comes from the corresponding business associations, among which the following should be identified: the Spanish Association of Manufacturers of Paint and Printing Dyes (ASEFAPI); National Association of Companies for the Fostering and Extraction of Oleaginous Substances (AFOEX). National Association of Wood Protection Companies (ANEPROMA). Likewise, in the case of some activities, general statistical information such as population was obtained from the Spanish National Statistics Institute (INE), the Industrial Survey (INE) or the publication entitled “Anuario Estadístico General” of the Directorate General for Traffic at the Ministry of Home Affairs

6.3.4.2.- Methodology

6.3.4.2.1.- Advanced methodology

For "*Underseal treatment and conservation of vehicles*" activities, NMVOC emissions were estimated by means of mass balance based on the information provided on a yearly basis by vehicle manufacturing plants (please see heading 6.3.1.2.1).

6.3.4.2.2.- Default methodology

The default methodology applied to estimate emissions is essentially that of EMEP/CORINAIR. The information regarding default emission factors was obtained from chapters B-643, B-646 and B-647 of the EMEP/CORINAIR Guidebook and CORINAIR Manual (1992). Additionally, for domestic solvent use activities (excluding paint) the emission factor suggested by IIASA[5] was used.

Table 6.3.4.2.2.1 lists for each of the activities in this category the emission factors used to estimate the NMVOC emissions, which make up the most common pollutants emitted by this set of activities and in the case of PAH, are used for the estimation of emissions in the Inventory. Together with the value and unit of measurement of each factor, the source from which it has been taken is also indicated.

5 IIASA: International Institute for Applied Systems Analysis. Interim Report IR-00-51, page 9, Table 14.

Table 6.3.4.2.2.1.- Emission factors

ACTIVITY	EMISSION FACTOR				
	NMVOC		PAH		SOURCE (**)
	VALUE/ LABEL	UNIT (*)	VALUE/ LABEL	UNIT	
GLASS WOOL ENDUCTION	1,400/E	g/t			EP, M-6-6
MINERAL WOOL ENDUCTION	1,400/E	g/t			EP, M-6-6
PRINTING INDUSTRY					
Paste inks	600,000/C	g/t			LG-B643
Back news inks	300,000/C	g/t			LG-B643
Gravure publication inks	400,000/C	g/t			LG-B643
Other liquid inks: Water-borne	5,000/C	g/t			ASEFAPI
Other liquid inks: Solvent-borne	500,000/C	g/t			M-1-18
Other printing inks	600,000/C	g/t			LG-B643
Varnishes and sundries	400,000/C	g/t			LG-B643
FAT, EDIBLE AND NON EDIBLE OIL EXTRACTION					
Sunflower oil	1,000,000/A	g/t			EP-AFOEX
Soya oil	1,000,000/A	g/t			EP-AFOEX
APPLICATION OF GLUES AND ADHESIVES	600,000/D	g/t			M-1-18
PRESERVATION OF WOOD					
With creosote	150,000/C	g/t	1,250/C	mg/t	LG-B646
With organic solvents	920,000/A	g/t			AITIM
UNDERSEAL TREATMENT AND CONSERVATION OF VEHICLES	1,200/D	g/VEH			CUEST.
DOMESTIC SOLVENT USE (OTHER THAN PAINT APPLICATION)	2,000/C	g/HAB			IIASA
VEHICLES DEWAXING	1,000/E	g/VEH			LG-B647
DOMESTIC USE OF PHARMACEUTICAL PRODUCTS	60/E	g/HAB			EP

(*) HAB: Inhabitants – VEH: Vehicles.
(**) AFOEX: National Association of companies for the Encouragement of Oil Seeds and Extraction
ASEFAPI: Spanish Association of Paint and Printing Inks Manufacturers
CUEST.: Questionnaires to Large Point Sources
EP: Own estimate
IIASA: International Institute for Applied Systems Analysis. Interim Report IR-00-51, page 9, Table 14 (value for *Western Europe)*
LG-Cap.: EMEP/CORINAIR Guide Book, chapter Cap.).
M-i-j (CORINAIR Manual 1992, part i, section j)

As an additional clarification of the methodology used to obtain the emission factors indicated in Table 6.3.4.2.2.1, in those cases where they are not directly extracted from the reference given, the following comments are indicated for the different activities

- Glass wool and mineral wool enduction: The emission factor is that indicated in the source as the sum for the following compounds: phenol, phenolic compounds, formaldehyde and total organic carbon.

- Printing industry: In the selection of emission factors for the different types of ink, the criteria indicated below have been applied, taking as a general reference the criteria listed in heading 8.1 of chapter B643 of the EMEP/CORINAIR Guidebook.

  Paste inks: for this type of ink, the factor assumed is 25% lower than that corresponding to “Flexography” in the “Decoration” sector listed in the source since, according to the information provided by ASEFAPI, the percentage of NMVOC in the inks does not exceed the value of 65%, for which reason the selected factor of 600 g/kg of ink seems to be more representative of the reality for this sector in Spain.

Black news inks: an intermediate value has been taken from those listed in the source for the sectors of “Press” (54 kg/t of ink) and “Edition/Publications” (range 182-425 kg/t of ink).

Gravure inks: the rounded value of 400 kg/t of ink similar to the 425 kg/t included in the source for the rotogravure technique in the “Edition/Publication” sector.

Other liquid inks - water-borne: the value has been taken from the questionnaires filled in by the ASEFAPI for the Directorate-General for Environmental Quality and Assessment.

Other liquid inks – solvent-borne: the value used in the previous edition of the Inventory for the inks as a whole has been maintained.

Other printing inks: an intermediate value has been taken from those listed in the source for the techniques of “Sheet fed offset” (437 kg/t of ink) and “Flexography” (800 kg/t of ink) in the “Rigid metallic packaging” sector.

Varnishes and sundries: a rounded value has been taken from the datum included for the “varnish” technique in the “Others” section of the source, bearing in mind that the datum of 363 kg/t indicated is expressed as a function of the tonnes of varnish and not of the tonnes of ink.

- Fat edible and non edible oil extraction: For this activity the socio-economic variable used is the amount of organic compound consumed, assuming that the consumption is emitted in its entirety. In accordance with the foregoing, the emission factor is identical to the unit (1,000,000 g/t).

- Preservation of wood: For protecting wood with creosote, the NMVOC emission factor used has been the one recommended in the source with regard to conditions in which no abatement techniques are used. In the case of PAH, the factor corresponds to the sum of the values in the source when regarding the four compounds in the persistent organic pollutants protocol, namely: Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene and Indene(123-cd)pyrene.

- Domestic use of pharmaceutical products: The factor selected has been taken from the case in France and corresponds to the consumption of ethyl alcohol or ethanol in France per inhabitant, according to information provided by the CITEPA.

6.4.- Other sources

Since every category in this sector is a NMVOC key source, no analysis for additional sources is reported here.

6.5.- References

- “Anuario de la piel (Leather annual report)”. Madrid: Consejo Español de la Piel

- Dirección General de Tráfico. “Anuario estadístico general”. Madrid: DGT, 1990-2008

- EMEP/EEA 2009. “Air Pollutant Emission Inventory Guidebook”. UNECE-Convention on long-range transboundary air pollution & European Environmental Agency.

- "Industrial Survey". Spanish National Statistics Institute (INE).
- Klimont, Zbigniew… [et al]. Interim Report IR-00-51. "Estimating Costs for Controlling Emissions of Volatile Organic Compounds (VOC) from Stationary Sources in Europe". IIASA, 2000.
- "The Chemical Industry in Spain". Ministry of Industry and Energy (MINER), currently Ministry of Industry, Tourism and Trade (MITYC).
- EMEP/CORINAIR Guide Book (1996). "Atmospheric Emission Inventory Guidebook". First Edition. February 1996. UNECE-convention on long-range transboundary air pollution & European Environmental Agency.
- EMEP/CORINAIR Guidebook. "Atmospheric Emission Inventory Guidebook". Second Edition. September 1999. UNECE-convention on long-range transboundary air pollution & European Environmental Agency.
- EMEP/CORINAIR Guidebook. "Atmospheric Emission Inventory Guidebook". Third Edition. Updated to December 2006. UNECE-Convention on long-range transboundary air pollution & European Environmental Agency.
- EMEP/CORINAIR Guidebook. "Atmospheric Emission Inventory Guidebook". Third Edition. Updated to December 2007. UNECE-Convention on long-range transboundary air pollution & European Environmental Agency.
- "Los Plásticos en España". Spanish Confederation of Plastics Bussines (ANAIP).
- CORINAIR Manual (1992). "Default Emission Factors Handbook". Second Edition. Edited by CITEPA for DG-XI CEC.
- IPCC Reference Manual. "Greenhouse Gas Inventory Reference Manual", Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. IPCC-OECD-IEA. 1997.
- UNECE-CLRTAP (1997). Draft BAT Background Document. Task Force on the Assessment of Abatement Options/Techniques for Volatile Organic Compounds. French-German Institute for Environmental Research. University of Karlsruhe, Germany. November 1997.
- USEPA, 1995 ("Compilation of Air Pollutant Emission Factors. Volume I: Stationary Point and Area Sources". AP-42. 5th Edition. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

7.- AGRICULTURE

Chapter update: September 2010

7.1.- Sector analysis

The chapter on agriculture addresses processes (and associated emissions) pertaining to agricultural and livestock activities, specifically those related to cropland treatment and livestock management. Activities related to emissions resulting from combustion in agricultural mobile machinery and stationary combustion facilities that may be used in agriculture are excluded from this chapter and described instead in the sections corresponding to energy.

As for the emissions generated by agricultural activities, it is worth noting the significant contribution to greenhouse gases with respect to the total inventory of CH_4 and N_2O, mainly resulting from enteric fermentation (CH_4), manure management (CH_4 and N_2O) and agricultural soils (N_2O).

As for the substances described in the present report, so-called air pollutants, the prevailing agricultural processes, partially different from those generating GHG, are listed and described below:

Manure Management (4B)

The processes described here pertain to livestock facilities, including the stage when animals generate their excreta (solid and liquid), the storage and disposal of excreta found in livestock housing, and finally the potential subsequent treatment of such excreta at *ad-hoc* facilities located on farms. On the other hand, this section does not include manure treatments taking place on farmland (application of manure as organic fertilizer, energy recovery from manure or transformation into other production inputs).

The main substances in this category are: NH_3, $PM_{2.5}$, PM_{10} and TSP.

Agricultural Soils (4D)

The processes described herein account for all emissions generated by agricultural soils, both in terms of their nitrogen values (NO_X and NH_3) or the agricultural practices that result from mechanical-physical handling operations (PM_{10} and TSP). Some of the most relevant nitrogen values applied to soils are: synthetic nitrogen fertilizers and animal manure. Particle emissions in agriculture are associated with land preparation practices and product harvesting.

The main substances in this category are: NO_X, NH_3, PM_{10} and TSP. However, $PM_{2.5}$ emissions were not accounted for due to lack of verified emission factors although, due to the inherent nature of the processes, these emissions are presumably generated.

Field burning of agricultural wastes (4F)

This activity is a combustion process with special characteristics, as it takes place in open fields, thus rendering the mixture of fuel to air and flame temperature the most relevant parameters in the generation of these pollutants.

The main substances in this category are: NO_X, NMVOC, SO_X, NH_3, CO, DIOX and PAH. However, particle emissions were not accounted for due to lack of verified emission factors although, due to the inherent nature of the processes, these emissions are presumably generated.

7.2.- Analysis by pollutant

7.2.1.- NO_X

NO_X agricultural emissions, whose pattern is shown in Table 7.2.1.1 and in Figure 7.2.1.1 experienced a 32.5% decrease between 1990 and 2008, descending from 28.7 gigagrams (Gg) to 19.4 Gg.

Table 7.2.1.1.- NO_X emissions (Amounts in Gg)

Category	1990	1995	2000	2004	2005	2006	2007	2008
4B Manure Management	-	-	-	-	-	-	-	-
4D Agricultural soils	14.1	12.5	16.6	14.7	13.2	13.7	13.9	11.6
4F Residue burning	14.6	13.1	10.1	7.8	5.8	7.5	7.8	7.8
Total Agriculture	**28.7**	**25.6**	**26.7**	**22.5**	**19.0**	**21.2**	**21.7**	**19.4**

Figure 7.2.1.1.- Pattern of NO_X emissions

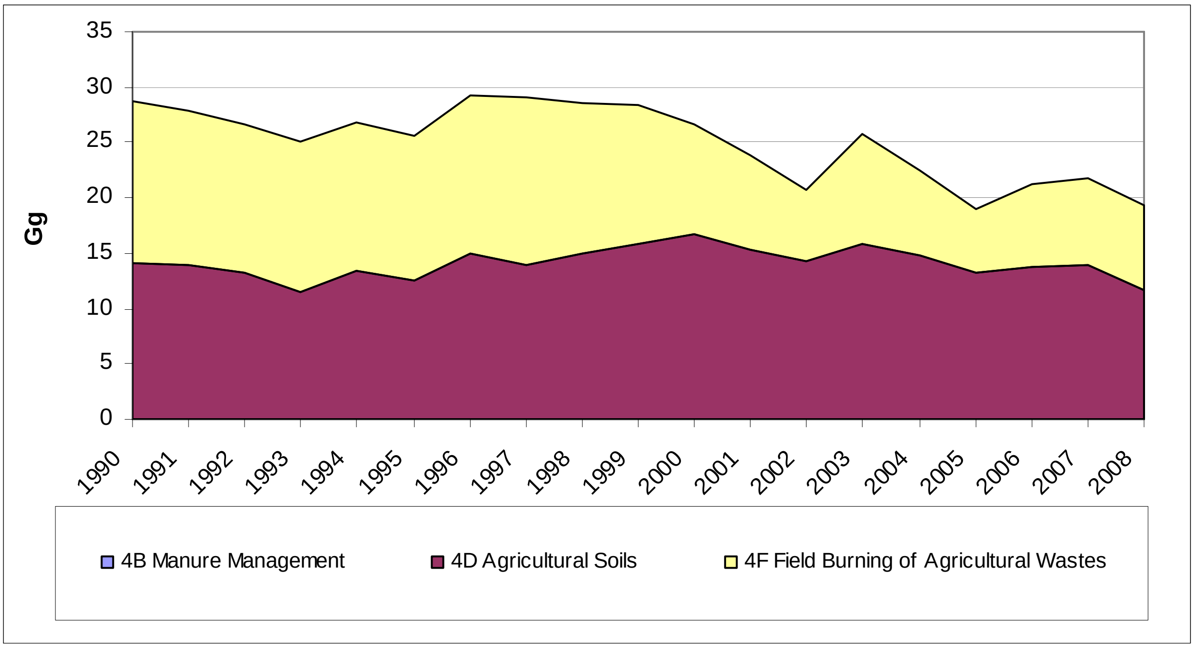


Figure 8H7.2.1.1 shows a clear downward trend for NO_X emissions in agriculture. However, Agricultural Soils emissions (4D) remain virtually stable with respect to 1990, but for a sudden decrease in the last year, exhibiting peaks and valleys caused by variations in the nitrogen values applied to soils (activity variable for these emissions), essentially those of synthetic nitrogen fertilizers.

However, emissions resulting from Residue Burning are reduced by half (-46.8%) due to the enforcement of regulations limiting the burning of waste in open fields. It is worth mentioning that this reduction affects every pollutant generated by Residue Burning, although at different rates. As described in detail in section 7.3.3. “Field Burning of Agricultural Wastes”, this is because the absence of certain parameters means the activity variable is not the same for every pollutant.

The peaks and valleys present in the Residue Burning series are explained by the different yearly agricultural production rates, strongly dependent on annual rainfall. It should be also pointed out the importance of vineyard and olive grove production, which account for a significant portion of Residue Burning, particularly in the last few years, and do not exhibit any cutbacks in terms of percentages burnt throughout the series.

As shown in Figure 7.2.1.2, in 2008 agricultural emission make up 1.6% of the total emissions in Spain of NO_X, which signifies an overall decrease in its contribution compared to 1990 when represented 2.1% of the total.

Figure 7.2.1.2.- Percentage of NO_X emissions by category with respect to the inventory total

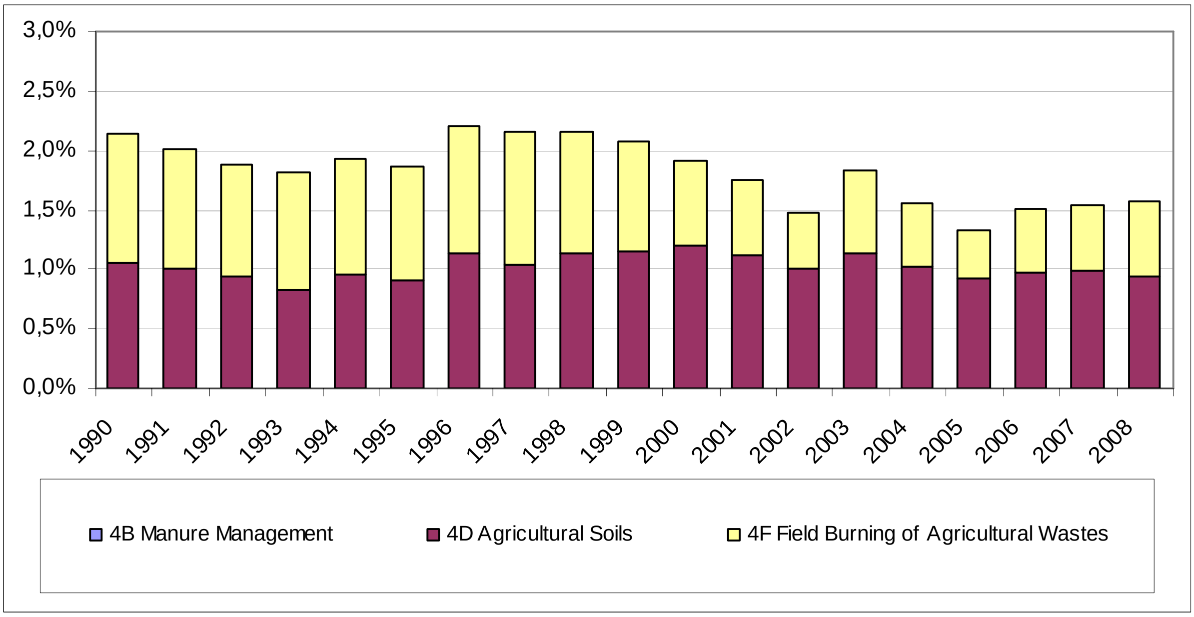
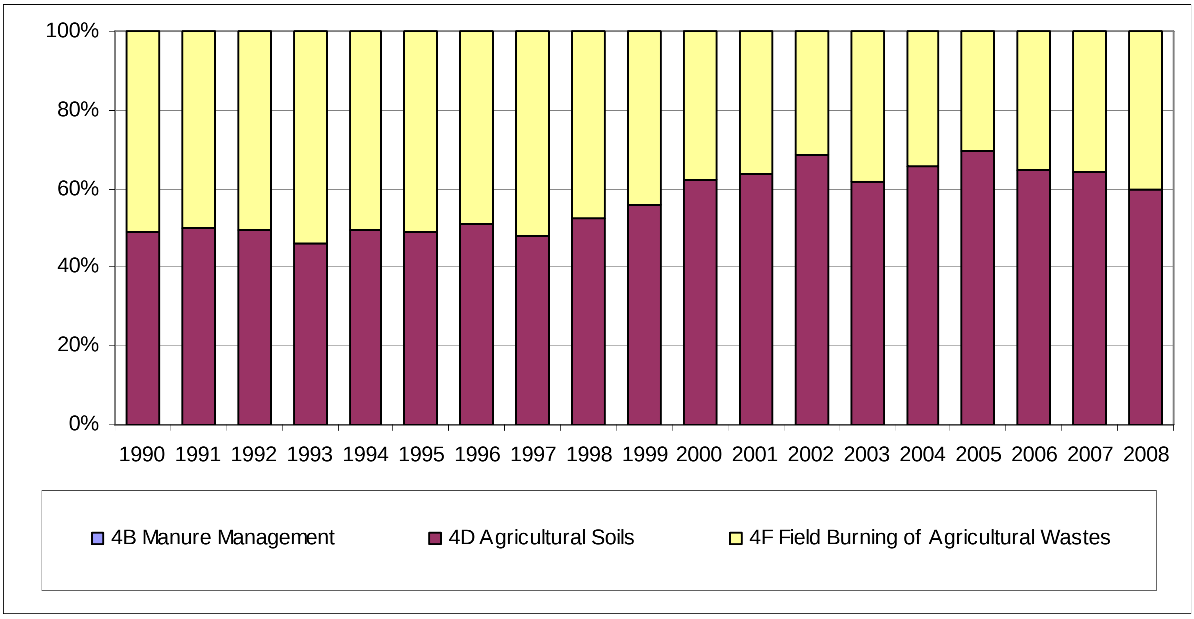


Figure 7.2.1.3 shows that the distribution of the emissions in this sector between categories has suffered a major variation in the period inventoried due to a constant decrease of Residues Burning emissions weight. From largest to smallest, in 2008, Agricultural Soils contribute almost 60% of the sector’s emissions, followed by Residue

Burning (40%). As shown before, NO_X emissions due to Manure Management does not take place.

Figure 7.2.1.3.- Percentage of NO_X emissions by category with respect to the sector total



In Agriculture Sector every key category is a net source of emissions, not a sink, therefore it could be also called “key sources”. The NO_X key sources identified for the period 1990-2008 are as follows:

- Field burning of agricultural wastes (4F): Source by trend 1991-1995 and 1999-2008.

- Agricultural soils (4D): Source by trend 1992-1995.

As a summary of the foregoing, Table 16H7.2.1.2 below shows, for this sector’s key categories for NO_X, the contribution of emissions to the levels and trends, the order number for this category in the list of key sources[1], as well as the absolute values, all referring to 2008.

Table 7.2.1.2.- NO_X key categories: Contribution to Level and Trend

Activity		NO_X (Gg) (2008)	Contribution Level (2008)			Contribution Trend (2008)		
Code	Description		%	K. Cat.	Rank	%	K. Cat.	Rank
4D	Agricultural soils	11.61	0.9%	NO	11	0.4%	NO	14
4F	Field burning of agricultural wastes	7.78	0.6%	NO	13	1.6%	YES	9

[1] Rank: Category order number in relation to key categories (ranked per level or trend contribution).

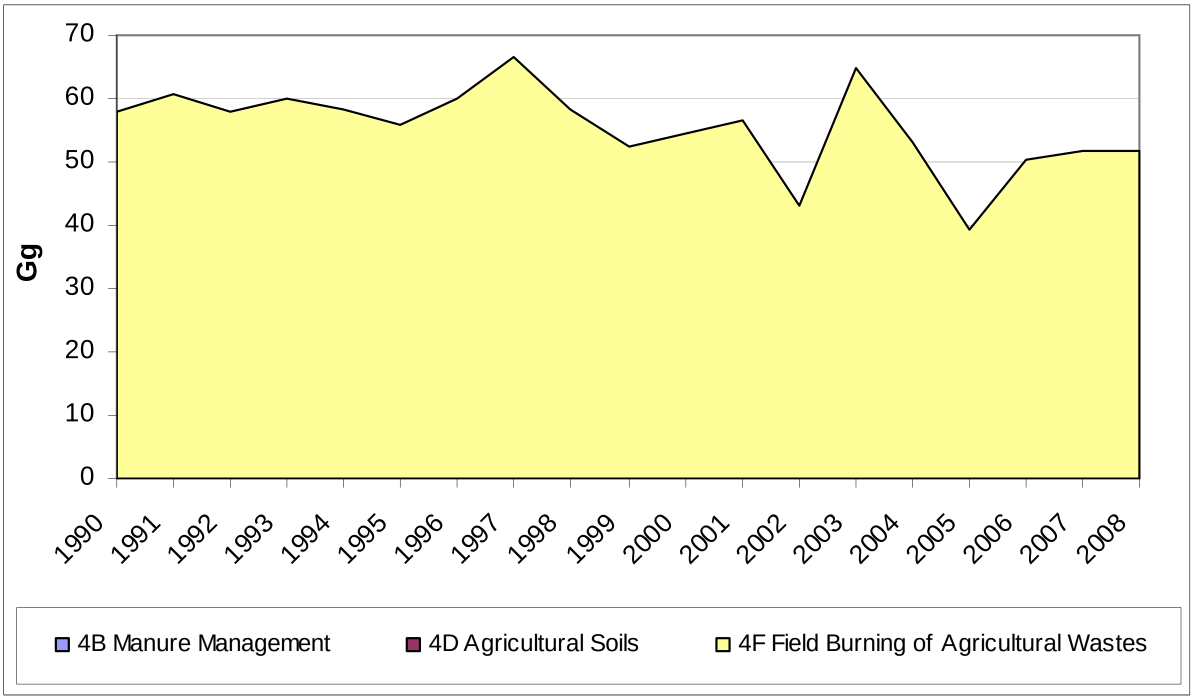
7.2.2.- NMVOC

NMVOC agricultural emissions, whose pattern is shown in Table 7.2.2.1 and in Figure 7.2.2.1 experienced a 10.7% decrease between 1990 and 2008, descending from 57.9 Gg to 51.7 Gg.

Table 7.2.2.1.- NMVOC emissions (Amounts in Gg)

Category	1990	1995	2000	2004	2005	2006	2007	2008
4B Manure Management	-	-	-	-	-	-	-	-
4D Agricultural soils	-	-	-	-	-	-	-	-
4F Residue burning	57.9	55.9	54.4	53.1	39.3	50.4	51.7	51.7
Total Agriculture	57.9	55.9	54.4	53.1	39.3	50.4	51.7	51.7

Figure 7.2.2.1.- Pattern of NMVOC emissions



Only category 4F ("Field Burning of Agricultural Wastes") generates emissions for this pollutant. Therefore, to analyze the trend for the series shown in Figure 20H7.2.2.1, please refer to section 7.2.1. NO_X.

As shown in Figure 7.2.2.2, in 2008 agricultural emission make up 6.3% of the total emissions in Spain of NMVOC, representing a slight increase from year 1990 (5.6%).

Figure 7.2.2.2.- Percentage of NMVOC emissions by category with respect to the inventory total

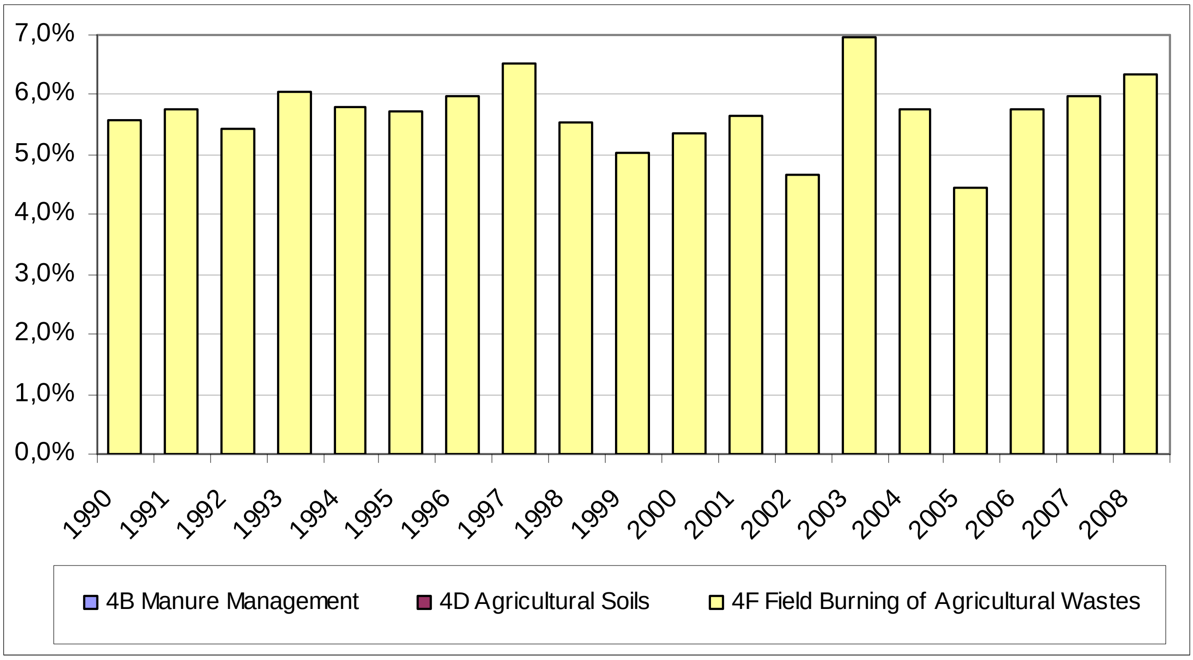
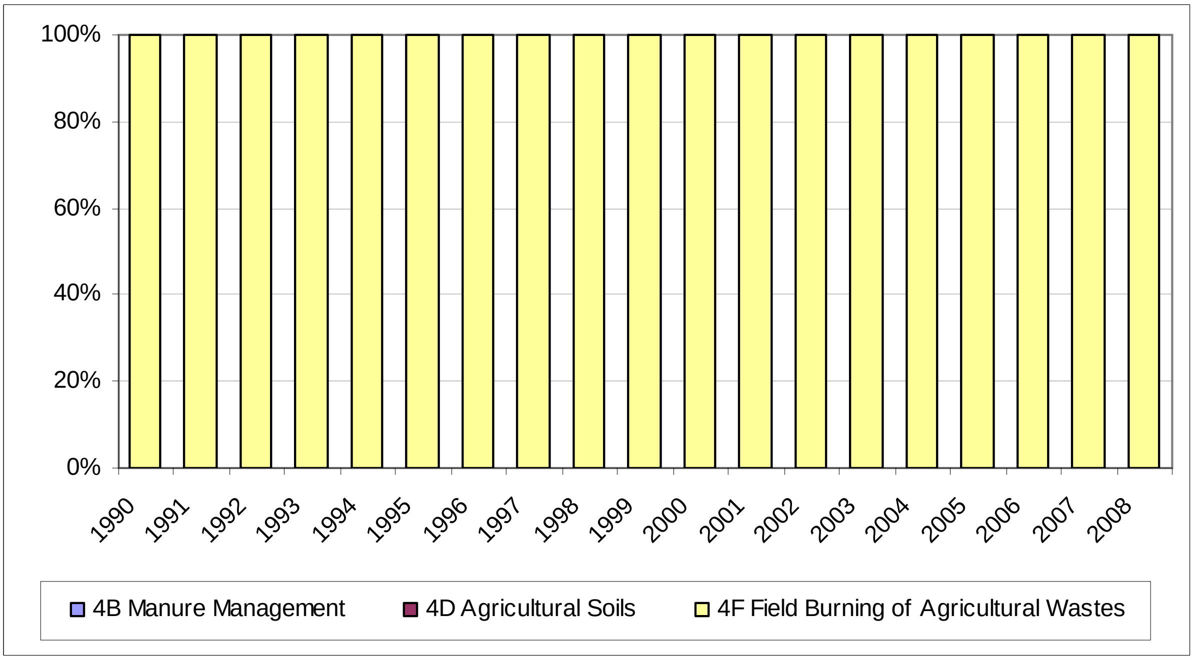


Figure 26H7.2.2.3 shows that only 4F category has emissions of this pollutant. Therefore, its contribution to the total NMVOC emissions of agricultural sector is 100%.

Figure 7.2.2.3.- Percentage of NMVOC emissions by category with respect to the sector total



The NMVOC key sources identified for the period 1990-2008 are as follows:

- Field burning of agricultural wastes (4F): Source by level 1990-2008 and by trend 1991-1994, 1996-1997, 1999, 2002-2003 and 2005.

As a summary of the foregoing, Table 28H7.2.2.2 below shows, for this sector's key categories for NMVOC, the contribution of emissions to the levels and trends, the order number for this category in the list of key sources, as well as the absolute values, all referring to 2008.

Table 7.2.2.2.- NMVOC key categories: Contribution to Level and Trend

Activity		COVNM (Gg) (2008)	Contribution Level (2008)			Contribution Trend (2008)		
Code	**Description**		**%**	**K. Cat.**	**Rank**	**%**	**K. Cat.**	**Rank**
4F	Field burning of agricultural wastes	51.68	6.3%	YES	4	1.2%	NO	15

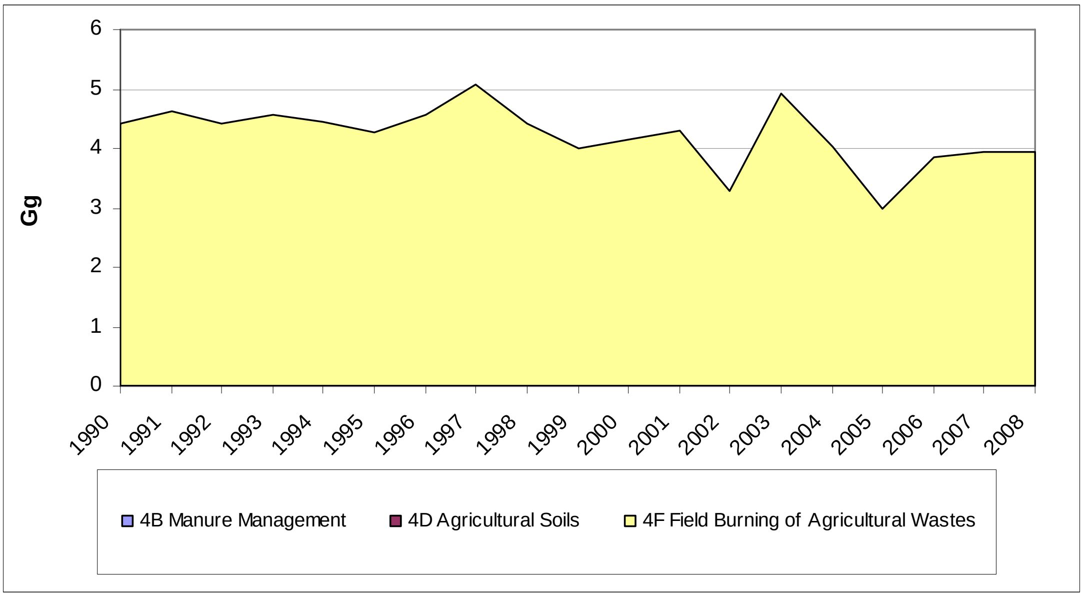
7.2.3.- SO_X

SO_X agricultural emissions, whose pattern is shown in Table 7.2.3.1 and in Figure 7.2.3.1 experienced a 10.7% decrease between 1990 and 2008, descending from 4.4 Gg to 3.9 Gg.

Table 7.2.3.1.- SO_X emissions (Amounts in Gg)

Category	1990	1995	2000	2004	2005	2006	2007	2008
4B Manure Management	-	-	-	-	-	-	-	-
4D Agricultural soils	-	-	-	-	-	-	-	-
4F Residue burning	4.4	4.3	4.1	4.0	3.0	3.8	3.9	3.9
Total Agriculture	**4.4**	**4.3**	**4.1**	**4.0**	**3.0**	**3.8**	**3.9**	**3.9**

Figure 7.2.3.1.- Pattern of SO_X emissions



Only category 4F ("Field Burning of Agricultural Wastes") generates emissions for this pollutant. Therefore, to analyze the trend for the series shown in Figure 32H7.2.3.1, please refer to section 7.2.1. NO_X.

As shown in Figure 7.2.3.2, in 2008 agricultural emission make up 0.7% of the total emissions in Spain of SO_X, which signifies, regardless of the decrease in absolute emissions for this activity, an important overall increase in its contribution compared to 1990 when represented 0.2% of the total.

Figure 7.2.3.2.- Percentage of SO_X emissions by category with respect to the inventory total

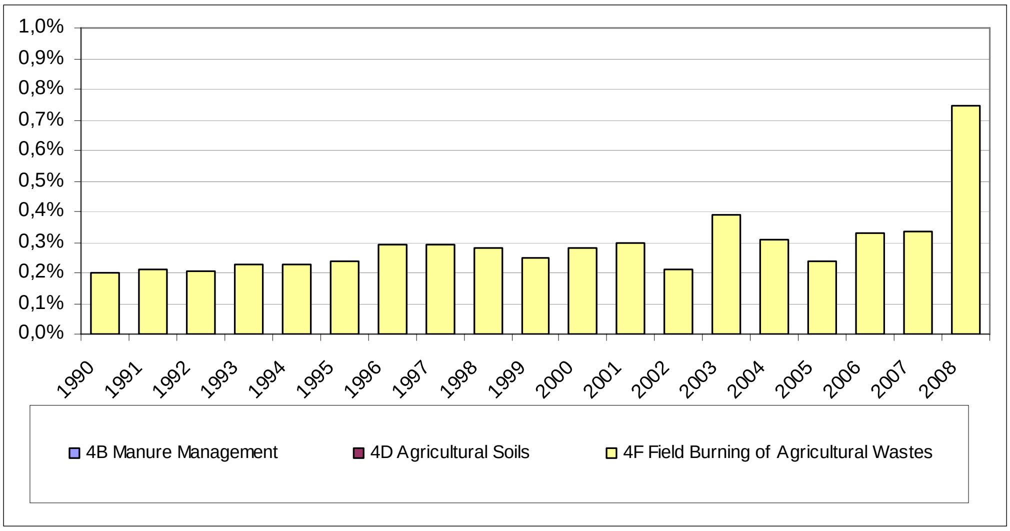
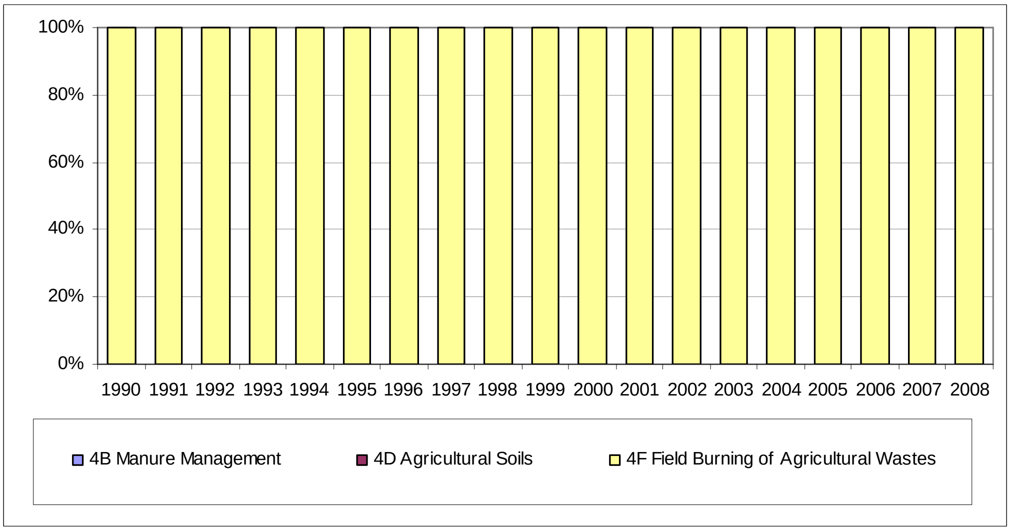


Figure 7.2.3.3 shows that only 4F category has emissions of this pollutant. Therefore, its contribution to the total SO_X emissions of agricultural sector is 100%.

Figure 7.2.3.3.- Percentage of SO_X emissions by category with respect to the sector total



No category has been identified as SO_X key source for the period 1990-2008.

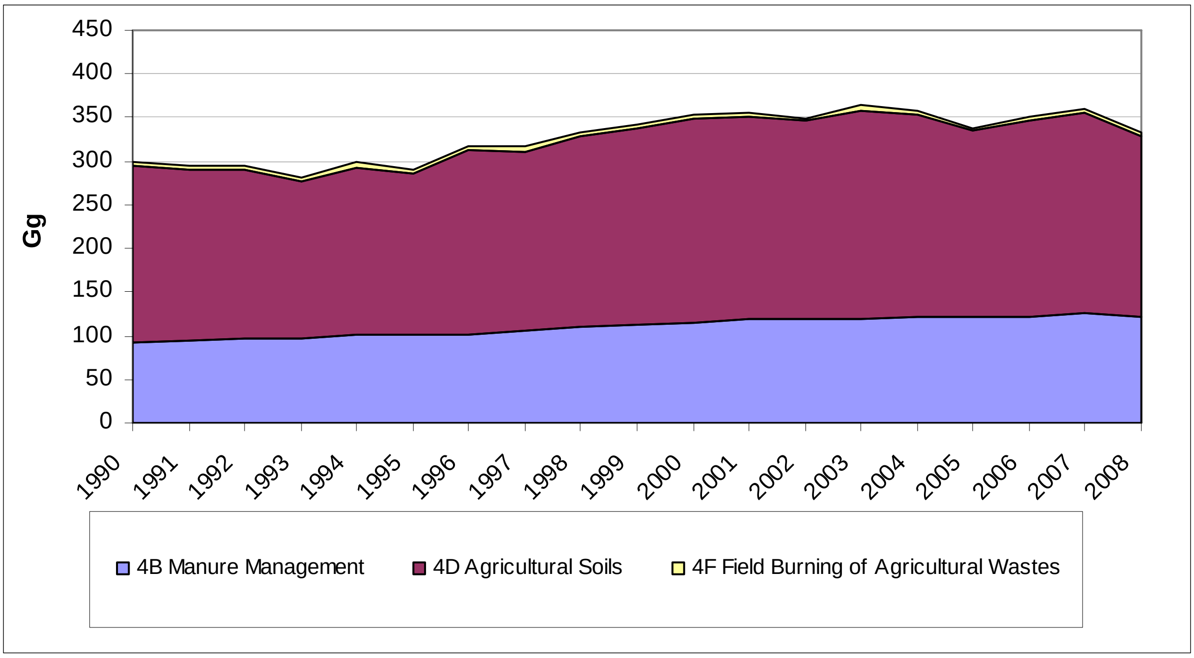
7.2.4.- NH_3

NH_3 agricultural emissions, whose pattern is shown in Table 7.2.4.1 and in Figure 7.2.4.1 experienced a 10.7% increase between 1990 and 2008, raising from 298.6 Gg to 332.7 Gg.

Table 7.2.4.1.- NH_3 emissions (Amounts in Gg)

Category	1990	1995	2000	2004	2005	2006	2007	2008
4B Manure Management	93.1	101.9	114.8	121.8	120.8	121.9	125.9	120.5
4D Agricultural soils	200.5	184.7	234.5	230.4	214.4	223.8	229.2	207.8
4F Residue burning	5.0	4.8	4.7	4.5	3.4	4.3	4.4	4.4
Total Agriculture	**298.6**	**291.4**	**354.0**	**356.8**	**338.6**	**350.0**	**359.5**	**332.7**

Figure 7.2.4.1.- Pattern of NH_3 emissions



NH_3 emissions exhibit an upward trend in the series under study (11.4%), due to the rise in livestock throughout the series. This increase in cattle heads implies an increase in nitrogen excretion and subsequently in nitrogen values for agricultural soils in the form of organic fertilizers and grazing. This increase in the nitrogen values largely explains the increase in emissions associated with Manure Management (29.4%) and, to a lesser extent, the increase in emissions in agricultural soils (3.6%), as syntethic fertilizers are also included in this category. On the other hand, emissions resulting from Residue Burning decreased by 10.7%, although due to their small contribution to total emissions in the sector they barely influence the trend.

As shown in Figure 7.2.4.2, in 2008 agricultural emission make up 92.8% of the total emissions in Spain of NH_3, which signifies, regardless of the increase in absolute emissions for this activity, an overall decrease in its contribution compared to 1990 when represented 94.0% of the total.

Figure 7.2.4.2.- Percentage of NH_3 emissions by category with respect to the inventory total

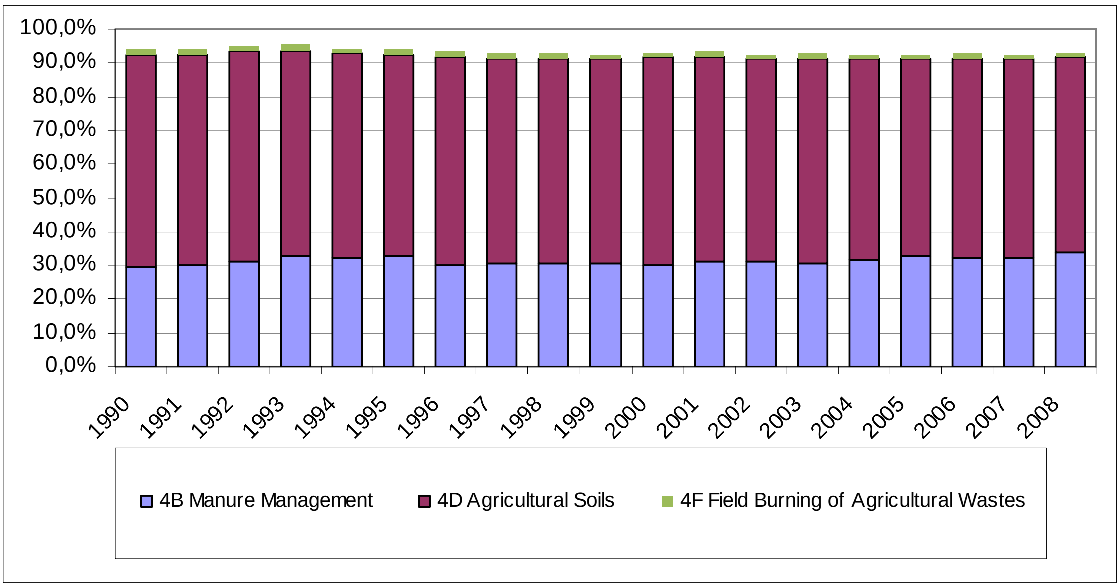
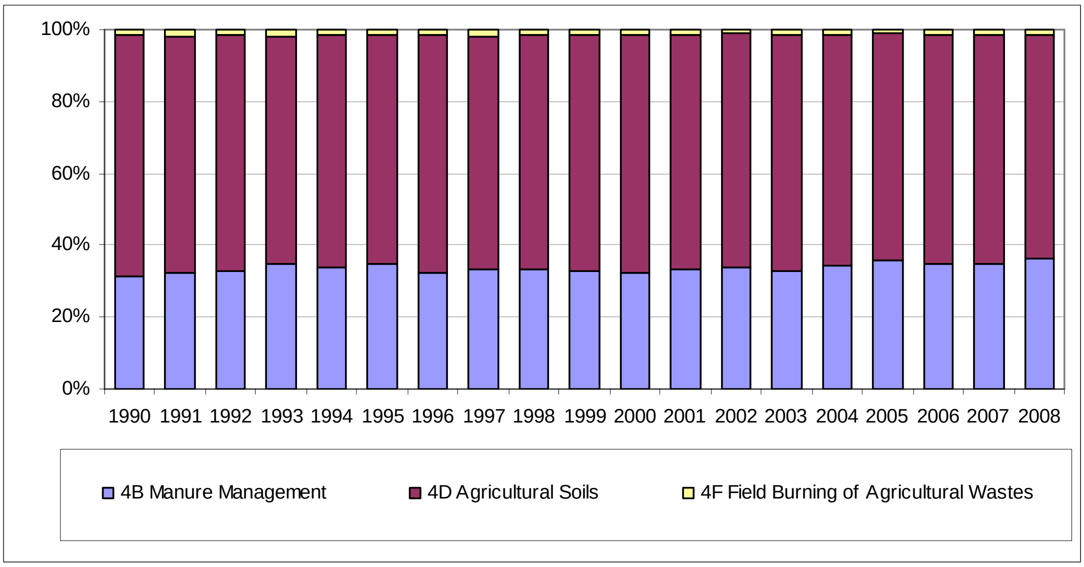


Figure 7.2.4.3 shows that the distribution of the emissions in this sector between categories has not suffered a major variation in the period inventoried. From largest to smallest, in 2008, Agricultural Soils contribute more than 62% of the sector's emissions, followed by Manure Management (36%) and Residue Burning (1%).

Figure 7.2.4.3.- Percentage of NH_3 emissions by category with respect to the sector total



The NH_3 key sources identified for the period 1990-2008 are as follows:

- Manure Management (4B): Source by level 1990-2008 and by trend 1991-2008.
- Agricultural soils (4D): Source by level 1990-2008 and by trend 1991-2008.
- Field burning of agricultural wastes (4F): Source by trend 1991, 1999-2000, 2002 and 2005.

As a summary of the foregoing, Table 48H7.2.4.2 below shows, for this sector's key categories for NH_3, the contribution of emissions to the levels and trends, the order number for this category in the list of key sources, as well as the absolute values, all referring to 2008.

Table 7.2.4.2.- NH_3 key categories: Contribution to Level and Trend

Activity		NH_3 (Gg) (2008)	Contribution Level (2008)			Contribution Trend (2008)		
Code	**Description**		**%**	**K. Cat.**	**Rank**	**%**	**K. Cat.**	**Rank**
4B	Manure management	120.51	33.6%	YES	2	30.3%	YES	2
4D	Agricultural soils	207.77	58.0%	YES	1	36.1%	YES	1
4F	Field burning of agricultural wastes	4.43	1.2%	NO	6	2.3%	NO	6

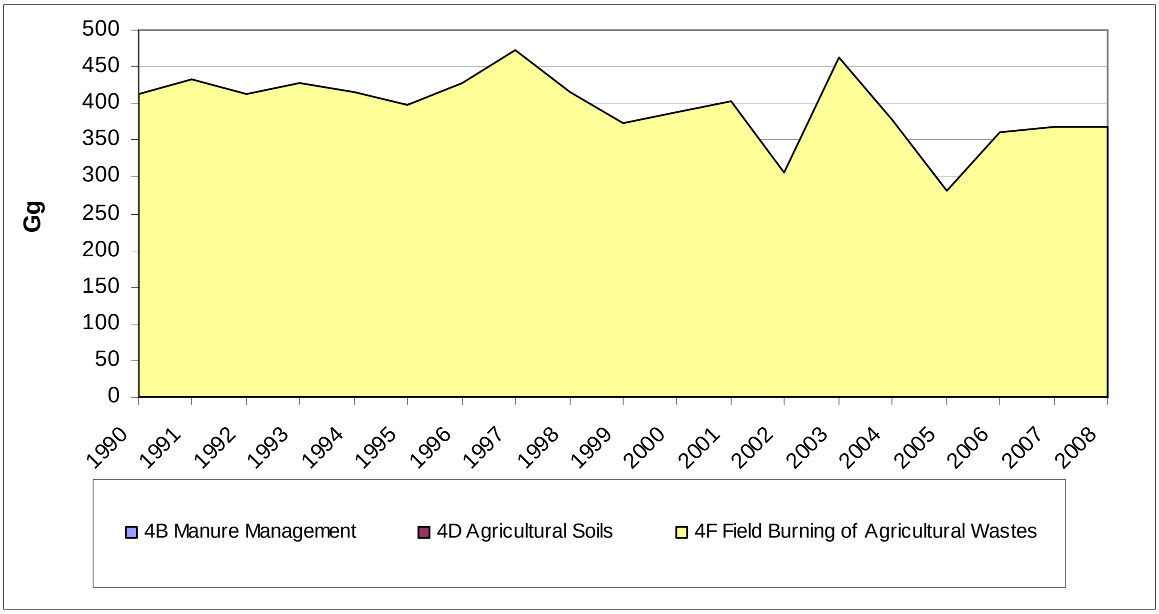
7.2.5.- CO

CO agricultural emissions, whose pattern is shown in Table 7.2.5.1 and in Figure 7.2.5.1 experienced a 10.7% decrease between 1990 and 2008, descending from 412.7 Gg to 368.5 Gg.

Table 7.2.5.1.- CO emissions (Amounts in Gg)

Category	1990	1995	2000	2004	2005	2006	2007	2008
4B Manure Management	-	-	-	-	-	-	-	-
4D Agricultural soils	-	-	-	-	-	-	-	-
4F Residue burning	412.7	398.5	387.7	378.4	280.1	359.6	368.5	368.5
Total Agriculture	**412.7**	**398.5**	**387.7**	**378.4**	**280.1**	**359.6**	**368.5**	**368.5**

Figure 7.2.5.1.- Pattern of CO emissions



Only category 4F ("Field Burning of Agricultural Wastes") generates emissions for this pollutant. Therefore, to analyze the trend for the series shown in Figure 52H7.2.5.1, please refer to section 7.2.1. NO_X.

As shown in Figure 7.2.5.2, in 2008 agricultural emission make up 18.5% of the total emissions in Spain of CO, which signifies, regardless of the decrease in absolute emissions for this activity, an overall increase in its contribution compared to 1990 when represented 11.3% of the total.

Figure 7.2.5.2.- Percentage of CO emissions by category with respect to the inventory total

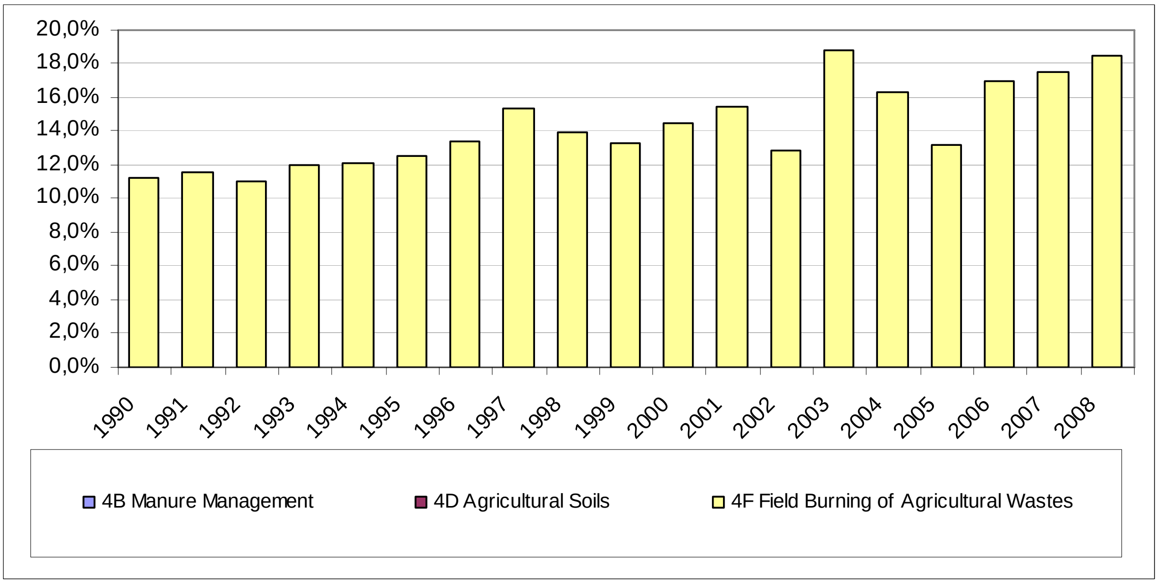
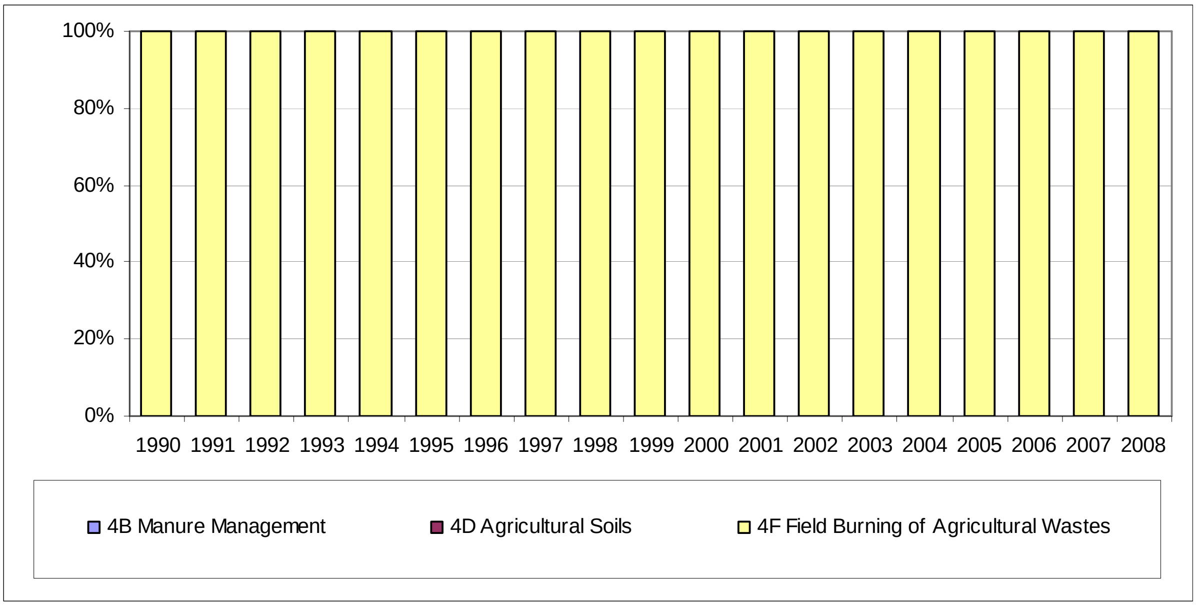


Figure 7.2.5.3 shows that only 4F category has emissions of this pollutant. Therefore, its contribution to the total CO emissions of agricultural sector is 100%.

Figure 7.2.5.3.- Percentage of CO emissions by category with respect to the sector total



The CO key sources identified for the period 1990-2008 are as follows:

- Field burning of agricultural wastes (4F): Source by level 1990-2008 and by trend 1991-2008.

As a summary of the foregoing, Table 60H7.2.5.2 below shows, for this sector's key categories for CO, the contribution of emissions to the levels and trends, the order number for this category in the list of key sources, as well as the absolute values, all referring to 2008.

Table 7.2.5.2.- CO key categories: Contribution to Level and Trend

Activity		CO (Gg) (2008)	Contribution Level (2008)			Contribution Trend (2008)		
Code	Description		%	K. Cat.	Rank	%	K. Cat.	Rank
4F	Field burning of agricultural wastes	368.47	18.5%	YES	3	8.8%	YES	4

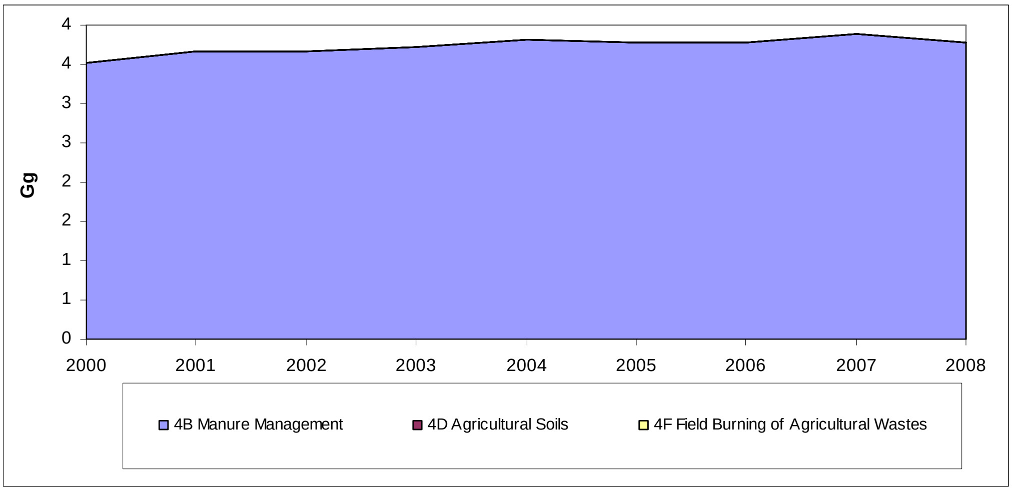
7.2.6.- $PM_{2.5}$

$PM_{2.5}$ agricultural emissions, whose pattern is shown in Table 7.2.6.1 and in Figure 7.2.6.1 experienced a 7.1% increase between 2000 and 2008, raising from 3.5 Gg to 3.8 Gg.

Table 7.2.6.1.- $PM_{2.5}$ emissions (Amounts in Gg)

Category	2000	2004	2005	2006	2007	2008
4B Manure Management	3.5	3.8	3.8	3.8	3.9	3.8
4D Agricultural soils	-	-	-	-	-	-
4F Residue burning	-	-	-	-	-	-
Total Agriculture	**3.5**	**3.8**	**3.8**	**3.8**	**3.9**	**3.8**

Figure 7.2.6.1.- Pattern of $PM_{2.5}$ emissions



The increase in particle emissions, and particularly $PM_{2.5}$ emissions, are due to the increase in livestock during the period under study. This increase varies depending on the type of particles due to the variable weight of the different animals in emissions based on their specific emission factor.

As shown in Figure 7.2.6.2, in 2008 agricultural emission make up 3.0% of the total emissions in Spain of $PM_{2.5}$, representing a 2.8% in year 2000.

Figure 7.2.6.2.- Percentage of $PM_{2.5}$ emissions by category with respect to the inventory total

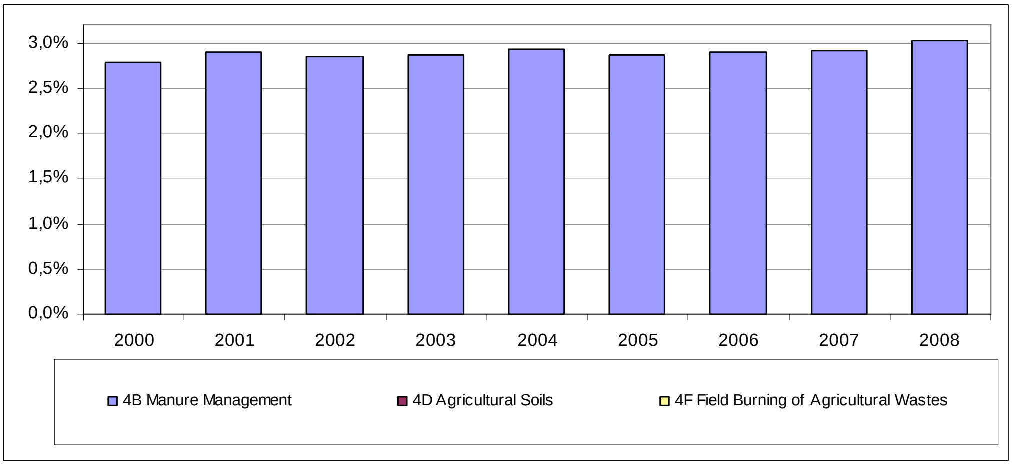
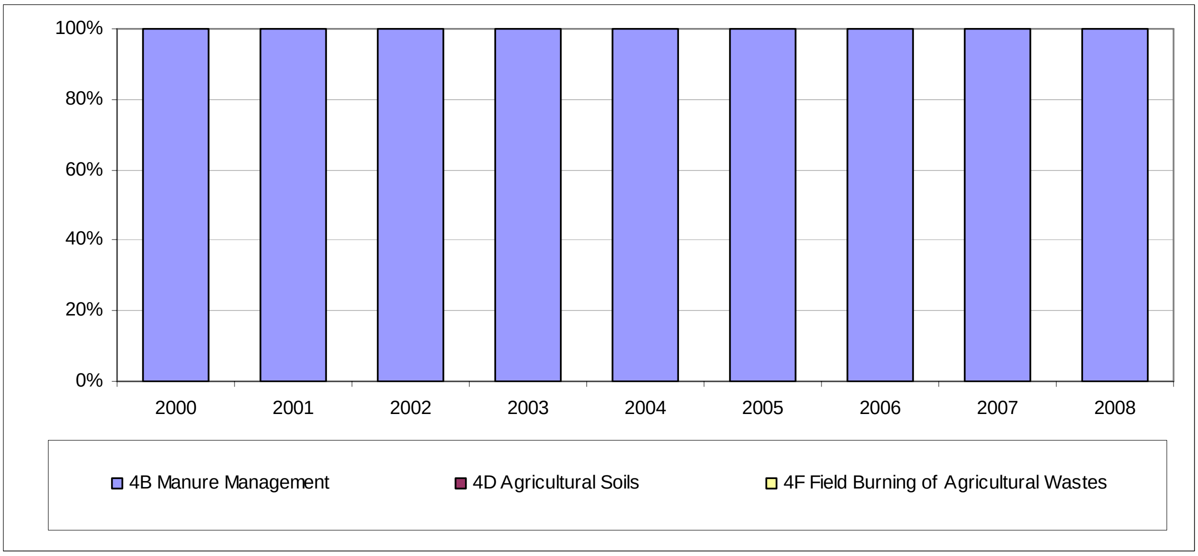


Figure 7.2.6.3 shows that only 4B category has emissions of this pollutant. Therefore, its contribution to the total $PM_{2.5}$ emissions of agricultural sector is 100%.

Figure 7.2.6.3.- Percentage of $PM_{2.5}$ emissions by category with respect to the sector total



The $PM_{2,5}$ key sources identified for the period 1990-2008 are as follows:

- Manure Managementl (4B): Sourece by level 2000-2008 and by trend 2001.

As a summary of the foregoing, Table 7.2.6.2 below shows, for this sector's key categories for $PM_{2,5}$, the contribution of emissions to the levels and trends, the order number for this category in the list of key sources, as well as the absolute values, all referring to 2008.

Tabla7.2.6.2.- $PM_{2,5}$ key categories: Contribution to Level and Trend

Activity		$PM_{2,5}$ (Gg) (2008)	Contribution Level (2008)			Contribution Trend (2008)		
Code	Description		%	K. Cat.	Rank	%	K. Cat.	Rank
4B	Manure Management	3.77	3.03%	YES	5	1.58%	NO	6

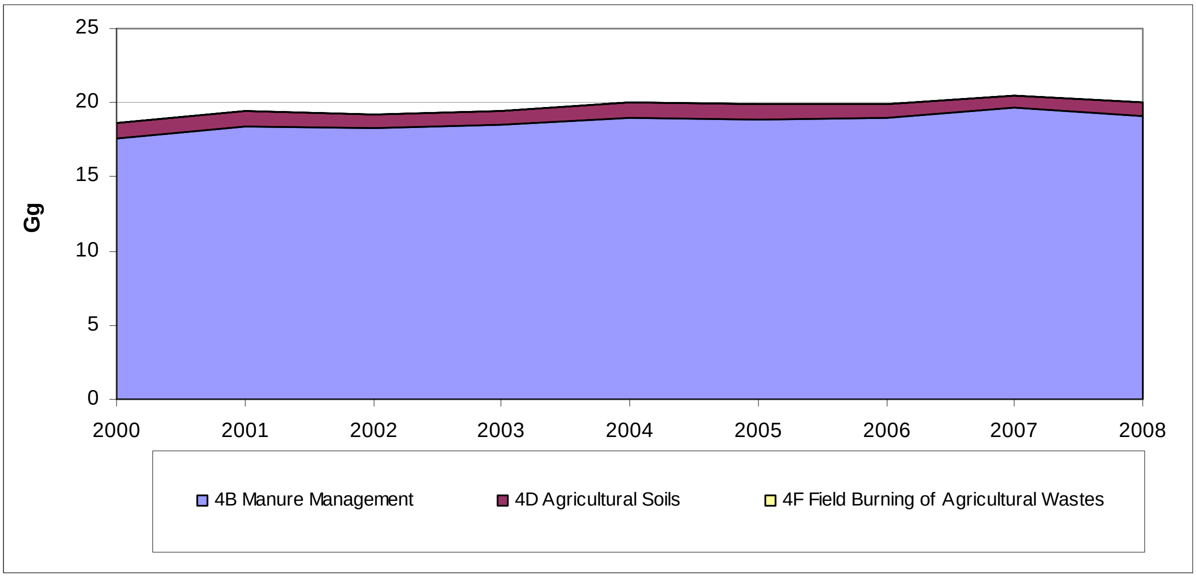
7.2.7.- PM_{10}

PM_{10} agricultural emissions, whose pattern is shown in Table 7.2.7.1 and in Figure 7.2.7.1 experienced a 7.4% increase between 2000 and 2008, raising from 18.6 Gg to 20 Gg.

Table 7.2.7.1.- PM_{10} emissions (Amounts in Gg)

Category	2000	2004	2005	2006	2007	2008
4B Manure Management	17.6	19.0	18.9	19.0	19.7	19.1
4D Agricultural soils	1.0	1.0	0.9	0.9	0.9	0.9
4F Residue burning	-	-	-	-	-	-
Total Agriculture	**18.6**	**20.0**	**19.9**	**19.9**	**20.5**	**20.0**

Figure 7.2.7.1.- Pattern of PM_{10} emissions



The upward trend for particle emissions is due to the increase in emissions associated with Manure Management (8.5%), see section 7.2.6. for a detailed explanation of this trend. On the other hand, the emissions for agricultural soils decrease (13%), due to the reduction in the number of hectares of arable crops between 1990 and 2008.

As shown in Figure 7.2.7.2, in 2008 agricultural emission make up 12.5% of the total emissions in Spain of PM_{10}, which signifies an overall increase in its contribution compared to 2000 when represented 10.9% of the total.

Figure 7.2.7.2.- Percentage of PM_{10} emissions by category with respect to the inventory total

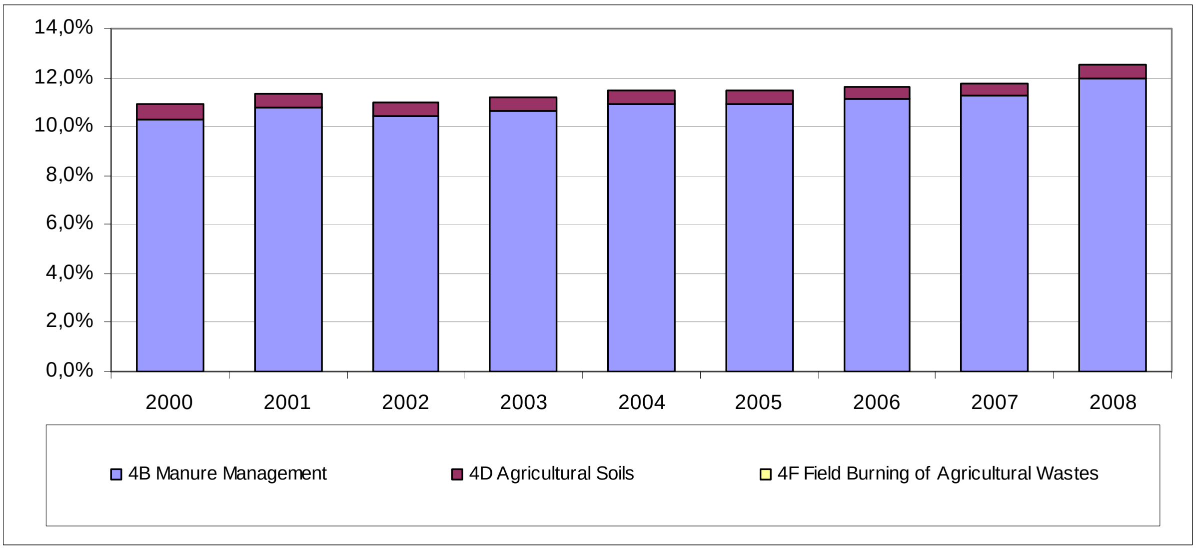


Figure 7.2.7.3 shows that the distribution of the emissions in this sector between categories has not suffered a major variation in the period inventoried, being Manure Management emissions preponderant. From largest to smallest, in 2008, Manure Management (96%), followed by Agricultural Soils (4%).

Figure 7.2.7.3.- Percentage of PM_{10} emissions by category with respect to the sector total

The PM_{10} key sources identified for the period 2000-2008 are as follows:

- Manure Management (4B): Source by level 2000-2008 and by trend 2001-2008.

As a summary of the foregoing, Table 7.2.7.2 below shows, for this sector's key categories for PM_{10}, the contribution of emissions to the levels and trends, the order number for this category in the list of key sources, as well as the absolute values, all referring to 2008.

Table 7.2.7.2.- PM_{10} categories: Contribution to Level and Trend

Activity		PM_{10} (Gg) (2008)	Contribution Level (2008)			Contribution Trend (2008)		
Code	**Description**		**%**	**K. Cat.**	**Rank**	**%**	**K. Cat.**	**Rank**
4B	Manure management	19.11	11.96	YES	4	8.04	YES	4

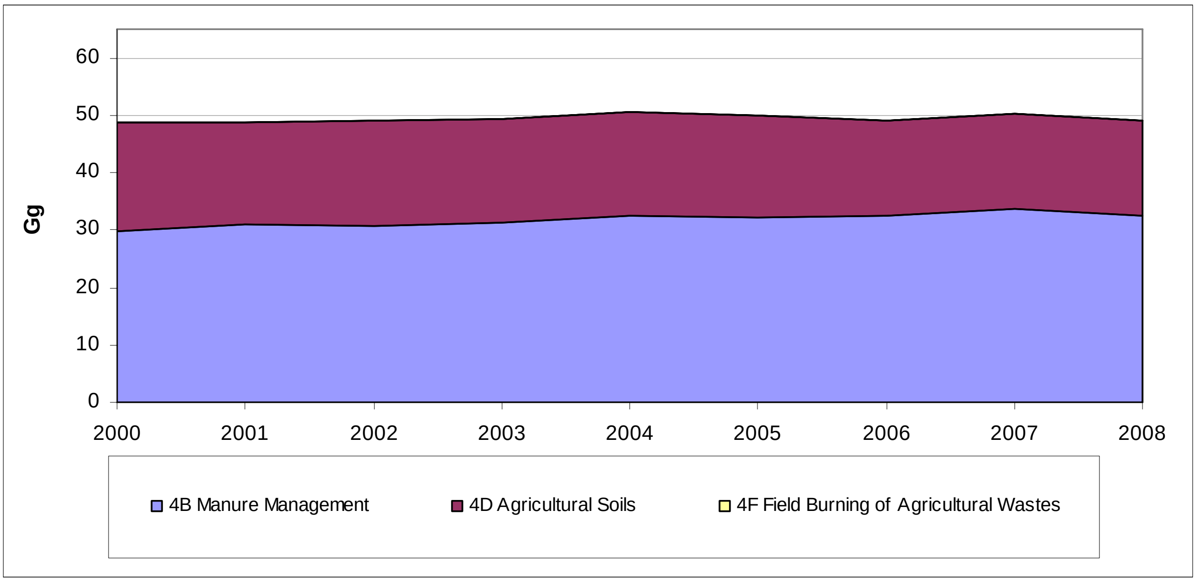
7.2.8.- TSP

TSP agricultural emissions, whose pattern is shown in Table 7.2.8.1 and in Figure 7.2.8.1 experienced a 0.5% increase between 2000 and 2008, raising from 48.7 Gg to 49 Gg.

Table 7.2.8.1.- TSP emissions (Amounts in Gg)

Category	2000	2004	2005	2006	2007	2008
4B Manure Management	29.8	32.5	32.3	32.6	33.7	32.5
4D Agricultural soils	18.9	18.0	17.7	16.6	16.5	16.5
4F Residue burning	-	-	-	-	-	-
Total Agriculture	**48.7**	**50.4**	**49.9**	**49.2**	**50.1**	**49.0**

Figure 7.2.8.1.- Pattern of TSP emissions



The changes in TSP emissions are analogous to those for PM_{10} (please see section 7.2.7), except that the greater contribution from Agricultural Soils, due to the emission factor, partly mitigates the increase in emissions.

As shown in Figure 7.2.8.2, in 2008 agricultural emission make up 23.2% of the total emissions in Spain of TSP, which signifies an slight overall increase in its contribution compared to 2000 when represented 21.1% of the total.

Figure 7.2.8.2.- Percentage of TSP emissions by category with respect to the inventory total

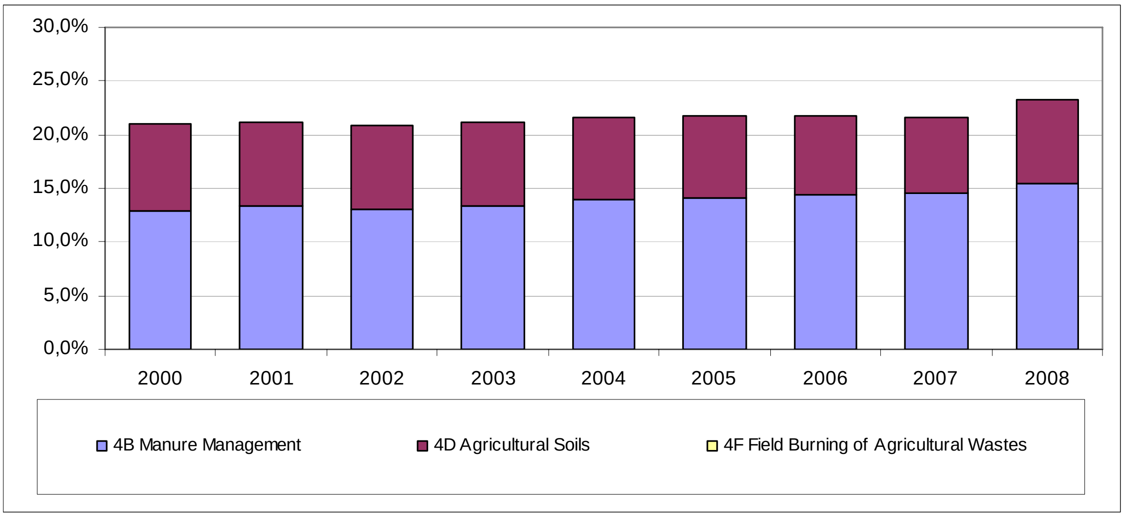
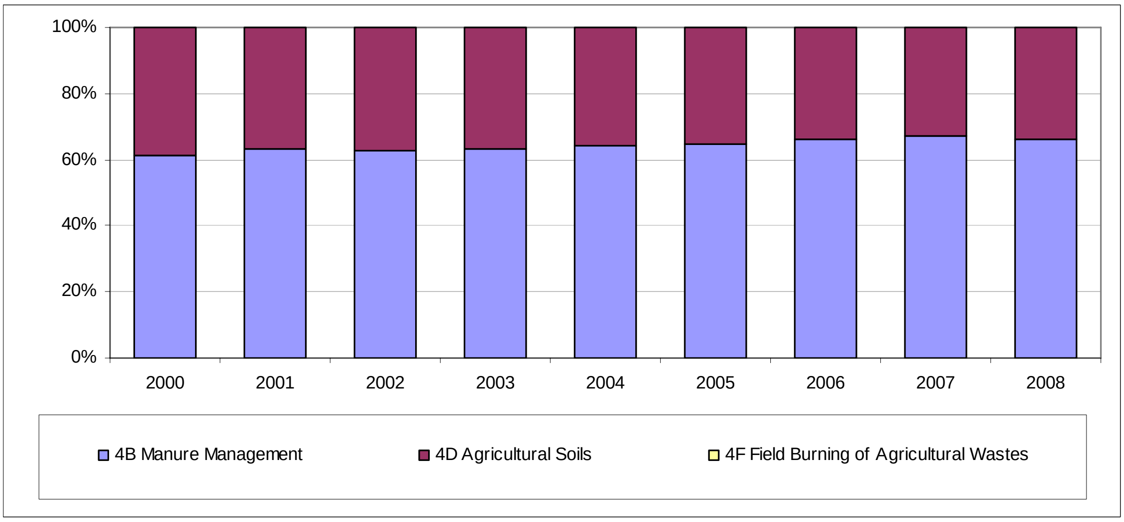


Figure 7.2.8.3 shows that the distribution of the emissions in this sector between categories has not suffered a major variation in the period inventoried. From largest to smallest, in 2008, Manure Management contribute (66%), followed by Agricultural Soils (34%).

Figure 7.2.8.3.- Percentage of TSP emissions by category with respect to the sector total



The TSP key sources identified for the period 2000-2008 are as follows:

- Manure Management (4B): Source by level 2000-2008 and by trend 2001-2008.
- Agricultural Soils (4D): Source by level 2000-2008 and by trend 2001 and 2001-2007.

As a summary of the foregoing, Table 7.2.8.2 below shows, for this sector's key categories for TSP, the contribution of emissions to the levels and trends, the order number for this category in the list of key sources, as well as the absolute values, all referring to 2008.

Table 7.2.8.2.- TSP categories: Contribution to Level and Trend

Activity		TSP (Gg) (2008)	Contribution Level (2008)			Contribution Trend (2008)		
Code	Description		%	K. Cat.	Rank	%	K. Cat.	Rank
4B	Manure management	32.51	15.37	YES	4	10.42	YES	4
4D	Agricultural soils	16.46	7.79	YES	5	1.66	NO	7

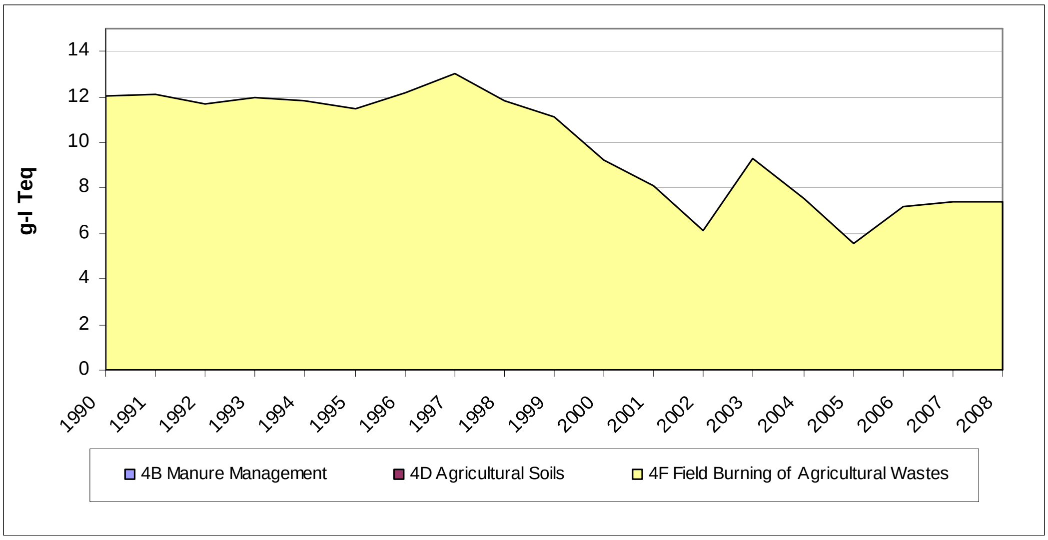
7.2.9.- DIOX

DIOX agricultural emissions, whose pattern is shown in Table 7.2.9.1 and in Figure 7.2.9.1 experienced a 38.8% decrease between 1990 and 2008, descending from 12.1 g-I Teq to 7.4 g-I Teq.

Table 7.2.9.1.- DIOX emissions (Amounts in g-I Teq)

Category	1990	1995	2000	2004	2005	2006	2007	2008
4B Manure Management	-	-	-	-	-	-	-	-
4D Agricultural soils	-	-	-	-	-	-	-	-
4F Residue burning	12.1	11.5	9.2	7.5	5.6	7.2	7.4	7.4
Total Agriculture	**12.1**	**11.5**	**9.2**	**7.5**	**5.6**	**7.2**	**7.4**	**7.4**

Figure 7.2.9.1.- Pattern of DIOX emissions



Only category 4F ("Field Burning of Agricultural Wastes") generates emissions for this pollutant. Therefore, to analyze the trend for the series shown in Figure 7.2.9.1, please refer to section 7.2.1. NO_X.

As shown in Figure 7.2.9.2, in 2008 agricultural emission make up 4.6% of the total emissions in Spain of DIOX, which signifies an overall decrease in its contribution compared to 1990 when represented 6.5% of the total.

Figure 7.2.9.2.- Percentage of DIOX emissions by category with respect to the inventory total

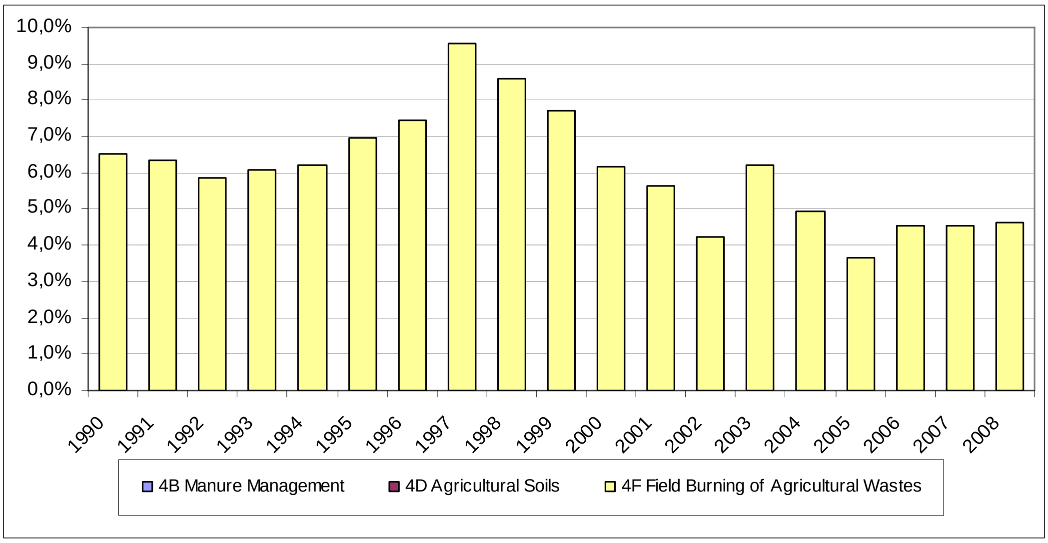
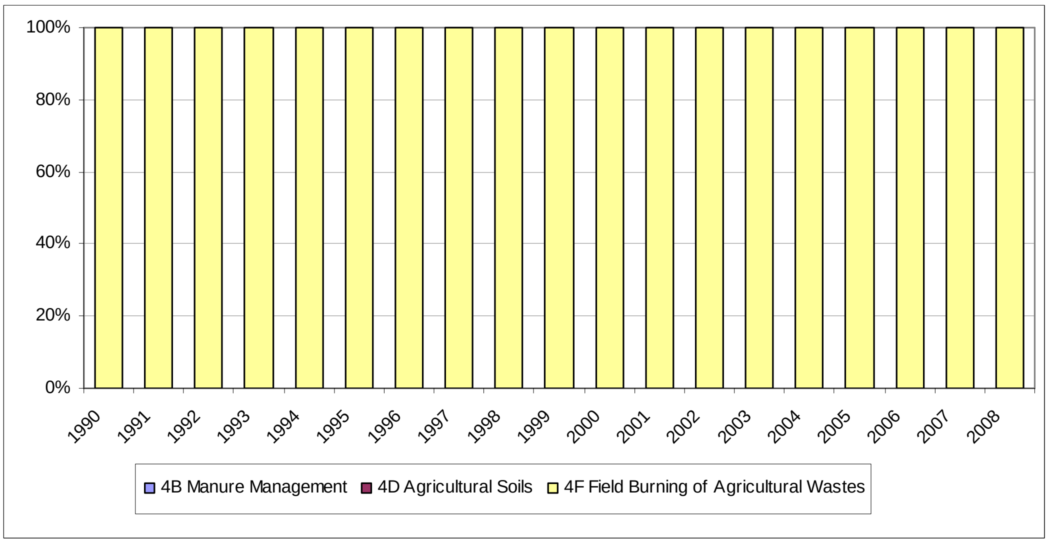


Figure 7.2.9.3 shows that only 4F category has emissions of this pollutant. Therefore, its contribution to the total DIOX emissions of agricultural sector is 100%.

Figure 7.2.9.3.- Percentage of DIOX emissions by category with respect to the sector total



The DIOX key sources identified for the period 1990-2008 are as follows:

- Field burning of agricultural wastes (4F): Source by level 1990-2008 and by trend 1992-1993, 1996-1998, 2002 and 2005-2008.

As a summary of the foregoing, Table 7.2.9.2 below shows, for this sector's key categories for DIOX, the contribution of emissions to the levels and trends, the order number for this category in the list of key sources, as well as the absolute values, all referring to 2008.

Table 7.2.9.2.- DIOX key categories: Contribution to Level and Trend

Activity		DIOX (g-I Teq) (2008)	Contribution Level (2008)			Contribution Trend (2008)		
Code	Description		%	K. Cat.	Rank	%	K. Cat.	Rank
4F	Field burning of agricultural wastes	7.39	4.61	YES	5	2.95	YES	6

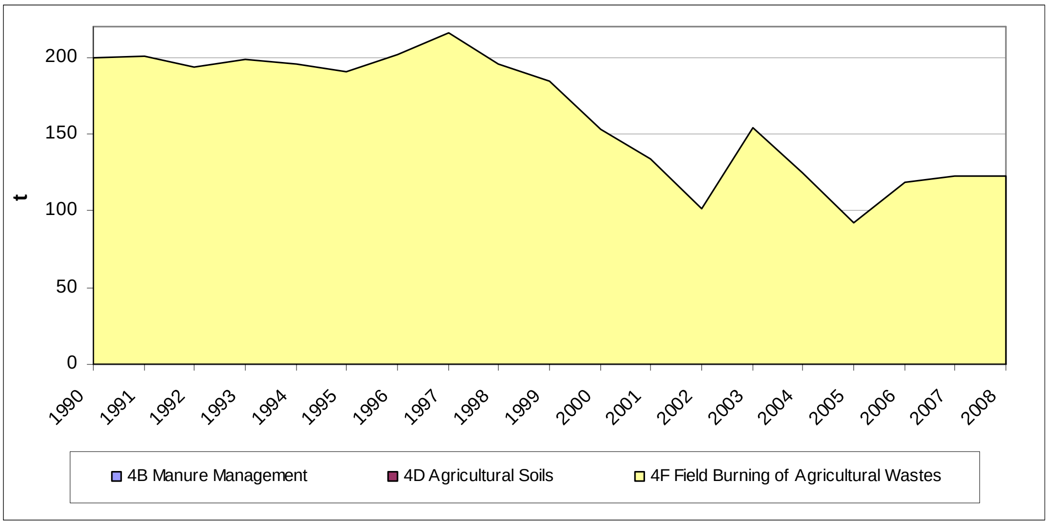
7.2.10.- PAH

PAH agricultural emissions, whose pattern is shown in Table 7.2.10.1 and in Figure 7.2.10.1 experienced a 38.8% decrease between 1990 and 2008, descending from 199.8 t to 122.4 t.

Table 7.2.10.1.- PAH emissions (Amounts in t)

Category	1990	1995	2000	2004	2005	2006	2007	2008
4B Manure Management	-	-	-	-	-	-	-	-
4D Agricultural soils	-	-	-	-	-	-	-	-
4F Residue burning	199.8	190.2	152.8	124.4	92.3	119.1	122.4	122.4
Total Agriculture	**199.8**	**190.2**	**152.8**	**124.4**	**92.3**	**119.1**	**122.4**	**122.4**

Figure 7.2.10.1.- Pattern of PAH emissions



Only category 4F (“Field Burning of Agricultural Wastes”) generates emissions for this pollutant. Therefore, to analyze the trend for the series shown in Figure 7.2.10.1, please refer to section 7.2.1. NO_X.

As shown in Figure 7.2.10.2, in 2008 agricultural emission make up 47.7% of the total emissions in Spain of PAH, which signifies an overall decrease in its contribution compared to 1990 when represented 62.2% of the total.

Figure 7.2.10.2.- Percentage of PAH emissions by category with respect to the inventory total

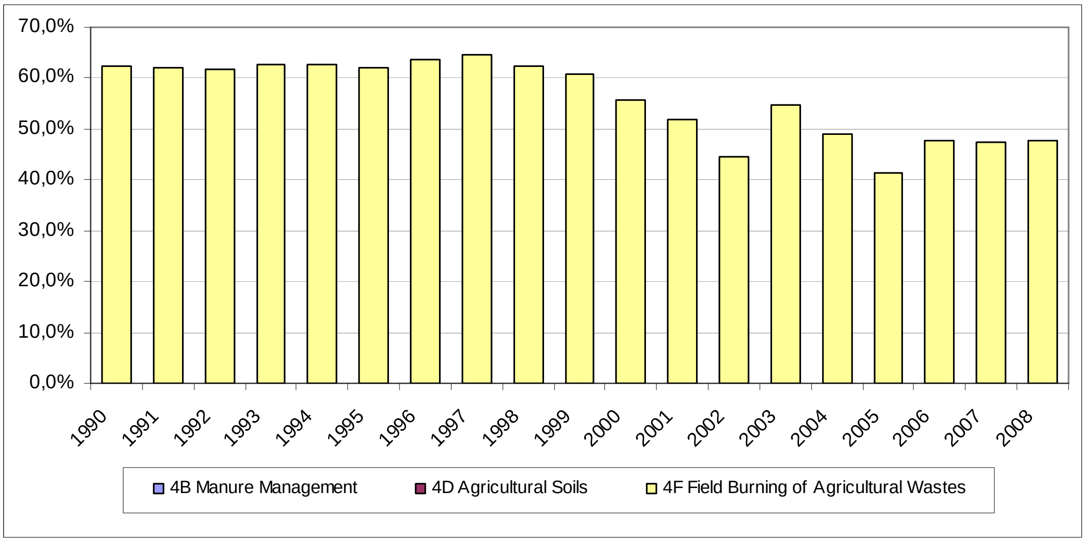
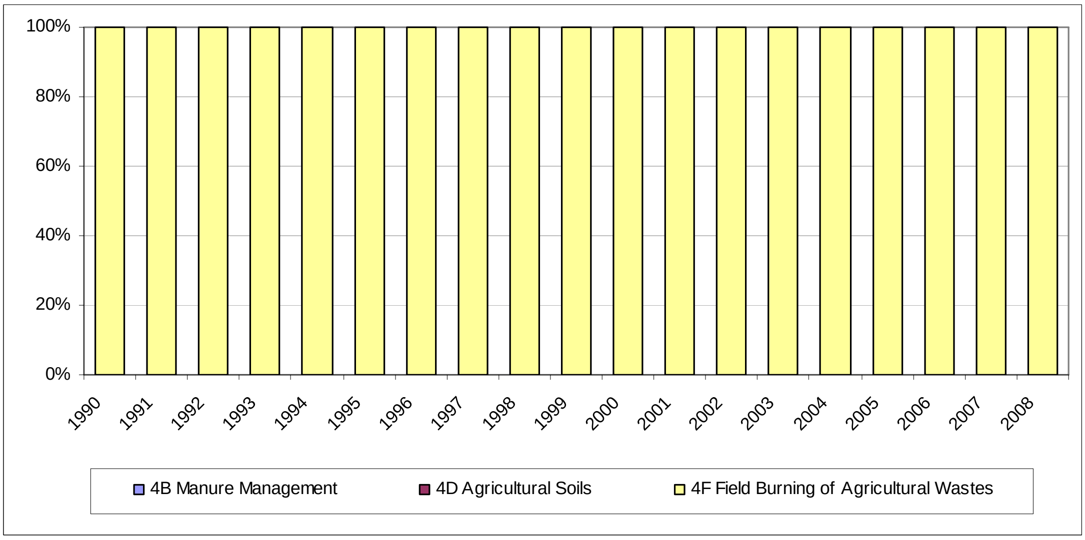


Figure 7.2.10.3 shows that only 4F category has emissions of this pollutant. Therefore, its contribution to the total PAH emissions of agricultural sector is 100%.

Figure 7.2.10.3.- Percentage of PAH emissions by category with respect to the sector total



The PAH key sources identified for the period 1990-2008 are as follows:

- Field burning of agricultural wastes (4F): Source by level 1990-2008 and by trend 1991-1997 and 1999-2008.

As a summary of the foregoing, Table 7.2.10.2 below shows, for this sector's key categories for PAH, the contribution of emissions to the levels and trends, the order number for this category in the list of key sources, as well as the absolute values, all referring to 2008.

Table 7.2.10.2.- PAH key categories: Contribution to Level and Trend

Activity		PAH (Mg) (2008)	Contribution Level (2008)			Contribution Trend (2008)		
Code	Description		%	K. Cat.	Rank	%	K. Cat.	Rank
4F	Field burning of agricultural wastes	122.38	47.75	YES	1	49.76	YES	1

7.3.- Analysis by key categories

7.3.1.- Manure Management (4B)

CORRESPONDENCE BETWEEN NOMENCLATURES	
NOMENCLATURE	CODE
CLRTAP-EMEP/NFR	4B
CMCC/CRF	4.B
CORINAIR/SNAP 97	10.05 and 10.09

Ammonia (NH_3) and particulate matters ($PM_{2.5}$, PM_{10} y TSP) emissions derived from the management systems for animal manure and animals are included under this category.

7.3.1.1.- Activity Data

7.3.1.1.1.- Number of animals[2]

The activity variable data comes from the "Anuario de Estadística Agroalimantaria", which will be referred as "Food and Agriculture Statistics Yearbook" and from the "Boletines mensuales de estadística agroalimentaria", which will be referred as "Monthly Bulletins of Agrarian Statistics" (both published by the Ministry of Environment and Rural and Marine Affairs, MARM).

[2] From now on, "Animals" will be understood as distinct species (cattle, sheep, pig, ...), "category" will refer to the breakdown of those animals according to classes considered in the MARM Yearbook and "breed" will refer to the distinct subspecies of animals in Spain (frisona, pirenaica, morucha, etc.)

The MARM documents previously cited, present information on the number of animals a much more detailed and itemized manner than CRLTAP-EMEP data requirements. Given the relevance, for these emissions calculations, of using the most specifically detailed information by category of animal, the category structure of the MARM sources has been adopted as basis. In addition, a subsequent disaggregation of some swine and poultry categories (excluding the “Other Poultry” category[3]) has been carried out in order to be able to consider the relevant differences in the production characteristics and nutritional requirements that have been taken into account in the emission estimation algorithm.

In the case of cattle and swine livestock, in which more than one statistic per year is available (June and December for cattle, and April, August and December for swine) all the figures are used for the calculation of the annual mean number of heads in each animal category. In the case of swine, the statistics differ further between the swine living in an open-grazing system and the total for all swine. The number of heads of swine under an intensive regime (farm) is obtained by subtracting the number of grazing animals from the total (farm = total - grazing), effected at the level of province and each animal category.

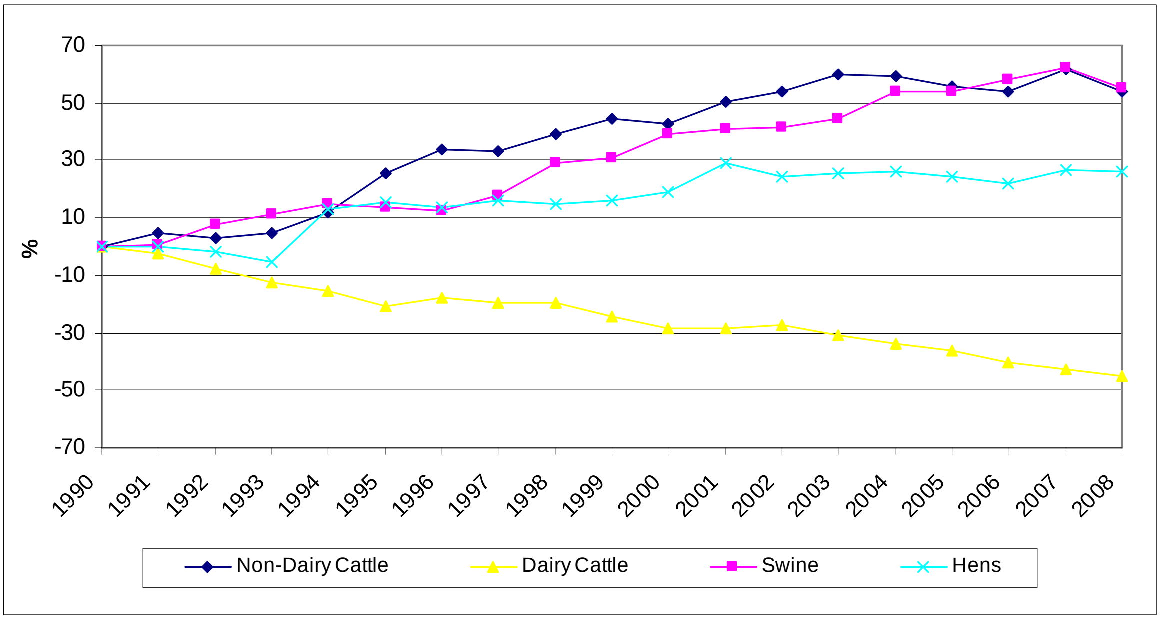
Table 7.3.1.1.1 and Figure 7.3.1.1.1 shows the pattern in the number of animals in the different species. In the 1990-2008 period, there was a significant increase in non-dairy cattle (54.1%), as well as in swine (54.9%), whereas dairy cattle and goats experienced a decline in the number of animals (44.8% and 19.9%, respectively).

Table 7.3.1.1.1.- Animal number

Animal	1990	1995	2000	2004	2005	2006	2007	2008
Non Dairy Cattle	3,468,803	4,356,381	4,952,152	5,531,611	5,398,028	5,350,773	5,607,848	5,344,456
Horses	244,799	241,075	249,213	293,683	304,801	315,918	327,036	411,428
Goats	3,663,314	2,522,528	2,829,959	2,833,223	2,904,691	2,956,730	2,891,574	2,959,329
Swine	16,370,967	18,613,916	22,752,492	25,226,495	25,225,916	25,897,837	26,553,508	25,362,100
Poultry	125,292,396	144,746,785	149,172,321	157,715,497	155,807,207	152,870,162	158,587,387	158,087,376
Other Poultry	14,024,101	17,205,721	20,988,421	21,244,853	20,621,566	19,158,417	24,277,820	24,445,942
Mules and Asses	203,103	136,054	85,709	98,890	102,185	105,480	108,775	137,869
Sheep	24,037,017	21,070,804	24,399,645	22,757,435	22,749,471	22,474,031	22,194,257	19,952,282
Dairy Cattle	1,610,541	1,278,120	1,149,794	1,069,173	1,028,249	963,041	918,840	888,722

[3] For now on, “poultry”

Figure 7.3.1.1.1.- Variation in animal number from 1990 (%)



7.3.1.1.2.- Nitrogen excreted

In the IPCC Reference Manual, Table 4-20 (page 4.99) proposes default values for the amount of nitrogen in the excreta of each type of animal in terms of nitrogen per head and year. These default values have been considered by experts in the sector not to be representative of the current reality in Spain and it has been decided to use national values.

The values of the national methodology have been obtained through the preparation of nitrogen balances for the bovine, porcine, ovine and poultry animal species. The detailed methodology, for cattle and sheep, can be found in Appendix 9 in the document “Metodología para la estimación de las emisiones a la atmósfera del sector agrario para el Inventario Nacional de Emisiones” (Junio 2006), which will be referred as UPV Report. The methodology for estimating the nitrogen excreted by swine and hens is contained in the documents entitled “Zootechnical bases for calculating the nitrogen balance and gas emissions produced by animal husbandry activities in Spain”, hereinafter “Zootechnical Document”, and “Methodology for estimating air emissions in the animal husbandry sector for the national emissions inventory”, hereinafter “Emissions Document”.

In order to obtain the figures of nitrogen excreted by the other animals (goats, horses, mules and asses), the input data have been taken from the table of default values in the IPCC Reference Manual (Table 4-20), using the row entitled “Near East and Mediterranean”, reproduced below. The stock of goats has been assimilated to sheep, taking in the first case the value indicated in the table below under the column “Ovine”. Similarly, in the case of equine species, the value taken has been that of the “Other animals” column.

Region	Animal (kg N /head and year)					
	Non dairy cattle	Dairy cattle	Poultry	Sheep	Swine	Other animal
Near East & Mediterranean	50	70	0.6	12	16	40

For the case of goats, it has been assumed that the figures can be scaled down by 50% for the calculation of the excreta from offspring following the recommendations of the IPCC Good Practice Guidance (Table 4.14, p. 4.45). This guide does not contain any reduction in excreta for “Other animals” (including horses, mules and asses for the purposes of the Inventory), therefore it has been decided to apply the same nitrogen excretion value to adult and young specimens in these species.

N excretion values per animal category are shown in the following Table 7.3.1.1.2.1.

Table 7.3.1.1.2.1.- N excretion per animal category (Amounts in kg N/head and year)

Animal Class						***N_{exc}(kg/year)***
Dairy Cows	Frisians					69.77
	Other					59.67
Other Cattle	Age < 12 months	Slaughter				59.17
		Other	Male	Meat		68,88
				Replacement		72,98
			Female	Meat		47,69
				Replacement		51,67
	12 months <Age< 24 months	Male		Slaughter		66,27
				Replacement		66,33
		Female		Slaughter		46,88
				Replacement		48,52
	Age > 24 months	Studs				59.71
		Female		Not calved	Slaughter	41,90
					Dairy – Frisians	51,59
					Dairy – Other	48,58
					Suckler cow	45,90
				Calved	Suckler cow	51,15
Sheep	Replacement lambs	Male				7.19
		Female				4.41
	Suckling lamb					0
	Spring lamb					2.68
	Reproductors	Male				6.92
		Female	Not calved			4,64
			Calved	Non dairy		5,61
				Dairy		6,47
Goats	Animals less than 1 year old					6
	Animals more than 1 year old					12
Horses	Animals less than 1 year old					40
	Animals more than 1 year old					40
Broilers	Broilers					0,42
	Pullets					0,34
	Breeding hens < 12 months					0,94
	Breeding hens > 12 months					0,93
Laying hens	Select hens	White industrial pullets				0,15
		Brown industrial pullets				0,20
		White industrial laying hens < 12 months				0,58
		Brown industrial laying hens < 12 months				0,64
		White industrial laying hens > 12 months				0,45
		Brown industrial laying hens > 12 months				0,52
		White industrial laying hens > 12 months in forced molting				0,41
		Brown industrial laying hens > 12 months in forced molting				0,42
		White industrial laying hens > 12 months in 2^{nd} cycle				0,55
		Brown industrial laying hens > 12 months in 2^{nd} cycle				0,61
	Free range hens	Free range pullets				0,16
		Free range laying hens < 12 months				0,57
		Free range laying hens > 12 months				0,52

Table 7.3.1.1.2.1 (cont.).- N excretion per animal category (Amounts in kg N/head and year)

Animal Class		***N_{exc}(kg/year)***
White Swine	Weaned piglets	2,24
	Pig from 20 to 49 kg	8,08
	Pig from 50 to 79 kg	9,72
	Pig from 80 to 109 kg	10,85
	Pig > 110 kg	10,14
	Young hogs	13,27
	Adult hogs	19,94
	Uncovered sow	13,56
	First-time pregnant sow	15,75
	Pregnant sow	23,25
	First-time breeding sows	33,61
	Breeding sows	37,95
	First-time resting sows	13,46
	Resting sows	17,46
Iberian Swine	Suckling pigs (8.5 to 24 kg)	3,78
	Pig from 24-49 kg for grazing or fodder	13,52
	Pig from 24-49 kg for feed-based finishing	13,93
	Pig from 50-79 kg for grazing or fodder	14,33
	Pig from 50-79 kg for feed-based finishing	18,07
	Pig from 80-109 kg for grazing or fodder	16,71
	Pig from 80-109 kg for feed-based finishing	20,58
	Pig > 110 kg, grazing or fodder	5,83
	Pig > 110 kg, finished with feed	23,96
	Young hogs	19,78
	Adult hogs	28,40
	Uncovered sow	20,83
	First-time pregnant sow	21,40
	Pregnant sow	23,22
	First-time breeding sows	27,13
	Breeding sows	29,52
	First-time resting sows	16,41
	Resting sows	18,57
Mules and Asses	Animals less than 1 year old	40
	Animals more than 1 year old	40

NB: For swine and poultry, the values showed represent the figures of the last year of the series.

Source: UPV Report and Zootechnical document.

For those animals presenting fixed excretion values throughout the series, since the distribution of the population within the categories for each animal class varies from year to year, the mean excretion values per animal class will be adjusted annually. However, the variation in the excretion values is small, because the distribution of the animal population by categories varies little from one year to the next. In the case of swine and hens, apart from the variation generated by the variable distribution of categories, there is a year-on-year variation due to the different parameterization used for the different years in the series inventoried. Table 7.3.1.1.2.2 below indicates the mean values of nitrogen excreted for each animal species in kg N / head and year.

Table 7.3.1.1.2.2.- N excreted per animal (kg N/head and year)

Year	Dairy Cattle	Other Cattle	Sows	Fattening Pigs	Sheep	Goats	Horses	Mules and Asses	Laying hens	Broilers	Other poultry
1990	66.56	53.06	22.65	7.66	5.01	11.05	40	40	0.513	0.420	0.588
1991	66.55	52.90	22.59	7.67	5.09	11.03	40	40	0.512	0.421	0.588
1992	66.83	52.71	22.64	7.76	5.03	11.05	40	40	0.511	0.423	0.588
1993	66.77	52.64	22.78	7.77	5.09	11.12	40	40	0.509	0.425	0.588
1994	66.95	52.69	22.77	7.61	5.11	10.99	40	40	0.509	0.426	0.588
1995	67.04	52.50	22.70	7.58	5.04	11.07	40	40	0.508	0.428	0.588
1996	67.09	52.72	22.92	7.63	5.09	11.02	40	40	0.506	0.428	0.588
1997	66.83	52.68	22.88	7.43	4.91	10.95	40	40	0.505	0.428	0.587
1998	67.23	52.71	22.74	7.43	5.04	11.06	40	40	0.503	0.428	0.587
1999	67.48	52.72	22.77	7.52	5.08	11.24	40	40	0.502	0.428	0.587
2000	67.47	52.44	22.70	7.64	5.11	11.33	40	40	0.500	0.428	0.586
2001	67.40	52.46	22.74	7.56	5.07	11.11	40	40	0.498	0.429	0.586
2002	67.42	52.39	22.45	7.49	5.08	11.17	40	40	0.495	0.430	0.586
2003	67.47	52.37	22.44	7.48	5.14	11.16	40	40	0.493	0.430	0.586
2004	67.50	52.19	22.39	7.22	5.07	11.23	40	40	0.491	0.431	0.585
2005	67.53	52.25	22.44	7.28	5.06	11.20	40	40	0.489	0.432	0.585
2006	67.48	52.27	22.60	7.48	5.08	11.10	40	40	0.489	0.432	0.585
2007	67.49	52.49	22.48	7.44	5.08	11.15	40	40	0.489	0.432	0.585
2008	67.67	52.45	22.23	7.46	5.13	11.28	40	40	0.490	0.432	0.587

7.3.1.1.3.- Manure management systems

The opinion of the experts concurs in considering that the systems used in Spain do not correspond to the default systems given in the IPCC (MS parameter). Therefore, in the current inventory edition, the MS parameter (percentage of each manure management system used per animal) has been obtained through: i) a extensive survey amongst rearing complexes (for swine and poultry); y ii) a bibliographical research (for the other animals).

The information on the distribution of manure management systems (AWMS) applied to the nitrogen excretion by each animal category, but for swine and poultry that could be found afterwards is shown in the following Table 7.3.1.1.3.1.

Table 7.3.1.1.3.1.- Distribution of manure management systems

Animal Class						***Manure management System(s)***
Dairy Cows	Frisians					25% Daily Recollection and deposit, 60% Solid Storage and 15% of Management in Liquid state.
	Other					25% Daily Recollection and deposit, 60% Solid Storage and 15% of Management in Liquid state.
Other Cattle	Age < 12 months	Slaughter				Storage of Solid
		Other	Male	Meat		Storage of Solid
				Replacement		Meadows and Pastures
			Female	Meat		Storage of Solid
				Replacement		Meadows and Pastures
	12 months <Age< 24 months	Male		Slaughter		Storage of Solid
				Replacement		Meadows and Pastures
		Female		Slaughter		Storage of Solid
				Replacement		Meadows and Pastures
	Age > 24 months	Studs				Meadows and Pastures
		Female	Not calved	Slaughter		Meadows and Pastures
				Dairy	Frisians	Meadows and Pastures
					Other	Meadows and Pastures
				Suckler cow		Meadows and Pastures
			Calved	Suckler cow		Meadows and Pastures
Sheep	Replacement lambs	Male				90% Meadows and Pastures and 10 Dry Lot
		Female				90% Meadows and Pastures and 10 Dry Lot
	Suckling lamb					n.a.
	Spring lamb					Storage of Solid
	Reproductors	Male				90% Meadows and Pastures and 10 Dry Lot
		Female	Not calved			90% Meadows and Pastures and 10 Dry Lot
			Calved	Non dairy		90% Meadows and Pastures and 10 Dry Lot
				Dairy		90% Meadows and Pastures and 10 Dry Lot
Goats	Animals less than 1 year old					Meadows and Pastures
	Animals more than 1 year old					Meadows and Pastures
Horses	Animals less than 1 year old					50% Meadows and Pastures, 12.5% Daily recollection and deposit, 30% Solid lot and 7.5% Management in liquid state.
	Animals more than 1 year old					50% Meadows and Pastures, 12.5% Daily recollection and deposit, 30% Solid lot and 7.5% Management in liquid state.
Mules and Asses	Animals less than 1 year old					50% Meadows and Pastures, 12.5% Daily recollection and deposit, 30% Solid lot and 7.5% Management in liquid state.
	Animals more than 1 year old					50% Meadows and Pastures, 12.5% Daily recollection and deposit, 30% Solid lot and 7.5% Management in liquid state.
Other Poultry	Animals less than 1 year old					Manure with bed
	Animals more than 1 year old					Manure with bed

Source: UPV Report.
n.a.: not applicable

As set out above, the percentage values for the various management systems used for swine and hens have been obtained through an extensive survey carried out at rearing complexes.

The results of this survey can be found in the document entitled “Excretions”[4], while the Emissions document contains a summary of these[5]. Nonetheless, it is important to stress that one of the findings in this study: although the IPCC methodology only considers one possible way of managing animal manure, the surveys have shown that, in Spain, animal manure is managed in different interconnected stages, each with their own management system. In other words, manure may move through multiple storage areas and later through some type of treatment.

7.3.1.2.- Methodology

7.3.1.2.1.- NH_3

The algorithm for estimating ammonia emissions is applied in two stages: the first part is intended to quantify the content of nitrogen in animal manure and the second aims at estimating the emissions of ammonia itself from the flow of nitrogen in the manure, taking into account the different phases in the disposal of manure and the chemical reactivity for the formation of NH_3 from the nitrogen contained in it, as well as the environmental conditions operating in each phase.

For the quantification of manure generation, the methodology followed was that of the UPV Report, but for swine and poultry where the methodology of Zootechnical and Emissions documents has been used, using nitrogen excretion rates and manure management systems presented in chapters 7.3.1.1.2 and 7.3.1.1.3. Meanwhile, for the calculation of the emissions, the basis will be the EMEP/CORINAIR Guidebook (2006).

In the EMEP/CORINAIR Guidebook (2006), appendix A, chapter B1090, there is a table with default emission factors of NH_3 in the treatment of animal manures, which it is shown below in Table 7.3.1.2.1.1. This table informs about the percentages of nitrogen emitted by manure from different animals in the successive cycle stages of generation, treatment and application. It is based in a fixed nitrogen excretion rate for each animal and volatilization rates (1st column) associated to nitrogen available in each stage (after deducting volatilizations in previous stages).

---

[4] [Excretions] MARM. Manure management systems characterization. Madrid 2010.

[5] Section 3.10.5 for white swine, 3.11.5 for Ibérico swine and 3.12.5 for hens.

Table 7.3.1.2.1.1.- EMEP methodology for the estimation of NH_3 emissions due to manure management

	Ratio	kg N	kg NH_3	Ratio	kg N	kg NH_3
	100903 Dairy cows			100903 Other cattle		
Excretion in housing		60			30	
Emission in housing	12%	7.2	8.7	12%	3.6	4.4
N in outside storage		52.8			26.4	
Emission in outside storage	6%	3.17	3.8	6%	1.58	1.9
N available for landspreading		49.63			24.82	
… of which mineral N[2]	50%	24.82		50%	12.41	
Emission of landspreading	40%	9.93	12.1	40%	4.96	6
Total ammonia emission			28.5			14.3
	100903 Fattening pigs			100904 Sows		
Excretion in housing		14			36	
Emission in housing	17%	2.38	2.89	17%	6.12	7.43
N in outside storage		11.62			29.88	2.18
Emission in outside storage	6%	0.7	0.85	6%	1.79	
N available for landspreading		10.92			28.09	
… of which mineral N[2]	50%	5.46		50%	14.04	6.82
Emission of landspreading	40%	2.18	2.65	40%	5.62	16.43
Total ammonia emission			6.39			
	100905 Sheep			100906 Horses		
Excretion in housing		2			20	
Emission in housing	10%	0.2	0.24	12%	2.4	2.9
N in outside storage		1.8			17.6	
Emission in outside storage	0%	0	0	0%	0	0
N available for landspreading		1.8			17.6	
… of which mineral N[2]	20%	0.36		20%	3.52	
Emission of landspreading	50%	0.18	0.22	50%	1.76	2.2
Total ammonia emission			1.34			8
	100907 Laying hens			100908 Broilers		
Excretion in housing		0.8			0.6	
Emission in housing	20%	0.16	0.19	20%	0.12	0.15
N in outside storage		0.64			0.48	
Emission in outside storage	4%	0.03	0.03	3%	0.01	0.02
N available for landspreading		0.61			0.47	
… of which mineral N[2]	40%	0.25		40%	0.19	
Emission of landspreading	50%	0.12	0.15	50%	0.09	0.11
Total ammonia emission			0.37			0.28
	100909 Other poultry			100910 Fur animals		
Excretion in housing		2			4.1	
Emission in housing	20%	0.4	0.48	12%	0.49	0.6
N in outside storage		1.6			3.61	
Emission in outside storage	3%	0.05	0.06	0%	0	0
N available for landspreading		1.55			3.61	
… of which mineral N[2]	40%	0.62		50%	1.8	
Emission of landspreading	50%	0.31	0.38	50%	0.9	1.09
Total ammonia emission			0.92			1.69

Source: EMEP/CORINAIR Guidebook (2006), chapter B1090, Table 4A, page 30.

For the sake of convenience, the following Table 7.3.1.2.1.2 shows the emission factor by emission phase referred to the nitrogen available in the different phases for each of the animal species considered in the inventory. Given the data required on emissions, the housing and manure storage phases considered in the EMEP/CORINAIR (2006) methodology are grouped together into a single category of emissions in the stockbreeding establishment. The housing and storage emission factors in this Table 7.3.1.2.1.2 refer to the nitrogen excreted in the stockbreeding establishment, so as to be able to handle

homogeneously the joint contribution of the emissions in housing and storage as a single stage[6].

Table 7.3.1.2.1.2.- NH_3 emission factors by emission source (Amounts in kg NH_3-N / kg N available at this stage)

Animal	Housing	Storage	Landspreading	Pasture
Non-Dairy Cattle	0.12	0.05256	0.2	0.2
Horses	0.12	0	0.1	0.1
Goats	0.1	0	0.1	0.1
Sows	0.17	0.04996	0.2	0.2
Hens	0.2	0.0324	0.1	0.1
Mules and Asses	0.12	0	0.1	0.1
Other Poultry	0.2	0.0238	0.2	0.2
Sheep	0.1	0	0.1	0.1
Broilers	0.2	0.0238	0.2	0.2
Fattening pigs	0.17	0.04996	0.2	0.2
Dairy Cattle	0.12	0.05256	0.2	0.2

This sector 4B takes account of the emissions in the housing and storage phases of this manure, with landspreading and pasture being accounted in sector 4D. Finally, the emissions must be multiplied by the coefficient 17/14 to obtain the emissions of this pollutant as mass.

7.3.1.2.2.- Particulate matter ($PM_{2.5}$, PM_{10} y TSP)

Particulate emissions from farm animals mainly originate in their feeding, excrement and housing, whereas hides, fur, pollen grains and insect parts are secondary emission sources. The polluting particles reflected in the Inventory's husbandry section are those measuring less than 2.5 μm ($PM_{2.5}$), less than 10 μm (PM_{10}) and the total of suspended particles (TSP). The emission factors per animal are shown in Table 7.3.1.2.2.1 below. The emission factors given in the EMEP/CORINAIR (2009) Guidebook (section "4.B Animal Husbandry and Manure Management", Table 3-10, p.27) have been used for $PM_{2.5}$ and PM_{10}. This methodological document does not provide emission factors for PST, therefore the emission factors shown in the "Methodology for calculating the emissions of particles from farming activities (T-4)" document (Table10, p. 46) have been adopted.

[6] In order to develop this procedure, in which housing and storage are treated as a single emission stage and therefore a single emission factor is taken and applied to the nitrogen excreted in stockbreeding establishments, a prior conversion is made of the estimation algorithm for the storage phase in which the emission factor, instead of being applied to the nitrogen remaining after the housing phase, is applied to the nitrogen generated in the excreta of the animal in the stockbreeding establishment.

Table 7.3.1.2.2.1.- Particle emission factors (Amounts in kg /head and year)

SNAP activity	Name	Solid systems			Liquid systems		
		PM 2,5	PM 10	TSP	PM 2,5	PM 10	TSP
10.05.01	Dairy Cattle	0.23	0.36	0.78	0.45	0.7	1.51
10.05.02	Non-dairy Cattle	0.16	0.24	0.52	0.21	0.32	0.69
10.05.03	Fattening pigs	0.081	0.5	1.02	0.069	0.42	0.86
10.05.04	Sows	0.094	0.58	1.18	0.073	0.45	0.91
10.05.06	Horses	0.12	0.18	0.39	-	-	-
10.05.07	Laying hens	0.002	0.017	0.017	-	-	-
10.05.08	Broilers	0.0068	0.052	0.052	-	-	-
10.05.09	Other Poultry	0.004	0.0032	0.11	-	-	-
10.05.12	Mules and Asses	0.12	0.18	0.39	-	-	-

Source: Fuente: EMEP/CORINAIR Guidebook (2009) and “Methodology for calculating the emissions of particles from farming activities (T-4)”.

7.3.2.- Agricultural Soils (4D)

CORRESPONDENCE BETWEEN NOMENCLATURES	
NOMENCLATURE	**CODE**
CLRTAP-EMEP/NFR	4D
CMCC/CRF	4.D
CORINAIR/SNAP 97	10.01 and 10.02

This sector 4D considers the emissions associated with arable crops, whether or not they are treated with fertilizer. The pollutants emitted originate in the field preparation and harvesting (particles) and in their provision with nitrogen (NO_X and NH_3). These contributions are effected through nitrogenated fertilizers, either mineral (basically synthetic chemicals), organic from animal manure, compost of municipal solid waste or sludge from waste water treatment plants.

Before beginning the presentation of the activity variables and the methodology, it is appropriate to clarify the method used to report on the Agricultural Soils emissions to CRLTAP-EMEP. The NFR classification includes the following codes within section 4D:

- 4 D 1 a Synthetic N-fertilizers.
- 4 D 2 a Farm-level agricultural operations including storage, handling and transport of agricultural products.
- 4 D 2 b Off-farm storage, handling and transport of bulk agricultural products.
- 4 D 2 c N-excretion on pasture range and paddock.

These categories differ from those listed in the CRF and there is no unambiguous correspondence between them; also there are not certainty, in this sector, that both nomenclatures coincide in coverage[7]. The CRF classification is based on the nitrogen contributions to the soil and the surface area devoted to rice (for sub-group 4.C) due to the IPCC methodology approach to greenhouse gases. Nonetheless, some pollutants, such as particles, do not depend on the provision of nitrogen to farmlands, but on the work carried out in the fields, therefore their association with any of these categories, in either NFR or CRF, is not clear. This problem is not as marked when the SNAP categorization is used, as this associates the emissions to the crops, not the provision of nitrogen as the others do.

On the basis of the foregoing, and in order to report on the emissions as exhaustively as possible, it has been decided to associate all the emissions from Agricultural Soils to NFR code 4D1a, even though its literal name indicates only mineral fertilizers.

7.3.2.1.- Activity Data

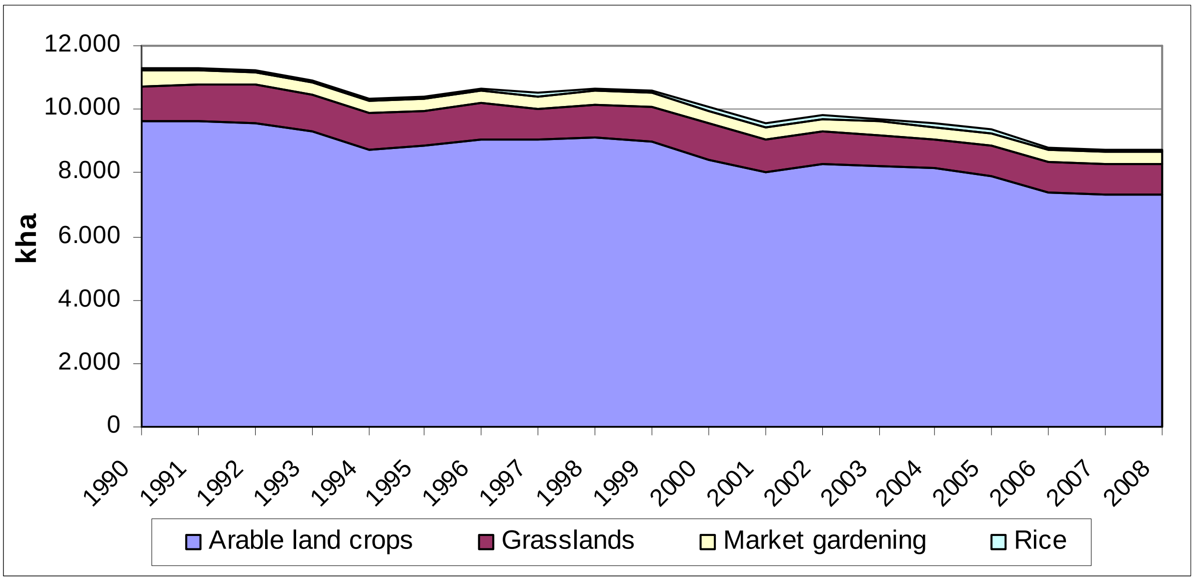
NH_3 and NO_X emissions depend on the provision of nitrogen to the soil in the form of mineral fertilization, organic fertilization, sludges or compost. Meanwhile, particle emissions depend on the plough surface areas, the basic activity variable for estimation of the particle emissions.

7.3.2.1.1.- Cultivated surface area

The information on cultivated areas and yields is obtained from statistics on a provincial level compiled in MARM's publication "Food and Agriculture Statistics Yearbook". Agricultural productions are obtained by multiplying cultivated areas by the yields. Arable crops surfaces are shown in the following Figure 7.3.2.1.1.1.

[7] The activities considered in CRF are as follows: 4.D.1.1 Synthetic fertilization, 4.D.1.2 Organic fertilization, 4.D.1.3 Biological fixation, 4.D.1.4 Crop residues, 4.D.2 Animal production, 4.D.3.1 Atmospheric deposition, 4.D.3.2 Leaching and run-off, and 4.D.4 Other.

Figure7.3.2.1.1.1.- Arable crops surface (ha)



7.3.2.1.2.- Synthetic fertilizers

The information of the nitrogenated fertilizers sales by mineral fertilizer type, in t of N, is derived from statistics at the national level published by the Food and Agriculture Statistics Yearbook of MARM and is shown in Table 7.3.2.1.2.1.

Table7.3.2.1.2.1.- Nitrogen fertilizers sales in Spain (Amounts in tonnes of N)

Year	Ammonium sulphate	Ammonium nitrosulphate	Calcium ammoniu m nitrate	Ammonium nitrate	Urea	Calcium nitrate	Sodium nitrate	Agricultural ammonia	Nitrogen solutions	Complex (NK, NPK)	Total
1990	102,648	23,608	205,900	121,002	265,098	6,216	3,364	19,024	48,314	279,000	1,074,174
1991	98,549	21,023	245,359	109,205	220,295	6,067	1,595	16,420	59,957	274,244	1,052,714
1992	91,519	18,108	200,200	114,542	229,155	7,343	2,815	18,499	45,009	244,062	971,252
1993	62,612	11,630	201,782	80,375	183,393	4,866	3,078	17,263	27,186	211,178	803,363
1994	83,764	13,677	251,325	109,361	195,002	6,806	3,650	14,815	40,583	263,353	982,336
1995	66,702	15,662	198,649	162,968	152,517	6,174	2,056	8,200	38,068	248,363	899,359
1996	82,006	24,973	237,271	173,718	239,968	8,839	1,318	3,704	46,637	320,285	1,138,719
1997	71,314	16,689	214,360	136,118	229,008	6,634	1,143	8,200	53,955	287,727	1,025,148
1998	72,198	18,627	235,680	134,877	264,327	6,534	1,156	5,389	47,433	324,868	1,111,089
1999	73,823	21,264	317,732	109,070	289,925	7,584	1,210	2,403	44,222	325,700	1,192,933
2000	88,723	27,451	328,201	129,634	323,084	11,160	2,201	2,825	49,874	301,178	1,264,330
2001	76,723	14,252	219,151	111,658	304,029	15,192	1,122	3,107	49,627	318,606	1,113,467
2002	89,272	14,291	179,806	92,442	277,042	9,123	1,170	2,959	41,838	296,587	1,004,530
2003	80,999	19,238	240,471	124,253	301,120	13,513	1,386	1,344	74,164	318,815	1,175,304
2004	83,609	14,262	214,000	93,437	274,286	12,749	1,188	3,616	58,780	289,205	1,045,132
2005	64,670	13,419	226,290	49,896	202,929	14,493	1,432	3,761	69,878	248,553	895,321
2006	90,079	14,356	223,753	51,320	244,112	14,982	1,067	4,001	76,272	220,354	940,296
2007	79,282	4,098	207,894	43,356	245,465	11,522	2,704	874	92,063	266,481	953,739
2008	86,706	793	169,449	32,853	190,697	13,575	4,541	1,317	39,346	196,246	735,523

7.3.2.1.3.- Organic fertilizers

For animal manure used as fertilizer, the amount of nitrogen added to the soil is obtained by calculating the nitrogen excreted and subtracting from this the parts volatilized

prior to its application in the field. For a detailed explanation of this process, please see section 7.3.1.2.

7.3.2.1.4.- Compost and sludge applied to agricultural soils

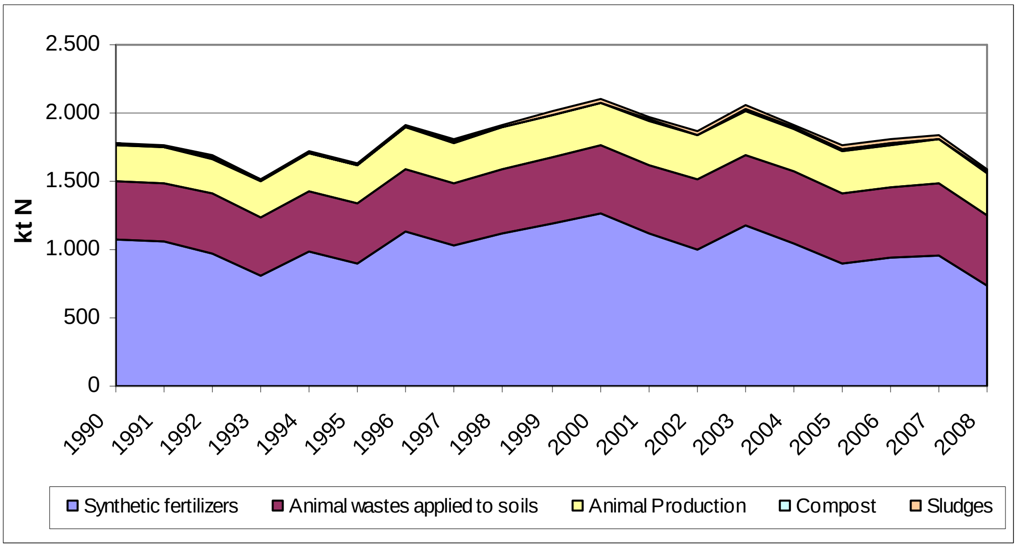
The tonnes of waste-water treatment sludge used in agriculture for the years 1990, 1991, 1992, have been obtained by means of interpolation of the data corresponding to 1989 and 1993. The figures for these two years have been taken respectively from the information prepared by the former MOPT on sewage sludge in the publication “The Environment in Spain, 1991” (referring to the year 1991) and in the “Study on treatment and final disposal of urban wastewater sewage sludge”, drawn up by the consulting firm “CADIC, S.A.” for the Department of Water Quality at the MOPTMA [Ministry for Public Works, Transport and the Environment] (referring to the year 1993). For the period 1997-2008, the figures are provided from the “National Sewage Register" prepared by MARM; for the 1994-1996 series they are obtained by means of interpolation based on the data corresponding to 1993 and 1997. Data on compost produced, assuming that it is used in its entirety for agriculture, are taken from the MARM publication, “The Environment in Spain”.

For the calculation of the nitrogen contained in sludge and compost, a national methodology has been used due to the lack of references. “Manual de buenas prácticas agrarias” from MAPA (BOE, 1999) specifications has been adopted for the nitrogen content in sludge. 1.3% has been adopted for the nitrogen content of compost used as a fertilizer, taking as the basis the “Manual del codi de bones pràctiques agràries: Nitrogen” from the Regional Government of Catalonia (Boixadera, 2000).

7.3.2.1.5.- Summary of nitrogen applied in agriculture

A summary of all nitrogen provisions to agricultural soils, relevant to NH_3 and NO_X emissions, is given in Table 7.3.2.1.5.1 below.

Figure 7.3.2.1.5.1.- N contributions to soils (t N)



7.3.2.2.- Methodology

7.3.2.2.1.- NO_X

According to the EMEP/CORINAIR Guidebook (2006), Chapter 10.1, Section 4.3, the flow of emissions of NO is the result of the interchange into the atmosphere of part of the nitrogen contained in the fertilizers applied to agricultural land. As the emission factor, it proposes a level of 0.3% of the amount of nitrogen added to these agricultural lands. In turn, this amount of nitrogen is obtained by estimating the nitrogen content added to the soils by the following set of paths: a) Synthetic-inorganic and organic fertilizers (animal wastes) and b) Compost and sludge applied in agriculture.

The product of the emission factor (0.3%) from the amount of nitrogen applied allows the emissions of NO to be calculated as the mass of nitrogen that must then be translated using factor 46/14 to the molecular mass of NO_2 as required in CLRTAP-EMEP.

7.3.2.2.2.- NH_3

Synthetic fertilizers

Here the methodology proposed in the EMEP/CORINAIR Guidebook (2006), Chapter 10.01 (crops with fertilizers), section 5.1, is followed.

In the generation of emissions of ammonia from the soils and agricultural crops that use nitrogen-bearing fertilizers (especially synthetic ones) the types of climate and soil have a great influence. In this sense, it may be stated that the emissions are greater, on the one hand, in warmer climates, and, on the other hand, in soils with a higher pH reading.

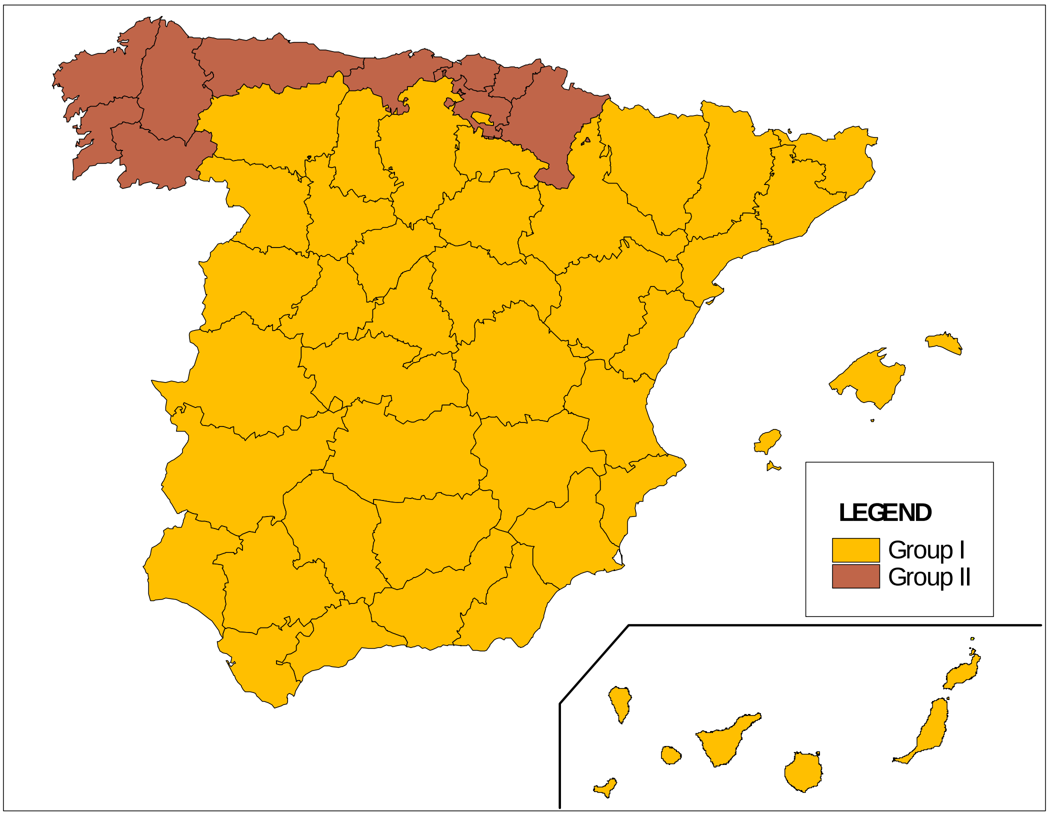
With a view to the practical application of the climatic differentiation, following the methodology proposed in the EMEP/CORINAIR Guidebook (2006) and applied in the ECETOC study (1994), the following combined groupings for climate and soil shall be distinguished:

- Group I: Regions with a hot climate and with a high proportion of limestone soils.
- Group II: Regions with a warm or hot climate with a certain proportion of limestone soils (or treated soils with a pH>7) but with large areas of acidic soils.
- Group III. Regions with a warm and warm-cold climate with a large proportion of acidic soils.

For the application of the methodology, a correspondence for the Spanish provinces has been established, NUTS 3 level of EUROSTAT, for those climate-soil groups based on the information of the average annual temperatures and the geographical location thereof. The information on the temperatures has been drawn up using the data from weather stations, provided by the Spanish National Meteorology Agency (AEMET). The correspondence of provinces to the climate-soil groups may only be considered to be approximate and, even so, with the logical reservations implicit in a procedure for generalisation of this type. The map for the zoning of the provinces into climate-soil groups is shown in Figure 7.3.2.2.2.1, it has been drawn up for applying the algorithm for calculating

the emissions. As it can be noticed, there are no Group III regions within the Spanish territory.

Figure 7.3.2.2.2.1.- NUTS3 zoning into climate-soil groups



Source: Own production. Consult previous paragraphs for a description of groups I and II.

Apart from the weather conditions (climate) and the conditions of the substratum (soil), the rate of emission of ammonia basically depends on: a) the type of nitrogen-bearing compound applied; and b) the type and system of cultivation to which it is applied. With regards to the types and systems for cultivation, there are differentiated between: i) herbaceous crops in general, amongst which harvested grazing lands are included; ii) grazing lands used for pasture and not harvested; and, iii) rice paddies. As regards to the nitrogen-bearing compounds used, the different types of fertilizers are considered: i) simple ones; ii) mixed-compound ones; and, iii) mixed-complex ones[8]. Amongst those types of fertilizer, urea is of special significance and has a different involvement, since its potential for emitting ammonia does not depend so much on the conditions of the soil, since its speedy hydrolysis raises the pH of the substratum considerably.

---

[8] The term simple fertilizers refers to those containing only one fertilizing element; mixed fertilizers (either binary or ternary) contain two or three fertilizing elements. Mixed fertilizers can in turn be classified as compound (if they contain the fertilizing elements in the form of a single chemical, e.g. $Ca(NH_4)PO_4$) or complex if they are mixtures of single fertilizers.

The combined impact of the climate-soil factors, type and system of crop; and type of nitrogen-bearing compound is shown in Table 7.3.2.2.2.1 in terms of (kg. of NH_3-N/ kg of N-fertilizer applied). It should be pointed out that the factors which appear in this table include, together with the volatilisation of the fertilizer itself, the contribution to the emissions of ammonia of the emission foliar and the breakdown of the vegetable biomass, given the great difficulty of separating these two elements from the volatilisation of the fertilizer itself.

Table 7.3.2.2.2.1.- Emission factors of NH_3 in crops with fertilizers (Amounts in kg NH_3-N / kg N-fertilizer)

Fertilizer	Cultures (in general)		Rice	
	Z.I	Z.II	Z.I	Z.II
Ammonium sulphate	0.15	0.10	0.30	0.30
Ammonium nitrosulphate	0.03	0.02	0.02	0.02
Calcium ammonium nitrate	0.03	0.02	0.02	0.02
Ammonium nitrate	0.03	0.02	0.02	0.02
Nitrogen solutions	0.08	0.08	0.08	0.08
Urea	0.16	0.12	0.30	0.30
Calcium nitrate	0.00	0.00	0.00	0.00
Sodium nitrate	0.00	0.00	0.00	0.00
Agricultural ammonia	0.04	0.04	0.04	0.04
Complex (NK, NPK)	0.03	0.02	0.02	0.02

Source: EMEP/CORINAIR Guidebook (2006), Chapter 10, Table 5.1 and own production.

Organic fertilization[9].

The methodology used to estimate NH_3 emissions in the application of animal manure to farmland is shown in section 7.3.1.2. However, activity 4D includes only the emissions in the fertilizing phase and the emissions during grazing, with housing and storage being accounted for in activity 4B.

7.3.2.2.3.- Particulate matter ($PM_{2,5}$, PM_{10} y TSP)

Particles are emitted as a result of harvesting and preparing fields for crop growing. Only arable crops (i.e. non-permanent crops) are considered as emission sources as these are the only ones for which emission factors are available. The calculation of the emissions is effected by multiplying the activity variable, in this case the hectare, by the emission factor using the RAINS model for arable soils as provided in the document entitled “Modelling particulate emissions in Europe, A framework to estimate reduction potential and control cost” from the IIASA. This document does not provide any value for the $PM_{2.5}$ emission factor in crop management, so the emissions of this kind of particle diameter have not been estimated.

9 The coverage given here to the term organic fertilization is restricted to that corresponding to animal manure according to the classification criterion followed in the IPCC methodology for nitrous oxide, which classifies compost and sewage sludge applied to agriculture (conventionally also included in the classification of organic fertilizers) within the activity named “Other sources of N applied to agricultural crops”.

Table 7.3.2.2.3.1.- Particulate matter emission factors in crops (Amounts in kg compound /ha)

Crop	PM_{10} (t/ha)	TSP (t/ha)
Arable crops	0.1	1.88

7.3.3.- Field burning of agricultural wastes (4F)

CORRESPONDE BETWEEN NOMENCLATURES	
NOMENCLATURE	**CODE**
CLRTAP-EMEP/NFR	4F
CMCC/CRF	4.F
CORINAIR/SNAP 97	10.03 (10.03.01 to 10.03.05)

Activity 4F includes in situ burning of undergrowth and other straw-like residue from agricultural crops. Furthermore, it must be taken into account that the burning of stubble and straw is not considered a net source of carbon dioxide (CO_2) emissions, as it is assumed that carbon emission in the form of CO_2, produced by combustion, is compensated with deposition through the growth of plants in the following productive cycle. However, the emissions of other gases are considered, among which SO_X, NO_X, NMVOC, CO and NH_3, as well as certain amounts of dioxins (DIOX) and larger amounts of polycyclic aromatic hydrocarbons (PAH) within the block of persistent organic pollutants (POP).

7.3.3.1.- Activity data

7.3.3.2.- Agricultural production

The productions have been taken from the national statistics in the “Food and Agriculture Statistical Yearbook” from the MARM for the 104 crops considered in the Inventory.

7.3.3.3.- Methodological parameters

Tables 4.17 (p. 4.85, IPCC Reference Manual) and 4.16 (p. 4.58, IPCC Good Practice Guidance) give values for the waste/crop ratio, dry matter and fractions of C and nitrogen parameters for some crops. The crop references shown in the said tables in the IPCC Reference Manual and the IPCC Good Practice Guidance are considered scant to cover the wide list of crops considered in the Inventory. This is why a bibliographical search has been carried out for the values of these parameters in order to be able to complement the corresponding data for all the crops considered in the Inventory.

The Table 7.3.3.3.1 presents the values for these parameters together with the source from which they are taken. These sources (with their respective identification code) are:

1. 1996 IPCC Reference Manual + IPCC Good Practice Guidance.

2. MARTÍNEZ, X. “Gestión y tratamiento de residuos agrícolas”. *RETEMA: Revista Técnica de Medio Ambiente,* Year 19, nº 111 (Mar-Apr. 2006), p. 62-75.

3. ROSELLÓ, J. and DOMÍNGUEZ, A. (2006). Personal communication.

4. Crop parameters: Harvest. Harvest index. http://c100.bsyse.wsu.edu/cropsyst/manual/parameters/crop/harvest.htm#HIconsts

5. KRIDER, J.N., et al. *Agricultural waste management field handbook.* Washington D.C.: Natural Resources Conservation Service (NRCS), 1999.

6. VILLALOBOS, F.J., et al. *Fitotecnia: bases y tecnologías de la producción agrícola.* Madrid: Mundi-Prensa, 2002.

7. WHEELER, R.M. “Carbon balance in biogenerative life support systems: some effects of system closure, waste management, and crop harvest index”. Advances in Space Research: the official journal of the Committee on Space Research (COSPAR), 2003, 31(1):169-75.

8. AGENCIA ANDALUZA DE LA ENERGÍA (1999). *Potencial y aprovechamiento energético de la biomasa del olivar en Andalucía*. Consejería de Innovación, Ciencia y Empresa Ed. 24 pág. En: <http://www.agenciaandaluzadelaenergia.es/cocoon/aae/portal/com/bin/contenidos/publicaciones/aprovechamiento_energetico/1130059713839_potencial_y_aprovechamiento.pdf>

9. SENOVILLA, L. Y ANTOLÍN, G. (2005). *Revalorización energética de los residuos de la industria vitivinícola*. Proyecto Final de Carrera. Cátedra de Energías Renovables. Universidad de Valladolid. Escuela Técnica Superior de Ingenieros Industriales. En: <http://www.eis.uva.es/energias-renovables/trabajos_05/SenovillaArranz.pdf>

10. LA CAL, J.A. (2007). *Biomasa del olivar: oportunidad para el sector oleícola y apuesta por la sostenibilidad de Jaén*. 126-127 pp. En: Energética XXI. Revista de Generación de Energía. Biomasa. Enero/Febrero 2007. Omnimedia Ed. Madrid. <http://www.energetica21.com/esp/biomasa07.html>

When it comes to selecting a value, a preferential criterion has been adopted, with the values in the IPCC Good Practice Guidance being ranked higher than those in the IPCC Reference Manual where there were discrepancies between the two sources. Table 7.3.3.3.1 includes quality labels ranging from A to E, where A is the maximum quality and E the minimum.

Of all the values in Table 7.3.3.3.1, it was finally decided to incorporate those associated with A, B or C quality codes on their labels into the Inventory as the information on parameters for crops and, as a result, to discard those labelled D or E as these were considered inferior in quality.

Table 7.3.3.3.1.- Parameters related to field burning of agricultural residues

	Crop	Ratio residue crop product	Source	Q	Dry Matter	Source	Q	Carbon Fraction	Source	Q	Nitrogen Fraction	Source	Q
MARKET GARDENING	Chard	0.25	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Chicory	0.25	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Garlic	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Artichoke	0.80	1	A	0.17	6	B	0.4100	3	C	0.0274	3	C
	Celery	1.00	4	D	0.05	6	B	0.4100	3	C	0.0274	3	C
	Borecole	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Aubergine	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Gourd and Courgette	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Thistle	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Onion	1.00	4	D	0.08	6	B	0.4100	3	C	0.0274	3	C
	Spring Onion	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Cabbage	4.00	7	C	0.14	6	B	0.4100	3	C	0.0274	3	C
	Cauliflower	4.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Escarole lettuce	0.25	4	D	0.06	6	B	0.4100	3	C	0.0274	3	C
	Asparagus	1.00	4	D	0.08	6	B	0.4100	3	C	0.0274	3	C
	Spinach	0.25	7	C	0.09	6	B	0.4100	3	C	0.0274	3	C
	Flowers	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Strawberry	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Chilli Pepper	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Lettuce	0.18	7	C	0.05	6	B	0.4400	3	B	0.0314	3	B
	Melon	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Turnip	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Potato	0.43	1	A	0.45	1	A	0.4226	1	A	0.0110	1	A
	Gherkin	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Cucumber	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Pepper	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Leek	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Radish	1.00	7	C	0.10	1	E	0.4100	3	C	0.0274	3	C
	Watermelon	1.00	4	D	0.10	1	E	0.4100	3	C	0.0274	3	C
	Tomato	1.00	7	C	0.10	1	E	0.4100	3	C	0.0274	3	C
	Carrot	1.00	4	D	0.16	6	B	0.4100	3	C	0.0274	3	C

Table 7.3.3.3.1. (continued)- Parameters related to field burning of agricultural residues

Crop		Ratio residue crop product	Source	Q	Dry Matter	Source	Q	Carbon Fraction	Source	Q	Nitrogen Fraction	Source	Q
FRUIT TREES	Avocado	0.16	4	D	0.80	4	E	0.5700	3	C	0.0036	3	C
	Apricot Tree	0.16	4	D	0.80	4	E	0.5700	3	C	0.0036	3	C
	Almond Tree	3.17	2	C	0.85	6	B	0.5700	3	C	0.0036	3	C
	Hazel	3.17	4	D	0.95	6	B	0.5700	3	C	0.0036	3	C
	Cherry Tree	0.16	4	D	0.80	4	E	0.5700	3	C	0.0036	3	C
	Cherimoya Tree	0.00	4	E	0.80	4	E	0.5700	3	C	0.0036	3	C
	Plum Tree	0.16	4	D	0.80	4	E	0.5700	3	C	0.0036	3	C
	Fig Tree	0.16	4	D	0.80	4	E	0.5700	3	C	0.0036	3	C
	Lemon Tree	0.07	2	C	0.80	4	E	0.5500	3	B	0.0203	3	B
	Mandarin Tree	0.07	2	C	0.80	4	E	0.5500	3	B	0.0203	3	B
	Apple Tree	0.16	2	C	0.80	4	E	0.5700	3	C	0.0036	3	C
	Peach Tree	0.16	4	D	0.80	4	E	0.5700	3	C	0.0036	3	C
	Quince Tree	0.16	4	D	0.80	4	E	0.5700	3	C	0.0036	3	C
	Orange Tree	0.07	2	C	0.80	4	E	0.5500	3	B	0.2030	3	B
	Medlar Tree	0.16	4	D	0.80	4	E	0.5700	3	C	0.0036	3	C
	Walnut Tree	3.17	2	C	0.80	4	E	0.5700	3	C	0.0036	3	C
	Olive Tree for Olives	1.13	2	C	0.7815	9	B	0.4952	8	B	0.0039	8	B
	Olive Tree for Oil	1.13	2	C	0.7815	9	B	0.4952	8	B	0.0039	8	B
	Pear Tree	0.16	4	D	0.80	4	E	0.5700	3	C	0.0036	3	C
	Banana Tree	0.00	4	E	0.80	4	E	0.5700	3	C	0.0036	3	C
	Grape for Grapes	0.43	2	C	0.736	9	C	0.5700	3	C	0.0036	3	C
	Grape for Wine	0.43	2	C	0.736	9	C	0.5700	3	C	0.0036	3	C
PULSES	Lupin	1.00	4	E	0.85	4	E	0.4252	4	C	0.0250	5	C
	Chickpea	1.00	4	E	0.85	4	E	0.4252	4	C	0.0250	5	C
	Pea	1.38	7	D	0.90	6	B	0.2211	4	C	0.0130	6	B
	Green Pea	1.50	1	A	0.87	1	A	0.2415	4	C	0.0142	1	A
	Broad Bean	1.00	4	E	0.85	6	B	0.2721	4	C	0.0160	6	B
	Green Broad Bean	1.00	4	E	0.85	6	B	0.4252	4	C	0.0250	5	C
	Bean	1.65	7	D	0.89	6	B	0.2041	4	C	0.0120	6	B
	Green Bean	2.10	1	A	0.86	1	A	0.2041	4	C	0.0120	6	B
	Lentil	1.43	7	D	0.85	4	E	0.4252	4	C	0.0250	5	C
	Vetch	1.00	4	E	0.85	6	B	0.4932	4	C	0.0290	6	B
FORAGE PULSES	Lucerne	0.00	1	A	0.25	6	B	0.4422	4	C	0.0260	6	B
	Esparcet	0.00	1	A	0.25	4	E	0.4252	4	C	0.0250	5	C
	Clover	0.00	1	A	0.25	4	E	0.4252	4	C	0.0250	5	C
	Forage Vetch	0.00	1	A	0.25	6	B	0.5102	4	C	0.0300	6	B
	Lentil Vetch	0.00	1	A	0.25	4	E	0.4252	4	C	0.0250	5	C
	Sulla	0.00	1	A	0.25	4	E	0.4252	4	C	0.0250	5	C

Table 7.3.3.3.1. (continued)- Parameters related to field burning of agricultural residues

Crop		Ratio residue crop product	Source	Q	Dry Matter	Source	Q	Carbon Fraction	Source	Q	Nitrogen Fraction	Source	Q
INDUSTRIAL CROPS	Cotton	2.00	4	E	0.93	6	B	0.2450	4	E	0.0098	6	B
	Colza	4.00	7	C	0.83	6	B	0.2000	4	E	0.0080	6	B
	Sugar Cane	2.00	4	E	0.83	1	A	0.4235		A	0.0040	1	A
	Linen	2.00	4	E	0.93	6	B	0.2650	4	E	0.0106	6	B
	Hop Plant	2.00	4	E	0.85		E						
	Sugar Beet	0.30	1	A	0.15	1	A	0.4072		A	0.0228	1	A
	Beetroot	0.30	1	A	0.15	1	A	0.4072		A	0.0228	1	A
	Tobacco	2.00	4	E	0.78	6	B				0.0400	6	B
	Soybean	2.10	1	A	0.87	1	A	0.3912	4	C	0.0230	1	A
	Sunflower	2.08	7	D	0.87	6	B	0.2000	4	E	0.0080	6	B
CEREALS	Oat	1.30	1	A	0.92	1	A	0.4118	4	C	0.0070	1	A
	Rice	1.40	1	A	0.85	1	A	0.4144		A	0.0067	1	A
	Barley	1.20	1	A	0.85	1	A	0.4567		A	0.0043	1	A
	Rye	1.60	1	A	0.90	1	A	0.3840	4	C	0.0048	1	A
	Maize	1.00	1	A	0.78	1	A	0.4709		A	0.0081	1	A
	Sorghum	1.40	1	A	0.91	1	A	0.5400	4	B	0.0108	1	A
	Wheat	1.30	1	A	0.85	1	A	0.4853		A	0.0028	1	A
	Triticale	1.30	4	E	0.90	6	B	0.5600	4	C	0.0070	6	B
	Forage Sorghum	0.00	1	A	0.26	6	B	0.5400	4	E	0.0108	4	D
	Forage Maize	0.00	1	A	0.85	5	B	0.5200	4	C	0.0065	5	B
OTHERS	Forage Pumpkin	0.00	1	A									
	Forage Cabbage	0.00	1	A	0.12	6	B				0.0300	6	B
	Polyphytic Pastures	0.00	1	A	0.25		E	0.5250	4	C	0.0210	5	B
	Other Forage Grasses	1.00	4		0.18	4					0.0150	4	
	Other Market Gardening	1.00	4		0.10	4					0.0150	4	
	Other Pulses	1.81	4		0.85	4					0.0150	4	
	Other Forage Pulses	1.00	4		0.20	4					0.0300	4	
	Other Cereals	1.50	4		0.85	4					0.0150	4	
	Other Citrics	0.07	4		0.80	4					0.0150	4	
	Other Forage	1.00	4		0.10	4					0.0150	4	
	Other industrials	2.00	4		0.80	4					0.0150	4	
	Other Permanent	1.00	4		0.80	4					0.0150	4	
	Other Non Citrics	1.00	4		0.80	4					0.0150	4	
	Other Tuber	0.50	4		0.40	4					0.0150	4	

The result is therefore the expansion and adjustment to the situation in Spain of Table 4-17 of the IPCC Reference Manual. Both tables are incomplete, in other words they do not show all of the crops considered in the Inventory, and so the emissions estimations can only be effected on the crops for which complete data are available on the parameters.

7.3.3.4.- Burnt fraction per crop

The amounts of agricultural stubble waste burnt in open fields have undergone a significant decline during the period inventoried because of a series of more and more restrictive regulations applied to this practice. Table 7.3.3.4.1 contains the fractions burnt by type of crop and period. The crops not listed are those felt not to involve *in situ* stubble burning.

Spanish regulations on cereals distinguish between two areas[10]: a southern area (Zone A) and a northern area (Zone B), each with different burning percentages as shown in the Table 7.3.3.4.1.

Table 7.3.3.4.1.- Burnt fraction per crop

Period	Crop	Burnt fraction (%)	
		Plant	Rest
1990	Cereals	-	7.1
	Tubers	100	-
	Sugar cane	100	-
	Cotton	50	-
	Linen, oilseed rape, sunflower and other industrial crops	50	-
	Soy	-	50
	Tobacco	100	-
	Flowers	100	-
	Vegetables (plant, bulb or root)	-	50
	Vegetables (fruit)	50	-
1991	Cereals	-	7.1
	Other crops	As in 1990	As in1990
1992	Cereals	-	7.1
	Other crops	As in1990	As in1990
1993	Cereals	-	7.1
	Other crops	As in1990	As in1990
1994	Cereals	-	7.1
	Other crops	As in1990	As in1990
1995	Cereals	-	7.1
	Other crops	As in1990	As in1990
1996-1999	Cereals	-	7.1
	Other crops	As in1990	As in1990
2000	Cereals (Zone A)	-	2.4
	Cereals (Zone B)	-	1.2
	Tuber	50	-
	Sugar cane	50	-
	Cotton	33.3	-
	Linen, oilseed rape, sunflower and other industrial crops	33.3	-
	Vegetables (fruit)	20	-
	Other crops	As in1990	As in1990
2001-2003	Cereals (Zone A)	-	1.2
	Cotton	33.3	-
	Tobacco	100	-
	Flowers	100	-
2004-2008	Tobacco	100	-
	Flowers	100	-
	Cotton	33.3	

[10] Zone A comprises the Regional Communities of Andalusia, Extremadura, Castilla la Mancha, Valencian Community, Murcia, Madrid and Castilla y León. Zone B comprises the Regional Communities of Aragon, Catalonia, Navarre, Rioja, the Basque Country, the Balearic Islands, Galicia, Asturias, Cantabria and the Canary Islands.

7.3.3.2.- Methodology

The basic methodology for the estimate of greenhouse gases has been taken from the IPCC Manual, Chapter 4, Section 4.3. For the calculation of SO_X, NMVOC and NH_3 emissions, it has been followed the methodology proposed in the EMEP/CORINAIR Guidebook (2006), Chapter 11.3, Fires of Forests and other Types of Vegetation. The methodology used for the estimation of dioxin (DIOX) and aromatic polycyclic hydrocarbon emissions (PAH) is explained in the algorithm describing how the values reflected in Table 7.3.3.2.3 are obtained.

For the calculation of the emissions due to stubble burning in open fields, IPCC proposes the following methodology: the total amount of carbon released in the stubble burning is calculated per crop through the application of the appropriate emission factors to this total to give the emissions of CO. For the calculation of the NO_X emissions, an analogous procedure is followed, with the total nitrogen released in the combustion being calculated first of all and then the appropriate emission factors for NO_X are applied to this total.

The emission factors proposed in the EMEP/CORINAIR Guidebook (2006) are based on the CO_2 released during stubble burning, not on the C released as in the case of CH_4 and CO. It is assumed that 93.5% of the carbon is released as CO_2, since the remaining 6.5% is released as CH_4 (0.5%) and CO (6%), as shown in Table 4.16 of the IPCC Reference Manual. Therefore, for SO_X, NMVOC and NH_3, the emission factor is not applied directly to the total carbon released, but only to 93.5% of this. These emission ratios are shown in the tables 7.3.3.2.1 and 7.3.3.2.2 below.

Table 7.3.3.2.1.- Emission ratios for C-based gases

Gas	Emission ratios pollutant units / t C	Molecular weight ratios
CH_4	0.005	16/12
CO	0.06	28/12
NH_3	$1.8 \cdot 10^{-3}$	-
SO_X	$1.6 \cdot 10^{-3}$	-
NMVOC	$21 \cdot 10^{-3}$	-

Source: EMEP/CORINAIR Guidebook (2006), cap. B1103 and Table 4.16 IPCC Reference Manual.

Table 7.3.3.2.2.- Emission ratios for L-based gases

Gas	Emission ratios in kg pollutant / kg N in combustion	Molecular weight ratios
N_2O	0.007	44/28
NO_X	0.121	46/14

Source: IPCC reference manual, Table 4.16.

For dioxins, the information (1 µg i-TEQ / tonne of burnt residue) has been taken from Table 4.5.1 (row “fuel wood” and column “semi-abatement”) from the publication “Technical Paper to the OSPARCOM-HELCOM-UNECE Emission Inventory of Heavy Metals and Persistent Organic Pollutants”, TNO-report, TNO-MEP-R 95/247. For the PAH, the EMEP/CORINAIR Guidebook (2006), Chapter “Estimation of PAH emissions”, has been used, combined with the information of Appendix 3 “Default emission factors for benzo[a]pyrene” (7.2 g/t) with that of heading 7 of the same chapter, adding the ratios of

each of the four PAH compounds of the Protocol as regards the benzo[a]pyrene; the result is 16,560 mg PAH/ t burnt residue (16,560 = 7,200 (0.6+0.3+1.0+0.4)).

This calculation procedure for the emissions is summarized in the following Table 7.3.3.2.3:

Table 7.3.3.2.3.- Algorithm for estimating DIOX and PAH emissions

Mass of residue burned	Mass of pollutant/mass of residue burned
$\Sigma_j (A_j \cdot B_j \cdot D_j \cdot F_j)$	DIOX[1] = 1,000 ng/t burnt residue
$\Sigma_j (A_j \cdot B_j \cdot D_j \cdot F_j)$	HAP[2] = 16,560 mg/t burnt residue

1: The DIOX are expressed in ng (nanogrammes) of I-TEQ per tonne of burnt residue.

2: The PAH are expressed in mg (milligrammes) per tonne of burnt residue.

7.4.- References

- AGENCIA ANDALUZA DE LA ENERGÍA. *Potencial y aprovechamiento energético de la biomasa del olivar en Andalucía*. Consejería de Innovación, Ciencia y Empresa Ed., 1999. <http://www.agenciaandaluzadelaenergia.es/cocoon/aae/portal/com/bin/contenidos/publicaciones/aprovechamiento_energetico/1130059713839_potencial_y_aprovechamiento.pdf>

- “Alimentos y racionamiento”, en BUXADÉ, C. (dir.) Zootecnia, bases de la producción animal. Madrid: Mundi-Prensa, 1995, vol. III.

- Anuario de Estadística. Madrid: Ministerio de Agricultura, Pesca y Alimentación., Secretaría General Técnica, 1990-2008.

- Balance del Nitrógeno en la Agricultura Española. Madrid: Ministerio de Agricultura, Pesca y Alimentación, Subdirección General de Medios de Producción Agrícola, 2000.

- BERDOWSKY, J.J.M., et al. Technical Paper to the OSPARCOM-HELCOM-UNECE Emission Inventory of Heavy Metals and Persistent Organic Pollutants. Report no. TNO-MEP-R 95/247, 1995.

- BLAXTER, K.L. y CLAPPERTON, J.L. “Prediction of the amount of methane produced by rumiants”. British Journal of Nutrition, 1995, 19:511-522.

- BOIXADERA, J., et al. Manual del codi de bones pràctiques agràries: Nitrogen. Barcelona: Generalitat de Catalunya, Departament d’Agricultura, Ramaderia i Pesca, 2000.

- Boletín mensual de estadística. Madrid: Ministerio de Medio Ambiente y Medio Rural y Marino, 1990-2008

- BUXADÉ, C. Vacuno de carne: aspectos claves. 2ª ed. Madrid: Mundi-Prensa, 1998.

- CALCEDO, V. “Cuotas lácteas y cambio estructural en España”. Mundo Ganadero, Jun 2004, vol. XV (167), p. 18-20.

- CASADA, M.E., SAFLEY, L.M., et al. Global Methane Emissions from Livestock and Poultry Manure. Washington D.C.: U.S. Environmental Protection Agency, 1990.

- CITEPA. CORINAIR Inventory: Default Emission Factors Handbook. 2nd ed. París: Commision of the European Communities, 1992.

- Código de buenas prácticas agrarias. Ministerio de Agricultura, Pesca y Alimentación, 1999.

- Crop parametres: Harvest. Harvest index. 2006. <http://c100.bsyse.wsu.edu/cropsyst/manual/parametres/crop/harvest.htm#HIconsts >

- CRUTZEN, P.J. y ANDREAE, M.O. “Biomasa burning in the Tropics: Impact on atmospheric chemistry and biogeochemical cycles”. Science, 1990, 250:1669-1678.

- [Excrections] MARM. Caracterización de sistemas de gestión de deyecciones. Madrid 2010.

- [IPCC Guidelines] 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Japan: IGES, 2006.

- ECETOC. Ammonia emissions to air in Western Europe. Bruselas: European Centre for Ecotoxicology and Toxicology of Chemicals, 1994.

- EICHNER, M.J. “Nitrous oxide emissions from fertilizad soils: summary of available data”. Journal of Environmental Quality, 1990, 19:272-190.

- EMEP/EEA 2009. “Air Pollutant Emission Inventory Guidebook”. UNECE-Convention on long-range transboundary air pollution & European Environmental Agency.

- [Emissions] MARM. “Metodología para la estimación de las emisiones a la atmósfera del sector ganadero para el inventario nacional de emisiones”. Madrid, 2010

- Emission Inventory of CH4 and N2O in the European Community. París: CITEPA, 1990.

- “Environmental Engineering: chapter 2 Composting”, en Nacional Engineeering Handbook, part 637. United Status Department of Agriculture, 2000.

- Estimation of Greenhouse Gas Emissions and Sinks. OECD, 1991.

- Federación Española de Asociaciones de Ganado Selecto. Bovino FEAGAS, En http://www.feagas.es/. Accedido el 10-11-2006.

- FUENTES GARCÍA, F.C., GONZALO ABASCAL, C. y SÁNCHEZ SÁNCHEZ, J.M. Manual de etnología animal: razas de rumiantes. Murcia: Diego Marín Editor, 2000.

- [IPCC Good Practice Guidance] Good Practice Guidance and Uncertainty Management in Nacional Greenhouse Gas Inventories. Londres: IPPC, OECD, IEA, 2000.

- [UPV Report] Torres Salvador, Antonio (coord.). *Metodología para la estimación de las emisiones a la atmósfera del sector agrario para el Inventario Nacional de Emisiones*, informe inédito, Universidad Politécnica de Valencia, 2006.

- [MAPA Report (2000)] Estimación de emisiones de gases de efecto invernadero, agricultura año 2000, informe inédito, Ministerio de Agricultura, Pesca y Alimentación, 2002.

- [MAPA Report (2001)] Estimación de emisiones de gases de efecto invernadero, agricultura año 2001 (criterios utilizados), informe inédito, Ministerio de Agricultura, Pesca y Alimentación, 2003.

- KLIMONT, Z., et al. Modelling particulate emissions in Europe: a framework to estimate reduction potencial and control costs. Laxenburg: IIASA, [2000].

- KRIDER, J.N., et al. Agricultural waste management field handbook. Washington D.C.: Natural Resources Conservation Service (NRCS), 1999.

- LA CAL, J.A. “Biomasa del olivar: oportunidad para el sector oleícola y apuesta por la sostenibilidad de Jaén”. Energética XXI. Revista de Generación de Energía. Biomasa. Enero/Febrero 2007. Madrid: Omnimedia Ed., 2007. 126-127 pp. <http://www.energetica21.com/esp/biomasa07.html>

- Libro Guía EMEP/CORINAIR (1996). “Atmospheric Emission Inventory Guidebook”. First Edition. February 1996. UNECE-convention on long-range transboundary air pollution & European Environmental Agency.

- Libro Guía EMEP/CORINAIR. “Atmospheric Emission Inventory Guidebook”. Second Edition. September 1999. UNECE-convention on long-range transboundary air pollution & European Environmental Agency.

- Libro Guía EMEP/CORINAIR. “Atmospheric Emission Inventory Guidebook”. Third Edition. Updated to December 2006. UNECE-Convention on long-range transboundary air pollution & European Environmental Agency.

- Libro Guía EMEP/CORINAIR. “Atmospheric Emission Inventory Guidebook”. Third Edition. Updated to December 2007. UNECE-Convention on long-range transboundary air pollution & European Environmental Agency.

- [IPCC Reference Manual] Greenhouse Gas Inventory: Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Londres: IPCC, OECD, IEA, 1997.

- MARTÍNEZ, X. “Gestión y tratamiento de residuos agrícolas”. RETEMA: Revista Técnica de Medio Ambiente, año 19, nº 111 (mar.-abr. 2006), p, 62-75.

- Medio Ambiente en España. Madrid: Ministerio de Medio Ambiente, 1985-2007.

- MINISTERIO DE AGRICULTURA, PESCA Y ALIMENTACIÓN. “Especie bovina”, en Catálogo de razas autóctonas españolas. Madrid: Dirección General de la Producción Agraria, 1981, vol. II.

- OECD Environmental Data, Données OCDE sur l'environnement: Compendium 2008. París: OCDE.

- ROSELLÓ, J. y DOMÍNGUEZ, A. (2006). Comunicación personal.

- SÁNCHEZ BELDA, A. Razas ganaderas españolas bovinas. Madrid: FEAGAS, Ministerio de Agricultura, Pesca y Alimentación, 2002.

- SCHÜTZ, H., et al. "A 3-year continuous record of the influence of daytime, season, and fertilizer treatment on methane emission rates from an Italian rice paddy". Journal of Geophysical Research, 94:16405-16416.

- SEILER, W., HOLZAPFEL-PSCHORN, A., et al. "Methane Emission from Rice Paddies". Journal of Atmospheric Chemistry, 1984, 241-268.

- Senovilla, L.; Antolín, G.. Revalorización energética de los residuos de la industria vitivinícola. Proyecto Final de Carrera. Cátedra de Energías Renovables. Universidad de Valladolid, Escuela Técnica Superior de Ingenieros Industriales, 2005

- SINEIRO, F. "La ganadería de vacuno de leche ante la reforma intermedia de la PAC", en Libro blanco de la agricultura y el desarrollo cultural. Jornada temática sobre la agricultura española en el marco de la PAC, Madrid, 6-7 febrero 2003.

- The Fertilizer Handbook. Washington D.C.: The Fertilizer Institute.

- URBANO TERRÓN, P. Tratado de Fitotecnia General. Madrid: Mundi-Prensa, 1999.

- VILLALOBOS, F.J., et al. Fitotecnia: bases y tecnologías de la producción agrícola. Madrid: Mundi-Prensa, 2002.

- WHEELER, R.M. "Carbon balance in biogenerative life support systems: some effects of system closure, waste management, and crop harvest index". Advances in Space Research: the oficial journal of the Comittee on Space Research (COSPAR), 2003, 31(1):169-75.

- [Zootechnical] MARM. Bases zootécnicas para el cálculo del balance de nitrógeno y de las emisiones de gases producidas por la actividad ganadera en España. Madrid, 2010.

8.- LAND USE AND LAND-USE CHANGE

As for the information this sector the reader is invited to look at chapter 7, 2010 edition, of the *Spain Green House Gasses Inventory (series 1990-2008)*, in CRF format, that can be accessed on the following web page:

http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php

9.- WASTES

Chapter update: July 2010.

9.1.- Sector analysis

This sector includes activities associated with the treatment and disposal of wastes. The emissions generated by these activities, as far as the atmospheric pollutants are concerned, mainly result from the burning of waste in unmanaged landfills (1990-2008) falling under category 6A; from the incineration of waste (1990-2003) under category 6C and from the application of sludge and compost production under category 6D. Category 6B (waste water treatments) is not included here, as for it no emissions from the pollutants described in this report have been estimated[1].

The following paragraph (9.2) shows the effect that changes in waste management systems have on the evolution of the pollutants trends and the growing importance among these systems of selective waste collection, separation for recycling, selective composting of organic waste, the incorporation of biomethanisation plants, and the alternative disposal of non-recoverable materials in landfills. As a general pattern we could confirm the increasing importance in the pollutant trends of the increase in composting, biogas recovering and the decrease of unmanaged landfills and domestic or municipal waste incineration without energy recovery.

The list NFR categories that are included in this sector is the one shown bellow:

- 6.A: Solid Waste Disposal on Land
- 6.B: Waste Water Handling
- 6.C: Waste Incineration
- 6.D: Others

9.2.- Analysis by pollutant

9.2.1.- NO_X

NO_X emissions resulting from waste treatment and disposal are scarcely relevant in the inventory as a whole (see Table 9.2.1.1). They exhibit a downward trend with an 86.5% reduction throughout the inventory period.

---

1 Nevertheless, there is evidence that NMVOC are emited.

***Table 9.2.1.1.- NO_X emissions** (Amounts in Gg)*

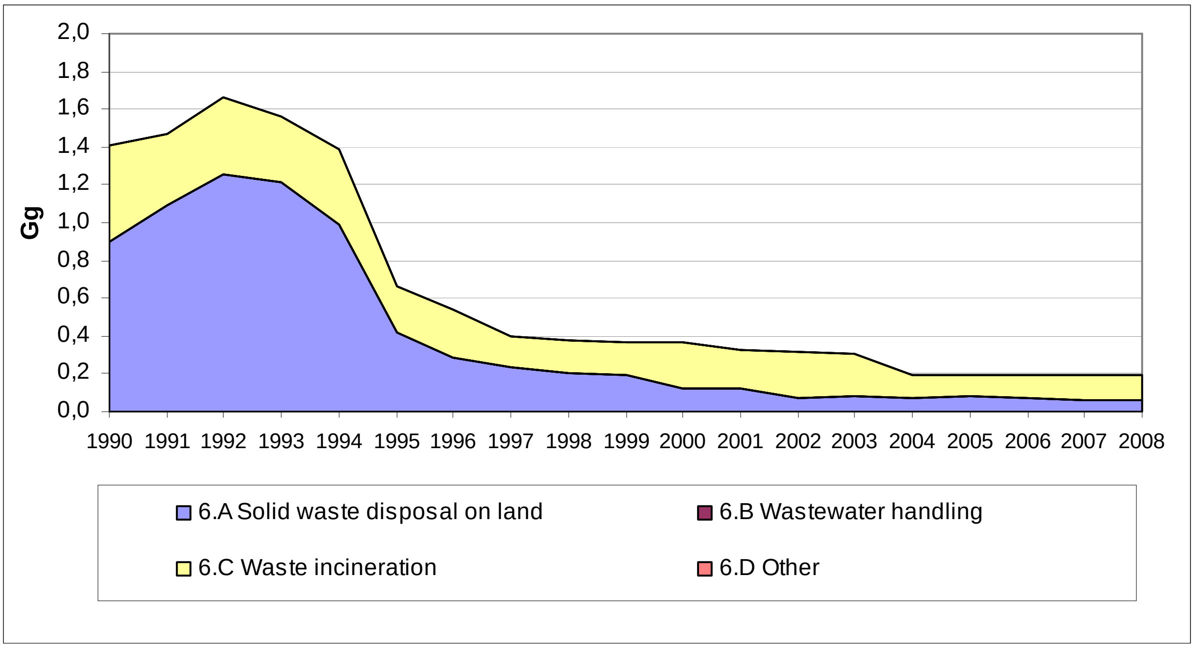
Category	1990	1995	2000	2004	2005	2006	2007	2008
6.A Solid waste disposal on land	0.9	0.4	0.1	0.1	0.1	0.1	0.1	0.1
6.B Wastewater treatment	-	-	-	-	-	-	-	-
6.C Waste incineration	0.5	0.3	0.2	0.1	0.1	0.1	0.1	0.1
6.D Others	-	-	-	-	-	-	-	-
Total Wastes	**1.4**	**0.7**	**0.4**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**

Figure 9.2.1.1 shows the evolution of NO_X emissions throughout the inventory period. The emissions trend is determined, in order of importance, by categories 6A (Solid waste disposal on land) and 6C (Waste incineration), with no positive contribution to these pollutant emissions by categories 6B (Waste water treatment) and 6D (Other treatments).

The significant decrease in the emissions levels recorded up to 2004 is essentially determined, as shown below, by i) the transfer from the Waste sector to the Energy sector in the accounting of emissions of incinerated urban solid waste in the measure that said incineration conducts its energy recovery (see Figure 9.3.2.1.2.1), and ii) the decrease of incinerated hospital wastes in Spain (see Figure 9.3.2.1.1.1).

As for waste disposal in landfills, the reduction in emissions is due to the progressive cutback in unmanaged waste burning, while emissions generated by the flaring of biogas exhibit a growing trend until 2005, when a mild drop is observed due to the replacement of flares by engines for energy recovery of captured biogas.

Figure 9.2.1.1.- Pattern of NO_X emissions



As shown in Figure 9.2.1.2, waste emissions in 2008 account for 0.015% of total emissions in Spain, which entail a reduction in their contribution to the whole inventory with respect to 1990, when they amounted to 0.105% of total emissions.

Figure 9.2.1.2.- Percentage of NO_X emissions by category with respect to the inventory total

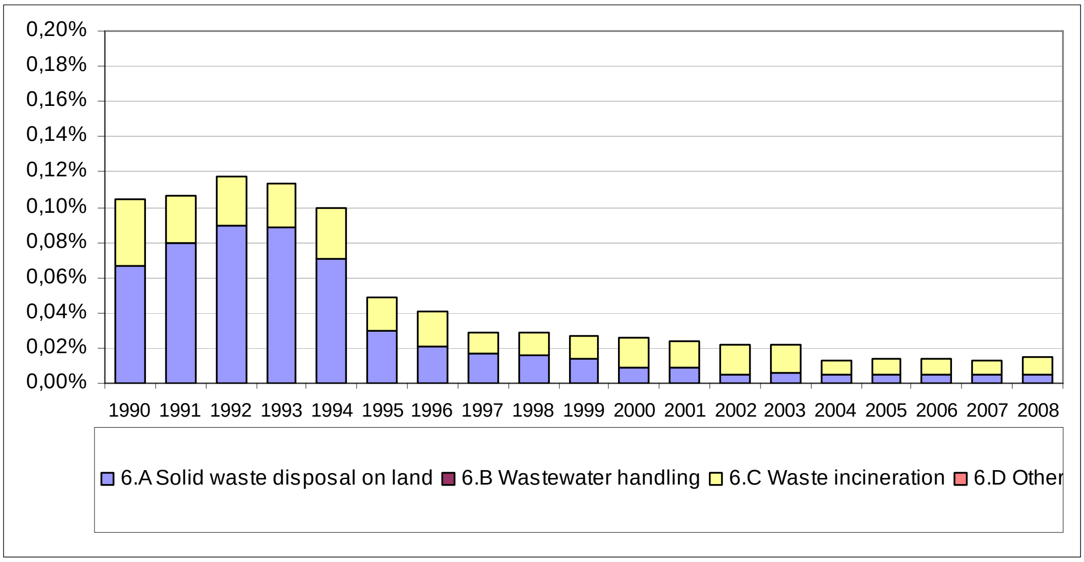
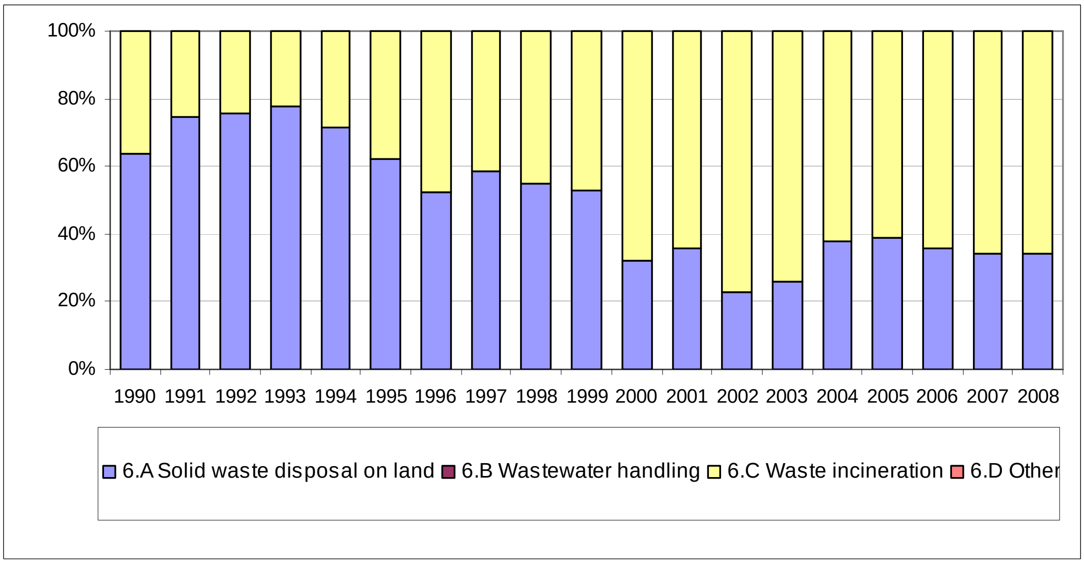


Figure 9.2.1.3 shows significant variations in the distribution of emissions for this sector among the different categories. During the period 1993-2002, category 6.C becomes increasingly relevant over time due to cutbacks in the burning of unmanaged waste in category 6.A. Please note that, from 2003 on, the weight of Landfilling increases, but this is an increase in percentage terms within the sector and not in absolute value.

Figure 9.2.1.3.- Percentage of NO_X emissions by category with respect to the sector total



9.2.2.- NMVOC

NMVOC emissions associated with waste treatment and disposal exhibit an upward trend by 59.65% throughout the inventory period (see Table 9.2.2.1).

Table 9.2.2.1.- NMVOC emissions *(Amounts in Gg)*

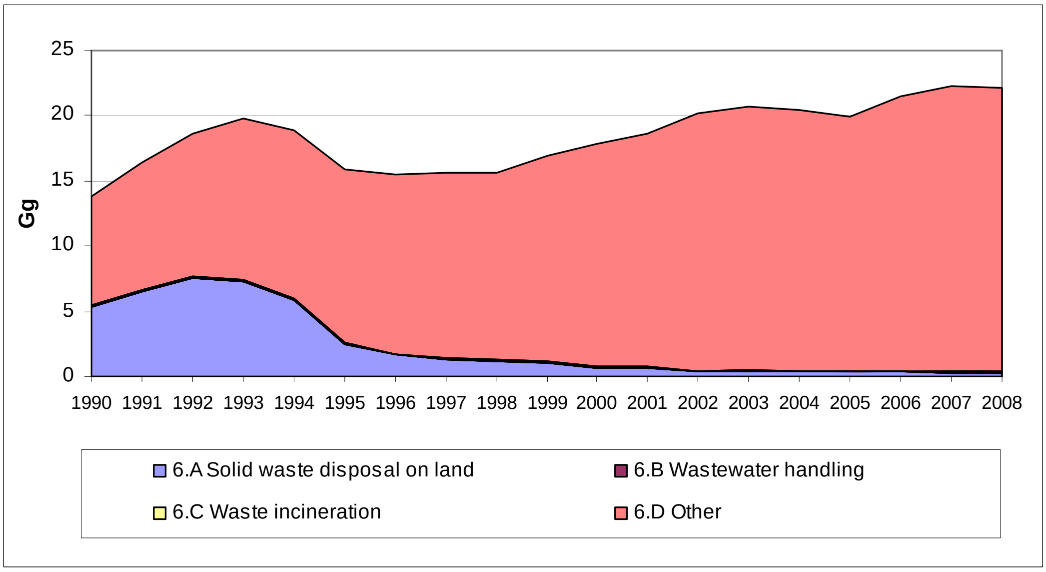
Category	1990	1995	2000	2004	2005	2006	2007	2008
6.A Solid waste disposal on land	5.4	2.5	0.7	0.3	0.3	0.3	0.3	0.3
6.B Wastewater treatment	-	-	-	-	-	-	-	-
6.C Waste incineration	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
6.D Others	8.3	13.3	17.1	20.1	19.5	21.2	21.8	21.7
Total Wastes	**13.8**	**15.9**	**17.8**	**20.5**	**19.9**	**21.5**	**22.2**	**22.1**

Figure 9.2.2.1 shows the evolution of NMVOC emissions throughout the inventory period. The emissions trend is determined, in order of importance, by categories 6D (Other treatments), 6A (Solid waste disposal on land) and 6C (Waste incineration), with no positive contribution to these pollutant emissions by categories 6B (Waste water treatment).

This significant increase in NMVOC emission levels under category 6D is determined by the increase in the amount of sludge generated at waste water treatment plants (see Figure 9.3.2.1.4.1). Due to the lack of better information, the amount of sludge spread in open air fields for drying purposes is assumed to be equal to the total amount of sludge generated. This activity variable, taken from the National Sludge Register, as with the emission factors considered, presents a high degree of uncertainty and it is under review for its improvement.

As for waste disposal in landfills, the reduction in emissions is due to the progressive cutback in unmanaged waste burning.

Figure 9.2.2.1.- Pattern of NMVOC emissions



-o-

As shown in Figure 9.2.2.2, waste emissions in 2008 account for 2.7% of total emissions in Spain, which entail a reduction in their contribution to the whole inventory with respect to 1990, when they amounted to 1.3% of total emissions.

Figure 9.2.2.2.- Percentage of NMVOC emissions by category with respect to the inventory total

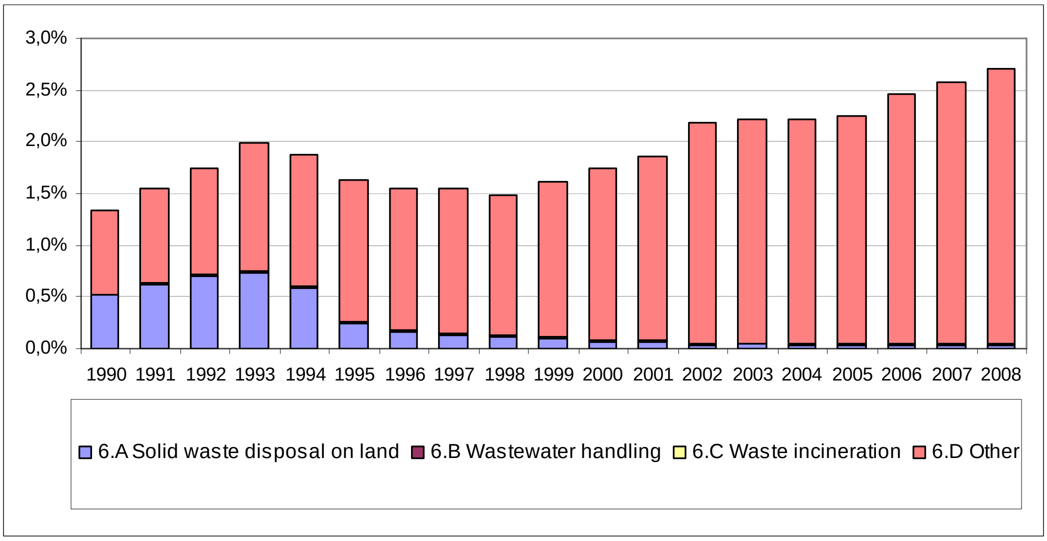
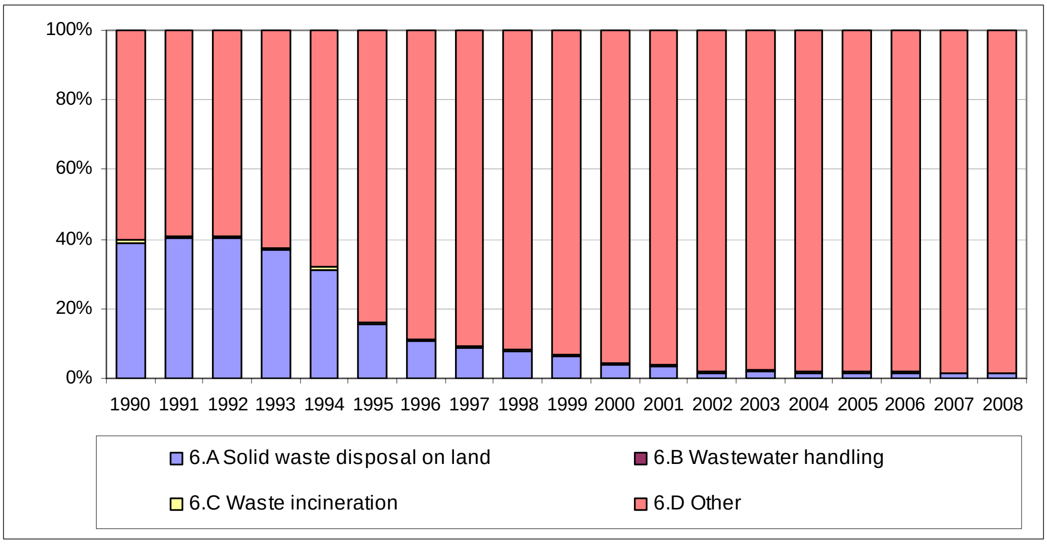


Figure 9.2.2.3 shows that the distribution of emissions for this sector among the different categories was subject to significant variations due to the progressive cutback in unmanaged waste burning in waste disposal at landfills and the increase of sludge generated at treatment plants, with the spreading of sludge being the activity that most contributed to NMVOC emissions.

Figure 9.2.2.3.- Percentage of NMVOC emissions by category with respect to the sector total



As for the key sources of NMVOC in this sector, the following have been identified for the period 1990-2008:

- Landfilling (6A) for its trend in the years 1991-1993 and 1995.

- Other treatments (6D) for its emission level in the years 1999-2008 and for its trend in the years 1991-2008.

As a summary of the foregoing, Table 9.2.2.2 below reflects, for the key categories for NMVOC in this sector, the emissions' contribution to the level and trend, the order number of the category in the list of key sources[2], as well as the absolute values, all referring to 2008.

Table 9.2.2.2.- NMVOC key categories: Contribution to Level and Trend

Activity		NMVOC (Gg) (2008)	Contribution Level (2008)			Contribution Trend (2008)		
Code	**Description**		**%**	**K. Cat.**	**Rank**	**%**	**K. Cat**	**Rank**
6.A	Solid waste disposal on land	0.3	0.04	NO	26	0.84	YES	17
6.D	Others	21.7	2.7	YES	11	3.05	YES	8

9.2.3.- SO_X

SO_X emissions resulting from waste treatment and disposal are scarcely relevant for the inventory as a whole (see Table 9.2.3.1). They exhibit a downward trend with a reduction of 83.3% throughout the inventory period.

Table 9.2.3.1.- SO_X emissions *(Amounts in Gg)*

Category	**1990**	**1995**	**2000**	**2004**	**2005**	**2006**	**2007**	**2008**
6.A Solid waste disposal on land	0.8	0.4	0.1	0.1	0.1	0.1	0.1	0.04
6.B Wastewater treatment	-	-	-	-	-	-	-	-
6.C Waste incineration	0.4	0.2	0.2	0.2	0.1	0.1	0.1	0.1
6.D Others	-	-	-	-	-	-	-	-
Total Wastes	**1.2**	**0.6**	**0.3**	**0.3**	**0.2**	**0.2**	**0.2**	**0.2**

Figure 9.2.3.1 shows the evolution of SO_X emissions throughout the inventory period. The emissions trend is determined, in order of importance, by categories 6A (Solid waste disposal on land) and 6C (Waste incineration), with no positive contribution to these pollutant emissions by categories 6B (Waste water treatment) and 6D (Other treatments).

The significant decrease in the emissions levels recorded up to 2004 is essentially determined, as shown below, by i) the transfer from the Waste sector to the Energy sector in the accounting of emissions of incinerated urban solid waste in the measure that said incineration conducts its energy recovery (see Figure 9.3.2.1.2.1), and ii) the decrease of incinerated hospital wastes in Spain (see Figure 9.3.2.1.1.1).

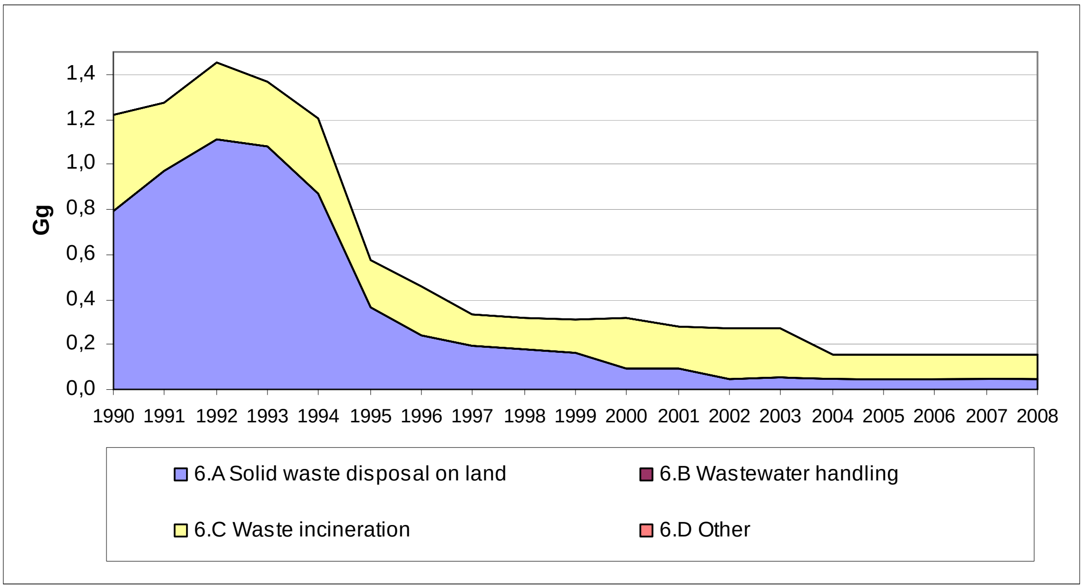
---

[2] Order determined by the contribution of the category's emissions to the level or trend.

As for waste disposal in landfills, the reduction in emissions is due to the progressive cutback in unmanaged waste burning.

As can be seen, the reasons are identical to those mentioned for NO_X.

Figure 9.2.3.1.- Pattern of SO_X emissions



As shown in Figure 9.2.3.2, waste emissions in 2008 account for 0.029% of total emissions in Spain, which entail a reduction in their contribution to the whole inventory with respect to 1990, when they amounted to 0.056% of total emissions.

Figure 9.2.3.2.- Percentage of SO_X emissions by category with respect to the inventory total

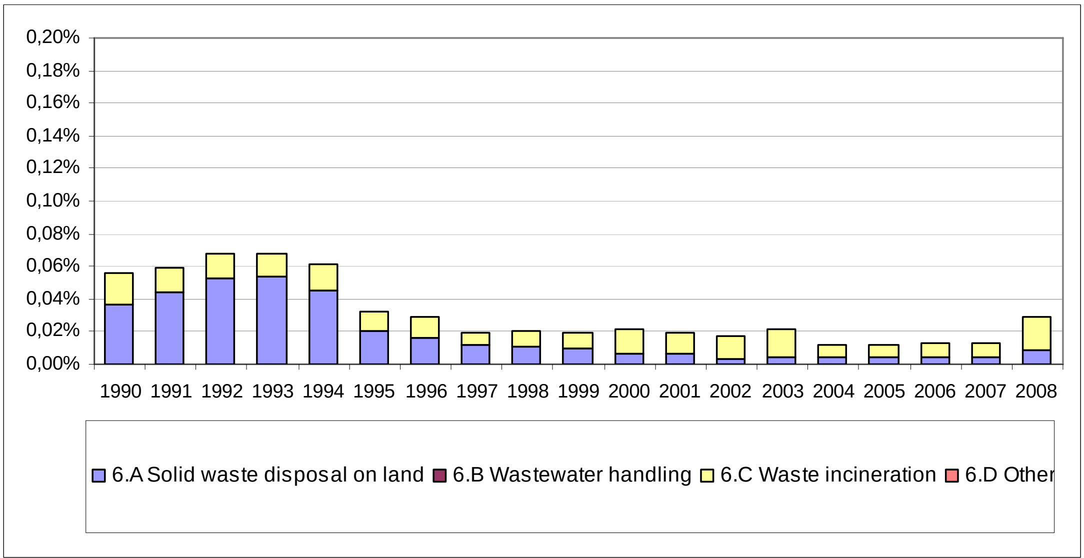
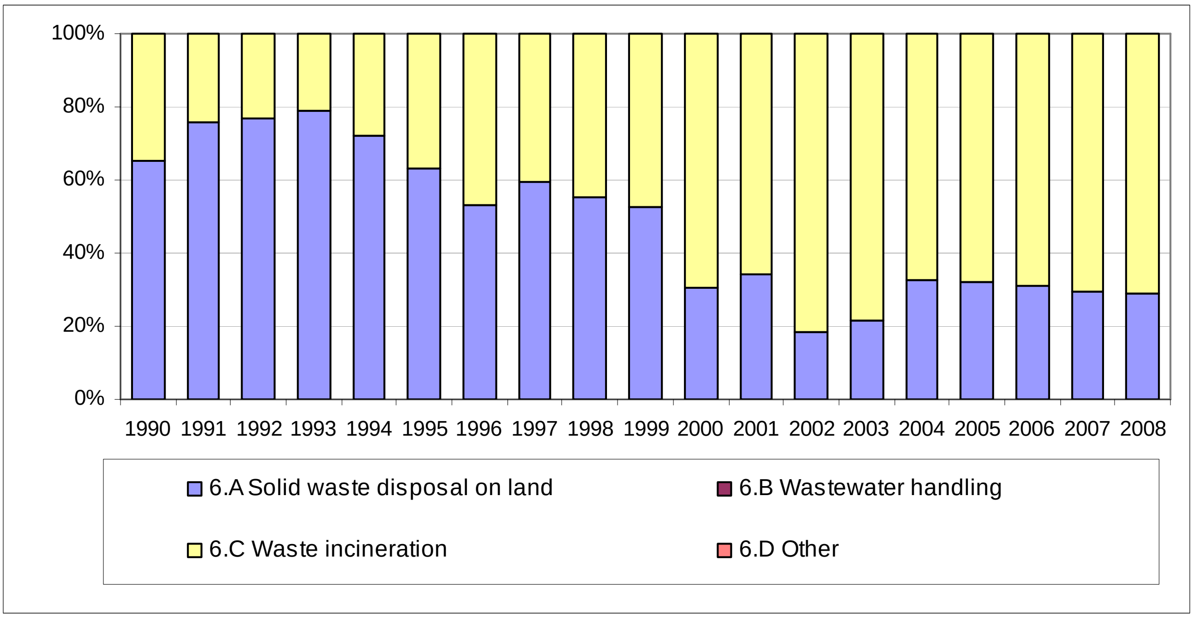


Figure 9.2.3.3 shows significant variations in the distribution of emissions for this sector among the different categories. During the period 1990-2003, category 6.C becomes increasingly relevant over time due to cutbacks in the burning of unmanaged waste in category 6.A. Please note that, from 2004 on, the weight of Landfilling increases, but this is an increase in percentage terms within the sector and not in absolute value.

Figure 9.2.3.3.- Percentage of SO_X emissions by category with respect to the sector total



9.2.4.- NH_3

NH_3 emissions associated with waste treatment and disposal exhibit an upward trend by 285.7% throughout the inventory period (see Table 9.2.4.1).

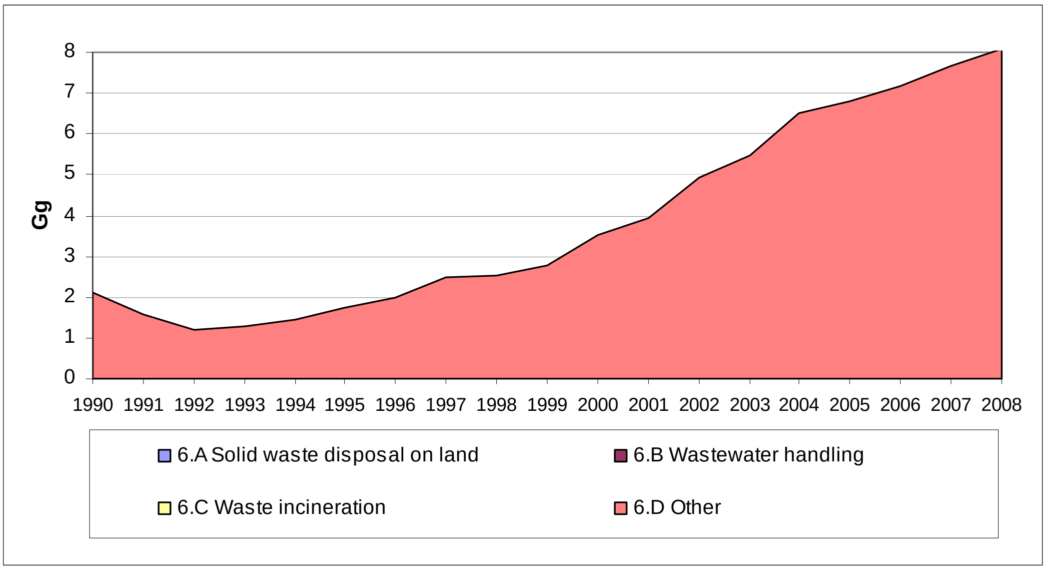
Table 9.2.4.1.- NH_3 emissions *(Amounts in Gg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
6.A Solid waste disposal on land	-	-	-	-	-	-	-	-
6.B Wastewater treatment	-	-	-	-	-	-	-	-
6.C Waste incineration	0.00002	0.00005	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003
6.D Others	2.1	1.7	3.5	6.5	6.8	7.2	7.7	8.1
Total Wastes	**2.1**	**1.8**	**3.6**	**6.5**	**6.8**	**7.2**	**7.7**	**8.1**

Figure 9.2.4.1 shows the evolution of NH_3 emissions throughout the inventory period. The emissions trend is determined, in order of importance, by categories 6D (Other treatments) and 6C (Waste incineration), with no positive contribution to these pollutant emissions by categories 6A (Solid waste disposal on land) and 6B (Waste water treatment).

The significant increase in NH_3 emission levels for category 6D is determined by the progressive increase in the amount of composted waste. The information source from which the activity variable has been taken is the publication entitled “Medio Ambiente en España” (The Environment in Spain), which presents a high degree of uncertainty for the first years inventoried, which explains the downward course of the emissions until 1992.

Figure 9.2.4.1.- Pattern of NH_3 emissions



As shown in Figure 9.2.4.2, waste emissions in 2008 account for 2.3% of total emissions in Spain, which entail a reduction in their contribution to the whole inventory with respect to 1990, when they amounted to 0.7% of total emissions.

Figure 9.2.4.2.- Percentage of NH_3 emissions by category with respect to the inventory total

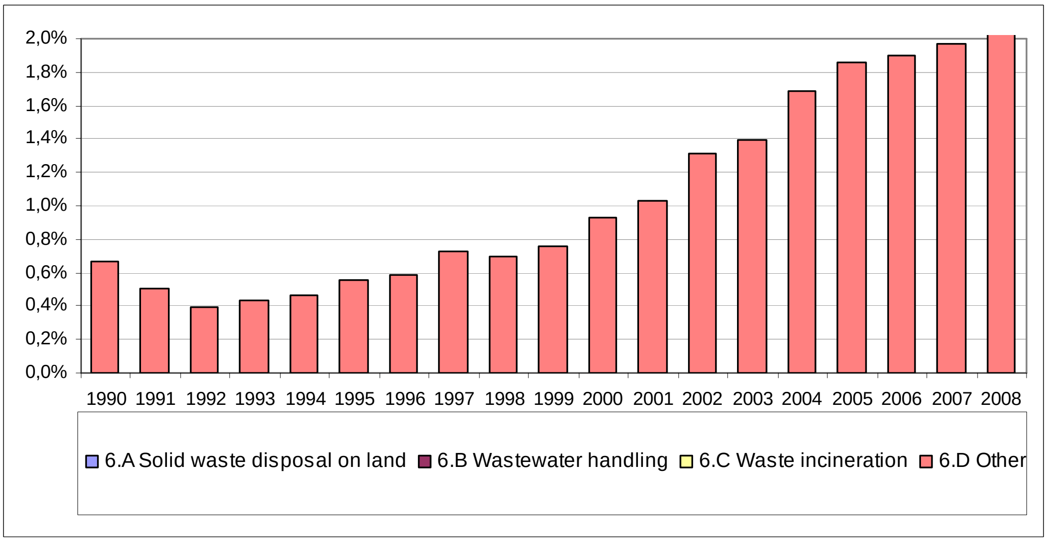
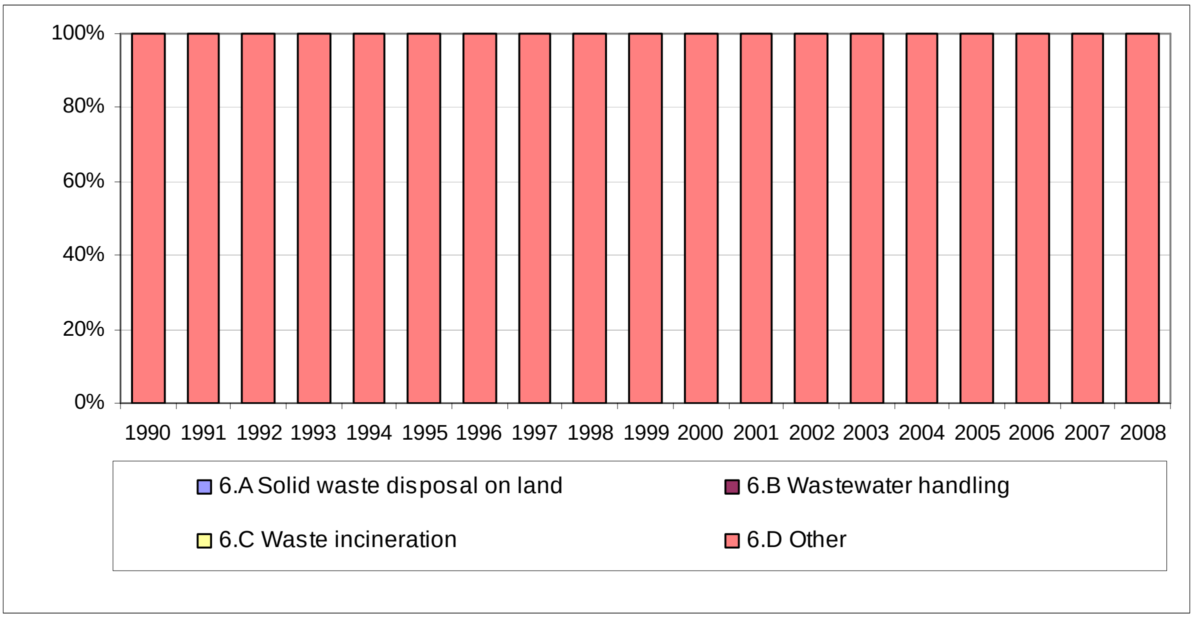


Figure 9.2.4.3 shows that the distribution of emissions for this sector among the different categories exhibited no variations, since they are all related to organic waste composting activities falling under category 6D.

Figure 9.2.4.3.- Percentage of NH_3 emissions by category with respect to the sector total



As for the key sources of NH_3 in this sector, the following have been identified for the period 1990-2008:

- Total wastes (6) for its emission level in the years 2006 and 2008 and for its trend in the years 1991-1993 and 2000-2008.

As a summary of the foregoing, Table 9.2.4.2 below reflects, for the key categories for NH_3 in this sector, the emissions' contribution to the level and trend, the order number of the category in the list of key sources[3], as well as the absolute values, all referring to 2008.

Table 9.2.4.2.- NH_3 key categories: Contribution to Level and Trend

Activity		NH_3 (Gg) (2008)	Contribution Level (2008)			Contribution Trend (2008)		
Code	Description		%	K. Cat	Rank	%	K. Cat	Rank
6	Wastes	8.1	2.3	YES	4	11.1	YES	4

[3] Order determined by the contribution of the category's emissions to the level or trend.

9.2.5.- CO

CO emissions resulting from waste treatment and disposal are scarcely relevant in the inventory as a whole (see Table 9.2.5.1) They exhibit a downward trend with an 88.9% reduction throughout the inventory period.

Table 9.2.5.1.- CO emissions *(Amounts in Gg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
6.A Solid waste disposal on land	16.7	7.7	2.2	1.3	1.4	1.3	1.2	1.2
6.B Wastewater treatment	-	-	-	-	-	-	-	-
6.C Waste incineration	0.4	0.7	1.2	0.7	0.7	0.7	0.7	0.7
6.D Others	-	-	-	-	-	-	-	-
Total Wastes	**17.2**	**8.4**	**3.4**	**2.0**	**2.1**	**2.0**	**1.9**	**1.9**

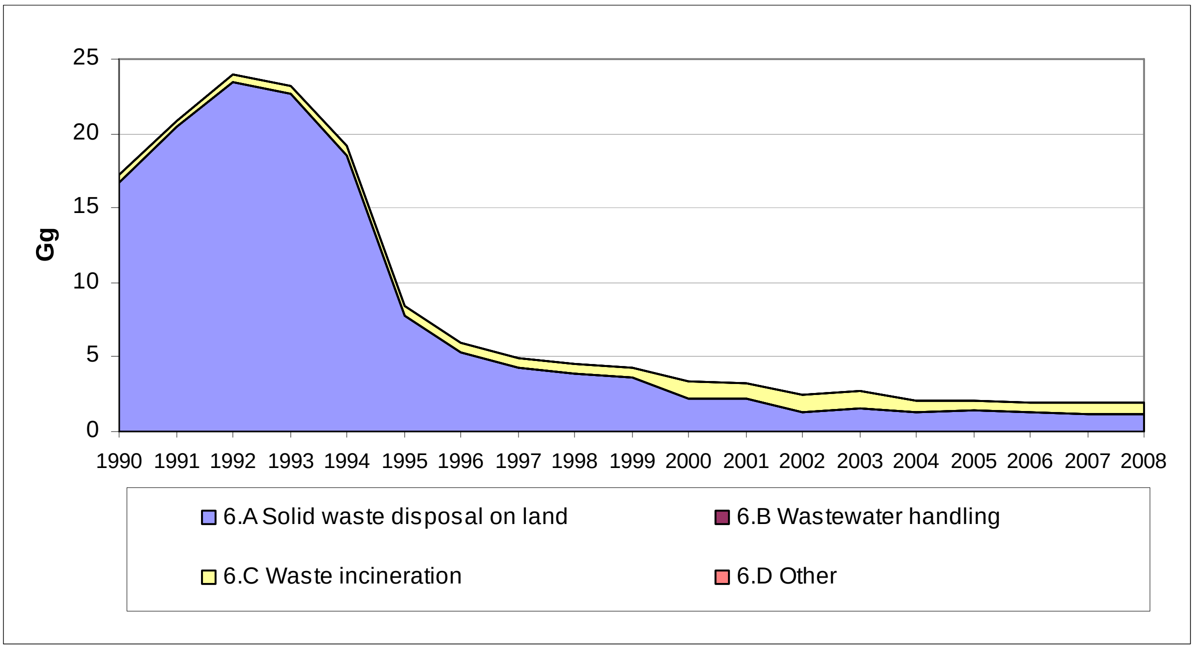
Figure 9.2.5.1 shows the evolution of CO emissions throughout the inventory period. The emissions trend is determined, in order of importance, by categories 6A (Solid waste disposal on land) and 6C (Waste incineration), with no positive contribution to these pollutant emissions by categories 6B (Waste water treatment) and 6D (Other treatments).

In category 6C, the emissions for the period 1990-1993 are seen to remain practically constant in the period 1990-1995. However, from 1994 on, there is a slight gradual increase in emissions, due to the increase in the emissions generated by the sludge incineration and cremation activities. The fall since 2003 on is due to the reduction in incinerated sludge from the waste water treatment plants (WWTPs) shown in Figure 9.3.2.1.4.1.

As for waste disposal in landfills, the reduction in emissions is due to the progressive cutback in unmanaged waste burning until 2005, when a mild drop is observed due to the replacement of flares by engines for energy recovery of captured biogas.

As can be seen, the reasons are identical to those mentioned for NO_X.

Figure 9.2.5.1.- Pattern of CO emissions



As shown in Figure 9.2.5.2, waste emissions in 2008 account for 0.1% of total emissions in Spain, which entail a reduction in their contribution to the whole inventory with respect to 1990, when they amounted to 0.47% of total emissions.

Figure 9.2.5.2.- Percentage of CO emissions by category with respect to the inventory total

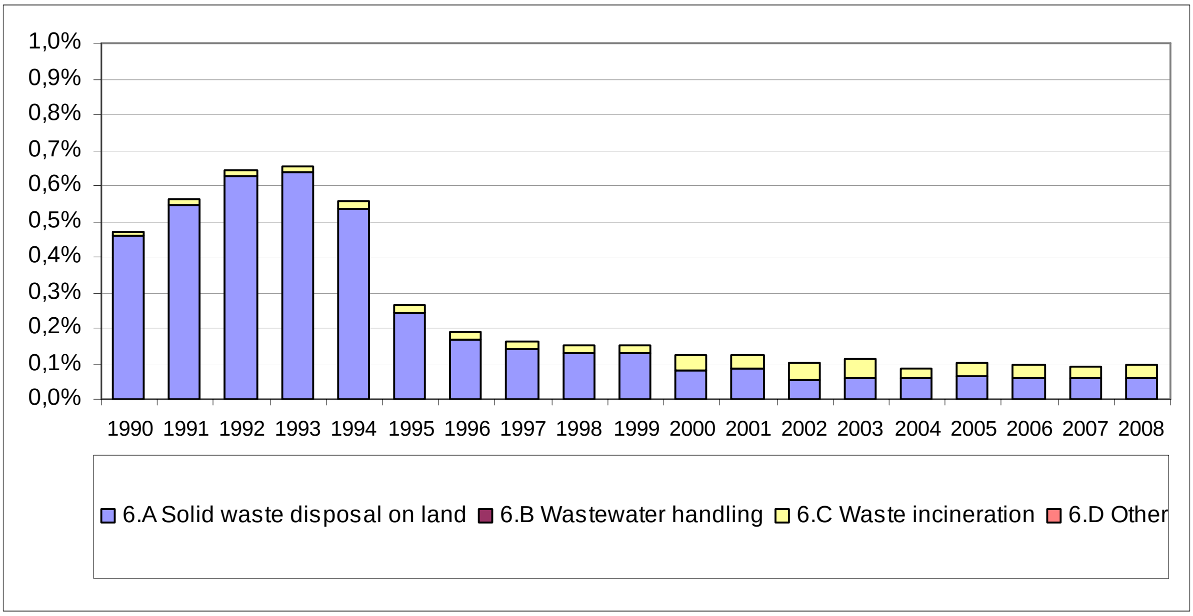
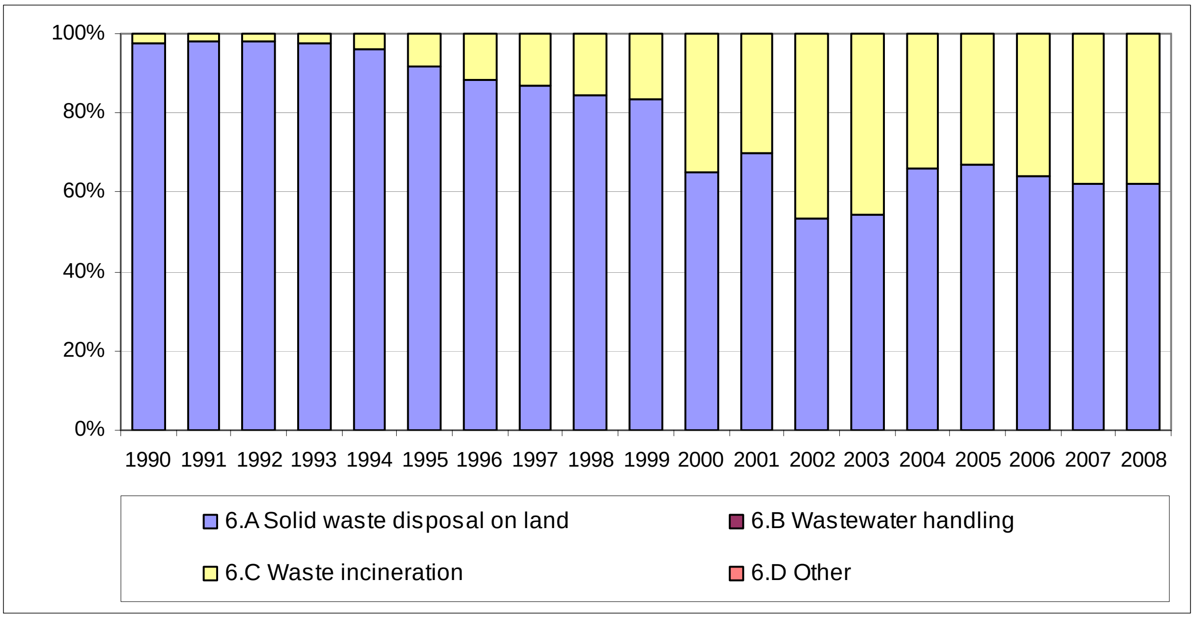


Figure 9.2.5.3 shows significant variations in the distribution of emissions for this sector among the different categories. During the period 1990-2002, category 6.C becomes increasingly relevant over time due to cutbacks in the burning of unmanaged waste in category 6.A. Please note that, from 2003 on, the weight of Landfilling increases, but this is an increase in percentage terms within the sector and not in absolute value.

Figure 9.2.5.3.- Percentage of CO emissions by category with respect to the sector total



As for the key sources of CO in this sector, the following have been identified for the period 1990-2008:

- Solid waste disposal on land (6.A) for its trend in the years 1991-1993 and 1996.

As a summary of the foregoing, Table 9.2.4.2 below reflects, for the key categories for CO in this sector, the emissions' contribution to the level and trend, the order number of the category in the list of key sources[4], as well as the absolute values, all referring to 2008.

Table 9.2.5.2.- CO key categories: Contribution to Level and Trend

Activity		CO (Gg) (2008)	Contribution Level (2008)			Contribution Trend (2008)		
Code	**Description**		**%**	**K. Cat**	**Rank**	**%**	**K. Cat**	**Rank**
6.A	Solid waste disposal on land	1.2	0.1	NO	17	0.49	NO	12

[4] Order determined by the contribution of the category's emissions to the level or trend.

9.2.6.- PM $_{2,5}$

$PM_{2,5}$ emissions resulting from waste treatment and disposal are scarcely relevant for the inventory as a whole (see Table 9.2.6.1) They exhibit an upward trend by 14.3% throughout the inventory period

***Table 9.2.6.1.- $PM_{2,5}$ emissions** (Amounts in Gg)*

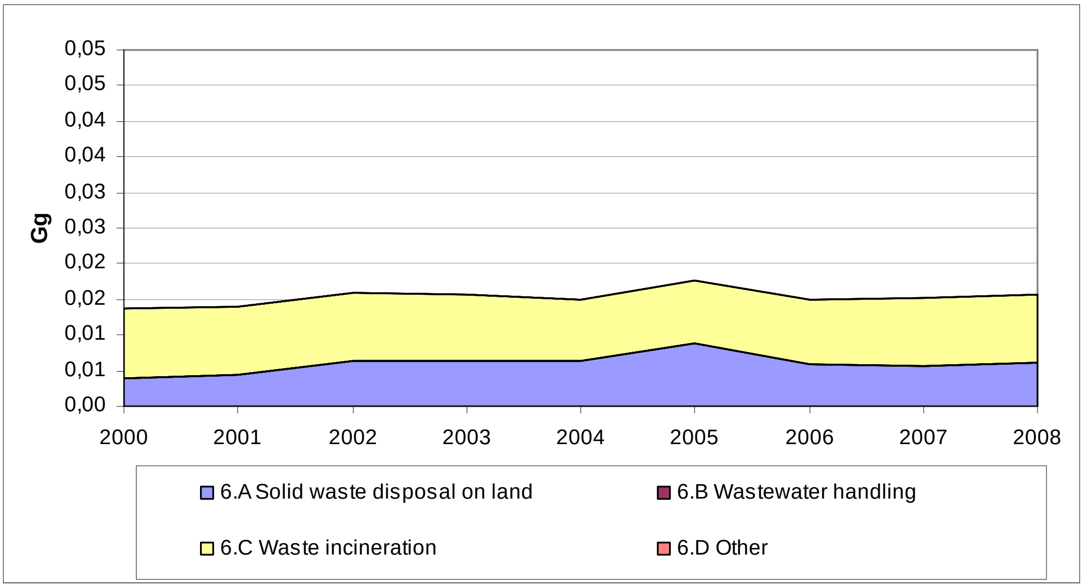
Category	2000	2001	2002	2003	2004	2005	2006	2007	2008
6.A Solid waste disposal on land	0.0040	0.0044	0.0063	0.0064	0.0064	0.0087	0.0059	0.0057	0.0062
6.B Wastewater treatment	-	-	-		-	-	-	-	-
6.C Waste incineration	0.0096	0.0096	0.0097	0.0092	0.0086	0.0088	0.0090	0.0095	0.0095
6.D Others	-	-	-		-	-	-	-	-
Total Wastes	**0.014**	**0.014**	**0.016**	**0.016**	**0.015**	**0.018**	**0.015**	**0.015**	**0.016**

Figure 9.2.6.1 shows the evolution of $PM_{2,5}$ emissions throughout the inventory period. The emissions trend is determined, in order of importance, by categories 6C (Waste incineration) and 6A (Solid waste disposal on land), with no positive contribution to these pollutant emissions by categories 6B (Waste water treatment) and 6D (Other treatments).

In the case of Waste incineration, emissions have remained virtually constant, with a slight increase in the final inventory years, With the exception of the last year, as a consequence of increased emissions resulting from a rise in the incineration of corpses, see Figure 9.3.2.1.3.1.

Emissions from biogas flaring under the Landfilling category grew until 2005, subsequently decreasing due to the replacement of flares by engines used in energy recovery of captured biogas.

Figure 9.2.6.1.- Pattern of $PM_{2,5}$ emissions



As shown in Figure 9.2.6.2, waste emissions in 2008 account for 0.0157% of total emissions in Spain, which entail a reduction in their contribution to the whole inventory with respect to 1990, when they amounted to 0.0137% of total emissions.

Figure 9.2.6.2.- Percentage of $PM_{2,5}$ emissions by category with respect to the inventory total

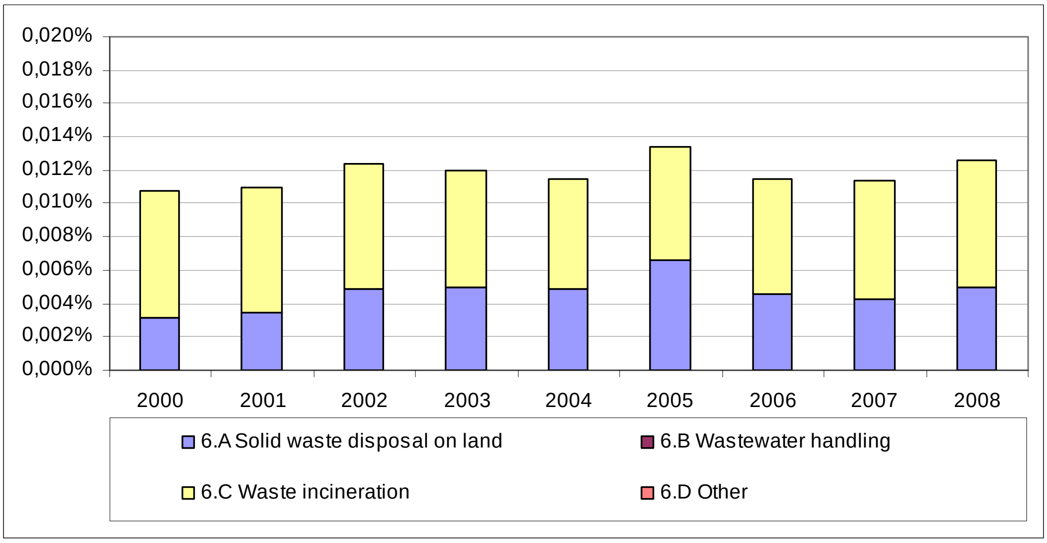
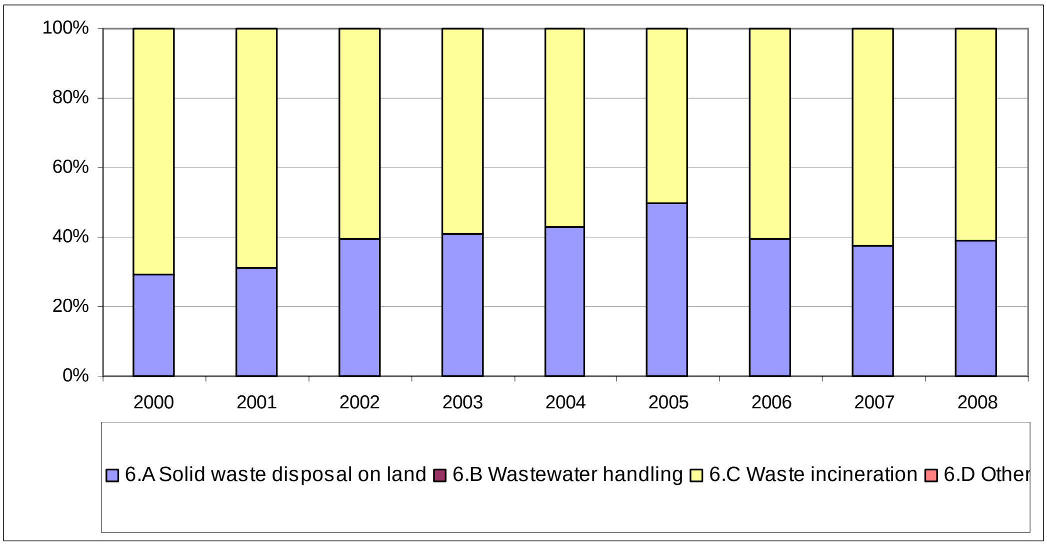


Figure 9.2.6.3 shows certain variations in the distribution of emissions among the different categories for this sector. Waste incineration was the most significant category for $PM_{2.5}$ emissions, despite the growing significance of waste disposal in landfills up to 2005, when this category starts to exhibit a downward trend, with the exception of the last year where it has increased lightly in relation to 2007.

Figure 9.2.6.3.- Percentage of $PM_{2,5}$ emissions by category with respect to the sector total



9.2.7.- PM_{10}

PM_{10} emissions resulting from waste treatment and disposal are scarcely relevant for the inventory as a whole (see Table 9.2.7.1) They exhibit a downward trend with an 18.1% reduction throughout the inventory period.

Table 9.2.7.1.- PM_{10} emissions *(Amounts in Gg)*

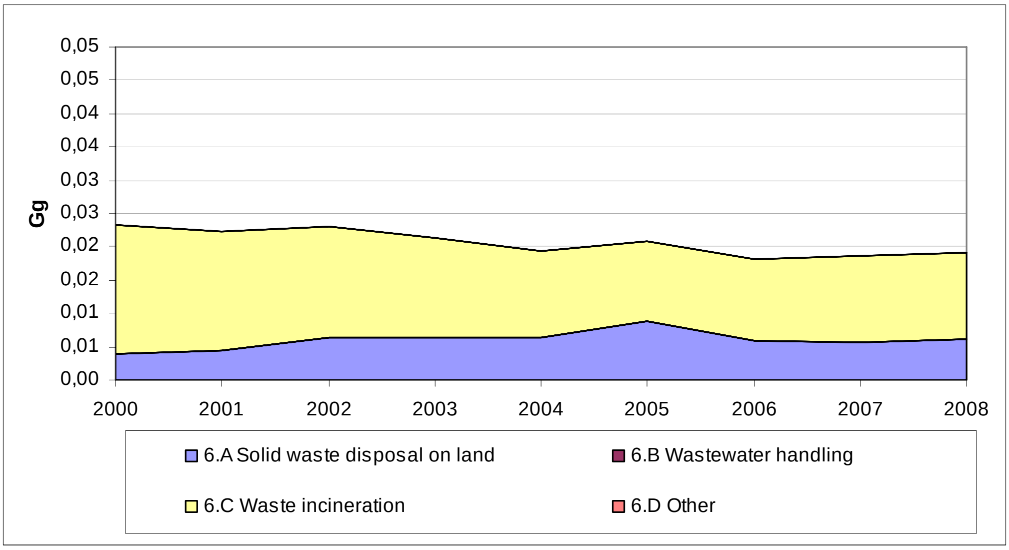
Category	2000	2001	2002	2003	2004	2005	2006	2007	2008
6.A Solid waste disposal on land	0.0040	0.0044	0.0063	0.0064	0.0064	0.0087	0.0059	0.0057	0.0062
6.B Wastewater treatment	-	-	-		-	-	-	-	-
6.C Waste incineration	0.0192	0.0179	0.0167	0.0150	0.0130	0.0121	0.0123	0.0129	0.0129
6.D Others	-	-	-		-	-	-	-	-
Total Wastes	**0.0232**	**0.0223**	**0.0230**	**0.0214**	**0.0194**	**0.0208**	**0.0182**	**0.0186**	**0.0190**

Figure 9.2.7.1 shows the evolution of PM_{10} emissions throughout the inventory period. The emissions trend is determined, in order of importance, by categories 6C (Waste incineration) and 6A (Solid waste disposal on land), with no positive contribution to these pollutant emissions by categories 6B (Waste water treatment) and 6D (Other treatments).

Emissions resulting from biogas flares in the Waste disposal in landfills category up to 2005 exhibit a growing trend. From 2005 onwards, the decreasing trend is explained by the reduction in the amount of biogas burnt in flares until 2005, when a mild drop is observed due to the replacement of flares by engines for energy recovery of captured biogas.

Regarding Incineration, emissions have decreased until 2005 due to the progressive drop in incinerated hospital waste in Spain; the slight increase from the last year has been due to the increase in cremations (see Figure 9.3.2.1.3.1) and the fact that hospital waste incineration has remained constant (see Figure 9.3.2.1.1.1).

Figure 9.2.7.1.- Pattern of PM_{10} emissions



As shown in Figure 9.2.7.2, waste emissions in 2008 account for 0.0201% of total emissions in Spain, which entail a reduction in their contribution to the whole inventory with respect to 1990, when they amounted to 0.0239% of total emissions.

Figure 9.2.7.2.- Percentage of PM_{10} emissions by category with respect to the inventory total

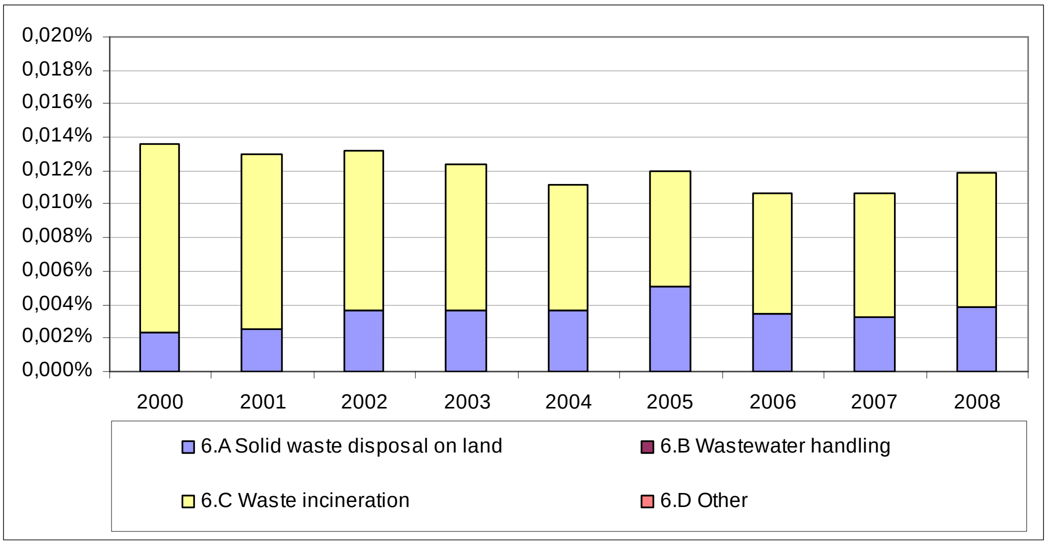
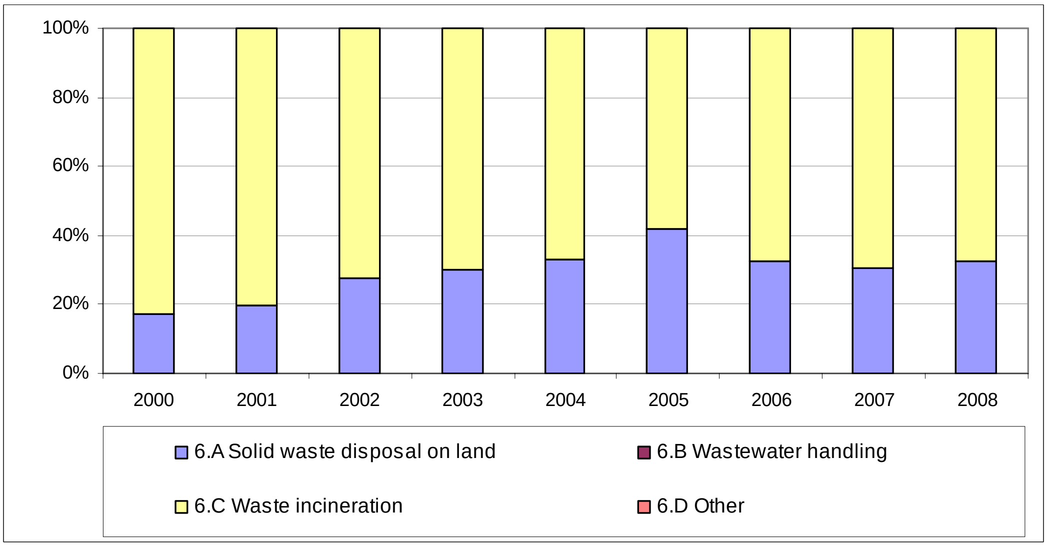


Figure 9.2.7.3 shows certain variations in the distribution of emissions among the different categories for this sector. Waste incineration was the most significant category for PM_{10} emissions, despite the growing significance of waste disposal in landfills up to 2005, when this category starts to exhibit a downward trend.

Figure 9.2.7.3.- Percentage of PM_{10} emissions by category with respect to the sector total



9.2.8.- TSP

TSP emissions resulting from waste treatment and disposal are scarcely relevant for the inventory as a whole (see Table 9.2.8.1) They exhibit a downward trend with an 15.9% reduction throughout the inventory period.

***Table 9.2.8.1.- TSP emissions** (Amounts in Gg)*

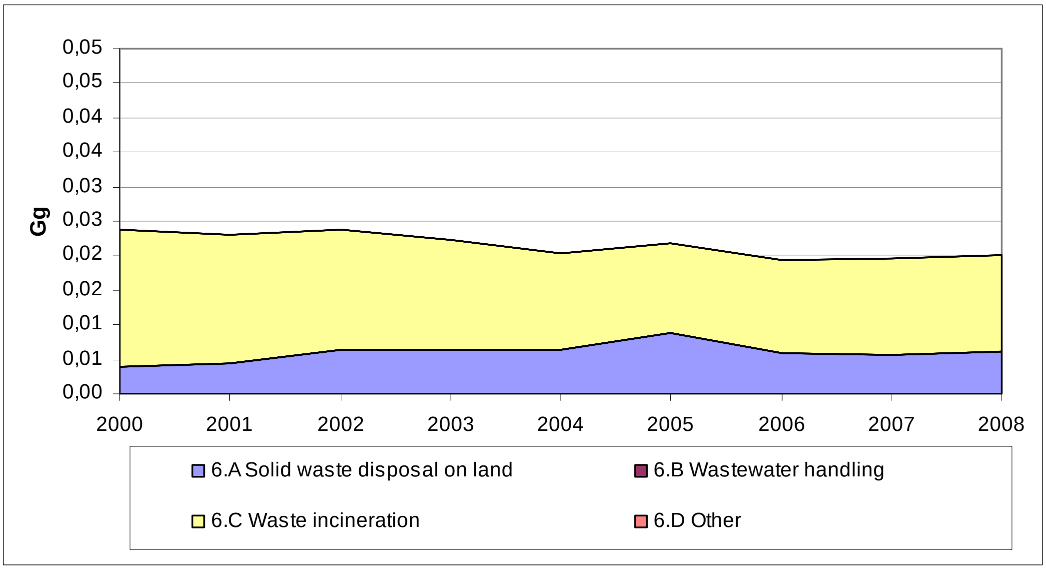
Category	2000	2001	2002	2003	2004	2005	2006	2007	2008
6.A Solid waste disposal on land	0.0040	0.0044	0.0063	0.0064	0.0064	0.0087	0.0059	0.0057	0.0062
6.B Wastewater treatment	-	-	-		-	-	-	-	-
6.C Waste incineration	0.0198	0.0186	0.0175	0.0158	0.0139	0.0131	0.0133	0.0139	0.0139
6.D Others	-	-	-		-	-	-	-	-
Total Wastes	**0.0239**	**0.0230**	**0.0238**	**0.0223**	**0.0203**	**0.0218**	**0.0192**	**0.0196**	**0.0201**

Figure 9.2.8.1 shows the evolution of TSP emissions throughout the inventory period. The emissions trend is determined, in order of importance, by categories 6C (Waste incineration) and 6A (Solid waste disposal on land), with no positive contribution to these pollutant emissions by categories 6B (Waste water treatment) and 6D (Other treatments).

Emissions resulting from biogas flares in the Waste disposal in landfills category up to 2005 exhibit a growing trend until 2005, when a mild drop is observed due to the replacement of flares by engines for energy recovery of captured biogas.

Regarding Incineration, emissions have decreased until 2005 due to the progressive drop in incinerated hospital waste in Spain; the slight increase from the last year has been due to the increase in cremations (see Figure 9.3.2.1.3.1) and the fact that hospital waste incineration has remained constant (see Figure 9.3.2.1.1.1).

Figure 9.2.8.1.- Pattern of TSP emissions



As shown in Figure 9.2.8.2, waste emissions in 2008 account for 0.0201% of total emissions in Spain, which entail a reduction in their contribution to the whole inventory with respect to 1990, when they amounted to 0.0239% of total emissions.

Figure 9.2.8.2.- Percentage of TSP emissions by category with respect to the inventory total

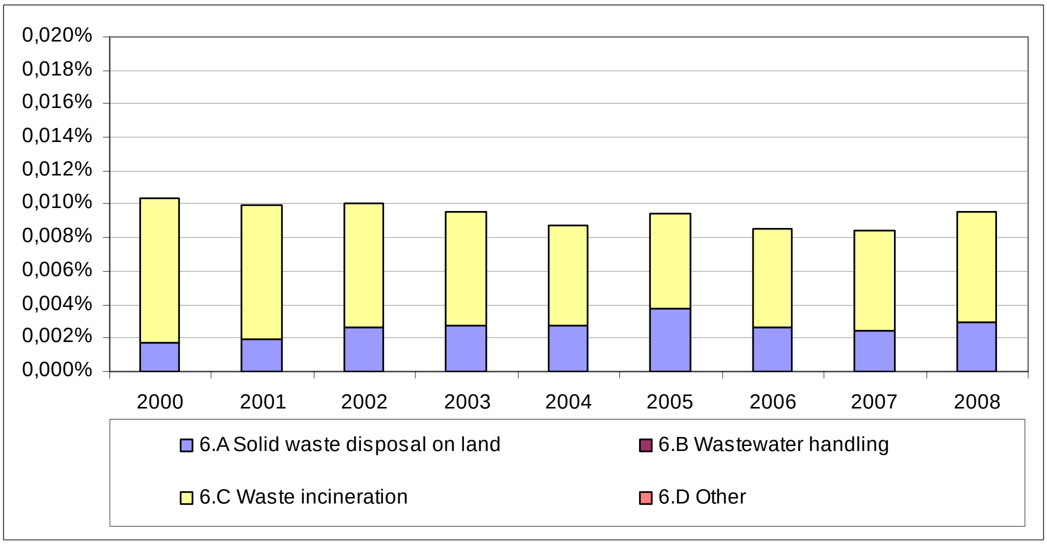
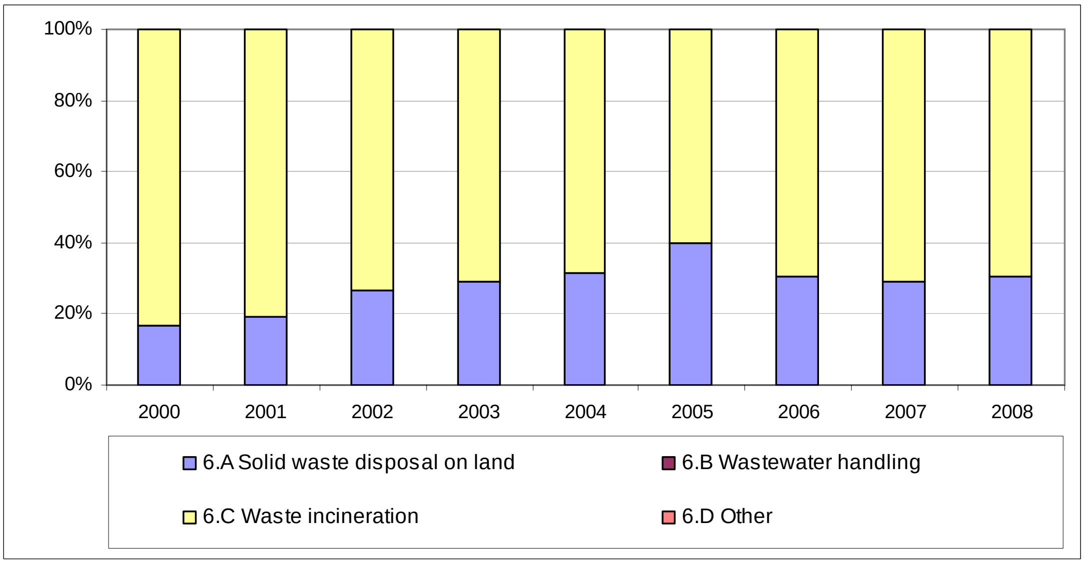


Figure 9.2.8.3 shows certain variations in the distribution of emissions among the different categories for this sector. Waste incineration was the most significant category for TSP emissions, despite the growing significance of waste disposal in landfills up to 2005, when this category starts to exhibit a downward trend.

Figure 9.2.8.3.- Percentage of TSP emissions by category with respect to the sector total



9.2.9.- Pb

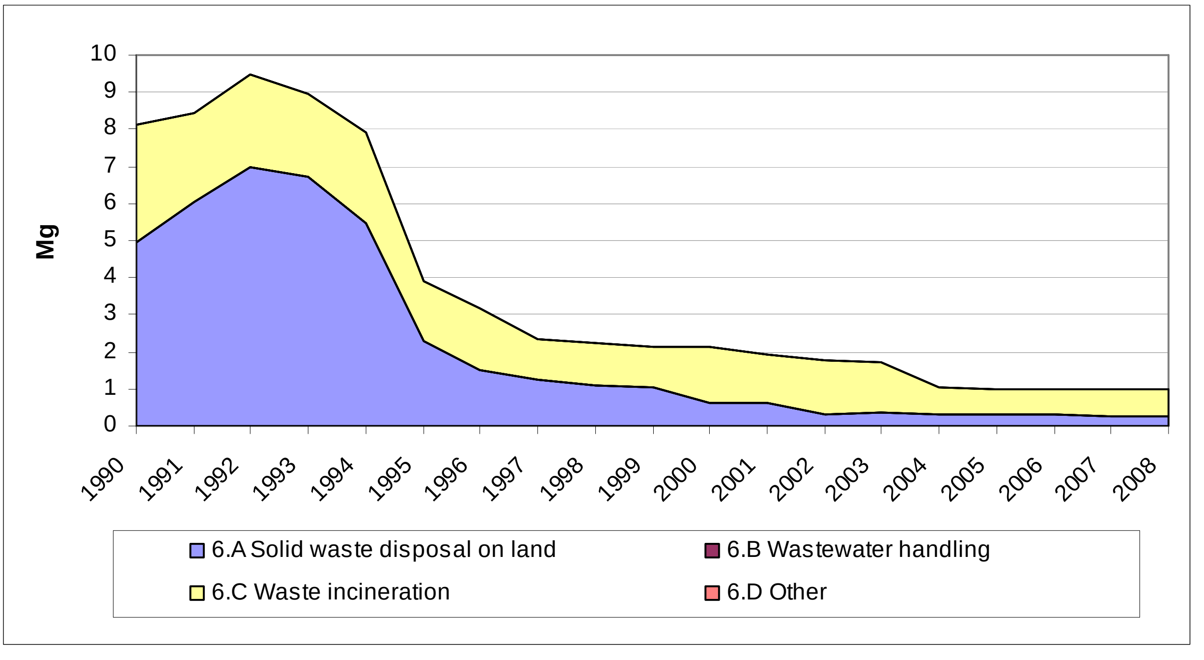
Pb emissions in this sector shown in table 9.2.9.1. are scarcely relevant in the inventory and are related to categories 6A (Solid Waste Disposal on Land) and 6C (Waste Incineration). The whole sector has witnessed a reduction in Pb emissions, from 8.10 Mg in 1990 to 0.98 Mg in 2008.

Table 9.2.9.1.- Pb emissions *(Ammounts in Mg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
6.A Solid Waste Disposal on Land	4.97	2.27	0.60	0.36	0.32	0.31	0.30	0.28
6 B Waste Water Handling	-	-	-	-	-	-	-	-
6 B Waste Incineration	3.13	1.64	1.54	0.70	0.70	0.68	0.70	0.70
6.D Other	-	-	-	-	-	-	-	-
Total Wastes	**8.10**	**3.91**	**2.14**	**1.06**	**1.02**	**0.99**	**1.00**	**0.98**

Figure 9.2.9.1. shows the evolution of Pb emissions throughout the inventory period. The trend in emissions is similar to those of SO_X (see section 9.2.3).

Figure 9.2.9.1.-Pattern of Pb emissions



Regarding the share of Pb emissions for this sector in the inventory as a whole, figure 9.2.9.2. shows its scant relevance, under 0.8 per cent of the total for all years with rises and falls in the corresponding share.

Figure 9.2.9.2.- Percentage of Pb emissions by category in relationto the total inventory

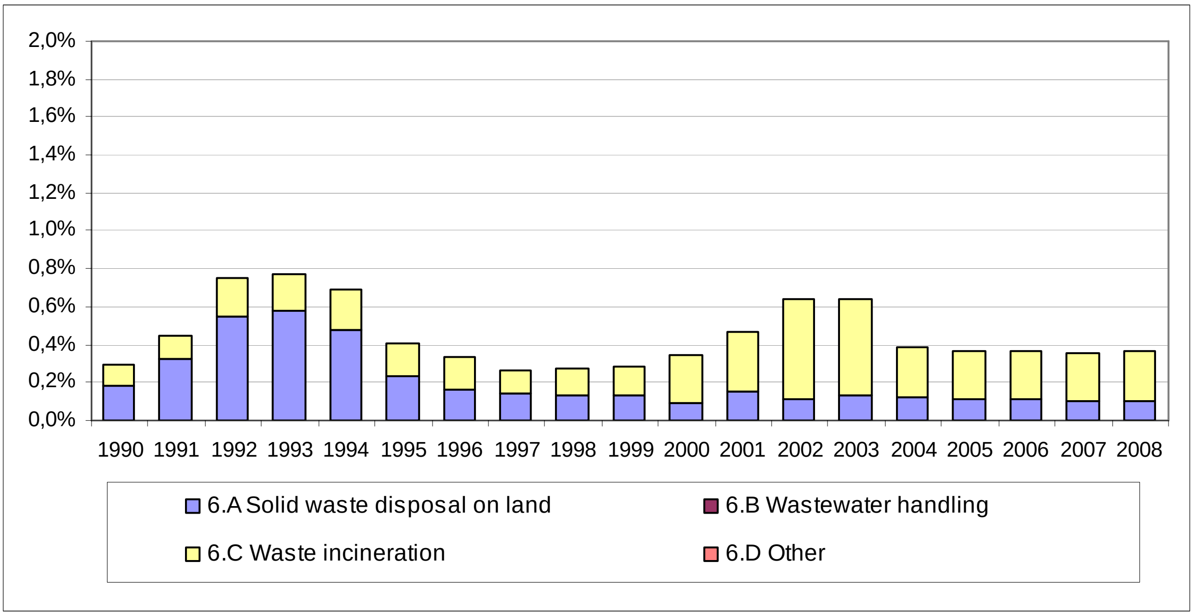
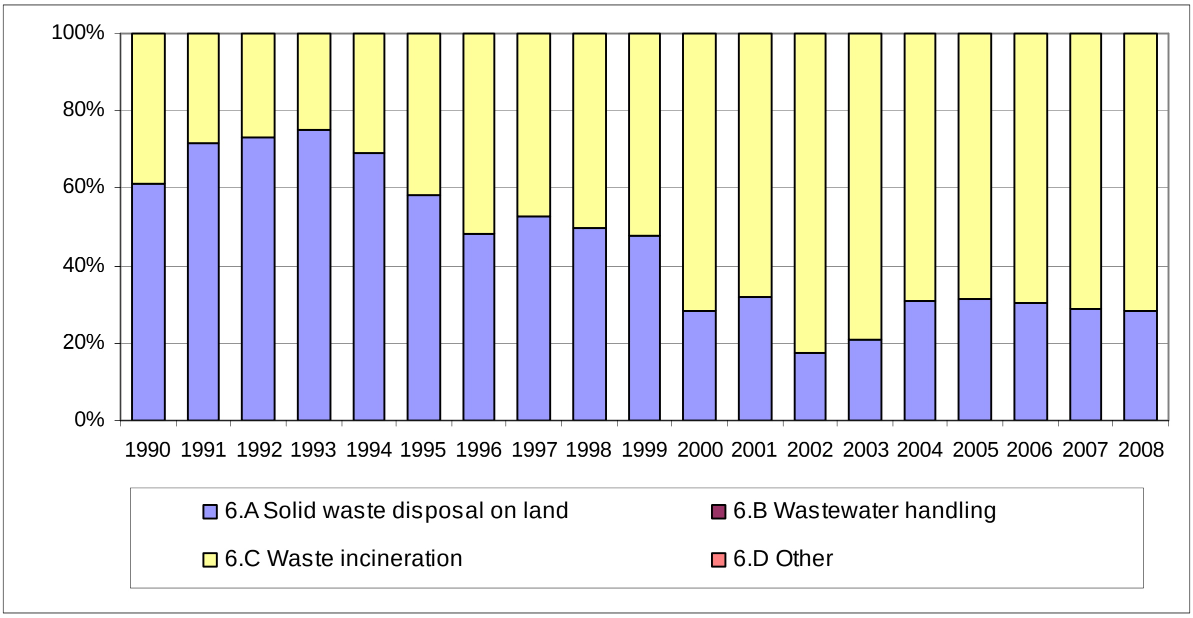


Figure 9.2.9.3. shows significant variations in the distribution of emissions for this sector among the different categories. The main category from 1990 to 1995 corresponds to category 6A Solid Waste Disposal on Land and from 1996-2008 corresponds to category 6C Waste Incineration.

The following pollutants, SO_x Pb, Cd, Hg, DIOX and PAH, all share (as far as their estimating algorithms are referred, the same set of activity variables, and consequently, the same underlying causes for their distribution changes among the emitting categories in the inventoried period: decrease since year 1995 of waste burnt in unmanaged landfills and the disappearance from 2004 of the MSW incinerating plants that do not recover energy. Category 6.C increases, along the years, its weight on emissions contribution due to the corresponding downfall of category 6.A emissions The distribution differences among categories on the said pollutants are explained by the differences on their respective emissions factors.

Figure 9.2.9.3.- Percentage of Pb by emissions by category in relation to the total sector



9.2.10.- Cd

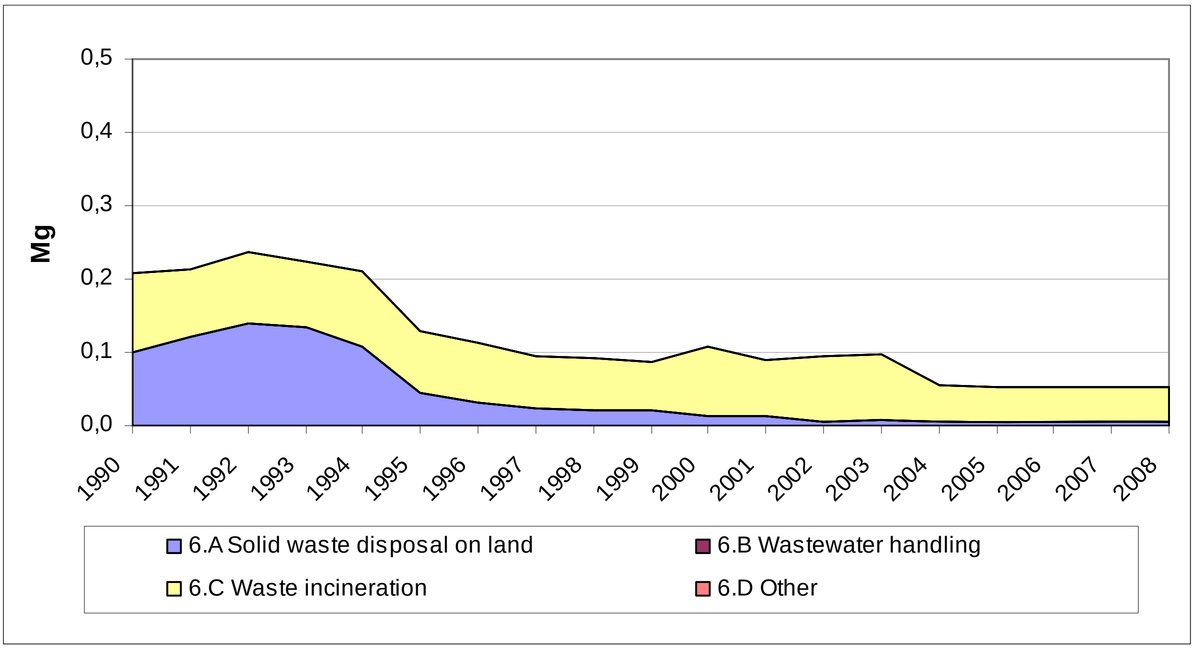
Cd emissions in this sector shown in table 9.2.9.1. are scarcely relevant in the inventory and are related to categories 6A (Solid Waste Disposal on Land) and 6C (Waste Incineration). The whole sector has witnessed a 76.2% reduction in Cd emissions, from 0.21 Mg in 1990 to 0.05 Mg in 2008.

Table 9.2.10.1.- Cd emissions *(Ammounts in Mg)*

Category	**1990**	**1995**	**2000**	**2004**	**2005**	**2006**	**2007**	**2008**
6.A Solid Waste Disposal on Land	0.10	0.05	0.01	0.01	0.01	0.01	0.01	0.01
6 B Waste Water Handling	-	-	-	-	-	-	-	-
6 B Waste Incineration	0.11	0.08	0.09	0.09	0.05	0.05	0.05	0.05
6.D Other	-	-	-	-	-	-	-	-
Total Wastes	**0.21**	**0.13**	**0.11**	**0.10**	**0.05**	**0.05**	**0.05**	**0.05**

Figure 9.2.10.1. shows the evolution of Cd emissions throughout the inventory period. The trend in emissions is similar to those of SO_X and Pb. Therefore, to analyze the trend for the series shown, please refer to section 9.2.3 SO_X

Figure 9.2.10.1.- Pattern of Cd emissions



The share of Cd emissions for this sector in the inventory as a whole, as shown in figure 9.2.10.2. shows its scant relevance, under 1 per cent of the total for all years with a general trend of decrease in its contribution

Figure 9.2.10.2.- Percentage of Cd emissions by category in relationto the total inventory

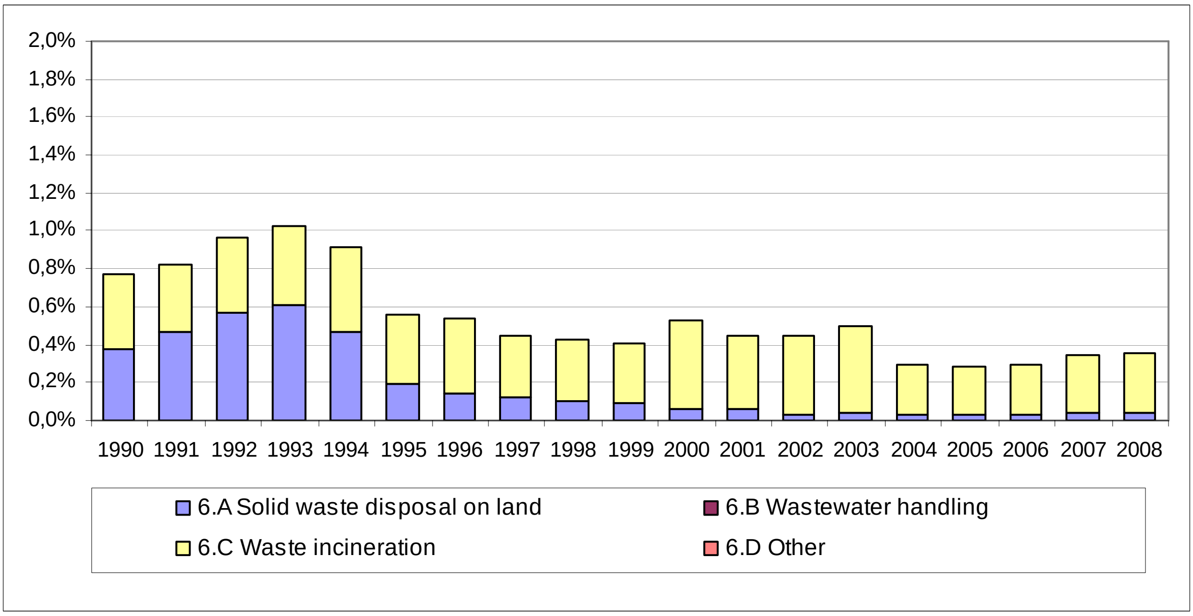
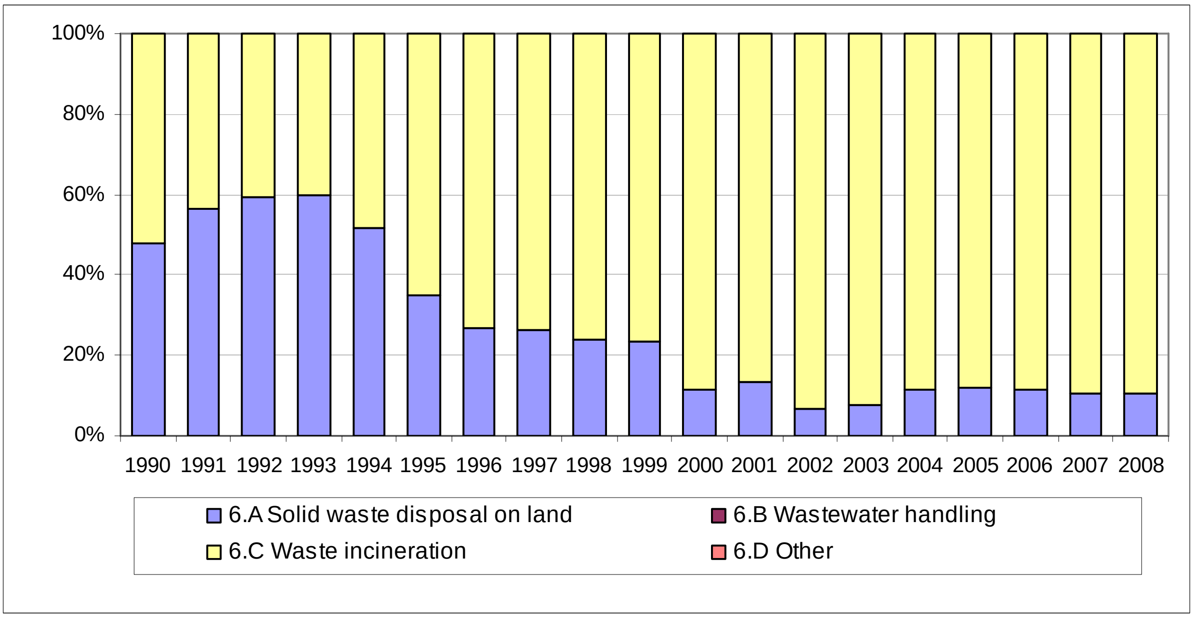


Figure 9.2.10.3. shows significant variations in the distribution of emissions for this sector among the different categories. The main category from 1990 to 1994 corresponds to category 6A Solid Waste Disposal on Land and from 1995-2008 corresponds to category 6C Waste Incineration.

The following pollutants, SO_x Pb, Cd, Hg, DIOX and PAH, all share (as far as their estimating algorithms are referred, the same set of activity variables, and consequently, the same underlying causes for their distribution changes among the emitting categories in the inventoried period. The distribution differences among categories on the said pollutants are explained by the differences on their respective emissions factors.

Figure 9.2.10.3.- Percentage of Cd by emissions by category in relation to the total sector



9.2.11.- Hg

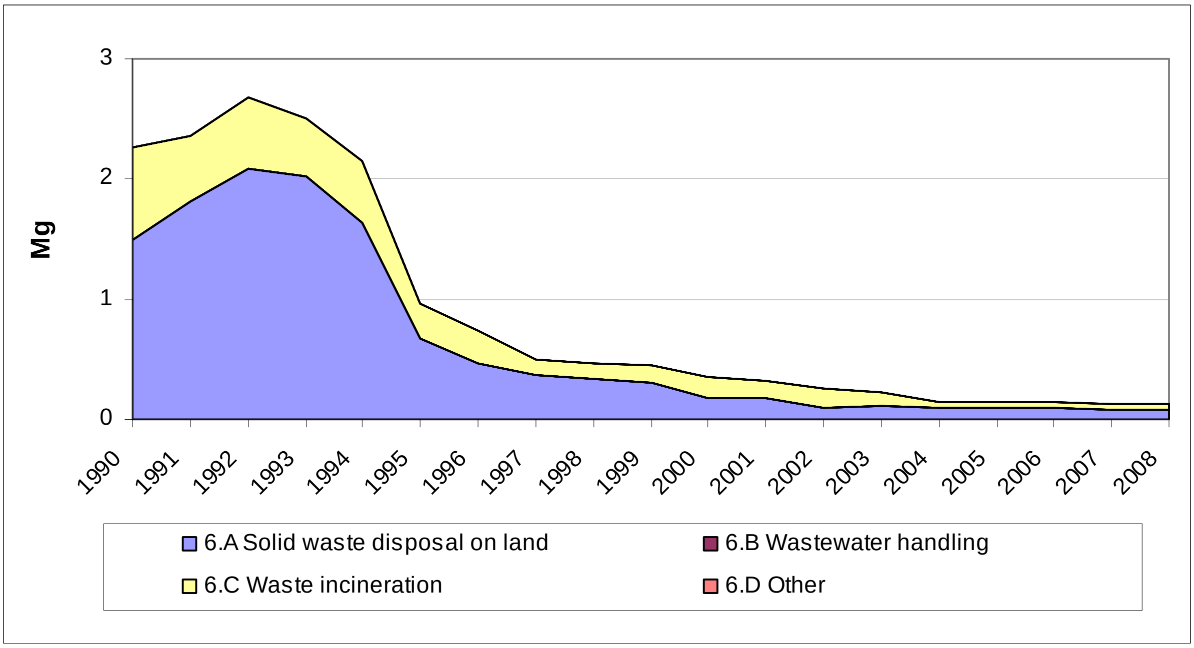
Hg emissions in this sector have a smaller incidence in the inventory as a whole, since they account. Table 9.2.11.1. shows emissions by category in this sector. According to the available data, there was an decrease of 94% in 2008 with respect to 1990, going from 2.26 Mg in 1990 to 0.13 Mg in 2008.

***Table 9.2.11.1.- Hg emissions** (Ammounts in Mg)*

Category	**1990**	**1995**	**2000**	**2004**	**2005**	**2006**	**2007**	**2008**
6.A Solid Waste Disposal on Land	1.49	0.68	0.18	0.11	0.09	0.09	0.09	0.09
6 B Waste Water Handling	-	-	-	-	-	-	-	-
6 B Waste Incineration	0.77	0.27	0.16	0.12	0.05	0.05	0.05	0.05
6.D Other	-	-	-	-	-	-	-	-
Total Wastes	**2.26**	**0.96**	**0.35**	**0.23**	**0.14**	**0.14**	**0.14**	**0.13**

Figure 9.2.11.1. shows the evolution of Hg emissions throughout the inventory period. The trend in emissions is similar to those of SO_X , Pb and Cd .Therefore, to analyze the trend for the series shown, please refer to section 9.2.3 SO_X.

Figure 9.2.11.1.- Pattern of Hg emissions



The share of Hg emissions for this sector in the inventory as a whole, as shown in figure 9.2.11.2. reveals a progressive reduction in its contribution with a marked decrease during the 1994-1995 period, with a general trend of decrease in its contribution

Figure 9.2.11.2.- Percentage of Hg emissions by category in relationto the total inventory

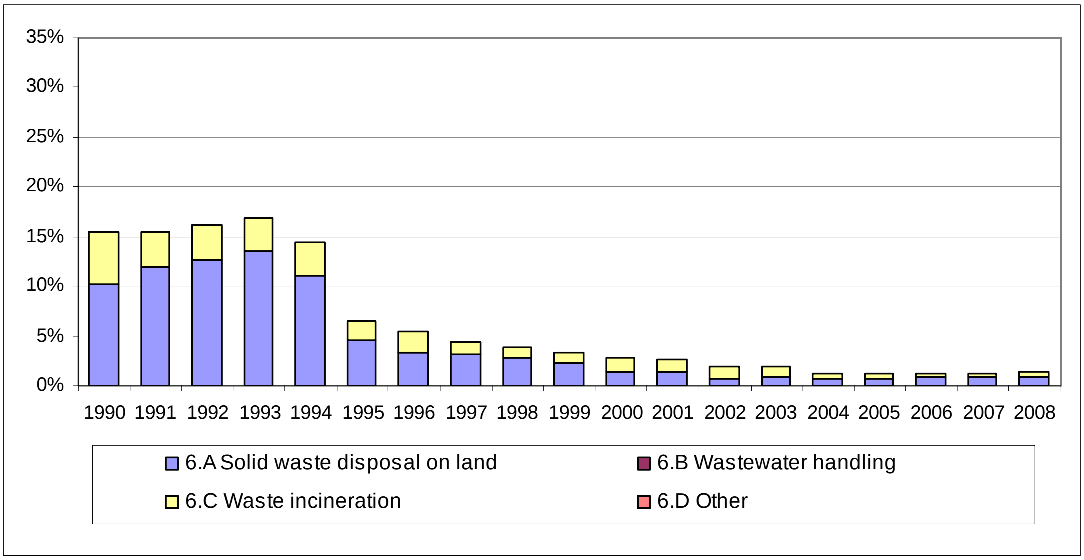
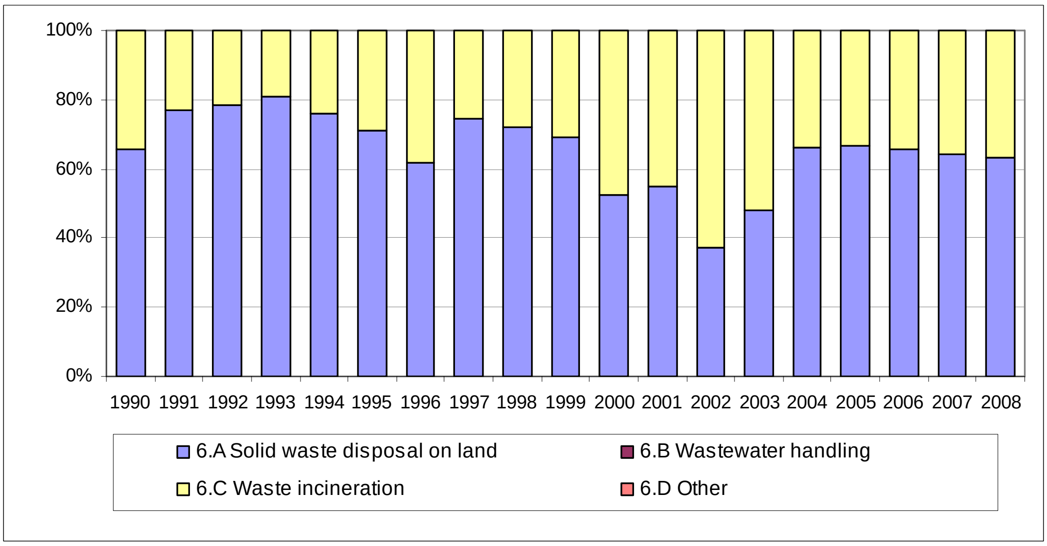


Figure 9.2.11.3. shows significant variations in the distribution of emissions for this sector among the different categories. The main category from 1990 to 2008, except for 2002 and 2003, corresponds to category 6A Solid Waste Disposal on Land.

The following pollutants, SO_x Pb, Cd, Hg, DIOX and PAH, all share (as far as their estimating algorithms are referred, the same set of activity variables, and consequently, the same underlying causes for their distribution changes among the emitting categories in the inventoried period. The distribution differences among categories on the said pollutants are explained by the differences on their respective emissions factors.

Figure 9.2.11.3.- Percentage of Hg by emissions by category in relation to the total sector



As for the key sources of Hg in this sector, the following have been identified for the period 1990-2008:

- Solid Waste Disposal on Land (6A) for its emisión level in 1990-1999 and for its trend in the years 1991-2008.

- Waste Incineration (6C) for its emisión level in 1990-1994 and for its trend in the years 1991-2008.

As a summary of the foregoing, Table 9.2.11.2. below reflects, for the key categories for Hg in this sector, the emissions' contribution to the level and trend, the order number of the category in the list of key sources[5], as well as the absolute values, all referring to 2008.

Table 9.2.11.2..- Hg key sources: Level and Trend contribution

Activity		Hg (Mg) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	Description		%	Key source	Rank	%	Key source	Rank
6.A	Solid Waste Disposal on Land	0.09	0.88	NO	6	17.9	YES	2
6.C	Waste Incineration	0.05	0.51	NO	7	9.17	YES	5

9.2.12.- DIOX

Dioxin emissions (DIOX) are generated in this sector by categories 6A (Solid Waste Disposal on Land) and 6C (Waste Incineration). Table 9.2.12.1. shows emissions for this pollutant, which decrease from 39.9 g-I Teq in 1990 to 4.5 g-I Teq in 2008.

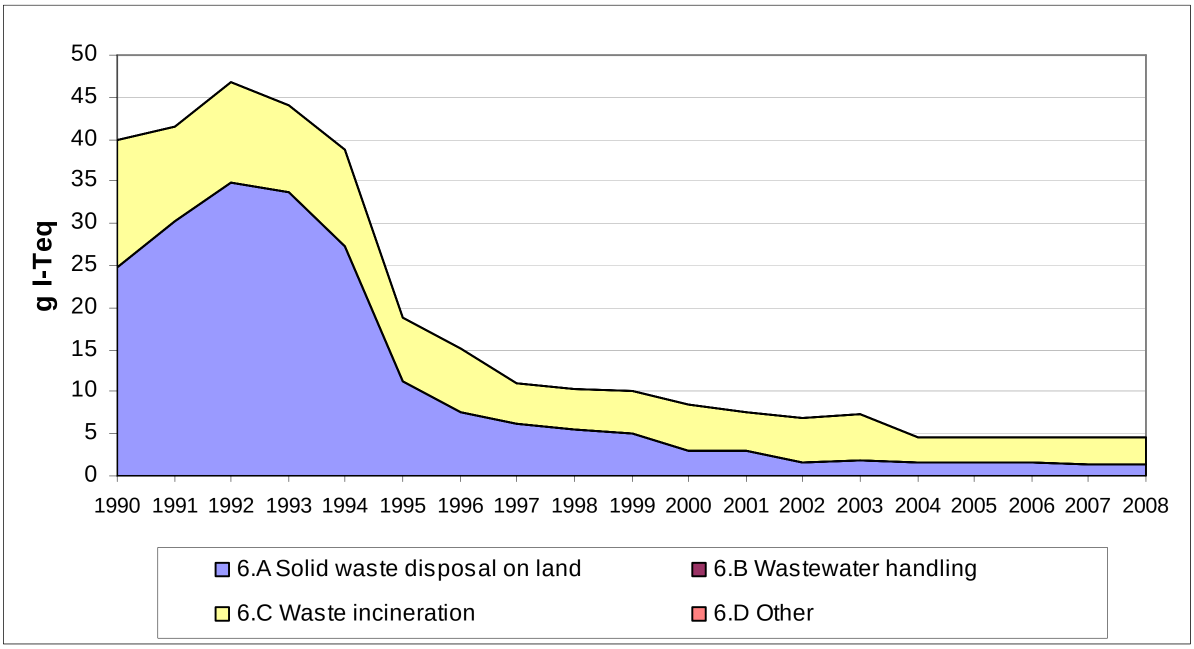
Table 9.2.12.1.- DIOX emissions *(Ammounts in g I-Teq)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
6.A Solid Waste Disposal on Land	24.8	11.4	3.0	1.6	1.5	1.5	1.4	1.4
6 B Waste Water Handling	-	-	-	-	-	-	-	-
6 B Waste Incineration	15.1	7.4	5.5	3.1	3.0	3.1	3.2	3.1
6.D Other	-	-	-	-	-	-	-	-
Total Wastes	**39.9**	**18.7**	**8.5**	**4.7**	**4.6**	**4.6**	**4.6**	**4.5**

Figure 9.2.12.1. shows the evolution of DIOX emissions throughout the inventory period. The trend in emissions is similar to those of SO_X , Pb, Cd and Hg. Therefore, to analyze the trend for the series shown, please refer to section 9.2.3 SO_X.

[5] Order determined by the contribution of the category's emissions to the level or trend.

Figure 9.2.12.1.- Pattern of DIOX emissions



The share of DIOX emissions for this sector in the inventory as a whole, as shown in figure reveals an important contributión from 1990 to 1994, with a general trend of decrease in its share.

Figure 9.2.12.2.- Percentage of DIOX emissions by category in relationto the total inventory

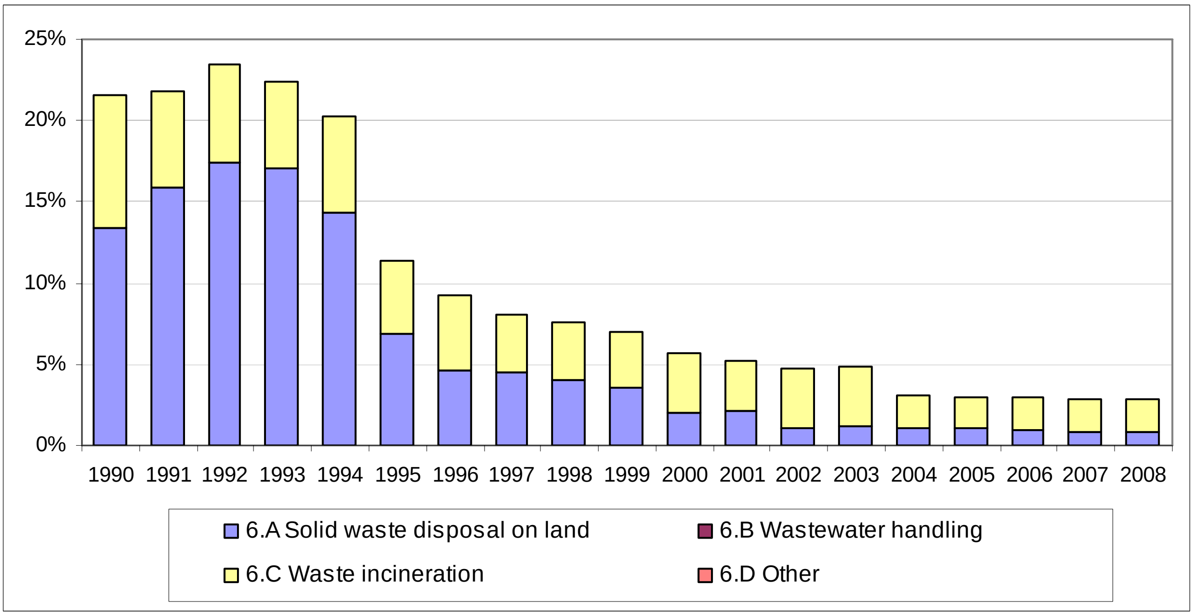
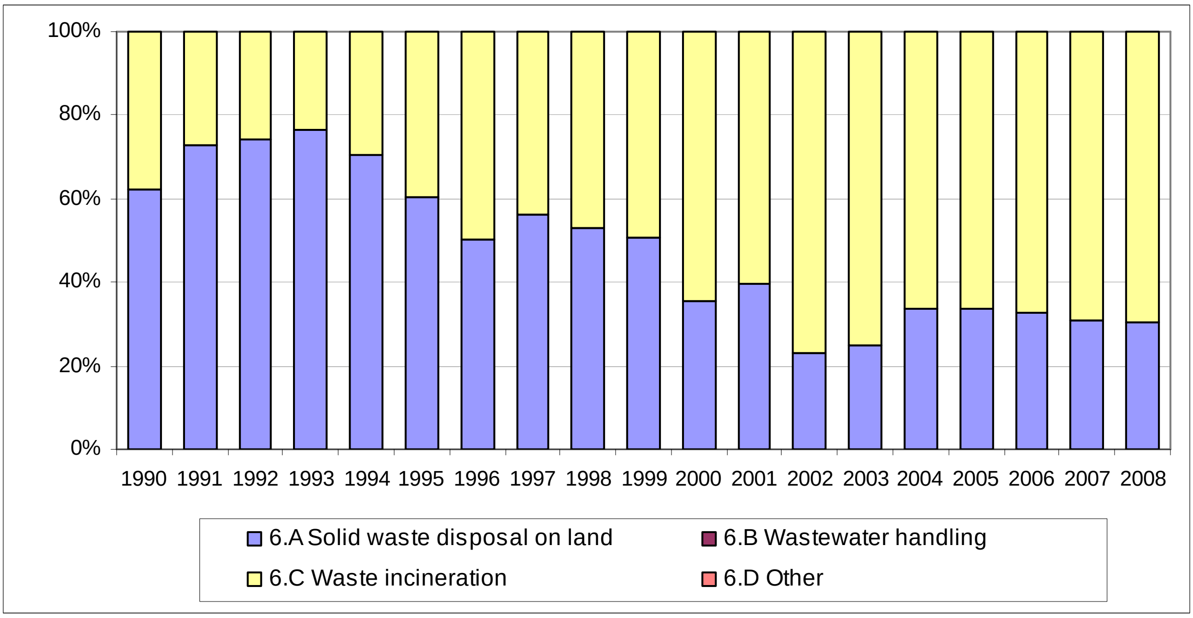


Figure 9.2.12.3. shows significant variations in the distribution of emissions for this sector among the different categories. The main category from 1990 to 1999 corresponds to category 6A Solid Waste Disposal on Land and from 2000 to 2008 corresponds to Waste Incineration.

The following pollutants, SO_x Pb, Cd, Hg, DIOX and PAH, all share (as far as their estimating algorithms are referred, the same set of activity variables, and consequently, the same underlying causes for their distribution changes among the emitting categories in the inventoried period. The distribution differences among categories on the said pollutants are explained by the differences on their respective emissions factors.

Figure 9.2.12.3.- Percentage of DIOX by emissions by category in relation to the total sector



As for the key sources of dioxins for this sector, the following have been identified for the period 1990-2008:

- Solid Waste Disposal on Land (6A) for its emisión level in 1990-1999 and for its trend in the years 1991-2008.

- Waste Incineration (6C) for its emisión level in 1990-1996, 2000-2003 and for its trend in the years 1991-2008.

As a summary of the foregoing, Table 9.2.12.3. below reflects, for the key categories for DIOX in this sector, the emissions' contribution to the level and trend, the order number of the category in the list of key sources[6], as well as the absolute values, all referring to 2008.

[6] Order determined by the contribution of the category's emissions to the level or trend.

Table 9.2.12.3.- DIOX key sources: Level and Trend contribution

Activity		DIOX (g I-Teq) (2008)	Level Contribution (2008)			Trend Contribution (2008)		
Code	**Description**		**%**	**Key source**	**Rank**	**%**	**Key source**	**Rank**
6.A	Solid Waste Disposal on Land	1.37	0.86	NO	8	19.4	YES	2
6.C	Waste Incineration	3.14	1.96	NO	6	9.5	YES	5

9.2.13.- PAH

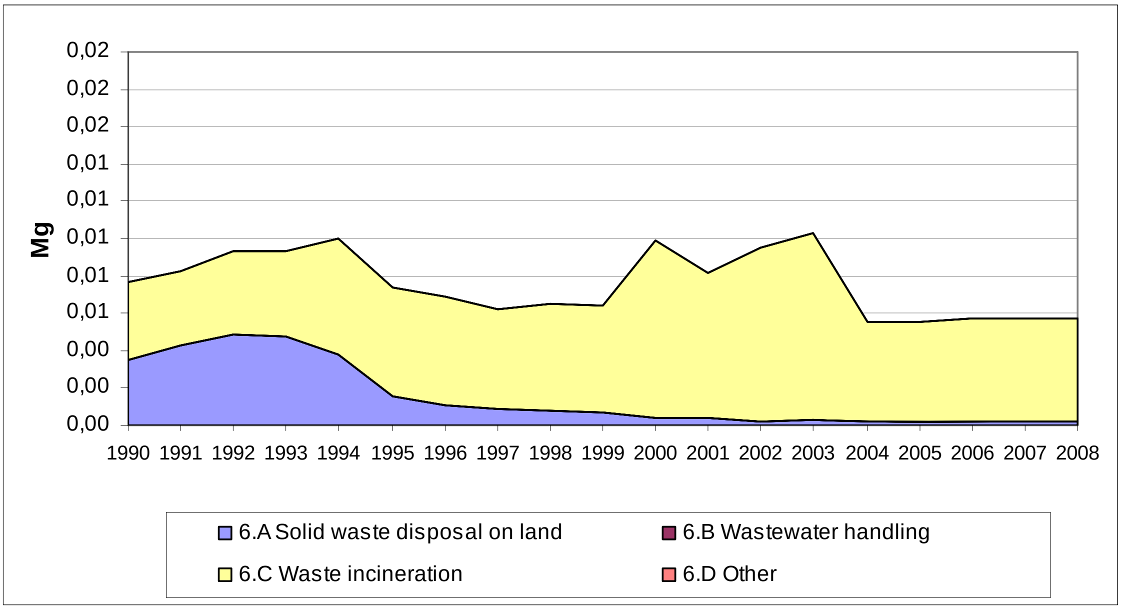
As shown in table 9.2.13.1., PAH emissions are scarcely relevant in the inventory and are related to categories 6A (Solid Waste Disposal on Land) and 6C (Waste Incineration). According to the available data, PAH emissions for this sector decreased by 14.3% in 2008 with respect to 1990, from 0.007 Mg in 1990 to 0.006 Mg in 2008.

***Table 9.2.13.1.-PAH Emissions** (Ammounts in Mg)*

Category	1990	1995	2000	2004	2005	2006	2007	2008
6.A Solid Waste Disposal on Land	0.003	0.002	0.0004	0.0002	0.0002	0.0002	0.0002	0.0002
6 B Waste Water Handling	-	-	-	-	-	-	-	-
6 B Waste Incineration	0.004	0.006	0.009	0.005	0.005	0.005	0.006	0.006
6.D Other	-	-	-	-	-	-	-	-
Total Wastes	**0.007**	**0.008**	**0.01**	**0.006**	**0.006**	**0.006**	**0.006**	**0.006**

Figure 9.2.13.1. shows the evolution of PAH emissions throughout the inventory period. The trend in emissions is similar to those of SO_X, Pb, Cd and Hg. Therefore, to analyze the trend for the series shown, please refer to section 9.2.3 SO_X.

Figure 9.2.13.1.- Pattern of PAH emissions



As for the share of PAH emissions for this sector in the inventory as a whole, figure 9.2.13.2. shows that its relevance is very small, being lower 0.02% for all years, with rises and falls in the corresponding share, suffering in the period from 1990 to 2008 increases and decreases in the participative quota of the waste incineration and an important decrease in the solid waste disposal.

Figure 9.2.13.2.- Percentage of PAH emissions by category in relationto the total inventory

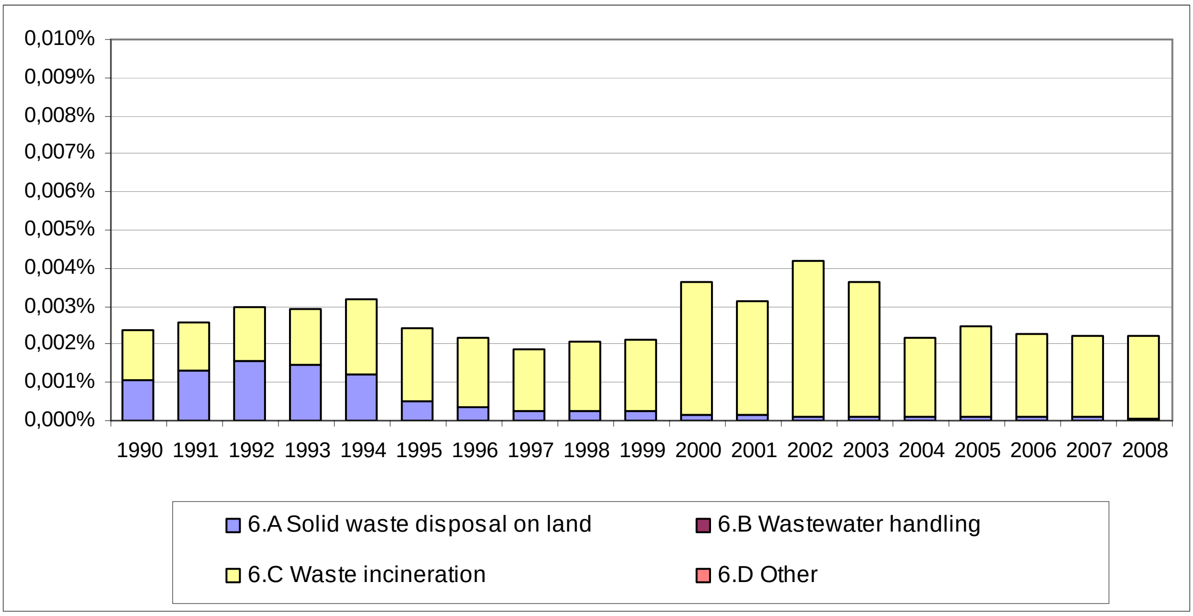
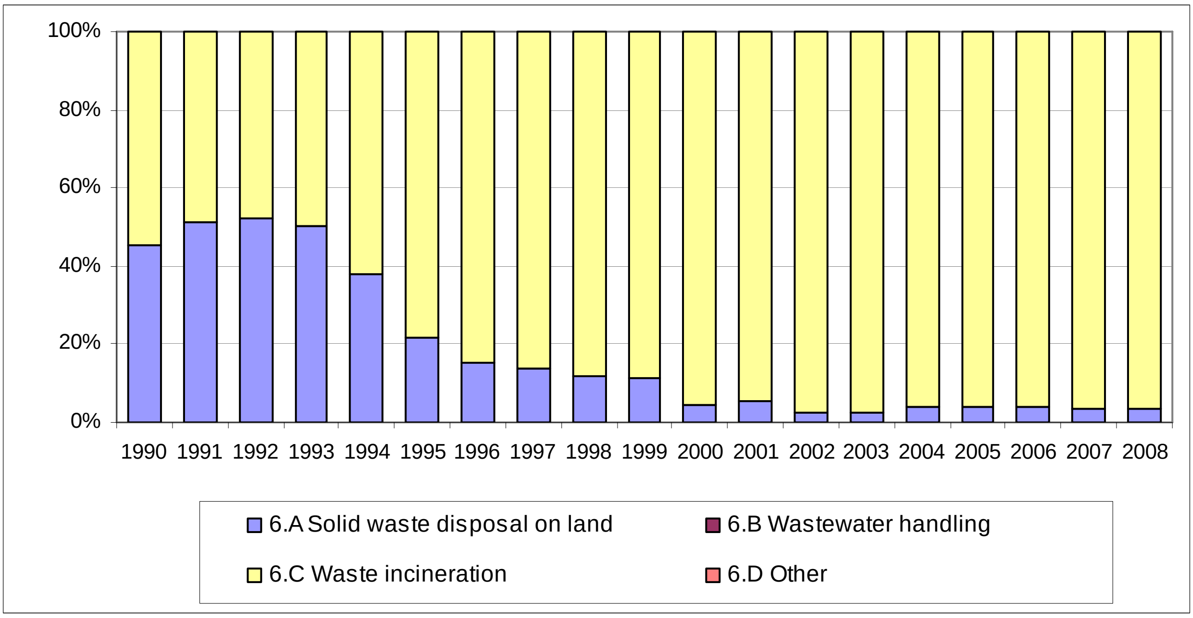


Figure 9.2.13.3. shows significant variations in the distribution of emissions for this sector among the different categories. The main category from 1990 to 2007 corresponds to category 6C Waste Incineration.

The following pollutants, SO_x Pb, Cd, Hg, DIOX and PAH, all share (as far as their estimating algorithms are referred, the same set of activity variables, and consequently, the same underlying causes for their distribution changes among the emitting categories in the inventoried period. The distribution differences among categories on the said pollutants are explained by the differences on their respective emissions factors.

Figure 9.2.13.3.- Percentage of PAH by emissions by category in relation to the total sector



9.3.- Analysis by key categories

9.3.1.- Solid Waste Disposal on Land (6A)

Within 6A NFR category the following relevant emissions sources have been identified: waste burning in unmanaged landfills and flaring of biogas from managed landfills

9.3.1.1.- Activity variables

9.3.1.1.1.- Unmanaged Waste Disposal Sites

Solid Waste Disposal Siites (SWDS) are classified by their management systems in managed and unmanaged SWDS. In the case of unmanaged landfills, a fraction of its mass is burned, for the purpose of reducing its volume and, in such cases, generates, in addition to the biogas emissions from the unburnt fraction of municpal solid waste (MSW), those corresponding to the combustion of the burned fraction.

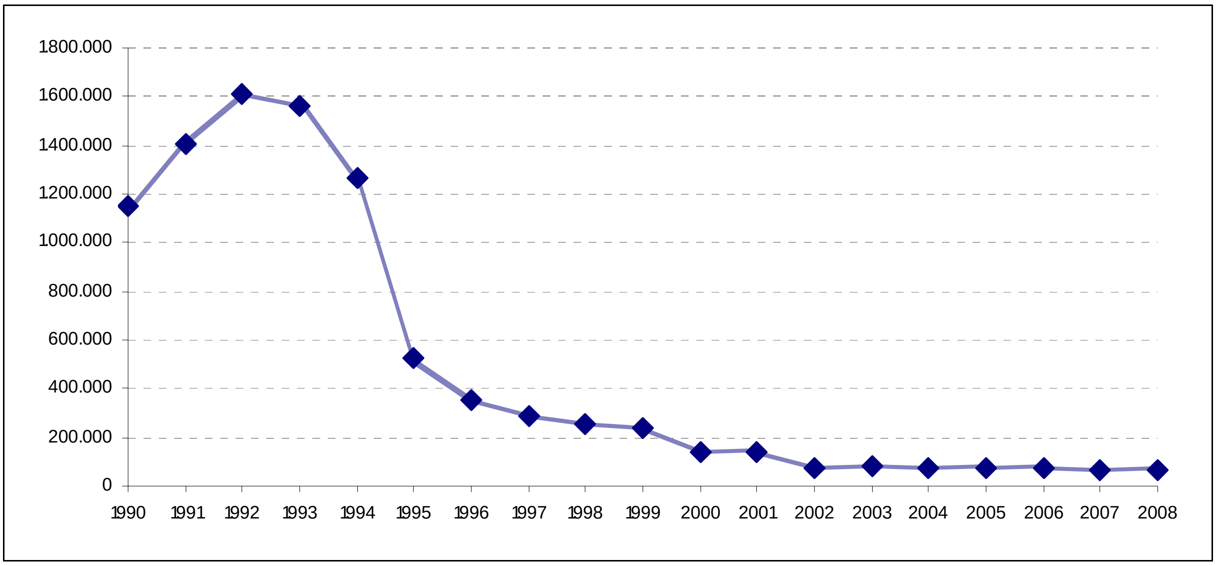
The disposal of MSW in SWDS constitutes the main system for handling these wastes in Spain in the period inventoried, even though the prercentaje of unmanaged SWDS of the total SWDS is highly superior in 1990 (29.7%) to that of 2008 (3.3%). The bigger awareness on environmental conditions as well as the measures implemented by the administrative authorities have induced, according to the publication “Medio Ambiente en España” (Environment in Spain), that wastes that were before disposed of unmanaged, are now increasingly treated and disposed in managed landfills.

Table 9.3.1.1.1.1 shows the unmanaged SWDS distinguishing between the fractions of waste burnt and not burnt by continuous burning processes for reducing the waste deposited and and Figure 9.3.1.1.1.1. shows the evolution of the amounts in Mg of waste burnt at unmanaged lnadfills in the period inventoried.

Table 9.3.1.1.1.1.- .- MSW disposal in unmanaged landfills *(Ammounts in Mg)*

Year	Not burnt	Burnt	FIQ	Total
1990	2,136,776	1,150,571	0.35	3,287,347
1991	2,607,832	1,404,218	0.35	4,012,050
1992	2,998,183	1,614,406	0.35	4,612,589
1993	2,897,118	1,559,986	0.35	4,457,104
1994	2,347,017	1,263,779	0.35	3,610,796
1995	2,104,257	526,064	0.20	2,630,321
1996	1,415,254	353,813	0.20	1,769,067
1997	2,573,788	285,977	0.10	2,859,765
1998	2,305,936	256,215	0.10	2,562,151
1999	2,120,490	235,610	0.10	2,356,100
2000	1,258,625	139,847	0.10	1,398,472
2001	1,255,791	139,532	0.10	1,395,323
2002	646,392	71,821	0.10	718,213
2003	752,826	83,647	0.10	836,473
2004	731,425	73,143	0.10	731,425
2005	644,142	71,571	0.10	715,713
2006	630,000	70,000	0.10	700,000
2007	593,685	65,965	0.10	659,650
2008	573,376	63,709	0.10	637,085

Figure 9.3.1.1.1.1.-Evolution of the waste burnt at unmanaged landfills *(Ammounts in Mg)*



The information is provided directly by the Ministry of Environment and Rural and Marine Affairs in the publication “Medio Ambiente en España” (The Environment in Spain). The fraction which expresses the amount of waste burnt at unmanaged landfills (FIQ) has been taken after consulting experts from the sector.

9.3.1.1.2.- Flare combustion of biogas

The basic activity variable comprises the amount of biogas combusted without energy recovery (flares).In the period from 1990 to 2008 new landfills providing individual biogas recovery information have been incorporated from which it was possible to obtain information on captures from 34 of the same.

The information on this variable has been assessed by the Inventory Working Party on the basis of the data received in the questionnaires sent to the large landfills that mostly also have biogas collection and sent for energy recovery in the form of combustion in engines or elimination through flaring. The quantity captured has been estimated as the minimum between the 70% of methane generated according to the first order kinetic methodology and the quantity reported in the questionnaire as captured or burned, (R_t); thus C_t=min(0,7*G; R_t).

The most influential variables in the calculation of the biogas produced by the decomposition of organic matter in landfills are the following

- The waste deposited at SWDS
- The composition of the waste
- The composition of biogas
- The parameters which are involved in the algorithms for estimating emissions

The MSW disposal in individualized landfills with biogas recovery is shown In the following table 9.3.1.1.2.1.. Table 9.3.1.1.2.2. shows the fraction of biogas and methane generated and burnt in flares and in Figure 9.3.1.1.2.1 it is shown the evolution of methane burnt at flares in the inventoried period. This trend change in 2005 due to the use of flares for energy recovery of captured biogas. Nonetheless, the data recorded in the inventory shows stagnant capture figures in recent years (possibly due to gaps in the information available), which in turn results in a relative increase in the amount of biogas generated and not captured compared to the amount of biogas captured (with or without energy recovery).

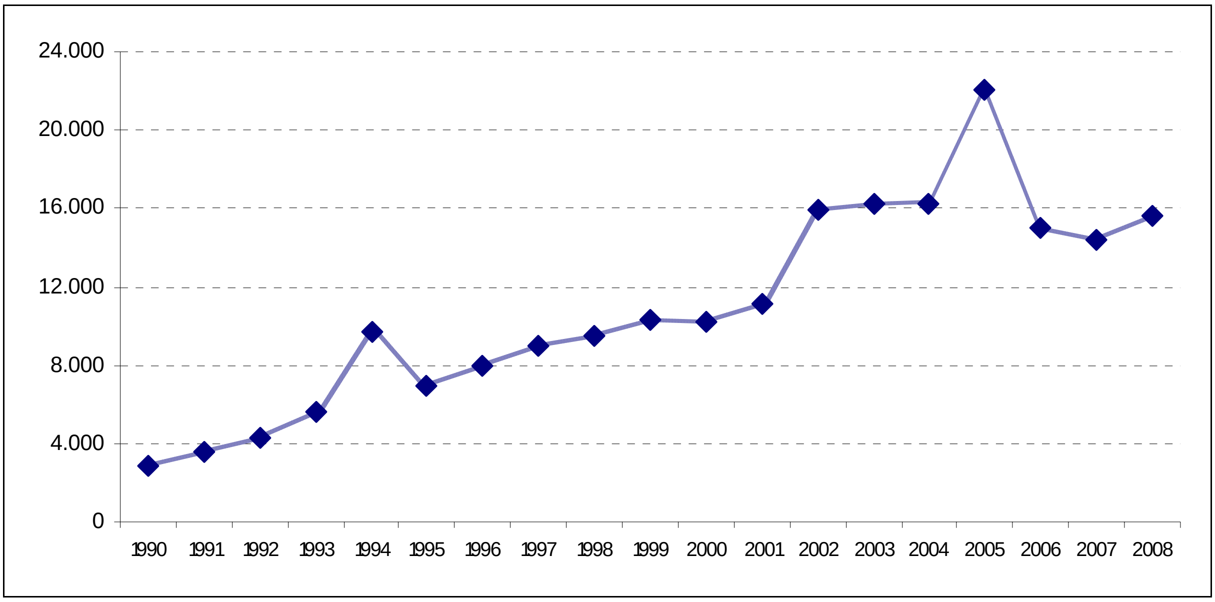
Table 9.3.1.1.2.1.- MSW disposal in managed landfills *(Ammounts in Mg)*

1990	1995	2003	2004	2005	2006	2007	2008
11,058,405	14,805,499	17,315,799	18,910,161	19,378,343	20,038,616	19,791,107	19,349,677

***Table 9.3.1.1.2.2.- Biogas and methane generated and burnt in flares** (Ammounts in Mg)*

Year	Generation		Flare Combustion	
	Biogas	Methane	Biogas	Methane
1990	375,765	102,704	8,415	2,822
1991	382,086	104,431	10,599	3,554
1992	388,600	106,212	12,872	4,332
1993	400,106	109,357	16,726	5,665
1994	414,738	113,356	29,399	9,687
1995	435,873	119,132	21,086	6,902
1996	464,554	126,971	24,480	7,915
1997	491,769	134,410	27,737	8,959
1998	519,353	141,949	29,600	9,520
1999	546,843	149,463	33,727	10,365
2000	578,063	157,996	35,207	10,222
2001	606,504	165,769	36,879	11,088
2002	643,161	175,788	51,590	15,958
2003	672,701	183,862	53,479	16,260
2004	717,052	195,984	54,815	16,244
2005	764,326	208,905	69,665	22,104
2006	812,823	222,160	49,277	14,968
2007	858,181	234,557	47,574	14,434
2008	905,465	247,481	51,063	15,597

***Figure 9.3.1.1.2.1.- Evolution of methane burnt at flares in individualized landfills with biogas recovery** (Ammounts in Mg)*



9.3.1.2.- Methodology

9.3.1.2.1.- Unmanaged Waste Disposal Sites

The estimate of the emissions from the burned fraction is obtained by multiplying the activity variable (Mg of waste burnt) by the corresponding emission factors (g/Mg of waste burnt).

In all the cases described below previous correction factors have been applied:

i) A 0.52 correction factor on the original data in order to be able to express in terms of gross mass the original emission factors which were assumed to be in terms of dry mass (this factor assumes 48% humidity in the waste burnt).

ii) A 0.83 correction factor to the fraction burnt to discount the part of non-burnable waste, mainly glass, ferrous and non-ferrous metals and other small entries.

This way all the emission factors shown below include the correction factor of 0.4316 (=0.52*0.83) which permits to apply both factors to the fresh mass of burnt waste in non-managed landfills.

The breakdown of the sources of reference for the emission factors is the following:

a) For the pollutants SO_x, NO_x, Cd, Hb, Pb and PAH the same factors have been taken as for SNAP activity 09.02.01, incineration of household waste, to which the combustion process considered here for the burning of waste in unmanaged landfills has been assimilated.

b) For the NMVOC and CO the basic information is taken from the Manual (Part I, sections 12.2.2 and 12.3), assuming 90% NMVOC and 10% CH_4 for the speciation of VOC (as indicated in the Manual). An additional 0.8 correction factor is applied to these three gases in order to discount 20% of the combustion efficiency of the gases linked to the carbon content. More specifically, the CO factor of the original source quoted is 42 kg/t, which, after applying the chained correction factors of 0.52 (conversion into dry mass), 0.83 (conversion into combustible fraction) and 0.8% (conversion into oxidised carbon) gives a value of 14,502 g CO/t waste, according to the figure in table 9.4.9. The same has been done to calculate the final value of the emission factors of NMVOC and CH_4 starting from an original value of 15 kg COV/t waste and a 90% speciation of NMVOC and 10% of CH_4.

9.3.1.2.2.- Flare combustion of biogas

Generation of biogas and methane in managed landfills

In the calculation of methane emissions from the decomposition of waste deposited in managed SWDS and of the unburned waste deposited in unmanaged SWDS, the first-order kinetic model proposed in the “2000 IPCC Good Practice Guidelines”, has been used, in accordance with its Tier 2 approach. According to this model, each unit of degradable

organic carbon mass present in waste at the moment of its deposit is reduced, following the passing of time ***t***, according to the equation

$$Q_t = Q_0 e^{-kt}$$

where k is the pace at which the carbon present in the waste diminishes, Q_0 is the amount of degradable organic carbon present at the moment of disposal, and Q_t the amount remaining in the waste after the time t has elapsed. Thus, the carbon emitted during the period (***t, t + 1***) will be:

$$C_t = Q_t - Q_{t+1} = Q_0 e^{-kt}(1 - e^{-k})$$

At times the calculation of annual methane emissions has been made under the implicit assumption that all the waste generated each year is deposited at the beginning of the same and that the chemical reaction generating the emission is triggered immediately after deposit. It is clear that both assumptions represent an approximation to maximum annual emissions, not the mean value, which would be desirable. This led the inventory work team to propose a more realistic approach at least with regard to the moment of the waste deposit (with respect to the delay in the start of the chemical reactions, there is currently no sufficient and verified information available to carry out a modification of the calculation procedures). This approach is taken as a result of the unfamiliarity with times of the year in which the waste is deposited in landfills; only the total annual amount is known, so it has been thought appropriate to adopt a statistical approach as a solution to the problem. To this end, it has been assumed that the probability of deposit of each unit of mass at the different times of year follows a uniform distribution, that is, the probability that a deposit was made at a particular time of the year is the same as that of any other and is equal to one. As a result, by applying a first-order kinetic model, a mass of waste deposited at point ***x*** in the year with an amount of degradable organic carbon Q_0 will be converted after time ***t*** into:

$$Q_t = Q_0 e^{-k(t-x)}$$

where ***x*** is a random variable uniformly distributed over the closed interval [**0,1**]. The mathematical expectation of the carbon content at the end of period ***t*** will therefore be:

$$E(Q_t) = \int_0^1 Q_0 e^{-k(t-x)} dx = \frac{1-e^{-k}}{k} e^{-kt} Q_0$$

and, in turn, the mathematical expectation of the carbon emitted during the period (***t***, ***t*** **+ 1**) will be:

$$E(C_t) = E(Q_t) - E(Q_{t+1}) = \frac{1-e^{-k}}{k}\left(e^{-kt} - e^{-k(t+1)}\right)Q_0 = \frac{\left(1-e^{-k}\right)^2}{k} e^{-kt} Q_0$$

In accordance with the foregoing, total emissions of a year from the deposits in the previous years of waste with the same parameter value k, are calculated by means of the following formula:

$$E_t = \frac{\left(1-e^{-k}\right)^2}{k} \sum_{i=0}^{t} R_{t-i} L_0 (t-i) e^{-k(t-i)} \qquad [9.3.1.2.2.1]$$

The parameter values used in Equation [9.3.1.2.2.1] are:

* Degradable organic carbon (DOC)
* Methane Correction Factor (MCF)
* The fraction (by volume) of methane in landfill (F)
* The fraction of DOC decomposes into biogas (DOC_F)
* The methane generation rate constant (k)

The values of the parameters mentioned above comes from the 2000 IPCC Good Practice Guidance in the absence of such information in the questionnaires of the surveyed landfills (whenever they are within the admissible variation range considered in the mentioned 2000 IPCC Good Practice Guidance). The assumed values for the parameters and their range of variation are shown in Table 9.3.1.2.2.1. below

Table 9.3.1.2.2.1.- Parameters used in the equation

Parameter		Expression or range of variation	Assumed value
Denomination	Symbol		
Fraction of carbon degraded	DOC_F	0.5-0.6	0.55
Oxidation factor	OX		0.1
Methane generation rate constant	K	$0.005 < k < 0.4$	0.05
The fraction (by volume) of methane in landfill	F		0.55
Methane correction factor	MCF	1	1

DOC: The degradable organic carbon content in MSW has been obtained by applying Equation [9.3.1.2.2.2] described below (Equation 5.4 of the 200 IPCC Good Practice Guidance) to the data on the standard composition information derived from the data evaluated in the corresponding questionnaires provided by grandes landfills that mayoritariamente perform biogas capture, as well as, the information on the national mean standard composition from the remaining landfills that is provided by the publication, “Medio Ambiente en España” (The Environment in Spain) (see Table 9.3.1.2.2.2.). For waste not originating in direct kerbside collection, the DOC values reported in the questionnaires were used; by default, once waste composition was assessed for each landfill, specific values were obtained from the inventory working team based on tables 2.4 and 2.5 in the IPCC 2006 Guidelines: i) composting plant refuse (0.2); ii) sewage sludge (0.175); and iii) others (0.04).

Table 9.3.1.2.2.2.- Nacional mean composition of MSW and Degradable organic carbon (DOC) associated *(Ammounts in %)*

Year	Organic Material	Paper and Cardboard	Plastics	Glass	Ferrous metals	Non-ferrous metals	Wood	Textiles	Rubber	Batteries	Various	DOC (%)
1970	52,00	17,00	3,00	2,50	4,50	1,30	4,00	4,80	4,00	0,10	6,80	17,72
1971	51,86	17,29	3,43	2,57	4,43	1,26	3,86	4,80	3,86	0,11	6,53	17,77
1972	51,71	17,57	3,86	2,64	4,36	1,21	3,71	4,80	3,71	0,11	6,32	17,82
1973	51,57	17,86	4,29	2,71	4,29	1,17	3,57	4,80	3,57	0,12	6,05	17,87
1974	51,43	18,14	4,71	2,79	4,21	1,13	3,43	4,80	3,43	0,13	5,80	17,92
1975	51,29	18,43	5,14	2,86	4,14	1,09	3,29	4,80	3,29	0,14	5,53	17,97
1976	51,14	18,71	5,57	2,93	4,07	1,04	3,14	4,80	3,14	0,14	5,32	18,02
1977	51,00	19,00	6,00	3,00	4,00	1,00	3,00	4,80	3,00	0,15	5,05	18,07
1978	50,88	19,06	6,00	3,13	4,00	1,00	2,98	4,80	3,00	0,15	5,00	18,07
1979	50,75	19,13	6,00	3,25	4,00	1,00	2,95	4,80	3,00	0,15	4,97	18,07
1980	50,63	19,19	6,00	3,38	4,00	1,00	2,93	4,80	3,00	0,15	4,92	18,07
1981	50,50	19,25	6,00	3,50	4,00	1,00	2,90	4,80	3,00	0,15	4,90	18,06
1982	50,38	19,31	6,00	3,63	4,00	1,00	2,88	4,80	3,00	0,15	4,85	18,06
1983	50,25	19,38	6,00	3,75	4,00	1,00	2,85	4,80	3,00	0,15	4,82	18,06
1984	50,13	19,44	6,00	3,88	4,00	1,00	2,83	4,80	3,00	0,15	4,77	18,06
1985	50,00	19,50	6,00	4,00	4,00	1,00	2,80	4,80	3,00	0,15	4,75	18,06
1986	48,13	19,88	6,75	6,10	4,00	1,00	2,73	4,80	1,88	0,15	4,58	17,91
1987	48,75	19,75	6,50	5,40	4,00	1,00	2,76	4,80	2,25	0,15	4,64	17,96
1988	49,38	19,63	6,25	4,70	4,00	1,00	2,78	4,80	2,63	0,15	4,68	18,01
1989	47,50	20,00	7,00	6,80	4,00	1,00	2,71	4,80	1,50	0,15	4,54	17,86
1990	46,75	20,00	7,00	6,80	4,00	1,00	2,71	4,80	1,50	0,15	5,29	17,75
1991	46,00	20,00	7,00	6,80	4,00	1,00	2,71	4,80	1,50	0,15	6,04	17,63
1992	45,00	20,25	8,79	6,85	4,06	1,00	1,84	4,81	1,26	0,18	5,96	17,33
1993	44,00	20,50	10,57	6,90	4,12	1,00	0,96	4,82	1,02	0,20	5,91	17,02
1994	44,00	20,70	10,57	6,90	4,12	1,00	0,96	4,82	1,02	0,20	5,71	17,10
1995	44,00	20,85	10,58	6,95	3,81	1,00	0,98	4,91	1,01	0,20	5,71	17,20
1996	44,00	21,00	10,58	7,00	3,50	1,00	1,00	5,00	1,00	0,20	5,72	17,30
1997 - 2008	44,00	21,20	10,59	6,90	3,43	0,68	0,96	4,81	1,01	0,20	6,22	17,29

$$Porcentaje\ de\ DOC\ (en\ masa) = 0.4(A) + 0.17(B) + 0.15(C) + 0.30(D) \qquad [9.3.1.2.2.2]$$

For the application of equation [9.3.1.2.2.2] the following categories of MW components cited in Table 9.3.1.2.2.2. have been associated with the variables, (A), (B), (C) and (D) that appear there:

(A) is associated with the “Paper and Carton” and “Textiles” components.

(B) is not associated with any compound from the table.

(C) is associated with the “Organic Matter” component..

(D) is associated with the “Wood” component.

Methane burnt in Flares

The emissions of the pollutants coming from the combustion of the biogas collected in managed landfills without energy recovery, have been calculated by multiplying the Mg of

methane burnt (table 9.3.1.1.2.2.) by the emission factors shown in table *9.3.1.2.2.3.*. The original source of information of the factors has been EPA AP-42 5th Edition, table 2.4-4 of section 2.4 "Municipal Solid Waste Landfill".

The factors for these pollutants are expressed in the original source quoted in: kg pollutant/millions of m^3 of standard dry methane burnt. To express the factor in g pollutant/methane burnt, the m^3 S (standard cubic metre) conversion factors were applied to m^3 N (normal cubic meter) of (273.15+15)/(273.15) and the density under normal circumstances of methane (715 g /m^3 N) to convert volume into mass.

Table 9.3.1.2.2.3.- Managed landfills with biogas recovery. Emission Factors

	Flares	Unit
CO	17,545	g CO/Mg CH_4
NO_X	950	g NO_X/Mg CH_4
$PM_{2.5}$	487	g $PM_{2.5}$/Mg CH_4
PM_{10}	487	g PM_{10}/Mg CH_4
TSP	487	G TSP/Mg CH_4

9.3.2.- Waste incineration (6C)

Within this category, the emissions produced by the incineration of hospital wastes, urban solid waste without energy recovery, corpses and all sludge from wastewater treatment. Emissions from industrial waste incineration are not counted under this category, as incineration takes place with energy recovery.

The significant decrease in the emissions levels recorded up to 2004 is essentially determined, as shown below, by i) the transfer from the Waste sector to the Energy sector in the accounting of emissions of incinerated urban solid waste in the measure that said incineration conducts its energy recovery, and ii) the decrease of incinerated hospital wastes in Spain. The decrease observed from 2003 to 2004 is due to the decrease in the sludge incinerated from wastewater treatment plants.

<u>9.3.2.1.- Activity variables</u>

9.3.2.1.1.- Hospital wastes

The clinical waste suitable for treatment by incineration are those with a low infection potential (Group III) and those named “*cytotoxic waste*” which present a high infection potential (Group IV).

The final activity variable is the amount of waste incinerated in Spain, see Table 9.3.2.1.1.1. The estimates of the amount of this type of waste generated is carried out based on the number of hospital beds, multiplying it by a waste generation factor per bed and day. The information regarding number of hospital beds is provided by the Statistics Yearbook of Spain, edited by the National Institute of Statistics, and by the Public Health Facilities Statistics of the Ministry of Health Management’s Institute of Health Information The parameter for the generation of hospital waste per bed and day has been obtained from the

"Study of Spain's generation and management of clinical wastes" created by the Institute on Sustainable Resources for the Ministry of the Environment.

Table 9.3.2.1.1.1.- Hospital wastes

Year	No. beds	gr/bed/day		Production of biohazardous waste (t/y)			Steriliz. (t/y)	Incinerat. Spain (t/y)	Incinerat. Abroad (t/y)
		Group III	Group IV	Total	Group III	Group IV			
1990	115,695	426	174	25,337	17,989	7,348	10,866	14,397	56.8
1995	137,469	365	149	25,791	18,314	7,476	11,503	10,090	39.1
2000	148,081	303	124	23,079	16,377	6,702	12,141	5,782	25.1
2003	144,916	264	109	19,730	13,964	5,765	12,523	3,198	16.2
2004	145,877	252	104	18,955	13,418	5,537	12,651	2,336	12.3
2005	145,892	240	100	18,105	12,780	5,325	12,780	1,471	8.12
2006	146,221	240	100	18,146	12,809	5,337	12,809	1,471	8.11
2007	146,840	240	100	18,223	12,863	5,360	12,863	1,471	8.07
2008	160,983	240	100	19,978	14,102	5,876	14,102	1,471	7.36

Figure 9.3.2.1.1.1.- Evolution of hospital wastes incinerated

9.3.2.1.2.- Domestic or municipal wastes

The basic information for activity variable, see Table 9.3.2.1.2.1, provide from the publication "Medio Ambiente en España" (Environment in Spain).

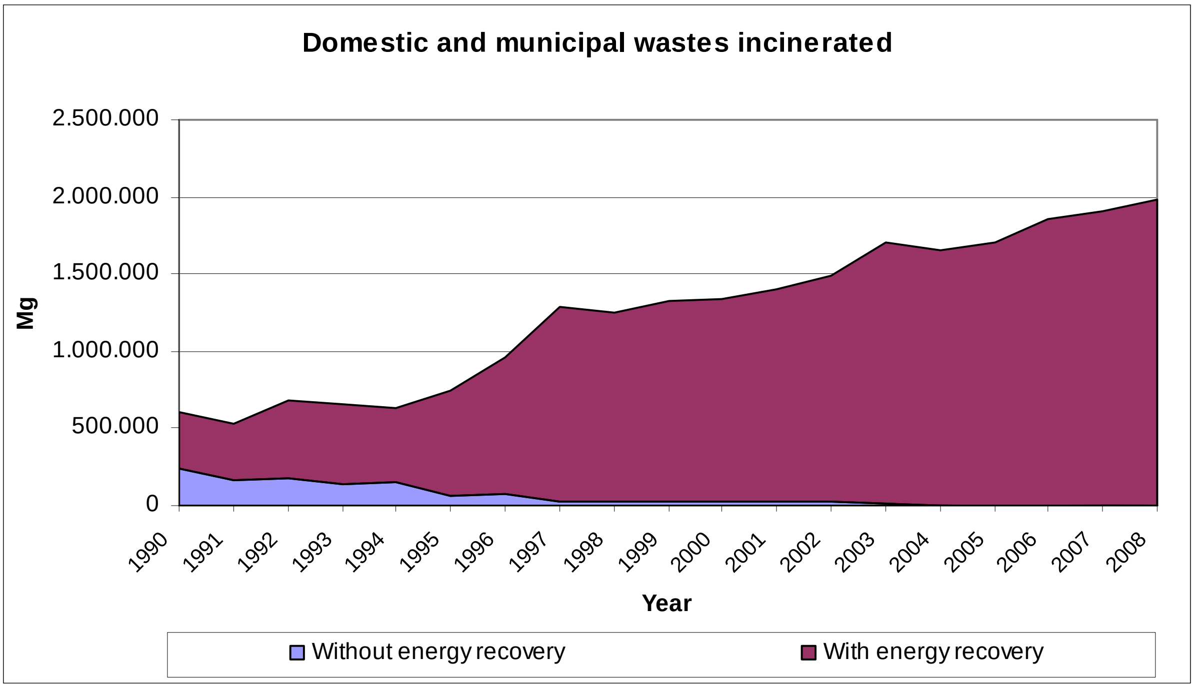
Table 9.3.2.1.2.1.- Incineration of domestic or municipal wastes *(Amounts in Mg)*

	1990	1995	2000	2004	2005	2006	2007	2008
A	236,605	67,909	24,908	0	0	0	0	0

B	370,744	681,878	1,311,071	1,656,337	1,708,509	1,860,245	1,900,611	1,985,448

A: without energy recovery; B: with energy recovery

Figure 9.3.2.1.2.1.- Evolution of domestic or municipal wastes incinerated



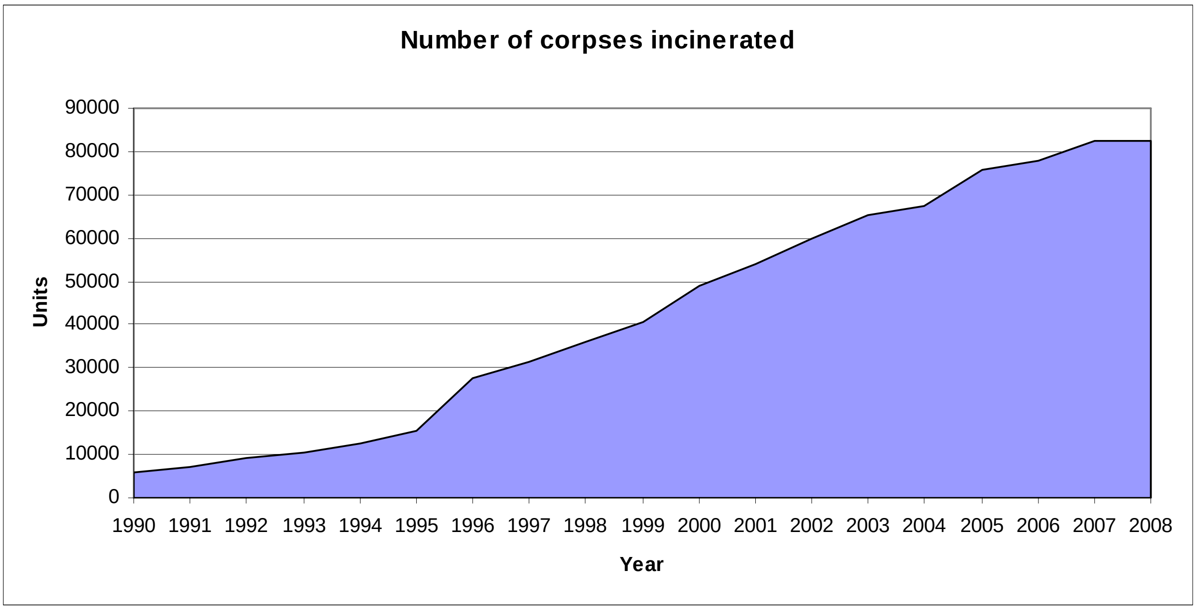
9.3.2.1.3.- Cremations

Cremation is a relatively recent practice in Spain and its use is still limited, though growing. The incineration of corpses in crematoriums, see Table 9.3.2.1.3.1, is currently the principal activity variable, this information has been provided by the European Federation of Funeral Services through a member of the Cemeteries, Statistics and Incineration Committee.

Table 9.3.2.1.3.1.- Incineration of corpses *(units)*

1990	1995	2000	2004	2005	2006	2007	2008
5,686	15,413	48,842	67,446	75,609	77,664	82,390	82,316

Figure 9.3.2.1.3.1.- Evolution of corpses incinerated



9.3.2.1.4.- Sludge from wastewater treatment plants

The emission produced by incineration of sludge in the wastewater treatment have been estimated for this category. A distinction is drawn between the values for this variable depending on the type of emission source, which in turn constrains the data source used. Thus we obtain: 1) the values assumed for surface area sources (Table 9.3.2.1.4.1) and 2) those obtained from the questionnaire for point sources (Table 9.3.2.1.4.2).

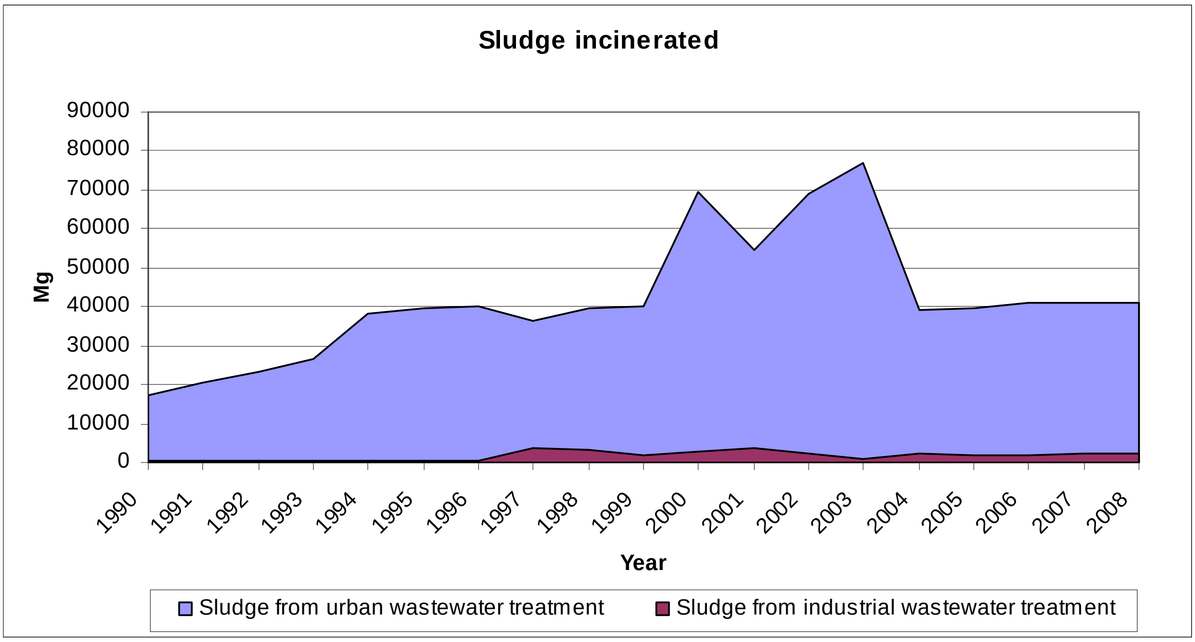
Table 9.3.2.1.4.1.- Incineration of sludge obtained from urban wastewater treatment *(Amounts in tonnes)*

1990	1995	2000	2004	2005	2006	2007	2008
17,092	39,816	69,647	39,171	39,724	41,067	41,041	40,842

Table 9.3.2.1.4.2.- Incineration of sludge obtained from industrial wastewater treatment *(Amounts in tonnes)*

1990	1995	2000	2004	2005	2006	2007	2008
497	463	2,736	2,143	2,076	1,873	2,431	2,387

Figure 9.3.2.1.4.1.- Evolution of sludge incinerated



With respect to the first, the area sources, the data for the years 1990, 1991, 1992, have been obtained by means of interpolation of the data corresponding to 1989 and 1993. The figures for these two years have been taken respectively from the information prepared by the former MOPT on sewage sludge in the publication "The Environment in Spain" (referring to the year 1991) and in the "Study on treatment and final disposal of urban waste water sewage sludge", drawn up by the consulting firm "CADIC, S.A." for the Department of Water Quality at the MOPTMA [Ministry for Public Works, Transport and the Environment] (referring to the year 1993). For the period 1997-2008, the figures come from the "National Sewage Register" prepared by the MAPA and the 1994-1996 series has been obtained by means of interpolation based on the data corresponding to 1993 and 1997.

With respect to the second source, the information has been collected from the data in the questionnaires for the National Emission Inventory sent out to plants in certain industrial sectors. Specifically, consideration has been given here to those corresponding to the oil refinery plants and paper pulp manufacturing plants when sewage sludge is incinerated there. For the oil refinery sector, the data in the questionnaires covering the years 1994 to 2008[7] have been extended backwards using the series for the volume of waste water treated. For the paper pulp manufacturing sector, the series only covers the years 1997-2008 in which replies were obtained directly via the questionnaires.

---

7 1998 is the last year in which this activity was carried out in the oil refining industry.

9.3.2.2.- Methodology

9.3.2.2.1.- Hospital wastes

The main influence of the type of incinerator on the emission into the atmosphere is determined by the capacity for incineration, the management of the process (continuous or by batches), and the implementation of the techniques for reducing emission. Amongst the latter, the following should be mentioned: the control of particles, including heavy metals, by means of the use of hose filters, electrostatic precipitators or high powered "Venturi" scrubbers. The emission of acid gas may be managed by means of wet/dry scrubbing techniques.

For the emission factors it has been decided to use, when the latter are differentiated according to the emission control techniques, those which correspond to the most widely used technique. The factors finally selected are shown in Table 9.3.2.2.1.1.

Table 9.3.2.2.1.1.- Emission factors

SO_X (g/Mg)	NO_X (g/Mg)	NMVOC (g/Mg)	CO (g/Mg)
70/D	2,500/D	7,400/E	125/D

Cd (mg/Mg)	Hg (mg/Mg)	Pb (mg/Mg)	$PM_{2,5}$ (g/Mg)	PM_{10} (g/Mg)	TSP (g/Mg)	DIOX (ng/Mg)	PAH (mg/Mg)
3,000/C	3,000/C	35,000/C	660/D	2,200/D	2,200/D	150,000/C	20/D

As follows, the breakdown of the sources of reference for the emission factors is commented on in detail. The main sources are Tables 8.3 and 8.4 from Chapter B927 in the EMEP/CORINAIR Guide Book. For particles, the emission factors taken are those proposed by CITEPA, page 259 (please refer to the bibliographical references). For the case of dioxins the factor taken has been 150 µg I-TEC/tonne of waste incinerated corresponding to the control techniques for abating particles.

9.3.2.2.2.- Domestic or municipal wastes

The emission factors were used for this activity are shown in Table 9.3.2.2.2.1.

Table 9.3.2.2.2.1.- Emission factors

SO_X (g/Mg)	NO_X (g/Mg)	NMVOC (g/Mg)	CO (g/Mg)	NH_3 (g/Mg)
1,600/D	1,800/C	19/D	700C	0/E

Cd (mg/Mg)	Hg (mg/Mg)	Pb (mg/Mg)	$PM_{2,5}$ (g/Mg)	PM_{10} (g/Mg)	TSP (g/Mg)	DIOX (ng/Mg)	PAH (mg/Mg)
200/D	3,000/D	10,000/D	30/C	30/C	30/C	50,000/B 5,000/B	7/D

Dioxins: Years 1990-1999 = 50,000 ng/t; Year 2000 = 5,000 ng/t

For the sources treated on a surface level, it has been assumed that in the years 90 to 95 the control technique is only *"Particle Abatement",* and as from the year 1996 and following *"Particle abatement + acid gas abatement".* Nonetheless, the emission factor for dioxins has been revised in 2000 according to our own estimations based on the techniques existing in the plants treated at the surface level in that year as listed in the publication entitled “Medio Ambiente en España” (Environment in Spain).

The breakdown of the sources of reference for the emission factors is the following: for SO_X, NO_X, VOC, CO, NH_3, Annex I Tables A1.1 to A1.6 from Chapter B921 in the EMEP/CORINAIR Third Edition Guide Book. In the case of the VOC, 95% of NMVOC have been assumed. In the case of PARTICLES, CEPMEIP emission factors have been taken for area sources, assuming low emission levels, whereas for the plants treated as point sources, measured TSP emission values have been made available and, bearing in mind that all particulates are less than 2.5 μm in diameter as inferred from the CEPMEIP’s proposed factors, the $PM_{2.5}$ and PM_{10} emissions have been assumed to be equal to TSP. For the heavy metals, the information comes from Table 2.5.2 of the PARCOM-ATMOS Manual. The EMEP/CORINAIR Third Edition Guide Book has also been used for the DIOX (see Table 8.1, in Chapter B921) and for the PAH as the sum of the corresponding factors of benzo[bk]fluoranthene, value 6,3 mg/t, and of the benzo[a]pyrene, value 0,7 mg/t.

9.3.2.2.3.- Cremations

For the emission factors, the information has been considered is taken from Tables 8.1, 8.2 and 8.3 in the EMEP/CORINAIR Guidebook, Chapter B991, pages 7 and 8, of the Third Edition. The factors have been taken from the said reference for heavy metals, dioxins and PAH. However, for the gases from Group 1 the information has been used that was provided by the European Federation of Funeral Services through a member of the Cemeteries, Statistics and Incineration Committee.

With respect to particles, the basis adopted has been the factor proposed by the CITEPA (page 264) for TSP (please refer to the bibliography). To obtain the emission factors for $PM_{2.5}$ and PM_{10}, the Inventory working party has estimated that 90% of particles are PM_{10} and 80% are $PM_{2.5}$, a hypothesis based on the information given in the document “Modelling Particulate Emissions in Europe, A Framework to Estimate Reduction Potential and Control Cost” IIASA (page 83).

Table 9.3.2.2.3.1 shows the said emission factors.

Table 9.3.2.2.3.1.- Emission factors

SO_X (g/c.i.)	NO_X (g/c.i.)	NMVOC (g/c.i.)	CO (g/c.i.)	NH_3 (g/c.i.)
13/E	156/E	14.6/E	725/E	3.2E

Cd (mg/c.i.)	Hg (mg/c.i.)	Pb (mg/c.i.)	$PM_{2,5}$ (g/c.i.)	PM_{10} (g/c.i.)	PST (g/c.i.)	DIOX (ng/c.i.)	PAH (mg/c.i.)
0.003107/E	0.9344/E	0.01860/E	104/E	117/E	130/E	4,000/E	$73.09 \cdot 10^{-6}$/E

Note: c.i. = corpse incinerated.

9.3.2.2.4.- Sludge from wastewater treatment plants

For the emission factors it has been decided to use, when the latter are differentiated according to the emission control techniques, those which correspond to the most widely used technique. The factors finally selected are shown in Table 9.3.2.2.4.1 below:

Table 9.3.2.2.4.1.- Emission factors

SO_X (g/Mg)	NO_X (g/Mg)	NMVOC (g/Mg)	CO (g/Mg)	Cd (mg/Mg)	Hg (mg/Mg)	Pb (mg/Mg)	DIOX (ng/Mg)	PAH (mg/Mg)
2,500/D	2,500D	840/D	15,500/D	1,000/D	1,000/D	15,000/D	60,000/E	127/D

The breakdown of the sources of reference for the emission factors is as follows: for the acidifiers and ozone precursors the information has been taken from the foot of Table 2, Chapter B-925 in the EMEP/CORINAIR Guide Book, assuming for each one the abatement techniques supposedly most appropriate from amongst the options appearing at the foot of the said Table. Thus, for NMVOC and CO, the value proposed in that reference has been taken directly whereas for SO_X and NO_X, the Inventory Working Party has selected the values considered most reasonable, in the light of the abatement technique, from those proposed in the said reference. For the heavy metals, the information comes from Table 2.5.4 of the PARCOM-ATMOS Manual. For the DIOX, the average value of 60 µg of the range 5-120 i-TEF/tonne of sludge incinerated has been taken that appears in Table 3 from Chapter B-925 in the EMEP/CORINAIR Guide Book. For the PAH, the reference source is Table 8.3.37 from the study “Compilation of Emission Factors for POPs, a case study of Czech and Slovak Republics”, and the value corresponds to the total PAH, although in the aforesaid source a speciation analysis thereof is also given.

9.3.3.- Others: Production of compost and Sludge Spreading (6D)

En esta categoría de la nomenclatura NFR 6D se han estimado las emisiones generadas por la producción de compost y el extendido de lodos.

<u>9.3.3.1.- Activity Variables</u>

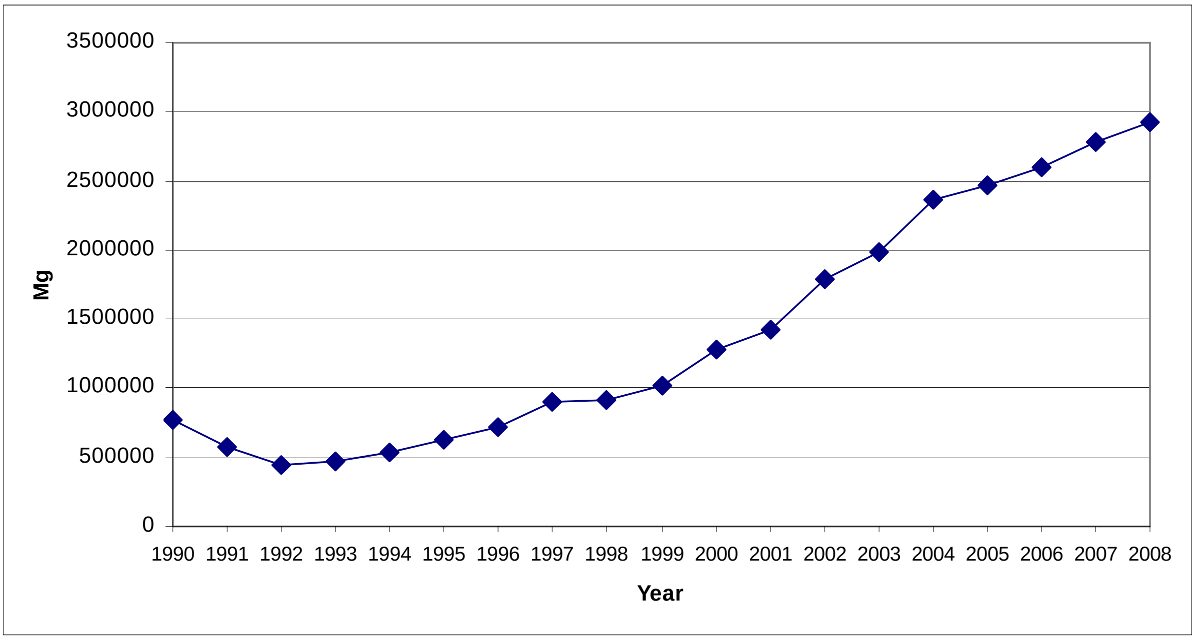
9.3.3.1.1.- Inputs in the composting process

This activity includes the emissions deriving from the composting of organic municipal waste excluding garden. The basic information and evolution in the inventoried period on the quantification of the data of the activity of the composting based on the waste is shown in Table and Figure 9.3.3.1.1.1., the information for which comes from the publication “Medio Ambiente en España” (The Environment in Spain) provided by the Ministry of Environment and Rural and Marine Affairs.

Table 9.3.3.1.1.1.- Inputs in the composting process *(Ammounts in Mg)*

1990	1995	2000	2004	2005	2006	2007	2008
769,116	625,904	1,273,329	2,361,992	2,469,588	2,593,699	2,775,598	2,928,977

Figura 9.3.3.1.1.1.- Evolution of composting (*Cifras en Mg)*



9.3.3.1.2.- Sewage sludge spreaded

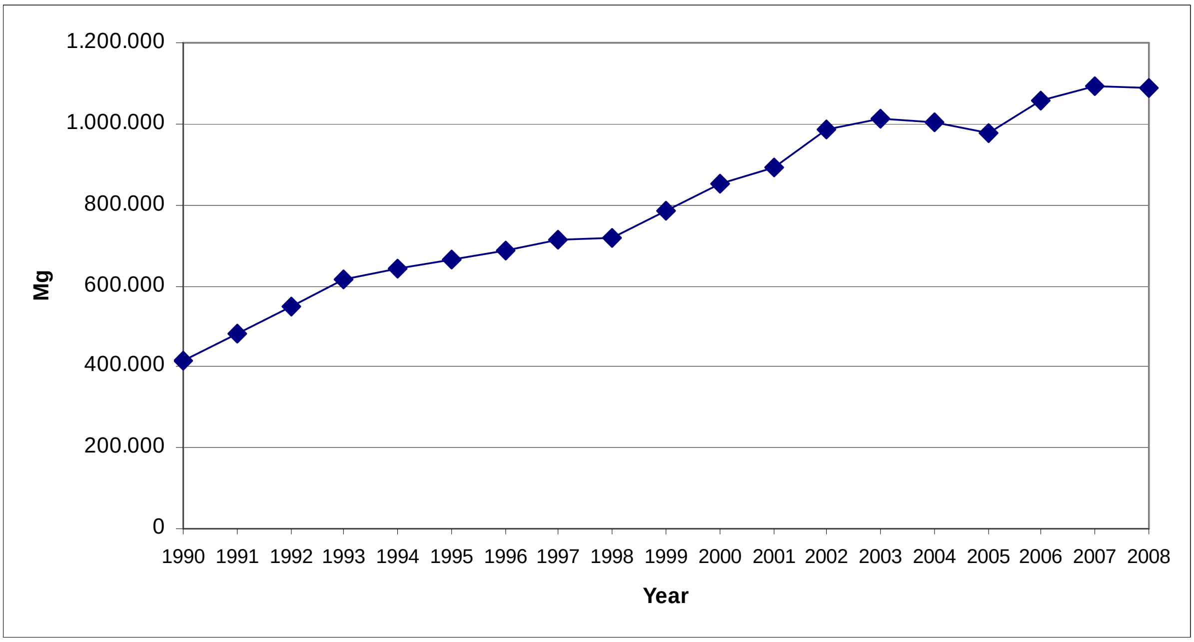
In this activity, the emissions are collected for sludge spreading that arises from wastewater treatment plants for drying and which may be considered as a process that is an integral part of wastewater treatments.

An attempt has been made to update the fraction series of the sludge drying, but the data for this activity as not been available. Due to the lack of better information the fraction of the sludge treated in wastewater treatment that is dried in the open air for spreading, is equal to the unit. Table 9.3.3.1.2.1. llustrates the figures of the activity variable for sludge spreading.

***Table 9.3.3.1.2.1.- Sewage sludge spreaded** (Amounts in Mg)*

1990	1995	2000	2004	2005	2006	2007	2008
416,884	665,155	853,482	1,002,857	975,396	1,057,573	1,092,252	1,086,968

Figure 9.3.3.1.2.1.- Evolution of sewage sludge spreading *(Amounts in Mg)*



9.3.3.2.- Methodology

9.3.3.2.1.- Production of compost

The NH_3 emission factor considered is proposed by the reference publication: "Carbon dioxide and ammonia emissions during composting of mixed paper, yard waste and food waste" Komilies et al. Waste Management 26 (2006) 62-70. The emission factor is 2.76 g NH_3/kg of waste composted.

9.3.3.2.2.- Sludge spreading

The estimated gas has been the fraction of the NMVOC of the VOC, the respective values of 20 kg (NMVOC) and 29 kg CH_4 per tonne of all dried sludge (see page 14 of the "Report on Complementary Information in the Frame of the Assistance Provided for CORINAIR 90 Inventory", CITEPA). The previously mentioned figure of 20kg is the mean in the dispersion range that is spread of 7.1 kg to 29 kg (see page 14, "Report on Complementary Information in the Frame of the Assistance Provided for CORINAIR 90 Inventory").

9.4.- Other sources

9.4.1.- Wastewater treatment (6B)

Except for NMVOC, category 6B does not generate any of the pollutants considered in the present report. No information is available regarding NMVOC emission factors, which explains why the corresponding emissions have not been calculated to date.

9.5.- References

- CADIC. *Estudio sobre tratamiento y eliminación final de los fangos de depuradoras de aguas residuales urbanas*. Ministerio de Obras Públicas, Transportes y Medio Ambiente. Dirección General de Calidad de las Aguas, 1993

- EMEP/EEA 2009. “Air Pollutant Emission Inventory Guidebook”. UNECE-Convention on long-range transboundary air pollution & European Environmental Agency.

- EPA. “Chapter 2: Solid Waste Disposal”. *AP-42 Volume I*. 5th ed. North Carolina: EPA, 1995

- *Estadística de Establecimientos Sanitarios con Régimen de Internado*. Madrid: Ministerio de Sanidad y Política Social*,* 1999-2005

- Fontelle, J.P., Chang, J.P. *Report on complementary information in the frame of the assistance provided for CORINAIR 90 Inventory*. París: CITEPA, 1993

- *Good practice guidance and uncertainty management in National Greenhouse Gas Inventories.* London: IPCC, OECD, IEA, 2000

- Holoubek, Ivan… [et al]. *Compilation of emission factors for persistent organic pollutants: a case study of emission estimates in the Czech and Slovak Republics.* Masaryk University, Axys Environmental Consulting, 1993

- Instituto Nacional de Estadística. *Anuario Estadístico de España*. Madrid: INE, 1991-1995

- Instituto para la Sostenibilidad de los Recursos. *Generación y gestión de los residuos sanitarios en España*. Madrid: ISR, 2006

- Klimont, Zbigniew… [et al]. *Modelling particulate emissions in Europe: a framework to estimate reduction potential and control costs.* Laxenburg: IIASA, 2002

- Komilis, Dimitris P., HAM, Robert K. “Carbon dioxide and ammonia emissions during composting of mixed paper, yard waste and food waste”, *Waste Management*, vol. 26, Issue 1, 2006, pp. 62-70

- Libro Guía EMEP/CORINAIR. "Atmospheric Emission Inventory Guidebook". Third Edition. Updated to December 2006. UNECE-Convention on long-range transboundary air pollution & European Environmental Agency.

- Libro Guía EMEP/CORINAIR. "Atmospheric Emission Inventory Guidebook". Third Edition. Updated to December 2007. UNECE-Convention on long-range transboundary air pollution & European Environmental Agency.

- *Medio ambiente en España*. Madrid: Ministerio de Medio Ambiente, Centro de Publicaciones, 1989-2008

- *Revised 1996 IPCC guidelines for National Greenhouse Gas Inventories.* London: IPCC, OECD, IEA, 1997

- Van der Most, P.F.J., Veldt, C. Emission factors manual PARCOM-ATMOS: final version. 1992

10.- OTHER

No activity has been identified for inclusion in this chapter that is devoted to any other eventual activity that were not included in the previous sectors chapters.

11.- RECALCULATIONS AND PLANNED IMPROVEMENTS

Chapter updated in July, 2010.

This chapter presents the main changes registered in estimations of emissions in the current inventory (2010) over the previous edition (2009) with comments, as well as their implications on emission trends. It also includes the description of the improvements planned for the inventory (by affected categories).

11.1.- New calculations

New calculations have been made for the period 1990-2007 in a group of activities which are described individually below under the subsection “Comments by Activity”. These calculations have generally been motivated by changes in estimation methods, which also normally entail the revision of the representative activity variables and the emission factors themselves, or by corrections of errors detected.

For 2007, it should moreover be pointed out that new calculations were also made in all those cases where there was an updated version of the activity variables available, and where the provisional –or simply predicted– figures in the original sources were updated, which were used in the “previous” edition. In subsection entitled “General Comments”, the most relevant sources of general information affecting this type of re-estimation are listed.

11.1.1.- General comments

The changes in the categories with the greatest emission potential have been motivated primarily by changes in some of the following information sources:

11.1.1.1.- Large Point Sources (LPS) Questionnaires

In the case of Large Point Sources, for which information is gathered through a specific questionnaire, data relating to 2008 have been included in their entirety in the current edition, and at the same time, errors detected in the questionnaires corresponding to 1990-2007 have been corrected. These changes have affected plants in the following sectors:

Thermal power plants.

Petroleum refineries.

Paper pulp plants.

Vehicle manufacturing plants.

Municipal waste incineration plants

Municipal landfills

11.1.1.2.- Activity statistics

The basic statistical data in the Agriculture sector have been revised due to the availability of a more up-to-date version of the sector's basic statistical publication, namely the Statistical Yearbook of the Ministry of the Environment and Rural and Marine Affairs.

11.1.1.3.- Energy balances

The most relevant change in scope is the systematic review of fuels balance specifically used for the emissions inventory. It is worth noting that only international energy questionnaires –and on occasion only a summary– were available for the final year of each edition of the inventory, which signifies that figures contained in the following year's edition require subsequent verification against the information provided in the International Energy Agency (IEA) and EUROSTAT's energy balances.

11.1.1.4.- Revision of emission factors for stationary engines using natural gas

For stationary motors using natural gas as a fuel, the emission factors for NO_X, NMVOC and CO have been revised with the information provided by the main companies supplying this kind of facilities. The following table shows the factors in the current edition of the inventory and a comparison with those used in the previous edition.

Table 11.1.1.- Emission factors for stationary engines using natural gas

	Emissions (g)	**NMVOC (g/GJ)**	**CO (g/GJ)**
1990-2007 edition	1.200	200	50
1990-2008 edition	312	87	452

Of the pollutants mentioned, particular attention has been paid to those which have reached national emission ceilings, namely NO_X and NMVOC, for which the modifications are described in more detail below.

As can be seen in Table 11.1.1, through to the 1990-2007 edition, the inventory used emission factors of 1,200 g NO_X/GJ_{LHV} and 200 g at/GJ_{LHV}. The reference for these factors came from the 2007 edition of the EMEP/CORINAIR[1] Guidebook (which itself maintained data from previous editions).

The results of the sensitivity analysis for the emissions, particularly in the case of NO_X, confirmed that the emission factor of 1.200 g/GJ had a very high incidence in the emissions in the industrial fuel category 1A2, as well as in the entire inventory. In view of this fact, and of a possible overvaluation of the emission factor, a comparative analysis was carried out with US-EPA AP42 factors as shown in Tables 11.1.2 and 11.1.3 (with the original values shown on the left, and the values in the units in which the factors of the inventory are expressed, on the right). From an observation of the tables it can be deduced that for NO_X

[1] See EMEP/CORINAIR 2007 Guidebook, Table 24, chapter B111, and Table 5, chapter B112 for NOX, and Table 26, chapter B111 for NMVOC.

the EPA AP-42 values are not lower than those used in the 1990-2007 edition of the inventory, although for NMVOC the factor in the 1990-2007 edition of the inventory could be considered to be overvalued. In order to confirm this situation, the US-EP was consulted, and no information was obtained which contradicted the values published in Tables 11.1.2. and 11.1.3, although it was strongly recommended that specific consultations be made to the companies manufacturing and distributing this type of engines.

In line with the above, and through the SERCOBE Association of manufacturers and distributors of capital assets, a research project was initiated with the companies representing the sector. The Strategic Environmental Information Unit (UIAE) responsible for the inventory prepared a questionnaire in order to compile information on emission factors for this type of engines and on their use in Spain. As a result of this process, answers were received from four large companies representing the sector. Three of these reported on using lean burn natural gas engines, and a fourth reported on engines which used heavy fuel oil. Of the answer received regarding lean burn natural gas engines, emission factors from the company which had the largest market share were chosen. These values were expressed as a concentration (mg of pollutant/Nm^3 of effluent gases to 15% oxygen), and the concentrations were converted into emissions factors in g of pollutant/GJ using the calculations for conversion of fuel mass to volume of effluent which appear in Royal Decree 646/1991. The values resulting from this process are shown in Tables 11.1.2. and Table 11.1.3 in the row entitled *"Inventory"*, notifying here that these values lie within the ranges which appear in Table 4-9, chapter 1.A.1 *"Combustion in energy industries"* in the EMEP/EEA 2009 Guidebook (280-810 g NO_X/GJ and 30-110 g NMVOC/GJ).

Table 11.1.2.- Emission factors for NO_X in stationary engines using natural gas (without NO_X abatement techniques)

Source		Load coefficient (L) Original figures (Lb/$MMBtu_{HHV}$)		Load coefficient (L) Figures in g/GJ_{LHV}	
		L < 90%	90% < L < 105%	L < 90%	90% < L < 105%
EPA AP-42	2-stroke engines with lean burn	1,94	3,17	915	1.496
	4-stroke engines with lean burn	0,847	4,08	400	1.925
	4-stroke engines with rich burn	2,27	2,21	1.071	1.043
Inventory	Engines (not specified)			1.200	

Table 11.1.3.- Emission factors for NMVOC in stationary engines using natural gas (without NMVOC abatement techniques)

Source		Load coefficient (L) Original figures (Lb/$MMBtu_{HHV}$)		Load coefficient (L) Figures in g/GJ_{LHV}	
		L < 90%	90% < L < 105%	L < 90%	90% < L < 105%
EPA AP-42	2-stroke engines with lean burn	0,12		56,6	
	4-stroke engines with lean burn	0,118		55,7	
	4-stroke engines with rich burn	0,0296		14,0	
Inventory	Engines (not specified)			200	

11.1.2.- Comments by activity

The re-calculations by activity categories discussed in this sub-section are sorted by NRF source category for those activities whose estimated emissions have experienced significant changes for the period 1990-2007 with regard to the estimations provided in the previous edition.

1.A.1.a Energy industries: Public electricity and heat production

Pollutants affected: Main pollutants (NO_X, NMVOC, SO_X, NH_3, CO), heavy metals, particulate matter and POP.

Activity data

Information for the years 2007 on fuel consumption by low-power electricity generation plants operating under the ordinary regime has been revised in accordance with the data appearing in Annex V of the Statistics on Electrical Power (prepared by the Ministry of Industry, Tourism and Trade, MITYC), which were not available at the time of the previous edition of the inventory.

The consumption of soft coal in one thermal power plant in 2001 has been revised after an erroneous figure was detected as a result of the implementation of a QA/QC procedure in the consumption figures provided at the time by the power plant itself

The lower heating value of the anthracite consumed in 2004 has also been revised in another thermal power plant as a result of the QA/QC procedure.

For the period 1994-2000 the lower heating value of natural gas consumed in one thermal power plant was revised after an error was identified in the units in which the lower heating value was expressed.

The consumption of natural gas coal in 2004 in a combined-cycle thermal power plant was revised after an erroneous figure was detected as a result of the implementation of a QA/QC procedure (consumption rate did not correspond to the energy generated).

The quantities of biogas burnt (period 1995-2007) have been revised in facilities located in landfills which practice energy recovery for this biogas, according to the updated information provided in the individualised questionnaire by the landfill facilities themselves. The quantities of gas oil (period 1997-2007) and natural gas (period 1990-2007) as auxiliary fuels in two landfill facilities have been revised, in accordance with the updated information provided in the questionnaire by the landfill facilities themselves.

The emissions of particulate matter, Zn and HAP have also been revised in 2007 (each pollutant in one plant) in the municipal waste incineration activity with energy recovery, after having detected the incorrect entry in the database of the emissions data measured.

For the first time the emissions estimations for an industrial waste incineration plant with energy recovery for the 2001-2007 period have been included in the present edition of the inventory; this information was collected by means of an individualised questionnaire from this plant.

Emission factors:

The estimation of dioxin emissions for 2006 has been revised due to the consumption of gas oil in a combined-cycle thermal power plant, after detecting the omission of the emission figures for this pollutant in the database.

In addition to the above, the changes described in subsection 11.1.1.4. should also be taken into account.

1.A.1.b Petroleum refineries

Pollutants affected: main pollutants (NO_X), heavy metals (As, Cd and Cr).

Emission factors:

The variations originated by the re-calculations in this activity are the result of the correction of the emission factors applied to the emissions estimation, in order to adapt to the modes of combustion and control techniques in certain facilities in two refineries. These modifications affect the emissions of NO_X (1997-2008) and As, Cd and Cr (2004-2007).

1.A.1.c Transformation of solid fuels and other energy industries

Pollutants affected: Main pollutants (NO_X, NMVOC, CO), Hg, particulate matter and dioxins.

Activity data:

The natural gas consumption series for other energy sectors (not specified) has been modified for the whole of the inventoried period, and the remaining consumption (not assigned to other specific energy sectors) are allocated to these sectors.

The estimation of fuel consumption (coke and natural gas) corresponding to 2007 in the grey cast iron activity has been revised as a result of the new information provided by the Spanish Federation of Cast Iron Producers (FEAF).

In addition to the above, it is also necessary to take into account the changes resulting from subsection 11.1.1.3.

Emission factors:

For 2007, the emission factors for coke furnaces in an integral steelworks has been corrected after detecting that the emission factors for NO_X, NMVOC and CO had been incorrectly entered into the database.

In addition to the above, it is also necessary to take into account the changes resulting from sub-section 11.1.1.4.

1.A.2.a Manufacturing and construction industries: Iron and steel

Pollutants affected: Main pollutants (NO_X, NMVOC, SO_X, NH_3, CO), heavy metals, particulate matter and POP.

Activity data:

Re-calculations are derived from the changes described in subsection 11.1.1.3.

Emission factors:

For 2007 the omission of the emissions of SO_2 have been corrected in one furnace in an integral steelworks.

The emission factors for NMVOC for blast furnace gas and steel plant gas in boilers has been modified with the information which appears in the EMEP/CORINAIR Guidebook, and which replace emission factors which had been used from the CORINAIR Manual (1992). This modification affects the period 1990-2002.

The emission factor for CO in steel plant gas has also been modified in several combustion facilities (boilers and furnaces) in an integral steelworks, assimilating it to blast furnace gas, after having observed the use in previous editions of the inventory of an atypical emission factor for steelwork gas.

In addition to the above, it is also necessary to take into account the changes resulting from sub-section 11.1.1.4.

1.A.2.b Manufacturing and construction industries: Non-ferrous metals

Pollutants affected: Main pollutants (NO_X, NMVOC, SO_X, CO), heavy metals, particulate matter and POP.

Activity data:

In the manufacture of primary zinc, fuel consumption rates have been revised in one plant for the period 1990-2005 according to the information provided by the plant itself (consumption for 2000-2005 and extrapolation to the period 1990-1999).

In addition to the above, it is also necessary to take into account the changes resulting from subsection 11.1.1.3.

Emission factors:

The emission factor for PAH in electrode preparation furnaces in an aluminium manufacturing plant in 2007 was revised after detecting the incorrect entry of this factor in the database. Additionally, in this same plant the emission of SO_2 was revised for 2007 for anode furnaces, according to the updated emissions information for this pollutant provided by the plant itself.

Moreover in another aluminium manufacturing plant, the emissions of $PM_{2.5}$ (2002) and TSP, PM_{10} and $PM_{2.5}$ (2007) were corrected after an error was detected in the emission estimation algorithm for these pollutants in this plant.

In addition to the above, it is also necessary to take into account the changes resulting from subsection 11.1.1.4.

1.A.2.c Manufacturing and construction industries: Chemical industry

Pollutants affected: Main pollutants (NO_X, NMVOC, SO_X, CO), heavy metals, particulate matter and POP.

Activity data:

The lower heating value (LHV) of the off-gas consumed in a co-generation plant in the chemical sector corresponding to 2007 was revised after an error was detected in the value of this parameter (the LHV provided for 2006 had been maintained).

In addition to the above, it is also necessary to take into account the changes resulting from subsection 11.1.1.3.

Emission factors:

Re-calculations are derived from the changes described in subsection 11.1.1.4.

1.A.2.d Manufacturing and construction industries: Paper pulp, paper and printing industry

Pollutants affected: Main pollutants (NO_X, NMVOC, SO_X, CO), heavy metals, particulate matter and POP.

Activity data:

Re-calculations are derived from the changes described in subsection 11.1.1.3.

Emission factors:

Emissions from several combustion facilities in paper pulp manufacturing plants were revised, entering the measured emissions provided by the plant itself into the database, instead of using the estimations from default emission factors contained in the previous inventory edition.

The emissions for particulate matter for 2007 in combustion facilities in another paper pulp manufacturing plant have been corrected after detecting that the emissions for 2006 had been repeated for that year.

In addition to the above, it is also necessary to take into account the changes resulting from subsection 11.1.1.4.

1.A.2.e Manufacturing and construction industries: Food, beverages and tobacco industries

Pollutants affected: Main pollutants (NO_X, NMVOC, SO_X, CO), heavy metals, particulate matter and POP.

Activity data:

Re-calculations are derived from the changes described in subsection 11.1.1.3.

Emission factors:

Re-calculations are derived from the changes described in subsection 11.1.1.4.

1.A.2.f Manufacturing and construction industries: Other

Pollutants affected: Main pollutants (NO_X, NMVOC, SO_X, NH_3 and CO), heavy metals, particulate matter and POP (DIOX and PAH).

Activity data:

The consumption of natural gas in 2004 and 2005 has in a glass wool manufacturing plant has been revised in accordance with the information provided by the plant itself.

The consumption of natural gas in the period 2004-2007 in a rock wool plant has been revised in accordance with the information provided by the plant itself.

The consumption of natural gas for 2007 (gas turbines, stationary engines, and processing furnaces) in the manufacture of fine ceramic products (tiles) has been modified as a result of the consumption rates provided by the Spanish Association of Tiles, Pavements and Ceramic Tiles (ASCER).

The consumption of gas oil allocated to mobile machinery for construction and public works (category 1A 2fii) has been updated for the period 1997-2007. In the present edition the variable applied has been changed, as an activity indicator, to determine the evolution of the consumption of fuels for previous years taking as a base the estimation for 1996, calculated from data for effort and specific consumption of the operating fleet in this year.

In addition to the above, it is also necessary to take into account the changes resulting from subsection 11.1.1.3.

Emission factors:

With regard to the modification made in the furnaces for cement clinker production, the variation was motivated by the change proposed by the OFICEMEN Business Association (Spanish Association of Cement Manufacturers) in the volume of effluent gases from clinker furnaces per ton of clinker produced. This volume has gone from 2,000 Nm^3 per tonne of clinker in the 1990-2007 edition to 2,300 Nm^3 per tonne of clinker in the 1990-2008 edition. This change indicated by OFICEMEN is the result of an identical change shown in the IPPC's BREF documents, specifically in the 2007 draft version (revised in 2010) vs. the 2001 version. It is important to note that the effect of the specific flow rate has a direct incidence on the emission factor expressed in g of pollutant/t of clinker, given that the base information provided for this calculation by OFICEMEN is the concentration of the pollutant expressed in mg/Nm^3 of effluent gases. This concentration must then be multiplied by the specific flow rate per ton of clinker manufactured in order to obtain the emission factors in the units used in the inventory.

The dioxin emission factor for 2007 for anthracite consumed in lime furnaces has been revised after detecting the incorrect entry of the emission factor into the database.

The omission of Zn emissions for 2007 has also been corrected in the combustion facilities of a vehicle manufacturing plant.

In addition to the above, it is also necessary to take into account the changes resulting from subsection 11.1.1.4.

1.A.3.a Domestic and international air traffic in airports (LTO phase)

Pollutants affected: Main pollutants (SO_X), heavy metals, particulate matter and POP.

Emission factors:

For SO_X, heavy metals, particulate matter and PAH, a minor revision was made in the emission factors for LTV, which are calculated using the specific consumption estimated for each national airport, and the default emission factors in the EMEP/CORINAIR Guidebook expressed in terms of fuel mass. This modification was made, in the case of particulate matter, in order to equalise the treatment of the airports classified as large point sources with the remaining airports, and generally, for the set of pollutants mentioned, in order to resolve an inaccuracy in the calculations in previous editions, by applying the specific consumption factor.

This correction represented a modification in the estimated emission factors for SO_X, heavy metals and PAH for all the years in the period 2000-2007 in the case of particulate matter.

1.A.3.b Road transport

Activity data:

The series of fossil and renewable fractions in gas oil has been revised, and the natural gas series used in road transport since 1997 has been added.

Field information on the heavy vehicle fleet operating in urban centres and on roads for goods transportation has been used, and this information has represented a substantial change in the vehicle fleet in operation with regards both traffic in urban environments and on roads.

Emission factors:

The methodology used for exhaust and evaporation emissions has been updated, using COPERT IV instead of COPERT III, the methodology used previously.

1.A.3.c Railways

Pollutants affected: Main pollutants (NO_X, NMVOC, SO_X, NH_3, CO), heavy metals, particulate matter and POP.

Activity data:

The consumption of fuel allocated to diesel locomotives has been revised for the period 1994-2007. Subsequent to the preparation of the 2009 edition of the inventory, an error was detected in the estimation of the national consumption of this mode of transport due to the omission of the historic series corresponding to one regional railway company. The correction of this omission in the present

edition represented an annual increase of between 0.3% (1994) and 3.3% (2007) in the figures for gas oil for railway traffic.

This modification with regards to the previous edition has been transferred to the corresponding emissions of the various pollutants. A distinction should be made with the revision of SO_X emissions, which were also affected by the change caused by the incorporation of an unaccounted item in the mean annual characteristics (sulphur content) for fuel consumed by railway traffic.

1.A.3.d Maritime navigation: Domestic and international traffic

Pollutants affected: Main pollutants (SO_X) and particulate matter.

Emission factors:

The characteristics of maritime fuel oil have been revised for the whole of the period 1990-2007, and the mean sulphur content of this fuel has been modified. After consulting technicians in the Merchant Shipping Department of the Ministry of Public Works, it was decided to significantly increase the sulphur content established by default for this fuel, by applying a conservative criterion in the inventory.

This change in the composition of fuel oil has led to a correction in the emission factors for SO_X and particulate matter which, calculated based on the sulphur content, have been applied for this type of fuel in maritime navigation.

1.A.4.a Commercial / Institutional

Pollutants affected: Main pollutants (NO_X, NMVOC, SO_X, CO), heavy metals, particulate matter and POP.

Activity data:[2] The total consumptions estimated for co-generation in the commercial/institutional sector have been modified. The allocation of the consumption in this activity has been updated as a result of the review of the pro-rating factors for consumption in co-generation according to purpose (for public electricity and heat production) and the elimination of items of combustion which it was detected were already counted in other sectors in the inventory[3].

---

[2] An error has been detected in the energy estimation (lower heating value) consumed for natural gas in categories 1.A.4.a.i, 1.A.4.b.i and 1.A.4.c.i, as the original figures, expressed in terms of higher heating value, were not converted with the corresponding conversion factor, but with the factor estimated for a previous year. The result of this error is quantified in variations, with regard to the corrected data for natural gas, of 2.6% for 1992, less than 1% for 2002 and 2003, and around 0.1% for the remaining years.

[3] With regard to the double accounting, it is worth mentioning that in this edition the analysis of the detailed information by centre available for 2008 has made it possible to detect differences in the criteria applied by the information source and the inventory when identifying the socio-economic sector of co-generation and autoproduction plants. These divergences in classification gave rise in certain cases to double accounting when the inventory supplemented direct information from the plant with information provided at the sector level, from the questionnaires on co-generation plants for 2000 and 2002-2007.

The consumption of each type of fuel in co-generation is calculated based on the proportion which is estimated to be dedicated to electricity generation (C_{ELECT}) and the percentage (F_{ELECT}) which this proportion is estimated to represent of the total consumed in co-generation. The fraction consumed in co-generation allocated to heat production (C_{ELECT} $(1-F_{ELECT})/ F_{ELECT}$) is discounted from the final consumption allocated to the commercial/institutional sector, assuming that the remaining quantities (for non-co-generation facilities) are consumed in boilers. The reallocation of a part of this consumption to co-generation facilities (boilers, turbines and engines) and non-co-generation facilities (boilers) has caused variations in the estimations for this subgroup.

With regard to fuels whose consumption in the commercial/institutional sector is considered to be limited to co-generation activities, as is the case of biogas, the total figures for consumption allocated to this subgroup has been modified in accordance with the revision of the pro-rating factors F_{ELECT} for these fuels.

The distribution of consumption in co-generation has also been modified according to type of combustion facility (boilers, stationary engines or gas turbines) for 2006 and 2007. In the current edition the distribution factors for consumption have been revised by type of facility and estimated for each type of fuel for these years. The assumption in previous editions of an increasing participation of gas turbines and stationary engines in the consumption of natural gas, gas oil and fuel oil for co-generation, to the detriment of boilers, throughout the whole of the period inventoried, led to the allocation of consumptions to turbines and engines which are considered to be high for the last years in the period, and in the present edition it was decided to maintain the structure estimated for 2005[4] as of 2006.

Emission factors:

Re-calculations are derived from the changes described in subsection 11.1.1.4.

1.A.4.c Agriculture/Forestry/Fishing

Pollutants affected: Main pollutants (NO_X, NMVOC, SO_X, NH_3, CO), heavy metals, particulate matter and POP.

Activity data:

For all the years in the period 1990-2007 the consumption of gas oil, in energy units, allocated to stationary combustion facilities in this socio-economic sector (category 1.A.4.c.i) has been corrected. In the previous edition the type of gas oil consumed in this sector was revised, as well as certain characteristics of the fuel, including the heating value, although the pertinent modification to the estimation of the consumption in fixed facilities, with the exclusion of watering engines, was not made. This rectification, which involved a moderate increase (less than 2%)

4 For the next edition it is anticipated there will be a substantial improvement in this distribution, as the availability of information at the plant level and by type of facility is expected to be available for the last years in the period in the inventory.

in the energy figures estimated for gas oil, affects the historic series of consumption and, as a result, the emissions themselves.

For 2007 the estimation of gas oil allocated to stationary diesel engines for watering (category 1.A.4.c.i) has been revised as a result of updating the activity data (watering area) estimated for that year. In the previous edition, due to the unavailability of the reference source (Statistical Yearbook of the MARM), it was decided to replicate the watering areas from the previous year, and this has been rectified in the current edition with the corresponding figures published for the reference year.

The consumption of fuels (gas oil and as small proportion of petrol) estimated for 2005 to 2007 has been modified into units for reforestation, cutting and extraction operations in the timber sector (category 1.A.4.c.ii). The variation in the consumption figures is the result of the availability in the current edition of updated base information (data on reforested areas in 2005 and volume of timber cut in 2006 in the Statistical Yearbook published by the MARM), which has been extended to subsequent years. The re-estimation of the consumption allocated to tractors for timber extraction for 2006 and 2007 has caused a reallocation of the consumption of gas oil in forestry and farm tractors, whose consumption is calculated by discounting the proportions allocated to forestry tractors from the total tractor consumption, estimated based on factors of energy effort and requirements.

This revision of the gas oil consumed by farm tractors (category 1.A.4.c.ii) also revealed an error in the quantity discounted for 2007 with regard to the consumption of tractors in forestry work. This error had a very slight repercussion on the figure for the total consumption allocated to tractors (modification of less than 0.1% of consumption).

1.B.2.a Fugitive emissions: Oil products

Pollutants affected: Main pollutants (NMVOC, SO_X).

Activity data:

For the first time, in this edition of the inventory, emissions from drilling activities carried out on hydrocarbon drilling and exploration platforms have been computed (in category 1.B.2.a.i Exploration, production and transport). In the present edition, the emissions of NMVOC due to leakage, venting or incineration in flares on drilling and/or exploration platforms have been estimated based on the methane factor proposed by default in the 2000 IPCC Good Practice Guidance, and from speciation of the volatile organic compounds emitted. As the methodological reference does not specify a differentiating factor by type of emission (leakage, venting, incineration) and there is no distinction available with regards the number of wells per fuel (crude, gas, combined), it was decided to collect the total estimated emissions in all the different categories into category 1B2ai.

The activity data (quantity of crude processed) with reference to marine platforms (category 1.B.2.a.i Exploration, production and transport) for 2007 has been revised in order to incorporate the correction made by a refinery regarding the

figures for treated crude which had been consigned by the plant in the questionnaire corresponding to the past edition of the inventory. As a result of this update, NMVOC emissions for that year have also been revised.

The activity data applied in the determination of emissions due to the distribution, handling and storage of petroleum products (category 1.B.2.a.v Distribution of petroleum products) for 2007 have also been revised. The availability of updated information regarding the activity variable in question (fuel sales) for liquid petroleum gases and kerosene represented a modification in NMVOC emissions for that year.

Emission factors:

The NMVOC emission factor corresponding to the production of crude oil (category 1.B.2.a.i) has been modified. The factor applied in the present edition, which replaces the emission factor in the CORINAIR Manual, is derived from the methane factor proposed in the 2000 IPCC Good Practice Guidance and from speciation of the organic compounds emitted.

The emission factors for SO_X due to coke calcination (category 1.B.2.a.iv Refining /storage) have been revised for 1990-1993. The previous emission factor applied for this period has been replaced with the implicit emission factor corresponding to 2004, obtained from the estimation, based on mass balance, declared by the plant in the questionnaire for the National Inventory.

1.B.2.b Fugitive emissions: Natural gas

Pollutants affected: Main pollutants (NMVOC).

Activity data:

The historic series of natural gas losses in the distribution system has been revised. In the present edition, the estimations for the period 1990-2007 regarding the volume leaked, calculated from loss factors by pipeline length, according to the material of the pipeline and the work pressure, has been modified after revision of one of these factors, motivated by reports presented by the industry association.

Emission factors:

The NMVOC emission factor corresponding to the production of natural gas has been modified. The factor applied in the present edition, which replaces the emission factor included in the CORINAIR manual, is derived from the methane factor proposed in the 2000 IPCC Good Practice Guidance and from a speciation of the organic compounds emitted.

1.B.2.c Fugitive emissions: Venting and flaring

Pollutants affected: Main pollutants (NO_X, CO, SO_X, NMVOC) and particulate matter.

Activity data:

For the first time, this present edition of the inventory includes a computation of the emissions generated in the regulation and measuring stations for the transport of natural gas. The natural gas losses in this facility, which are a source of NMVOC, have been estimated for all the years in the period 1990-2007, leading to an increase in NMVOC emissions for this category of between 0.5% (2007) and 11.1% (2007) with regard to the estimation in the previous edition.

For petroleum flares, the activity data (quantity of crude processed) for 2007 has been revised due to the incorporation of a correction made by a refinery regarding the figures for treated crude which had been consigned by the plant in the questionnaire corresponding to the past edition of the inventory.

Similarly for gas flares, the management company of a regasification plant has corrected the figure declared in the last edition for 2007 corresponding to the volume incinerated in the flares in the facilities.

2.B.2 Nitric acid

Pollutants affected: Main pollutants (NO_X and NH_3).

Emission factors:

The new calculations in this activity have been motivated by the revision of the estimations of the emissions of NO_X and NH_3 based on measurements of pollutants and the emissions control techniques implemented, according to the information provided in the questionnaire by the plants currently manufacturing nitric acid.

2.B.5 Chemical Industry. Others

Pollutants affected: Main pollutants (NMVOC) Cd and particulate matter.

Activity data:

The production of phosphate fertilisers has been updated for the years in the period 2003-2007, in accordance with the new information available in the "Chemical Engineering Yearbook".

The production of propylene in for 1991, 1992 and 1996 has been revised after detecting the input of erroneous data into the database.

The production of low and high density polythene (2007), synthetic rubbers (2003, 2004, 2005 and 2007) and ethyl benzene (2000-2007) has been revised in accordance with the information provided by the primary company in the organic chemistry sector.

The production of styrene butadiene latex has been updated for the years in the period 2003-2007, in accordance with the new information available in the "Chemical Engineering Yearbook".

2.C.1 Iron and steel production

Pollutants concerned: Other.

Emission factors:

The CO emission factor for steelworks gas burnt in the flares at an integrated iron and steel plant has been revised for the entire period 1990-2007, following the detection of the incorrect inclusion of this factor on the database.

2.D.1 Paper pulp production

Pollutants concerned: Main pollutants (NMVOC).

Activity data:

The production of paper pulp in 2007 was revised at one plant, following the detection of an error in the datum included in the previous edition of the inventory.

2.D.2 Food and beverages

Pollutants concerned: Main pollutants (NMVOC).

Activity data:

The data for 2007 corresponding to wine production have been updated in accordance with the new information available for this year in the MARM's "Statistical Yearbook".

3.A.2 Other industrial paint applications

Pollutants concerned: Main pollutants (NMVOC).

Activity data:

The data for 2007 corresponding to the NMVOC balance have been updated for a vehicle manufacturing plant as a result of the revised information furnished by the plant itself through a questionnaire.

3.C Chemical products manufacture and processing

Pollutants concerned: Main pollutants (NMVOC).

Activity data:

The activity variable for 2007 (number of employees) has been revised in the manufacture of pharmaceutical products as more up-to-date information has been available for this year.

3.D.2 Domestic use of solvents

Pollutants concerned: Main pollutants (NMVOC).

Activity data:

The activity variable corresponding to the activity of glue and adhesive applications has been revised for the years 2000-2007, as more up-to-date basic information has been available.

3.D.3 Other product use

Pollutants concerned: Main pollutants (NMVOC).

Activity data:

The data for 2007 corresponding to the NMVOC balance have been updated for a vehicle manufacturing plant as a result of the revised information furnished by the plant itself through a questionnaire. This has affected the activity of vehicle underseal treatments carried out at that plant.

4.B Manure Management

Pollutants concerned: NH_3 and particulate matter.

Activity data:

In the present edition of the inventory, the modifications made have been as follows: the revision of the entire series of equine animals (horses, mules and asses), in the light of the new information available; the updating of the milk production data for dairy cattle in 2007; the modification in the number of sheep for 1990, 1992, 1995 and 2004-2006, in accordance with new information available in the MARM's "Statistical Yearbook".

Emission factors:

The differences between the two editions in NH_3 emissions are mainly due to the updating of the emission estimation methodology (excretions of nitrogen, manure management systems, etc.) for swine and poultry (hens and fattening chickens).

In the case of particulate emissions, the differences come from the updating of the emission factors to the new methodology in the 2009 EMEP/EEA Guidebook.

4.D Agricultural soils

Pollutants concerned: NO_X and NH_3.

Activity data:

The first recalculation has to do with excreted nitrogen and, therefore, with the nitrogen values applied in the "Organic Fertilizers" and "Animal Production" activities. The differences between both editions are mainly due to the updating of the emission estimation methodology for swine and poultry (hens and fattening

chickens). This methodology implies a major change in both excreted nitrogen and the management systems used for these species.

Others amendments made to manure nitrogen in the present edition are: the revision of the entire series of equine animals (horses, mules and asses), in the light of the new information available; and the modification in the number of sheep for 1990, 1992, 1995 and 2004-2006, in accordance with new information available in the MARM's "Statistical Yearbook".

Furthermore, the information on the consumption of mineral fertilizers has been updated for the years 1999-2000 and 2003-2007, using new data available in the MARM's "Statistical Yearbook". Finally, the amounts of compost applied in agriculture were revised for 2006 in accordance with newly available information.

4.F Burning of agricultural waste

Pollutants concerned: Main pollutants (NO_X, NMVOC, SO_X, NH_3, CO), heavy metals, particulate matter and POP.

Activity data:

The data on surface areas and crop yields have been updated for 2007, in the light of the newly information available in the MARM's "Statistical Yearbook".

6.A Solid waste disposal in landfills

Pollutants concerned: Main pollutants (NO_X, CO) and heavy metals

Activity data:

Information on biogas capture (with and without energy recovery) has been obtained from a landfill in the present edition of the inventory for the period 2001-2008. In addition, new calculations have also been effected for all those landfills for which an update version of the activity variables or other parameters used in the emission estimation algorithm was available, as the provisional or merely projected values of the emissions in the previous edition have been updated in the original sources.

Emission factors:

Degradable organic carbon (DOC) has been updated for waste streams other than direct kerbside collection. The values used for the DOC parameter are those shown in the questionnaires and, by default, after examining the waste type composition for all the individualized landfills, specific values proposed by the inventory working party have been obtained based on Tables 2.4 and 2.5 in chapter 2 of the IPCC 2006 Guidelines: i) compost plant refuse (0.2), ii) wastewater sludge (0.175) and iii) others (0.04).

6.C Waste Incineration

Pollutants concerned: Main pollutants (NO_X, NMVOC, SO_X, NH_3 and CO), heavy metals, particulate matter, DIOX and PAH.

Activity data:

The information on the incineration of corpses corresponding to the period 2004-2006 has been updated.

6.D Other waste

Pollutants concerned: Main pollutants (NH_3)

Activity data:

Updates have been applied to the amount of waste used in aerobic composting for the period 1994-2003 as previous editions had not discounted rejects from the amount of waste intended for the composting process at three facilities and had not included the plant fraction for some facilities in 2005 and 2006. A revision has also been carried out on the 2007 data in accordance with the publication entitled "The Environment in Spain".

11.2.- Comparison of results (1990-2007) between the 2009 and 2010 editions

This section presents the comparative analysis of the results obtained for the period 1990-2007 in this current edition of inventories (2010) with homologous results for the same period in the previous edition (2009).

Comparisons are carried out first for aggregated emissions of each substance analyzed, subsequently specifying the contribution to the difference according to category breakdown. Absolute and relative differences are based on the figures published in the last edition, assumed to be the most representative. Thus, differences are negative when figures for the last edition exceed those of the previous one, and vice versa.

On the other hand, it is worth noting that NMVOC emissions from foliar biomass in agricultural crops are not included. The reason for not including the said emissions is their non-anthropogenic nature.

The summary presentation by type of pollutant is supported by a series of graphs, Figures 11.2.1 to 11.2.13 and Tables 11.2.1 to 11.2.13. The graphs show the comparative evolution, in terms of absolute emission values, of the results of both editions whereas the tables show the differences with a breakdown by groups (value in the 2008 edition minus the value in the 2009 edition)[5]. The absolute emissions data are expressed in the units indicated in the corresponding Table or Figure for the pollutant in question.

[5] Blank cells in Tables 11.2.1 to 11.2.13 mean that there is no difference in the emissions estimations between both inventory editions.

Table 11.2.1.- NO_X differences in tonnes

Year	NFR Category									
	1.A.1	1.A.2	1.A.3	1.A.4	1.B	2	3	4	6	Total
1990	428	-8,393	-98,896	-153	0	326		930		**-105,758**
1991	702	-6,403	-103,055	-163	-0	2,438		911		**-105,569**
1992	577	-3,811	-109,091	-223	0	2,000		932		**-109,615**
1993	479	-1,744	-102,110	-130	0	1,729		904		**-100,872**
1994	110	-1,589	-81,834	-50	0	1,930		1,010		**-80,423**
1995	214	2,640	-45,309	-118	0	2,392		1,071	-0	**-39,110**
1996	635	5,458	-32,714	-76	0	2,202		1,105	-0	**-23,389**
1997	363	11,184	-8,578	28	0	2,568		1,192	-0	**6,757**
1998	305	16,579	15,254	150	-0	2,158		1,190	0	**35,635**
1999	203	22,901	30,085	326	-0	2,476		1,144	-0	**57,134**
2000	202	32,428	18,594	1,002	-0	2,632		1,139	0	**55,998**
2001	392	37,846	26,995	1,244	0	2,054		1,141	-1	**69,670**
2002	531	41,362	31,542	1,954		2,530		1,144	-1	**79,063**
2003	806	52,553	29,911	2,217	0	2,693		1,207	1	**89,387**
2004	390	57,753	8,027	2,925	0	2,327		1,334	3	**72,759**
2005	543	71,181	1,809	3,630	0	2,741		1,307	5	**81,215**
2006	443	62,548	-7,962	4,604	0	2,533		1,300	4	**63,471**
2007	197	64,799	-7,773	5,228	17	2,142		981	3	**65,594**

Table 11.2.2.- NMVOC differences in tonnes

Year	NFR Category									
	1.A.1	1.A.2	1.A.3	1.A.4	1.B	2	3	4	6	Total
1990	-125	190	58,603	-0	67	0				**58,735**
1991	-203	316	61,093	-0	115	120				**61,440**
1992	-167	503	60,648	-3	261	137				**61,379**
1993	-140	676	54,674	2	341	0				**55,553**
1994	-36	771	65,074	12	344	0				**66,165**
1995	-67	1,358	54,320	17	368	-0				**55,996**
1996	-187	1,649	54,929	26	379	-0				**56,796**
1997	-111	2,268	55,686	48	336	0				**58,227**
1998	-91	2,985	55,490	67	485	0				**58,937**
1999	-63	3,802	57,092	111	501	0				**61,443**
2000	-64	4,936	59,012	118	532	62	2,726			**67,321**
2001	5	5,593	58,669	171	571	123	-1,027			**64,106**
2002	-1	6,025	89,154	217	572	196	2,891			**99,054**
2003	-1	7,359	94,502	268	584	234	4,300			**107,246**
2004	-10	8,000	88,002	355	540	194	1,961			**99,041**
2005	42	8,815	93,537	445	499	189	1,632		0	**105,159**
2006	47	8,519	89,647	219	408	181	1,312		0	**100,334**
2007	4	9,270	84,080	856	204	430	1,008	-1,244	0	**94,609**

Table 11.2.3.- SO_X differences in tonnes

Year	NFR Category									
	1.A.1	**1.A.2**	**1.A.3**	**1.A.4**	**1.B**	**2**	**3**	**4**	**6**	**Total**
1990	0	-2,298	-7,993	2	-152	0				**-10,441**
1991	-0	-2,145	-7,997	2	-121	-0				**-10,261**
1992	-0	-1,914	-7,992	-0	-107	0				**-10,013**
1993	0	-1,780	-8,975	94	-135	0				**-10,795**
1994	0	-2,065	-9,981	140	0	0				**-11,906**
1995	-0	-2,173	-8,143	171	0	0				**-10,145**
1996	0	-2,129	-7,985	38	0	0				**-10,077**
1997	0	-1,211	-5,979	-1	0	0				**-7,192**
1998	0	-1,352	-5,526	-3	-0	0				**-6,881**
1999	-1	-1,522	-7,156	4	-0	-0				**-8,674**
2000	-1	-1,871	-7,709	2,344	0	0				**-7,237**
2001	-2	-2,397	-9,430	541	0	-0				**-11,288**
2002	-3	-2,142	-10,302	1,788	-0	-0				**-10,658**
2003	-3	-1,875	-10,665	883	0	0				**-11,660**
2004	-4	-1,798	-10,850	749	-0	0				**-11,902**
2005	-4	1,916	-11,405	1,997	0	0			0	**-7,496**
2006	-4	-1,197	-12,552	3,250	-0	-0			0	**-10,503**
2007	95	-1,986	-14,820	772	16	-1		-95	0	**-16,018**

Table 11.2.4.- NH_3 differences in tonnes

Year	NFR Category									
	1.A.1	**1.A.2**	**1.A.3**	**1.A.4**	**1.B**	**2**	**3**	**4**	**6**	**Total**
1990			48		0	0		24,005		**24,054**
1991			87		0	0		23,132		**23,219**
1992			136		0	0		23,915		**24,051**
1993			354			0		22,659		**23,013**
1994			273		0	0		26,787	31	**27,091**
1995			157		0	0		29,308	109	**29,574**
1996			-23			0		30,580	117	**30,674**
1997		0	-219		0	0		33,639	121	**33,541**
1998		0	-561		0	0		33,255	127	**32,820**
1999		0	-925		0	0		31,658	132	**30,866**
2000		0	-779		0	0		31,808	136	**31,165**
2001		0	-414			0		31,702	146	**31,434**
2002		0	-979		0	0		31,875	146	**31,042**
2003		-0	-298			0		31,855	36	**31,593**
2004		-0	288		0	0		37,026	0	**37,314**
2005		-1	993	0		0		37,621	-180	**38,433**
2006		-1	1,690	-0		0		38,096	-71	**39,714**
2007		-1	1,972	-0		0		35,167	44	**37,182**

Table 11.2.5.- CO differences in tonnes

Year	NFR Category								
	1.A.1	1.A.2	1.A.3	1.A.4	1.B	2	3	4	6	**Total**
1990	-480	-9,361	233,899	-16	-0	15				**224,058**
1991	-781	-9,309	253,897	-18	-0	5				**243,794**
1992	-644	-8,903	274,853	-50	-0	3				**265,259**
1993	-537	-9,002	266,508	-22	-0	3			0	**256,950**
1994	-137	-10,332	358,760	-55		12			-0	**348,249**
1995	-264	-12,742	320,960	-93	0	10			-0	**307,870**
1996	-732	-13,469	410,101	-118	-0	19			-0	**395,801**
1997	-441	-15,705	413,118	-201	0	28			-0	**396,799**
1998	-362	-18,141	445,475	-262	0	31			0	**426,742**
1999	-273	-21,357	315,181	-433	-0	27			-1	**293,143**
2000	-278	-25,068	332,135	-385	-0	22			8	**306,432**
2001	-22	-27,816	378,223	-559		32			-25	**349,833**
2002	-60	-29,528	384,906	-681	0	19			-21	**354,636**
2003	-43	-35,550	408,722	-1,000	0	21			12	**372,163**
2004	-170	-39,348	415,788	-1,199	0	3			48	**375,122**
2005	-165	-36,260	460,336	-1,557	0	15			83	**422,451**
2006	-120	-44,312	462,728	-2,486		12			76	**415,898**
2007	-33	-54,333	509,911	-1,546	3	14		-8,870	49	**445,194**

Table 11.2.6.- $PM_{2.5}$ differences in tonnes

Year	NFR Category								
	1.A.1	1.A.2	1.A.3	1.A.4	1.B	2	3	4	6	**Total**
2000	-3	75	5,412	53	0	0		-947	0	**4,590**
2001	-5	-33	6,165	-0	0	-0		-1,011	-1	**5,115**
2002	-6	-105	7,197	24	0	-0		-1,016	-0	**6,093**
2003	-4	-360	7,669	3	0	0		-1,045	0	**6,264**
2004	-6	-798	8,851	-1	-0	-0		-1,026	1	**7,020**
2005	-3	-1,221	8,942	104	0	0		-989	2	**6,835**
2006	-2	-1,405	8,413	194	0	-1		-976	2	**6,227**
2007	5	-1,432	8,377	-18	0	-0		-1,046	2	**5,887**

Table 11.2.7.- PM_{10} differences in tonnes

Year	NFR Category								
	1.A.1	1.A.2	1.A.3	1.A.4	1.B	2	3	4	6	**Total**
2000	-3	-96	5,437	67		-0		-2,726	0	**2,678**
2001	-5	-206	6,164	-0	0	-0		-2,948	-1	**3,003**
2002	-6	-229	7,217	30	0	-0		-2,901	-0	**4,110**
2003	-4	-519	7,674	4	0	1		-2,956	0	**4,201**
2004	-5	-897	9,088	-1	-0	-0		-2,883	1	**5,302**
2005	-3	-1,229	9,192	130		0		-2,713	2	**5,379**
2006	-2	-1,526	8,597	246	-0	-1		-2,681	2	**4,635**
2007	6	-1,644	8,725	-18	0	-0		-2,976	2	**4,094**

Table 11.2.8.- TSP differences in tonnes

Year	NFR Category								
	1.A.1	1.A.2	1.A.3	1.A.4	1.B	2	3	4	6	Total
2000	-3	-154	5,442	80		-0		10,695	0	**16,060**
2001	-5	-237	6,136	-0	0	-0		11,044	-1	**16,937**
2002	-6	-265	7,197	36	0	0		10,944	-0	**17,906**
2003	-4	-555	7,636	6	0	1		10,837	0	**17,920**
2004	-5	-966	9,257	-1	-0	-0		12,376	1	**20,660**
2005	-3	-1,236	9,363	155		0		12,492	2	**20,774**
2006	-2	-1,557	8,708	297	-0	-1		12,187	2	**19,634**
2007	7	-2,893	8,961	-18	0	-0		11,638	2	**17,696**

Table 11.2.9.- Pb differences in kilogrammes

Year	NFR Category									
	1.A.1	1.A.2	1.A.3	1.A.4	1.B	2	3	4	6	Total
1990	0	-1,857	-0	-0		-0				**-1,857**
1991	0	-1,636	0	-0		-0				**-1,636**
1992	0	-1,362	-0	0		-0				**-1,362**
1993	0	-1,162	0	0		-0				**-1,162**
1994	0	-1,215	0	-0		0				**-1,215**
1995	-0	-1,191	-0	-0		0				**-1,191**
1996	0	-1,005	0	-0		0				**-1,004**
1997	-1	-940	-0	0		-0				**-940**
1998	0	-862	0	0		0				**-862**
1999	0	-709	0	-0		0				**-709**
2000	0	-584	-0	34		0				**-550**
2001	1	-539	0			-0				**-538**
2002	-3	-528	0	15		0				**-516**
2003	-3	-455	8	3		0				**-447**
2004	-3	-431	-210	-1		0				**-645**
2005	-1	2	2	64						**67**
2006	-4	-387	-0	128					0	**-262**
2007	-0	1,250	-56	-3					0	**1,191**

Table 11.2.10.- Cd differences in kilogrammes

Year	NFR Category								
	1.A.1	1.A.2	1.A.3	1.A.4	1.B	2	3	4	6	Total
1990	0	-1,857	-17	-0		0				**-1,874**
1991	0	-1,636	-18	-0		0				**-1,654**
1992	0	-1,362	-19	-0		-0				**-1,381**
1993	-0	-1,162	-19	0		0				**-1,180**
1994	-0	-1,216	-21	0		-0				**-1,237**
1995	-0	-1,191	-22	-0		0				**-1,214**
1996	-0	-1,005	-26	-0		-0				**-1,031**
1997	0	-939	-25	-0		-0				**-965**
1998	-0	-862	-29	0		0			0	**-891**
1999	-0	-709	-32	0		0				**-740**
2000	-0	-584	-31	17		0				**-599**
2001	-1	-539	-34	0		-0				**-574**
2002	-3	-528	-34	7		-0				**-557**
2003	-3	-455	-36	1		0				**-493**
2004	-3	-431	-32	-0		-0			-0	**-467**
2005	-1	-1	-32	32		0				**-2**
2006	-3	-388	-36	64		-0			0	**-363**
2007	-2	2,265	-35	-1		0			0	**2,227**

Table 11.2.11.- Hg differences in kilogrammes

Year	NFR Category								
	1.A.1	1.A.2	1.A.3	1.A.4	1.B	2	3	4	6	Total
1990	-0	-139		-0		0				**-139**
1991	-0	-111		0		-0				**-111**
1992	-0	-118		-0		-0				**-118**
1993	-0	-94		0		0				**-94**
1994	-0	-107		-0		-0				**-107**
1995	0	-115		-0		-0				**-115**
1996	-0	-113		0		-0				**-113**
1997	-0	-96		-0		-0				**-96**
1998	-0	-131		0		-0				**-132**
1999	-0	-109		-0		0				**-109**
2000	0	-112		6		-0				**-106**
2001	-0	-114		-0		-0			0	**-114**
2002	-4	-117		3		-0				**-119**
2003	-4	-91		0		-0			0	**-95**
2004	-5	-123		-0		0			-0	**-129**
2005	-9	0		11					0	**2**
2006	-5	-97		21					0	**-81**
2007	-4	346		-1					0	**341**

Table 11.2.12.- DIOX differences in g-I Teq

Year	NFR Category									
	1.A.1	1.A.2	1.A.3	1.A.4	1.B	2	3	4	6	Total
1990	-0.0	-0.0	-0.0	-0.0					-0.0	**-0.0**
1991	-0.0	-0.0	-0.0	-0.0					-0.0	**-0.0**
1992	-0.0	-0.0	-0.0	-0.0					-0.0	**-0.0**
1993	-0.0	-0.0	-0.0	-0.0					-0.0	**-0.0**
1994	-0.0	0.0	-0.0	-0.0					0.0	**-0.0**
1995	0.0	-0.0	0.0	-0.0					0.0	**0.0**
1996	-0.0	-0.0	0.0	-0.0					-0.0	**0.0**
1997	0.0	-0.0	0.1	-0.0					0.0	**0.1**
1998	-0.0	-0.0	0.1	-0.0					-0.0	**0.1**
1999	-0.0	-0.0	0.2	-0.0					0.0	**0.2**
2000	0.0	-0.0	0.2	0.0					-0.0	**0.2**
2001	0.0	-0.0	0.2	-0.0					-0.0	**0.2**
2002	-0.0	-0.0	0.3	0.0					0.0	**0.3**
2003	-0.0	-0.0	0.3	0.0					-0.0	**0.3**
2004	-0.0	-0.0	0.3	-0.0					-0.0	**0.3**
2005	-0.0	0.0	0.3	0.1					0.0	**0.4**
2006	-0.0	0.0	0.3	0.1					0.0	**0.4**
2007	-0.0	-0.1	0.1	-0.0				-0.2	0.0	**-0.2**

Table 11.2.13.- PAH differences in kilogrammes

Year	NFR Category									
	1.A.1	1.A.2	1.A.3	1.A.4	1.B	2	3	4	6	Total
1990	0	-0	-3,994	0		163				**-3,831**
1991	-0	-0	-4,223			133				**-4,089**
1992	0	0	-4,595			110				**-4,486**
1993	0	-0	-4,529			110				**-4,420**
1994	-0	-0	-4,709	-0		151				**-4,558**
1995	-0	-0	-4,888			162				**-4,726**
1996	-0	0	-5,070			154				**-4,915**
1997	-0	0	-5,230			144				**-5,086**
1998	-0	2	-5,860			134				**-5,724**
1999	-0	1	-6,188			141				**-6,045**
2000	-0	2	-6,317			138				**-6,178**
2001	-0	1	-6,604			150				**-6,453**
2002	-0	1	-6,863			146				**-6,717**
2003	-0	-1	-7,363			139				**-7,226**
2004	-0	-5	-7,246			146				**-7,105**
2005	-0	-9	-7,619	0		147				**-7,481**
2006	-0	-10	-8,057	-0		149				**-7,918**
2007	1	-3,444	-8,321	-0		147		-3,301	0	**-14,917**

Figure 11.2.1 shows the evolution of aggregated NO_X emissions in the inventory. The review has entailed some modifications in percentage terms varying between 8.6% for 1990 and -6.0% in 2006. The difference between the two series in Figure 11.2.1 can be explained by two basic reasons:

1. The methodological revision of the NO_X factor in stationary natural gas engines, as already mentioned in heading 11.1.1.4

2. The review of the road transport sector affecting both the methodology applied (switch from Copert III to Copert IV) and the revision of the activity variables. The combined effect of these two changes has entailed a significant increase in emissions for the period 1990-1997, followed by a decline in subsequent years (except for 2006 and 2007).

Figure 11.2.2 illustrates the evolution of NMVOC emissions and, as can be seen in the diagram, shows a virtually uniform decrease throughout the period 1990-2007, with slightly larger variations in the most recent period, with percentage differences ranging between -5.3% and -10.6%. The difference between the two series in Figure 11.2.2 can be explained by two basic reasons:

1. The methodological revision of the NMVOC factor in stationary natural gas engines, as already mentioned in heading 11.1.1.4.

2. The review of the road transport sector affecting both the methodology applied (switch from Copert III to Copert IV) and the revision of the activity variables. Although these change partly offset each other, the overall result is a significant drop in NMVOC emissions throughout the period 1990-2007. This decline is largely concentrated in evaporative emissions of NMVOC (category 1A3Bv).

Total SOx emissions in Table 11.2.4 and Figure 11.2.4 show a small upward variation from the 2009 to 2010 edition with percentage changes in absolute terms lower than 1.4%.

Figure 11.2.4 compares the evolution of total NH_3 emissions and shows a general downward shift throughout the series from 1990-2007, with a slight gradual separation between the series in both editions, basically the result of the variation in the emissions for manure management and agricultural soils activities. In percentage terms, the drops in the inventory as a whole are between -6.9% and -9.5%.

The downward variations in total CO emissions (please see Figure 11.2.5 and Table 11.2.5), strongly marked by the significant fall shown in the historical series for road transport emissions, become wider in the course of the period inventoried, with the percentage difference ranging between -5.8% (1990) and -17.5% (1997).

The progress over time of the total emissions of particulate matter, in the three diameter grades (please see Figures 11.2.6 and 11.2.8 and Tables 11.2.7 and 11.2.8), is shown in a downward shift for all years in the inventory, with percentage variations in absolute values around 7% for TSP, 2.5% for PM_{10} and 4% for $PM_{2.5}$, essentially the result of the downward changes in emissions in road transport and the revision of the emission factors for manure management in farming activities.

For lead, cadmium and mercury (please see Figures 11.2.9, 11.2.10 and 11.2.11 and Tables 11.2.9, 11.2.10 and 11.2.11), it is possible to see a certain parallelism in the comparison of series in both editions of the inventory. The main source of the changes in emissions for the three metals mentioned is an update of the emission factors applied for

clinker furnaces in accordance with the revision made by the Best Available Technologies Reference Guide (BREF) for the cement sector. The difference in the amounts of the changes between the different metals is, in essence, the consequence of the weighting this activity has in the inventory as a whole.

As for dioxins (please see Figure 11.2.12 and Table 11.2.12), the differences in the emission figures estimated in the two editions of the inventory are practically negligible, with the absolute value of the percentage variation less than 0.1% for all the years in the period inventoried.

Finally, for PAH (please see Figure 11.2.13 and Table 11.2.13), an upward variation is shown for all the years in the period, mainly as a result of the review of the road transport emission series and, in the case of 2007, the joint effect of this review, the correction of an error in the emission factor applied to an aluminium plant and the revision of the activity variable in the farming sector corresponding to the burning of agricultural waste.

Figure 11.2.1.- Evolution of the difference in NO_x emissions

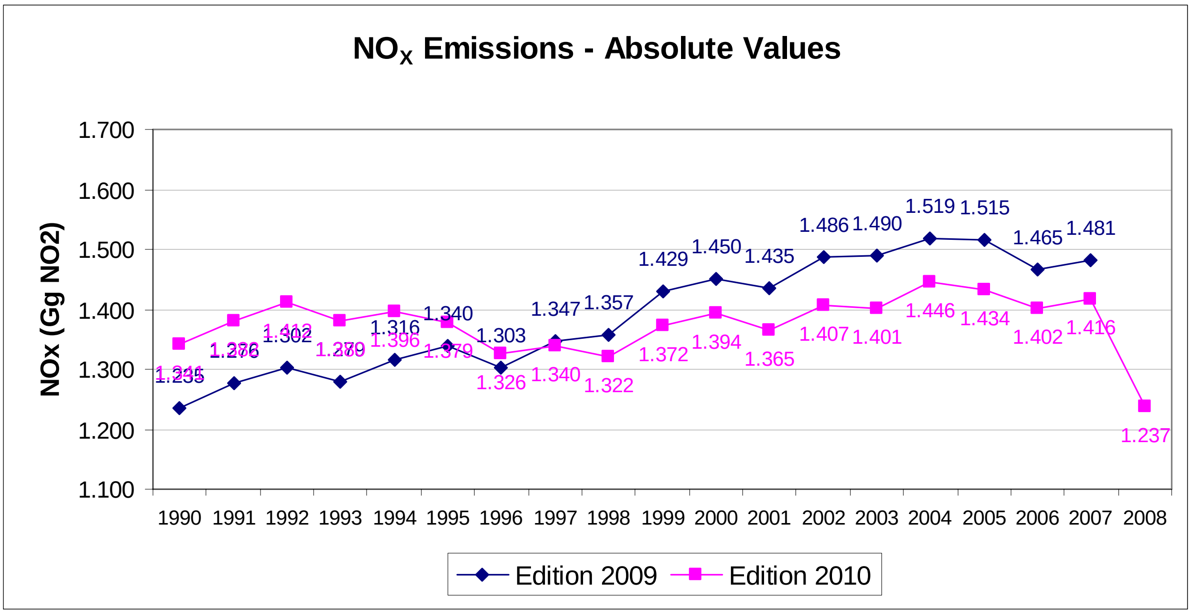


Figure 11.2.2.- Evolution of the difference in NMVOC emissions

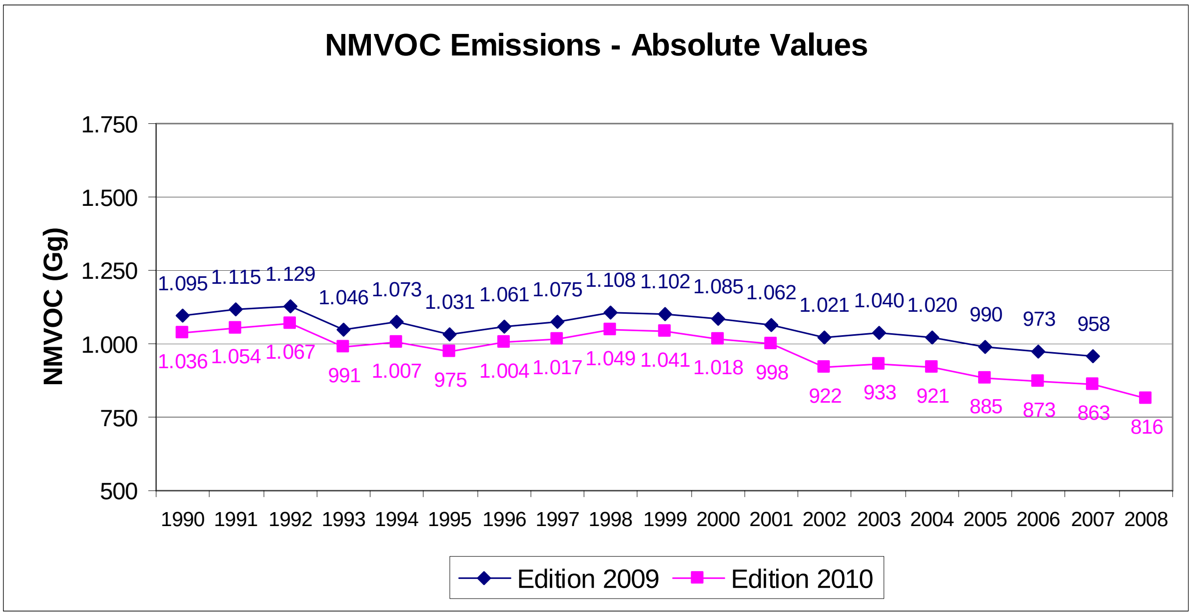


Figure 11.2.3.- Evolution of the difference in SO_X emissions

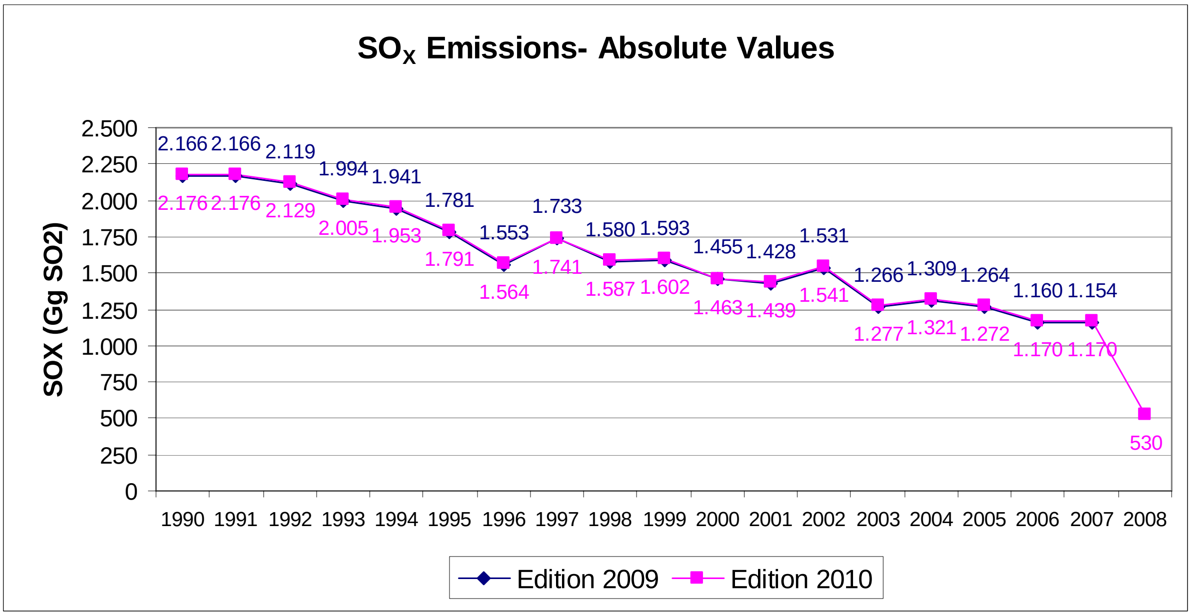


Figure 11.2.4.- Evolution of the difference in NH_3 emissions

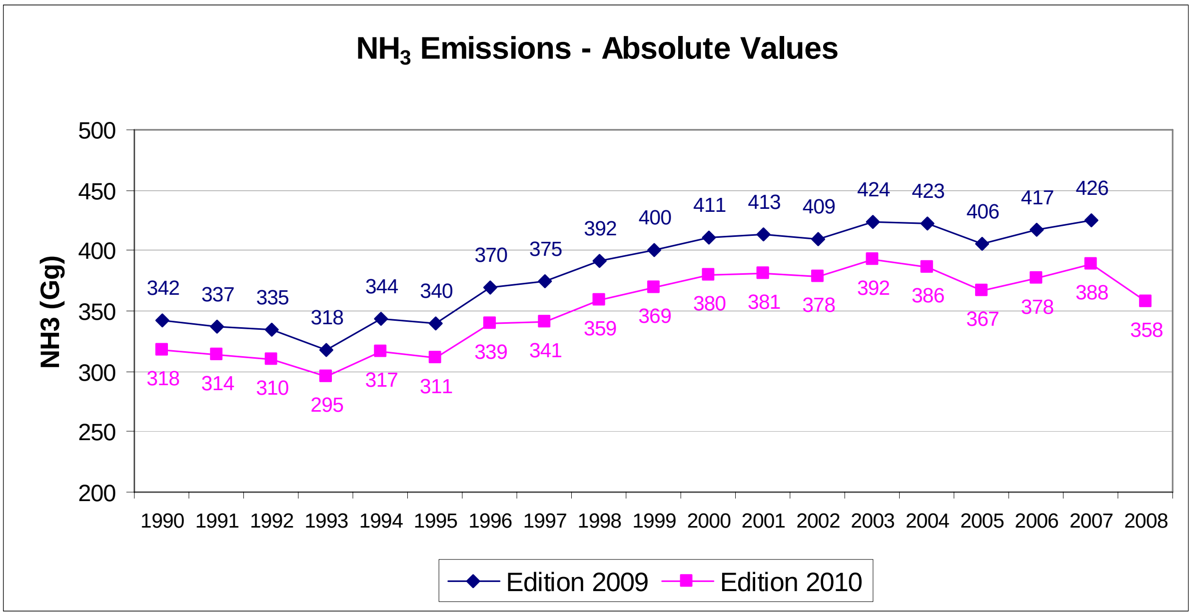


Figure 11.2.5.- Evolution of the difference in CO emissions

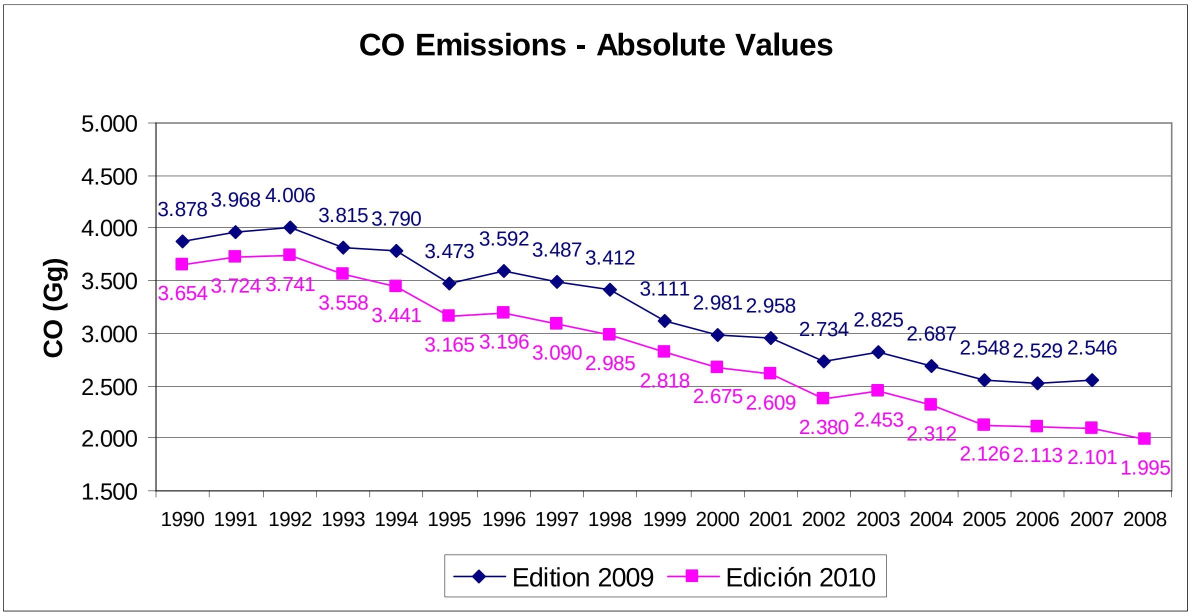


Figure 11.2.6.- Evolution of the difference in $PM_{2.5}$ emissions

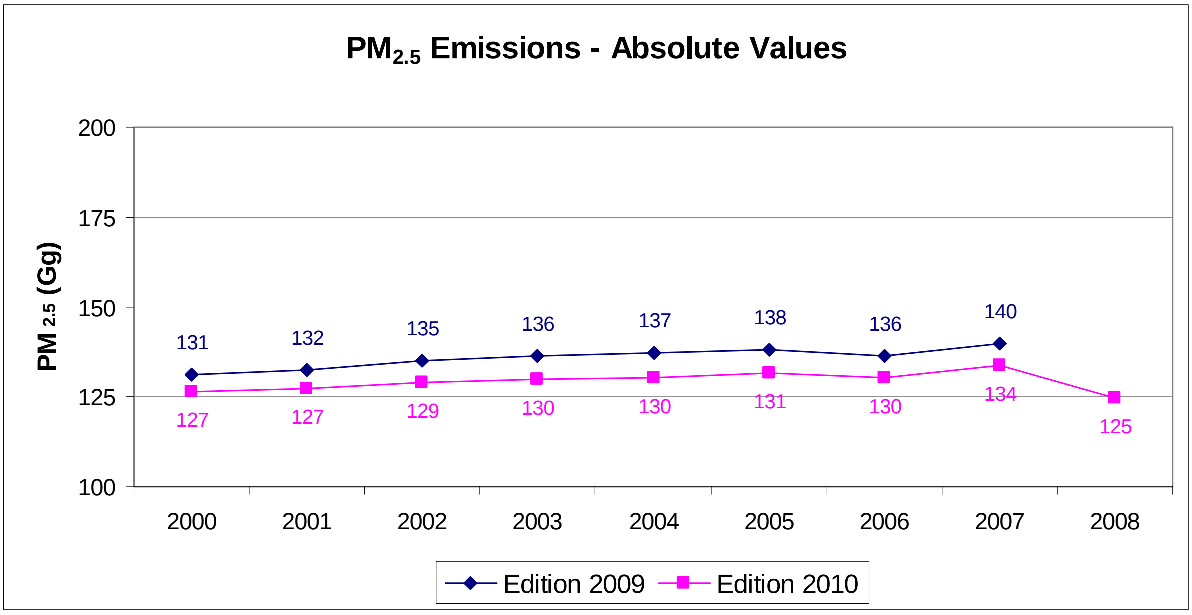


Figure 11.2.7.- Evolution of the difference in PM_{10} emissions

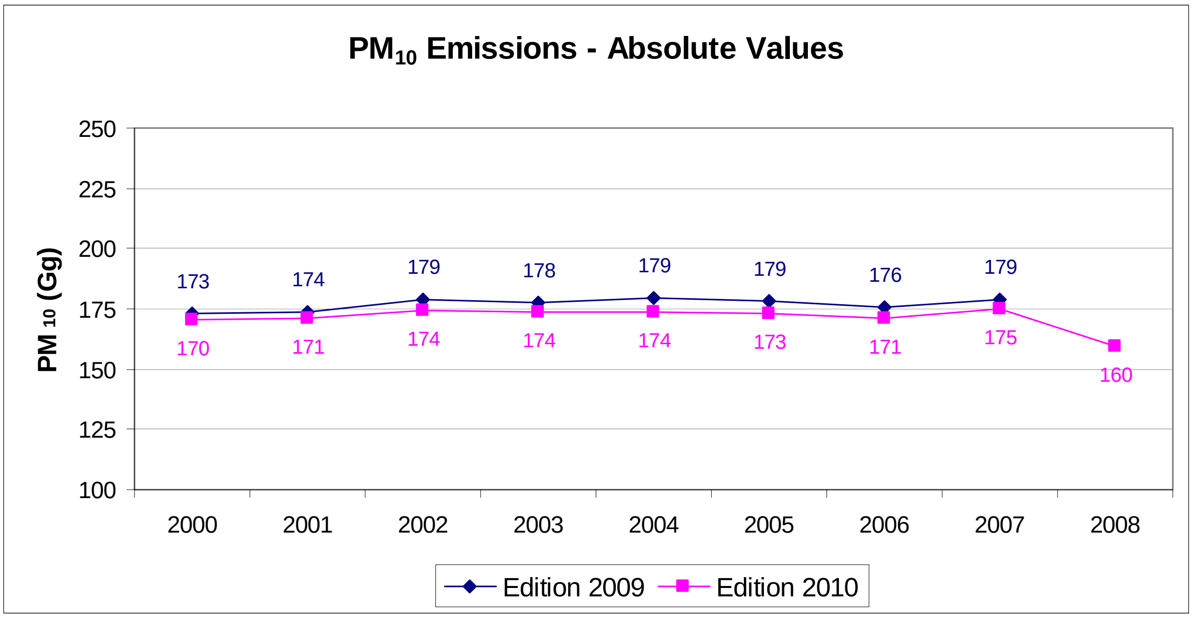


Figure 11.2.8.- Evolution of the difference in TSP emissions

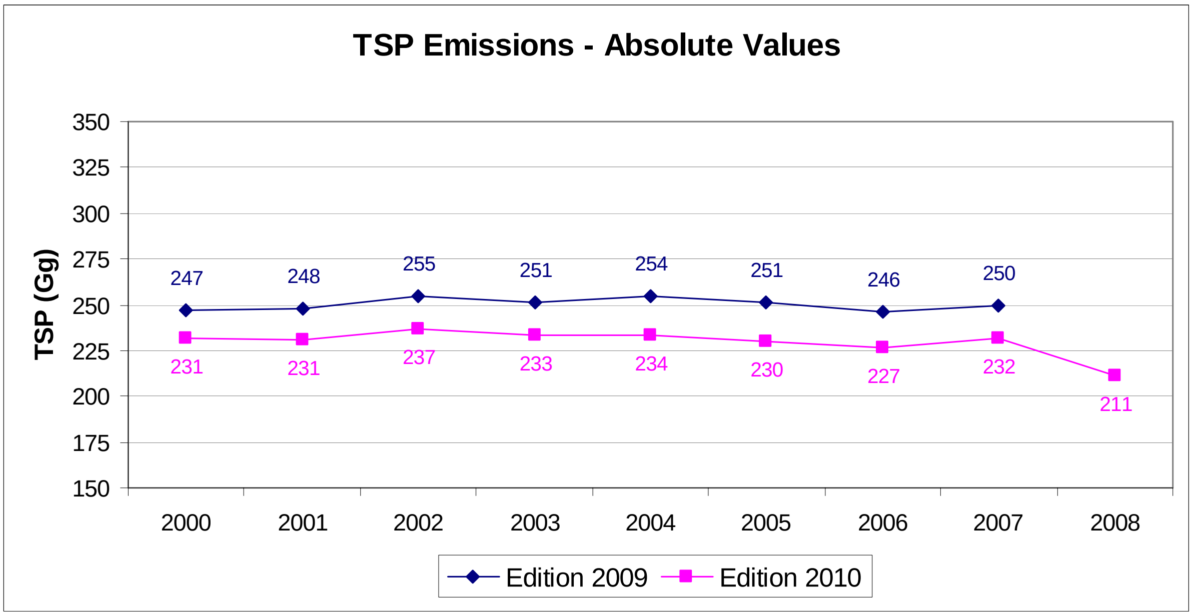


Figure 11.2.9.- Evolution of the difference in Pb emissions

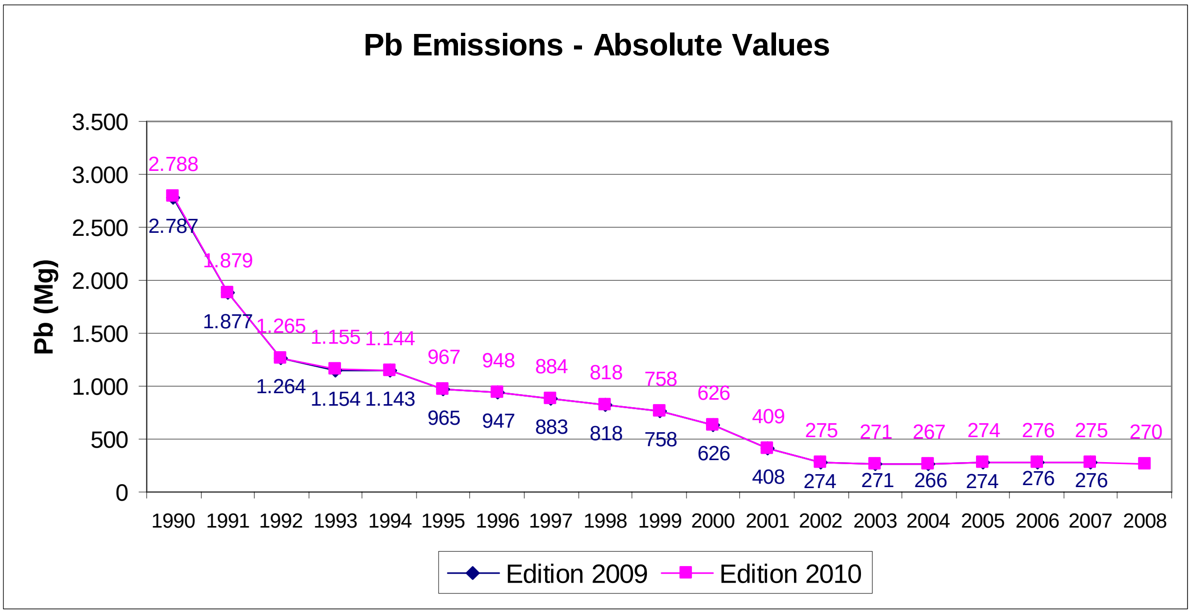


Figure 11.2.10.- Evolution of the difference in Cd emissions

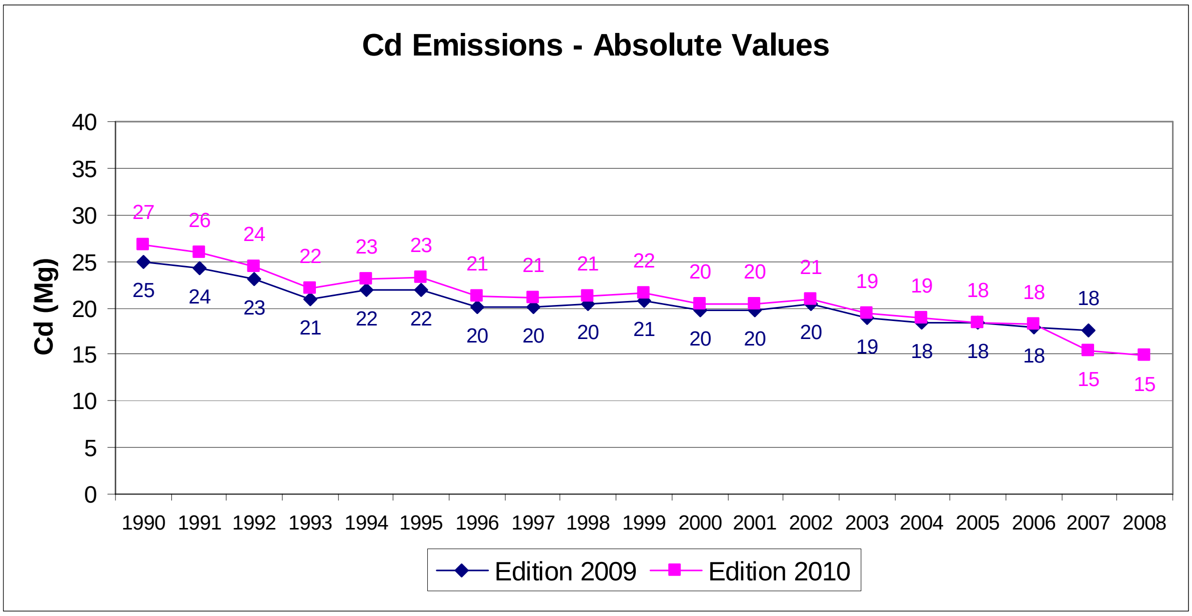


Figure 11.2.11.- Evolution of the difference in Hg emissions

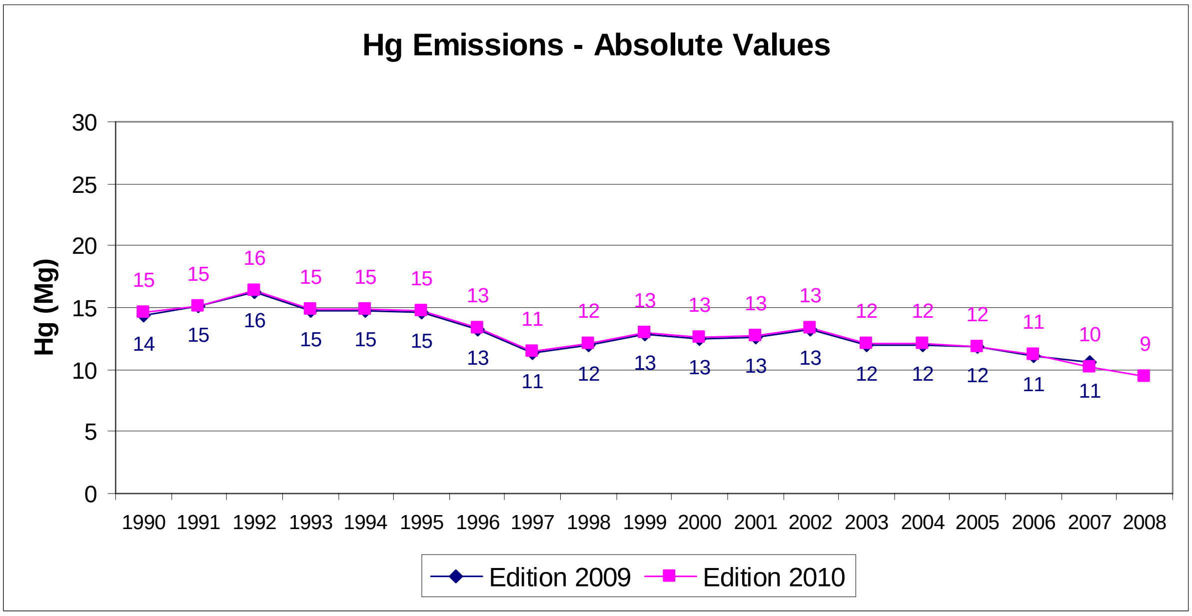


Figure 11.2.12.- Evolution of the difference in DIOX emissions

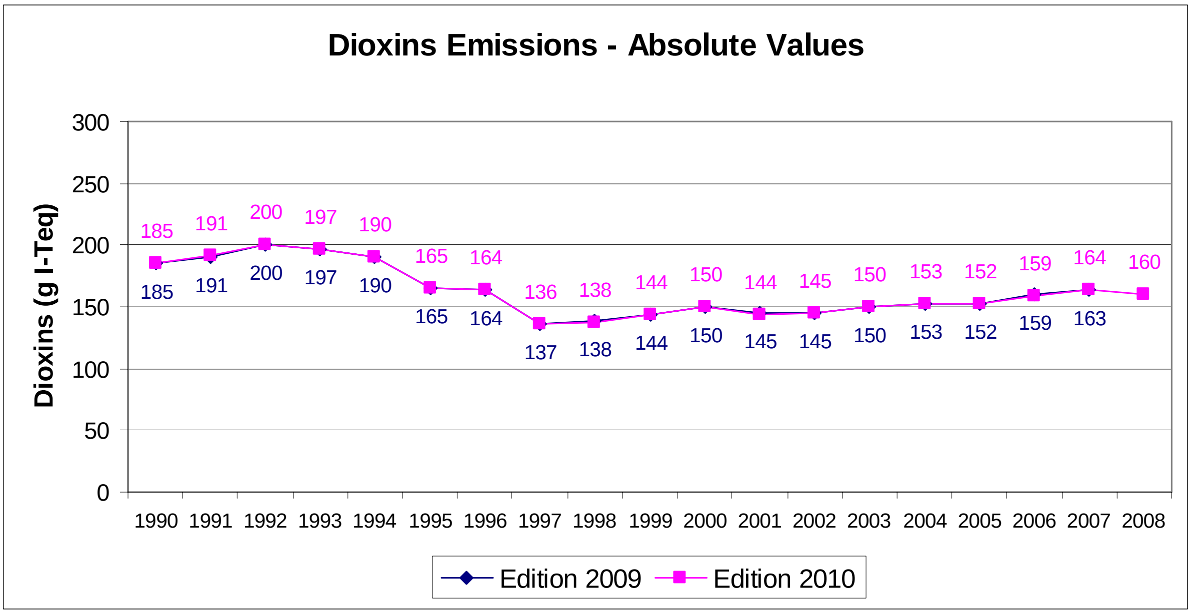
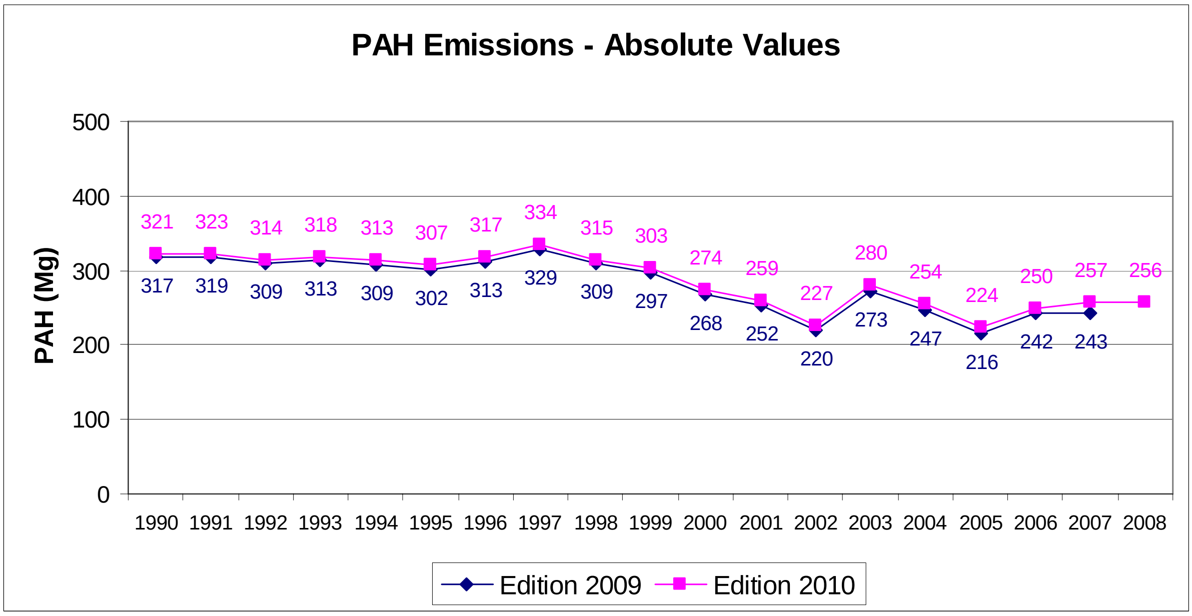


Figure 11.2.13.- Evolution of the difference in PAH emissions



11.3.- Improvement plans

Generically speaking, for the inventory as a whole, a number of horizontal actions are foreseen with a wide-ranging effect on the scope of the inventory, rather than a specific impact on certain activities. The following actions can be highlighted:

a) Harmonization of the Inventory with other emissions monitoring instruments.

Integration into the inventory of the basic information and the certified emissions of the facilities subject to the emission rights trading scheme.

b) Adaptation of the variation over time of certain emission factors (and associated activity variables) to the penetration of environmentally more efficient technologies.

c) Progression to more advanced emission estimation methodologies.

d) Quantitative estimation of uncertainty and improvements in the methodology for identifying key categories.

As for the analysis of uncertainty, it is planned to implement a quantitative diagnosis based on the Tier 1 approach, and then progress to a Tier 2 approach in the analysis of key categories, taking as the reference for both activities the 2009 EMEP/EEA Guidebook.

e) Systematic review of emission factors, as per the 2009 EMEP/EEA Guidebook.

This has already begun and the process is expected to be completed in the next two editions of the inventory for the review of the emission factors referenced from the EMEP/CORINAIR 2007 Handbook (or earlier versions) in the light of the new information provided in the 2009 EMEP/EEA Guidebook.

1.A.1.a Energy industries: Public electricity and heat production

Due to this sector's relevance, fuel characteristics will be more intensively monitored, mainly for those non-standard fuels that exhibit greater variations in terms of composition, so as to check more precisely for occasional outlying typical values at certain plants.

It is also planned to continue and extend, where appropriate, the individualized analysis of large landfills, especially the ones performing biogas recovery.

1.A.1.b Petroleum refineries

With a view to the future, emphasis will continue to be placed on the collection of information via questionnaires in order to improve the data about the characteristics of the fuels used and, as far as possible, the use of estimations based on continuous measurement so as to resort less and less to the use of default emission factors.

1.A.1.c Transformation of solid fuels and other energy industries

In this sector, the goal proposed is the compilation of individualized information for coke plants not located in integrated steel plants. In this line, it is planned to verify the aggregate information obtained from the inventory with the specific data on plants reporting certified CO_2 emissions within the emissions rights trading framework. Thus, information would be available at plant level for both the emissions produced in coke furnaces and also on the national coke and coke gas production with specifications for the characteristics of these fuels. Some actions have already been taken in this direction in the present edition of

the inventory, but it has not been possible to achieve a total effective result due to limitations on access to information on fuel consumptions and characteristics.

1.A.2 Manufacturing and construction industries

One horizontal action line for this group of categories involves the exploration of potential industrial sub-sectors carrying out captive lime production operations not investigated so far (sugar plants (category 1A2e), copper smelting (category 1A2b)); as these do not enter commercial circuits, they may be causing an under-estimation of the fuel consumed and the emissions associated with these activities.

For the entire category, with an implementation horizon in the medium to long term, it is hoped that the basic information on biomass consumption as well as standardization of its classes can be improved as this is relevant to determine the characteristics of heating values and emission factors.

1.A.2.a Manufacturing and construction industries: Iron and steel

An action line envisioned in the improvement plans aims at compiling plant-specific information in the cast iron industry since this activity is limited to a small number of plants in Spain and such data collection is presumably feasible and beneficial.

1.A.2.b Manufacturing and construction industries: Non-ferrous metals

Similarly to what the previous heading describes for category 1A2a, for this category it is planned to continue and improve access to individualized information per plant in certain non-ferrous metallurgical sectors where the number of plants is low and therefore there is a positive cost/benefit relationship for having information on a per plant basis (this includes secondary lead and secondary copper manufacturing activities, where individualized information is already available for some of the production plants).

1.A.2.f Manufacturing and construction industries: Other

For this category, it is planned to draw up a survey of the national fleet of mobile industrial machinery, with particular interest in those units operating in the construction, public works and mining sector, so as to allow an improved estimation of the consumption of fuels and associated emissions. This survey, to be conducted in future editions of the inventory in collaboration with Tragsa, a business group closely linked to the public administrations, aims at achieving a two-fold goal: i) characterization of the operating fleet of this kind of machinery having regard for qualities presumed to be relevant for emission levels (such as power, technology or age) and ii) assessment of the effective annual requirements for the activity.

1.A.3.a Civil aviation: International and domestic airport traffic

A collaboration project is currently under way among several national entities (the Directorate-General for Environmental Assessment and Quality, (DGCEA), the State Air Safety Agency (AESA) and the Airworthiness and Aeronautical Safety Studies and Services Company (SENASA)) as well as international organizations (EUROCONTROL) aimed at applying the existing methodology for air traffic and air traffic emissions model (MECETA

model). In the current phase of the project, the baseline information is being validated and the preliminary results obtained. The evaluation of the model is expected to be finalized in the course of 2010 and it will then be implemented for the estimation of consumptions and emissions in air traffic. These results are expected o be used for reporting with the new methodology in the next edition of the inventory.

1.A.3.b Road transport

Looking to the future, starting from the COPERT IV methodology already implemented in this edition of the inventory, it is proposed to advance in the following aspects: i) widening of the basic information for the estimation of the running fleet; and ii) widening of the basic information about the territorial breakdown of fuel consumption and the tallying of this consumption using the sales figures for territorial units: peninsula, Balearic and Canary Islands, Ceuta and Melilla.

1.A.3.d Navigation: International and domestic traffic

Due to the uncertainty currently associated with the consumption of fuels, gas-oil and residual oil, a collaboration project is currently being promoted by the General Directorate for Merchant Shipping, the State Ports Authority and the ANAVE association, to access and process the information corresponding to fuel consumption in national sea traffic and even on the maritime routes monitored. In the contacts held so far with the various bodies, the Directorate-General for the Merchant Navy has provided documentation about the data available in electronic format; this is being analyzed in order to develop a methodology allowing uncertainty to be reduced and the consistency of the series over time to be assured, thus resolving the limitations on the data, particularly in the early years of the period inventoried.

1.A.4.c Agriculture/Forestry/Fishing

For future editions of the inventory a review of the methodology will be carried out focussing particularly on mobile agricultural and forestry machinery (integrating information about energy requirement standards and other relevant parameters for the emissions estimation algorithms). This methodology considers the gradual renewal of the machinery and consequent introduction of technologies intended to limit emissions in this kind of machinery, in line with current legislation. This action line, undertaken in the last edition in collaboration with the Subdirectorate-General for Means of Production at the MARM, is currently in the process of verification and review of the present methodology with regard to an alternative methodology, essentially estimating consumption on the basis of a meticulous analysis of the activities of tractors engaged in agricultural work to determine the surface areas under cultivation and the yields obtained by type of crop.

1.B.1.b Fugitive emissions: Transformation of solid fuels

According to the improvement plans associated with combustion for this activity (category 1A1c) already mentioned above, the introduction of individualized plant-specific information for coke production plants not located in integrated steel plants will be considered. The declarations by these facilities, within the framework of the Emission Rights Trading Scheme, on certified CO_2 emissions and basic information for their determination are

presumed to enable a substantial improvement in the reliability of the national coke production data, the activity variable used for the manufacture of solid fuels, and in the accuracy of the estimates of steelwork gases in the inventory's fuel balance. The current edition of the inventory has undertaken actions aimed at compiling data through questionnaires, designed in collaboration with the Ministry of Industry, Trade and Tourism and sent out through the Regional Government authorities, on variables of interest covered in the directive regulating the declarations made by each plant for Emission Rights Trading. The response achieved in this first year has been irregular at the plant level and so, for the case of coke furnaces not located in iron and steel works, the partial information obtained so far has not allowed coke production to be estimated with data direct from the plants for these facilities as a whole nor verifications to be carried out on the aggregated data available and applied by the inventory.

1.B.2 Fugitive emissions: Oil and natural gas

The gas supply sector is, since July, 2008, a completely de-regulated market. In upcoming inventory editions, the list of new gas suppliers will be analyzed in greater depth as they access the gas market by requesting any information deemed relevant.

In addition, a process of methodological review is under way to improve the information on activities in the logistics for transporting and distributing petrol.

2.C.1 Iron and steel production

One action aimed at improving this sector is the proposed collection of individualized information for all electric steelworks. This would allow the verification of specific information with a much greater level of breakdown than currently available. This proposal has already been made to the Union of Iron and Steel Companies (UNESID).

3 Solvent and other product use

In this sector, a number of tasks are planned with the main business associations to undertake the review of the basic activity variables as well as the characterization of the processes and techniques applied for the use of solvents and their VOC contents. Among these actions, attention should be drawn to the planning for reviews of the methodologies and activity variables of the following activities:

- Domestic use of solvents (cleaning and cosmetic products)
- Paint application (on wood, other industrial applications in non-specific sectors and non-industrial application)
- Application of glues and adhesives.
- Polyester, polyurethane and polyvinylchloride processing

4 Agriculture

A large-scale global review of the methodology and the collection of the basic parameters is being carried out through two Working Groups:

i) Working Group on Livestock for the National Air Emissions Inventory (GT INV-GAN)

ii) Working Group on Agriculture for the National Air Emissions Inventory (GT INV-AG)

Both these groups comprise representatives from the Ministry of the Environment and Rural and Marine Affairs with the collaboration of experts in the field.

For animal husbandry activities, the forthcoming edition of the inventory will continue with the implementation of the improvements in husbandry species that have not been revised in the present edition of the inventory (which already included revisions for swine and poultry).

6.A Solid waste disposal in landfills

The work already carried out in previous editions of the inventory with respect to direct and individual data collection from landfills with biogas recovery will continue developing through questionnaires. This new base information will improve the verification of management parameters at individual landfills, as well as the estimations in the series for waste deposited in sanitary landfills. As a result of this work it is considered that there will be a significant improvement in the quality of the information and reliability of the corresponding emission estimations.

Accordingly, the collaboration process continues with the General Sub-Directorate of Sustainable Production and Consumption at the Ministry of the Environment, Rural and Marine Affairs, and a review process of the present data is currently under way through direct consultations with the persons with technical responsibility at the Regional Government level to improve the data about: the balance for the use and destination of the different types of waste, landfill procedures and management, and emerging waste treatments (composting, biomethanization, etc.).

6.C.e Incineration of sewage sludge from wastewater treatment plants

The priority action in this activity will focus on the review of the balance between generating and using the sludge from urban waste water treatment plants, verifying that the information is reported in homogeneous units of dry matter. The contacts foreseen for this improvement include the Directorate-General for Water at the MARM and representatives of the Regional Governments with which the UIAE maintains bilateral contacts on the disaggregation of the national inventory by region.

6.D Others

This category includes the sludge spreading activity. Both the activity variable, already mentioned in section 6.C.e above, and emission factors exhibit great uncertainty and are thus under analysis for improvement purposes.

The uses for sludge will also extend to the consideration of prior dewatering in its various mode: thermal, mechanical, traditional air-drying on the ground. This latter method is

the top priority for review in the next edition of the inventory, as it has major implications for NMVOC emissions.

Another activity in this category is biomethanization, an emerging practice in Spain for waste treatment and still of limited use as an alternative to deposits in large sanitary landfills. For the incorporation of this activity into the inventory, individualized questionnaires have begun to be distributed to these biomethanization plants. This information is expected to bring about a future improvement in the estimates of the emissions from this activity.