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INFORMATIVE INVENTORY REPORT 2011 FOR SLOVENIA

Submission under the UNECE Convention on Longe-range Transboundary Air Pollution

ENVIRONMENTAL AGENCY
OF THE REPUBLIC OF SLOVENIA

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1 Executive Summary

1.1 Background information on emission inventories

1.1.1 Annual report

This report is Slovenian's Annual Emissions Inventory Report (IIR). The report contains information on Slovenian's inventories for all years from the base years (1980 or 1990) of the protocols to 2009.
The gases reported under the LRTAP Convention are SO_2, NOX, NMVOC, CO, NH_3, TSP, PM10 and PM2.5, Pb, Cd, Hg, dioxins/furans (PCDD/DF), PAH, HCB PCB. The annual emission inventory for Slovenia is reported in the Nomenclature for Reporting (NFR) format as requested in the reporting guidelines. The issues addressed in this report are: trends in emissions, description of each NFR category, uncertainty estimates, recalculations, planned improvements and procedures for quality assurance and control. The structure of the report is, as far as possible, the same as the National Inventory Report to UNFCCC. This report and NFR tables are available to the public on the EIONET central data repository: http://cdr.eionet.europa.eu/si.

1.2 Responsible organization

The Environmental Research Agency (EARS), is responsible for the annual preparation and submission to the UNECE-LRTAP Convention of the Annual Slovenian Emissions Report and the inventories in the NFR format in accordance with the guidelines.
EARS participate in meetings under the UNECE Task Force on Emission Inventories and Projections and the related expert panels, where parties to the convention prepare the guidelines and methodologies on inventories.

1.3 Emission trends

1.3.1 Emission trends for main pollutants

The main part of the SO_2 emission originates from combustion of fossil fuels, i.e.mainly coal and oil, in public power and district heating plants. From 1980 to 2009, the total emission decreased by 95.1%. The large reduction is largely due to installation of desulphurisation plant and use of fuels with lower content of sulphur in public power and district heating plants. Despite the large reduction of the SO_2 emissions, these plants make up 56.9% of the total emission. Also emissions from industrial combustion plants and non-industrial combustion plants are important.
The largest sources of emissions of NO_X are transport followed by other mobile sources and combustion in energy industries (mainly public power and district heating plants). The transport sector is the sector contributing the most to the emission of NO_X in 2009, 53.7% of the Slovenian emissions of NO_X. The total emissions have decreased by 9.3% from 1990 to 2009.
Almost all atmospheric emissions of NH_3 result from agricultural activities. Only a minor part originates from transport. This part is, however, increasing due to increasing use of catalyst cars. The total ammonia emission decreased by 11.1 % from 1990 to 2009. This is due to decreasing livestock population.

The emissions of NMVOC originate from solvent use, road transport and non-industrial combustion. Solvent use is still the main contributor, even though the emissions have declined since reduction of solvent use. The evaporative emissions mainly originate from the use of solvents. The total anthropogenic emissions have decreased by 43.8% from 1990 to 2009, largely due to the increased use of catalyst cars and reduced emissions from use of solvents.
Transport is responsible for the dominant share of the total CO emission. Also other mobile sources and non-industrial combustion plants contribute significantly to the total emission of this pollutant. The emission decreased because of decreasing emissions from road transportation.

1.3.2 Emission trends for POPs and HM

The present emission inventory for PAH (poly aromatic hydrocarbons) includes the four PAHs reported to UNECE: benzo(a)pyrene, benzo(b)-fluoranthene, benzo(k)fluoranthene and indeno-(1,2,3-cd) pyrene. The most important sources of the PAH emission are combustion of wood in the residential sector. From years 1990 to 2009 the emission of PAH were reduced for 25.91 %.
The most important sources of PCDD/DF emissions are non-industrial combustion and production processes. From years 1990 to 2009 the emission of PCDD/DF were reduced for 39.88 %.
The most important source of HCB emissions is combustion in energy. From years 1990 to 2009 the emission of HCB were reduced for 98.89 %. The main reduction of HCB occurred in 2002 with improvement of technology in production process (Al production).
The most important sources of PCB into air are solvent use, production processes and combustion in energy. From years 1990 to 2009 the emission of PCB were reduced for 85.50 %.
In general, the most important sources of heavy metal emissions are production processes, combustion of fossil fuels and non-industrial combustion and road transport. The heavy metal emissions have decreased substantially in recent years. The reductions span from 30.29 % to 96.20 % for Hg and Pb, respectively. The reason for the reduced emissions is mainly increased use of gas cleaning devices. The large reduction in the Pb emission is due to a gradual shift towards unleaded gasoline.

1.4 Recalculations and improvements

In general, considerable work is being carried out to improve the inventories. New investigations and research carried out in Slovenia and abroad are, as far as possible, included as the basis for the emission estimates and included as data in the inventory databases. Furthermore, the updates of the EMEP/CORINAIR guidebook and the work in the Task Force on Emission Inventories and Projections and its expert panels are followed closely in order to be able to incorporate the best scientific information as the basis for the inventories. Further important references in this regard are the IPCC guidelines and IPCC good practice guidance. Implementation of new results in inventories is made in a way so that improvements better reflect Slovenia conditions and circumstances. In improving the inventories, care is taken to consider implementation of improvements for the whole time-series of inventories, to promote consistency. Such efforts lead to recalculation of previously submitted inventories. The most important recalculations for the various sectors are mentioned below.

The basic problems in Slovenia were missing activity data for years 1990-2004 for some emission sources (e.g. waste incineration), which are obtained from Statistical Office of the Republic of Slovenia. Plant communication was established to provide activity data.

Slovenia developed national emission factor for Pb glass (NFR code: 2A7) since 2003 (plant communication data 2003-2008), national emission factor for Hg (NFR code: 1A1a) since 1994 for Šoštanj power plant and for Trbovlje power plant since 2004 (NFR code: 1A1a) (Hower, 2005). National emission factor was also developed for Al production (NFR code: 2 C3) since 2002 based on BAT (best available techniques) used in operating plants (Homšak, 2007). Recalculations were performed according to new activity data for PCB (NFR code: 3D). Otherwise default emission factors for calculation POPs and HM emissions are used (Kanduč, 2009).

Emission factors for major and other pollutants from new Emission Inventory Guidebook 2009 (http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009) will be updated during this year. Till now only priority heavy metals (Pb, Cd and Hg) have been reported. Emissions for other heavy metals (As, Cr, Cu, Ni, Se, Zn) are planned to be included in reporting next years.

2 Introduction

2.1 National Inventory Background

2.1.1 History

National emission inventory (NEI) has been established according to INSTRUCTION for organizing the emission inventory of sources of air pollution (OJ of SRS No. 12-20, IV 1979) and is subject to continuous development.

In 1992 Slovenia joined (voluntary) in program CORINAIR 90, which was an air emission inventory for Europe. It was part of the CORINE work plan set up by the European Council of Ministers in 1985. The aim of CORINAIR 90 was to produce a complete, consistent and transparent emission inventory for the pollutants: SO_2, NO_x, NMVOC, CH_4, CO, CO_2, N_2O and NH_3.

In 1995 Slovenia had reported time series of SO_2 and NO_x from the year 1980 to 1993 in the frame of Mayor Review 1994 Questionnaire. Emissions on the national level were divided into 11 category sources (SNAP1). Calculations based on CORINAIR methodology.

In 1998 Mayor review Slovenia had reported a first estimation of Cd, Hg and Pb for the years 1990, 1994 and 1995, grouped into 11 main category sources. The calculations of Heavy Metals based on Technical Paper to the OSPARCOM-HELCOM UNECE Emission Inventory (Emission Factors Manual PARCOM-ATMOS) (van der Most and Veldt, 1992).

Slovenia reported first estimations (calculations) of POPs (Polycyclic Aromatic Hydrocarbons, Polychlorinated Biphenyls and Dioxins/Furans) in annual report 2000 for the year 1990 and for the years from 1994 to 1999. Emission calculations were divided into 11 main category sources. The calculations of POPs based on Technical Paper to the OSPARCOM-HELCOM UNECE Emission Inventory (Emission Factors Manual PARCOM-ATMOS).

In annual report 2004 inventory data for particulate matter TSP, PM10, PM2,5 were included.

2.1.2 Slovenia's Obligations

- Slovenia's annual obligations under the UNECE Convention on Long-range Transboudary Air Pollution (CLRTAP) and its Protocols comprising the annual reporting of national emission data on SO_2, NOX, NMVOC, NH_3, CO, TSP, PM10, and PM2,5 as well as on the heavy metals (Pb, Cd and Hg) and persistent organic pollutants (PAHs, PCB, Dioxins/Furans and hexachlorbenzene (HCB). Slovenia had succeeded the LRTAP Convention from Yugoslavia in 1992 with the Act on succession notification (OJ of RS - International Contracts No 35/92, 17 July 1992).

Protocols that Slovenia ratified under LRTAP Convention are listed below:

- The 1984 Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP); 41 Parties. Entered into force 28 January 1988**.** (Slovenia ratified the protocol in 6.7. 1992).

- The 1985 Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent; 22 Parties. Entered into force 2 September 1987.

- The 1988 Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes; 30 Parties. Entered into force 14 February 1991. (Slovenia ratified the protocol in 5.1. 2006).

- The 1991 Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes; 21 Parties. Entered into force 29 September 1997.

- The 1994 Protocol on Further Reduction of Sulphur Emissions; 26 Parties. Entered into force 5 August 1998. (Slovenia ratified the protocol in 7.5.1998).

- The 1998 Protocol on Heavy Metals; 27 Parties. Entered into force on 29 December 2003. (Slovenia ratified the protocol in 9.2.2004).

- The 1998 Protocol on Persistent Organic Pollutants (POPs); 25 Parties. Entered into force on 23 October 2003. (Slovenia ratified the protocol in 15.11.2005).

- The 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone; 20 Parties. Entered into force on 17 May 2005. (Guidance documents to Protocol adopted by decision 1999/1). (Slovenia ratified the protocol in 4.5.2004).

➢ Slovenia's obligations under the Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants (NEC Directive). The Slovene implementation of the European NEC Directive also entails the obligation for a national emissions inventory of the covered air pollutants.

➢ Slovenia's obligations under the Regulation (EC) No 850/2004 of the European Parlament and of the Council of 29 April 2004 on persistant organic pollutants (POPs) and amending Directive 79/117/EEC.

2.2 Institutional arrangements

In Slovenia, the institution responsible for emission inventories is the Environmental Agency of the Republic of Slovenia (EARS). In accordance with its tasks and obligations to international institutions, the Environmental Agency is obligated to perform inventories of GHG emissions, as well as emissions that are defined in the Convention on Long Range Transboundary Air Pollution (CLRTAP) within the specified time limit. The Environmental Agency cooperates with numerous other institutions and administrative bodies which relay the necessary activity data and other necessary data for performing inventory each year (Table 1, Figure 1).

The chief sources of data are the Statistical Office of the Republic of Slovenia (SORS) and the Ministry of Environment and Spatial Planning; however, the EARS obtain much of its data through other activities which it performs under the Environmental Protection Act. Emissions from Agriculture are calculated in cooperation with the Slovenian Agriculture Institute (SAI). Inventory institutional arrangements and data sources are presented in Table 1.

Table 1: Inventory Institutional Arrangements and Data Sources

NFR category	NFR sub-category	Sources of data
NFR 1 A – Energy. Fuel Combustion	NFR 1A1 - Energy Industry	• Large Combustion Plants (LCP) • Ministry of Energy, Directorate of Energy (DGE): annual energy statistics • Energy Agency • Statistical Office of the Republic of Slovenia: Joint Questionnaires, Energy Balances
	NFR 1A2 - Manufacturing Industries and Construction	• Statistical Office of the Republic of Slovenia: • Environmental Agency of the Republic of Slovenia
	NFR 1A3 – Transport	• Statistical Office of the Republic of Slovenia: Joint Questionnaires, Energy balances • Ministry of Transport, Directorate for National Roads (DRSC) • Ministry of Internal affairs (vehicle stock)
	NFR 1A4 – Other Sectors	• Statistical Office of the Republic of Slovenia:
NFR 1 B – Fugitive Emissions from Fuels		• • Ministry of Energy, Directorate of Energy (DGE) • Agency of Energy • Statistical Office of the Republic of Slovenia:
NFR 2 – Industrial Processes	NFR 2A – Mineral Products	• Statistical Office of the Republic of Slovenia: • Environmental Agency of the Republic of Slovenia
	NFR 2B – Chemical Industry	• Statistical Office of the Republic of Slovenia: • Environmental Agency of the Republic of Slovenia
	NFR 2C – Metal Production	• Statistical Office of the Republic of Slovenia: • Environmental Agency of the Republic of Slovenia
	NFR 2D – Other Production	• Statistical Office of the Republic of Slovenia: • Environmental Agency of the Republic of Slovenia
	NFR 2F – Consumption of POPsand HMs	• Chemicals office of the Republic of Slovenia
NFR 3 – Solvent and Other Product Use		• Statistical Office of the Republic of Slovenia • Environmental Agency of the Republic of Slovenia
NFR 4 – Agriculture		• Agricultural Institute of Slovenia • Statistical Office of the Republic of Slovenia
NFR 6 – Waste	NFR 6A – Solid Waste Disposal on Land	• Environmental Agency of the Republic of Slovenia
	NFR 6C – Waste icineration	• Statistical Office of the Republic of Slovenia • Environmental Agency of the Republic of Slovenia

2.3 Brief description of the process of inventory preparation, data collection, processing, data storage and archiving

Owing to the ever-increasing obligations of Slovenia with regard to reporting, the Environmental Agency of the Republic of Slovenia (EARS) has implemented a unified system of data collection for the purposes of making inventories, as well as secures reliable financing in accordance with the annual program of its work. The ability to fulfill its obligations with regard to reporting was also improved by the participation of EARS in the GEF project "Capacity building for improving GHG inventories", which ended in June 2006.

A Memorandum of Understanding has been concluded with institutions that participate in inventory preparation, binding these institutions to submit quality and verified data to the Environmental Agency in due time, because the time limits for GHG inventories and the NIR have shortened with the entry of Slovenia into the EU. In view of this, an agreement has been reached with the participating institutions to shorten the time limits for submitting data. For reasons of complexity, attention was mostly focused on the Joint Questionnaires of the Statistical Office of the Republic of Slovenia, on the basis of which the Statistical Office produces the Energy Balance of the Republic of Slovenia, wherein the most important data on the energy sector are to be found. Data flow in the Slovenian Inventory System is presented in Figure 1.

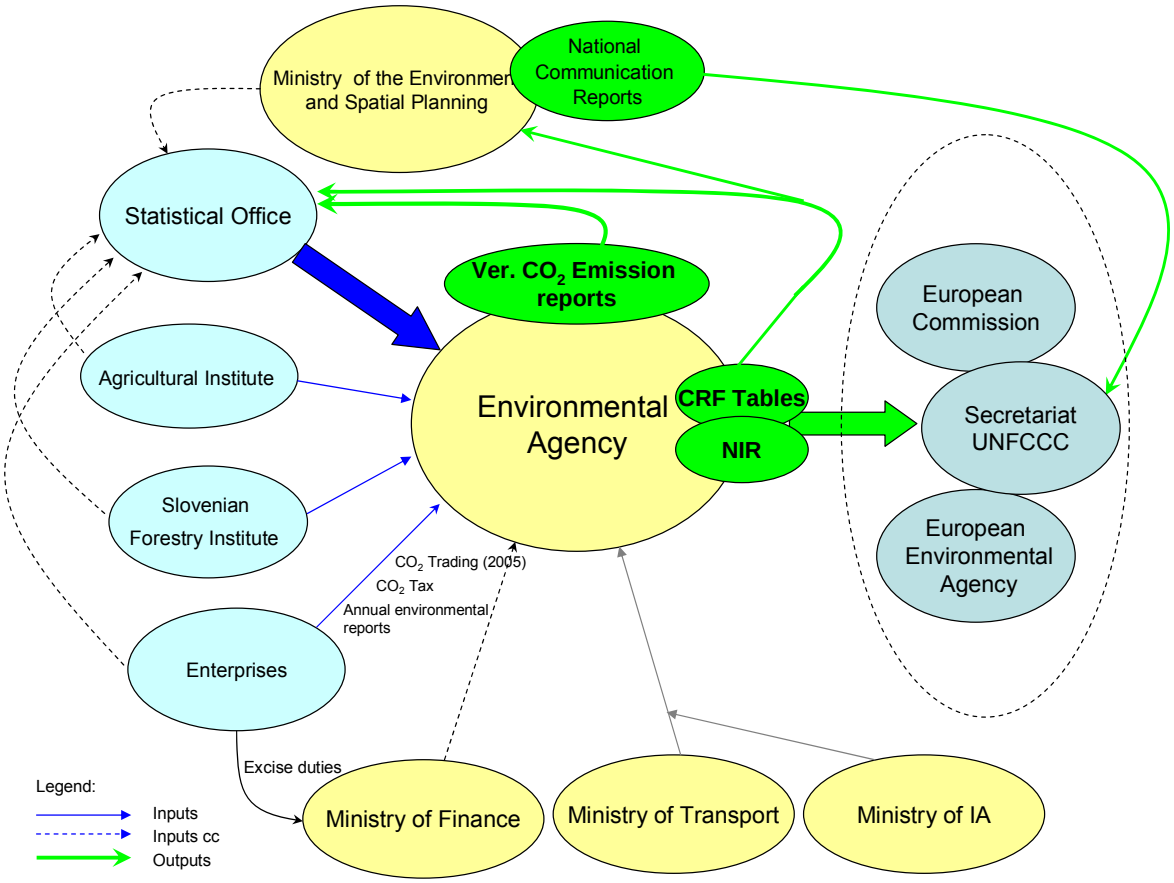

Figure 1: Data flow in the Slovenian Inventory System

The year 2003 presents the end of the process of harmonization of data collection among the Directorate of Energy, Ministry of Environment and Spatial Planning, and the Statistical

Office of the Republic of Slovenia. An end was put to previous parallel double collecting of data. The competence of collecting data has, by law, passed to the Statistical Office of the Republic of Slovenia, which checks the data and eliminates potential reporting errors, and submits consolidated data to the Directorate of Energy, which has been publishing data until 2005 in its Energy Yearbook of the Republic of Slovenia. In terms of content, the data were identical to those submitted in the Joint Questionnaires to the IEA.

At the beginning of 2007, the agreement between Statistical Office of the Republic of Slovenia and the EARS came into force. Accordingly, all statistical data which are necessary for preparing emission inventories are available each year by October 30 at the latest. In exchange, ETS data and emission estimates are reported to the Statistical Office within a defined time frame.

For submitting reports to different institutions, various report formats have been devised, since the same data are used to report to the UNFCCC, EEA, EC, and CLRTAP. All external reports of the Environmental Agency of the Republic of Slovenia are prepared in accordance with ISO 9001 via the Agency's reporting service, which keeps inventories of reports. Parallel to this, emissions data are submitted to the Statistical Office of the Republic of Slovenia, which makes this data available in its publications and submits them to EUROSTAT and the IEA.

In 2006, we started to develop a joint database for GHGs and other pollutants. It already contains all activity data, emission factors and other parameters together with a description of sources from 1980 on for other pollutants, and from 1986 on for GHG emissions. At defined control points, QC procedures are included. Some phases of the database were concluded, but the whole process is planned to be finished in 2010.

For each submission, databases and additional tools and submodels are frozen together with the resulting NFR-reporting format. This material is placed on central agency's servers, which are subject to routine back-up services. Material which has been backed up is archived safely.
Figure 1.1 shows a schematic overview of the process of inventory preparation. The figure illustrates the process of inventory preparation from the first step of collecting external data to the last step, where the reporting schemes are generated for the UNFCCC and EU (in the CRF format (Common Reporting Format)) and to the United Nations Economic Commission for Europe/Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (UNECE/EMEP) (in the NFR format (Nomenclature For Reporting)). For calculations and reporting the software tool is developed by EARS.

2.4 Brief description of methodologies and data sources used

Slovenia's air emission inventories are based on the Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (IPCC, 1997), the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000) and the CORINAIR methodology. CORINAIR (COoRdination of INformation on AIR emissions) is a European air emission inventory programme for national sector wise emission estimations, harmonized with the IPCC guidelines. To ensure estimates are as timely, consistent, transparent, accurate and comparable as possible, the inventory programme has developed calculation methodologies for most subsectors and software for storage and further data processing (EMEP/CORINAIR, 2007). The CORINAIR calculation principle is to calculate the emissions as activities multiplied by emission factors. Activities are numbers referring to a specific process generating emissions, while an emission factor is the mass of emissions pr unit activity. Information on activities to carry out the CORINAIR inventory is largely based on official statistics. The most consistent emission factors have been used, either as national values or default factors proposed by international guidelines. The emission factors used for emission calculations in year 2008 were used from EMEP/CORINAR Emission Inventory Guidebook, 2007.
The activity data of consumed fuel energy were provided by Statistical Office of the Republic of Slovenia (SORS). Additional data on the energy use of some types of waste (waste tires, oils and solvents) were acquired from verified ETS reports. Data on fuel consumption in agriculture and forestry refer to mobile sources only, while the rest of the fuel consumption of these sub-sectors is included in the public and service sub-sector. Emissions in road transport were determined with the COPERT IV model.
Emissions from industrial processes were mostly determined on the basis of statistical data on production and consumption of raw materials and by applying country-specific emission factors. After 1997, the Statistical Office of the Republic of Slovenia partly changed the manner of collecting and presenting these data, and therefore most of the data were obtained directly from individual companies (plant communication data).

2.5 Key Categories (to be updated each year)

This chapter presents results of Slovenia's key source analysis. The analysis of key source categories was performed on the basis of sectoral distribution and using the Tier 1 approach.

The analysis includes all pollutants reported under CLRTAP: main pollutants (SO_x, NO_x, NH_3, CO, NMVOC), Heavy Metals (Pb, Cd, Hg) and Persistent Organic Pollutants (PCB, PDCC/PDCF, PAH, HCB). Each pollutant was analyzed separately.

2.5.1 List of key categories by pollutant

The key sources by pollutant are presented in Tables from 2 to 13 in ascending NFR category order.

2.5.1.1 SO_x pollutant

The key source with the highest contribution to SOx emissions is 1 A 1 a Public Electricity and Heat Production with a share of 56.88%. The second most important source with a share of 16,63% is 1 A 2 f i Stationary Combustion in Manufacturing Industries and Construction: Other and the third most important source regarding the contribution to total amount of SOx emissions is 1 A 4 b i Residential: Stationary plants with a share of 8.8%. This three sources together contribute 82.31% to the total amount, which is 11.526 Gg SOx. Key source categories for SOx for the year 2009 are represented in Table 2.

Table 2: Key source categories for SOx for year 2009

NFR code	SOx Emissions [Gg]	Comulative Total
1 A 1 a Public electricity and heat production	6,5560	56,88
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	1,9168	73,51
1 A 4 b i Residential: Stationary plants	1,0140	82,31
1 A 4 a i Commercial / institutional: Stationary	0,7340	88,68
2 C 3 Aluminum production	0,3464	91,68
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)	0,2916	94,21
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,2524	96,40
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,1003	97,27
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	0,0935	98,09
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	0,0805	98,78
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0,0689	99,38
2 B 5 a Other chemical industry (Please specify the sources included/excluded in the notes column to the right)	0,0295	99,64
1 A 3 b i Road transport: Passenger cars	0,0213	99,82
1 A 3 b iii Road transport:, Heavy duty vehicles	0,0089	99,90
2 A 1 Cement production	0,0060	99,95
1 A 3 b ii Road transport:Light duty vehicles	0,0030	99,98
1 A 3 a i (i) International aviation (LTO)	0,0009	99,99
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,0006	99,99
1 A 3 a ii (i) Civil aviation (Domestic, LTO)	0,0005	99,99

1 A 2 f ii Mobile Combustion in manufacturing industries and construction: (Please specify in your IIR)	0,0003	100,00
1 A 3 c Railways	0,0001	100,00
1 A 3 b iv Road transport: Mopeds & motorcycles	0,0001	100,00

2.5.1.2 NOx pollutant

The key source with the highest contribution to NOx emissions are 1 A 3 b iii Road Transport: Heavy duty vehicles, with a share of 28,64%, 1 A 1 a Public Electricity and Heat Production with a share of 24,11%, 1 A 3 b i Road Transport: Passenger cars with a share of 20,83, 1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery with a share of 4,76% and 1 A 4 b i Residential: Stationary plants with a share of 4,61%. All key sources together contribute 82.95% to the total amount which is 45.147 Gg NOx. The key source categories for NOx for the year 2009 are represented in Table 3.

Table 3: Key source categories for NOx for year 2009

NFR code	NOx Emissions [Gg]	Comulative Total
1 A 3 b iii Road transport:, Heavy duty vehicles	12,9332	28,64
1 A 1 a Public electricity and heat production	10,8890	52,75
1 A 3 b i Road transport: Passenger cars	9,4043	73,58
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	2,1500	78,34
1 A 4 b i Residential: Stationary plants	2,0805	82,95
1 A 3 b ii Road transport:Light duty vehicles	1,8647	87,08
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	1,6540	90,74
1 A 2 f ii Mobile Combustion in manufacturing industries and construction: (Please specify in your IIR)	1,1324	93,25
1 A 4 a i Commercial / institutional: Stationary	0,9040	95,25
1 A 3 c Railways	0,6288	96,64
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,6042	97,98
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,3214	98,69
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	0,2097	99,16
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0,1609	99,51
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	0,1514	99,85
1 A 3 b iv Road transport: Mopeds & motorcycles	0,0488	99,96
1 A 3 a i (i) International aviation (LTO)	0,0088	99,98
1 A 1 b Petroleum refining	0,0076	99,99
1 A 3 a ii (i) Civil aviation (Domestic, LTO)	0,0020	100,00
1 A 1 c Manufacture of solid fuels and other energy industries	0,0015	100,00

2.5.1.3 NH_3 pollutant

The key sources with the highest contribution to NH3 emissions are 4 B 1 b Cattle Non-Dai, with a share of 32.55%, 4 B 1 a Cattle Dair, with a share of 26.75%, 4 B 8 Swine with a share of 14.72% and 4 D 1 a Synthetic N-fertilizers with a share of 9,6 contribute 83.62% to the total amount, which is 17.698 Gg NH3. The key source categories for NH3 for the year 2009 are represented in Table 4.

Table 4: Key source categories for NH_3 for year 2009

NFR code	NH3 Emissions [Gg]	Comulative Total
4 B 1 b Cattle non-dairy	5,7602	32,55
4 B 1 a Cattle dairy	4,7349	59,30
4 B 8 Swine	2,6047	74,02
4 D 1 a Synthetic N-fertilizers	1,6989	83,62
4 B 9 b Broilers	0,9488	88,98
4 B 9 a Laying hens	0,7203	93,05
1 A 3 b i Road transport: Passenger cars	0,4684	95,69
4 B 6 Horses	0,2350	97,02
4 B 3 Sheep	0,2187	98,26
4 B 9 c Turkeys	0,0946	98,79
4 B 4 Goats	0,0861	99,28
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)	0,0565	99,60
2 A 1 Cement production	0,0523	99,89
1 A 3 b ii Road transport:Light duty vehicles	0,0078	99,94
4 B 9 d Other poultry	0,0053	99,97
1 A 3 b iii Road transport:, Heavy duty vehicles	0,0048	99,99
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,0005	100,00

2.5.1.4 CO pollutant

The key sources with the highest contribution to CO emissions are 1 A 4 b i Residential: Stationary plants with a share of 56.86% and 1 A 3 b i Road Transport: Passenger cars with a share of 27.84%. Together they contribute 84.7% to the total amount, which is 124.631 Gg CO. The key source categories for CO for the year 2009 are represented in Table 5.

Table 5: Key source categories for CO for year 2009

NFR code	CO Emissions [Gg]	Comulative Total
1 A 4 b i Residential: Stationary plants	70,8644	56,86
1 A 3 b i Road transport: Passenger cars	34,6962	84,70
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	6,1065	89,60
1 A 3 b iii Road transport:, Heavy duty vehicles	2,3022	91,45
1 A 3 b iv Road transport: Mopeds & motorcycles	2,0586	93,10
1 A 1 a Public electricity and heat production	1,7479	94,50
1 A 3 b ii Road transport:Light duty vehicles	1,6692	95,84
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	1,5258	97,06
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	1,1306	97,97
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,6712	98,51
1 A 3 a ii (i) Civil aviation (Domestic, LTO)	0,6060	99,00
1 A 4 a i Commercial / institutional: Stationary	0,3784	99,30

1 A 2 f ii Mobile Combustion in manufacturing industries and construction: (Please specify in your IIR)	0,3703	99,60
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	0,1987	99,76
1 A 3 c Railways	0,1284	99,86
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	0,1015	99,94
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0,0593	99,99
1 A 3 a i (i) International aviation (LTO)	0,0126	100,00
1 A 1 b Petroleum refining	0,0027	100,00
1 A 1 c Manufacture of solid fuels and other energy industries	0,0005	100,00

2.5.1.5 NMVOC pollutant

The key sources with the highest contribution to NMVOC emissions are 1 A 4 b i Residential: Stationary plants with a share of 26.34%, 3 D 2 Domestic solvent use including fungicides with a share of 16.44%, 3 C Chemical products with a share of 12.11%, 1 A 3 b i Road Transport: Passenger cars with a share of 11.45%, 3 A 2 Industrial coating application with a share of 8.33% and 1 B 2 a v Distribution of oil products with a share of 6.35% All key sources together contribute 81.02% to the total amount, which is 31.055 Gg NMVOC. The key source categories for NMVOC for year 2009 are presented in Table 6.

Table 6: Key source categories for NMVOC for year 2009

NFR code	NMVOC Emissions [Gg]	Comulative Total
1 A 4 b i Residential: Stationary plants	8,1808	26,34
3 D 2 Domestic solvent use including fungicides	5,1058	42,78
3 C Chemical products	3,7583	54,89
1 A 3 b i Road transport: Passenger cars	3,5563	66,34
3 A 2 Industrial coating application	2,5887	74,67
1 B 2 a v Distribution of oil products	1,9697	81,02
3 D 1 Printing	0,6276	83,04
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,5971	84,96
1 A 3 b iv Road transport: Mopeds & motorcycles	0,5955	86,88
1 B 2 a iv Refining / storage	0,5531	88,66
1 A 3 b iii Road transport:, Heavy duty vehicles	0,5501	90,43
1 A 3 b v Road transport: Gasoline evaporation	0,5369	92,16
2 A 6 Road paving with asphalt	0,4719	93,68
2 D 2 Food and drink	0,3421	94,78
3 D 3 Other product use	0,2759	95,67
1 A 3 b ii Road transport:Light duty vehicles	0,2118	96,35
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,2065	97,01
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,1477	97,49
2 D 1 Pulp and paper	0,1447	97,96
1 A 2 f ii Mobile Combustion in manufacturing industries and construction: (Please specify in your IIR)	0,1169	98,33
1 A 1 a Public electricity and heat production	0,1158	98,71
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,1071	99,05
1 A 4 a i Commercial / institutional: Stationary	0,0958	99,36

3 B 1 Degreasing	0,0715	99,59
1 A 3 c Railways	0,0558	99,77
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	0,0204	99,83
3 B 2 Dry cleaning	0,0188	99,89
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	0,0123	99,93
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0,0100	99,97
1 A 3 a ii (i) Civil aviation (Domestic, LTO)	0,0096	100,00
1 A 3 a i (i) International aviation (LTO)	0,0005	100,00
1 A 1 b Petroleum refining	0,0003	100,00
1 A 1 c Manufacture of solid fuels and other energy industries	0,0001	100,00

2.5.1.6 Lead (Pb) pollutant

The key sources with the highest contribution to Pb emissions are: 2 C 5 b Lead Production with a share of 28.78%, 1 A 3 b i Road Transport: Passenger cars with a share of 23.97% and 2 C 5 d Zinc Production with a share of 18.78% and 2 C 1 Iron and Steel Production with a share of 16.88%. All together contribute 88.41% to the total amount, which is 13.562 Mg Pb. Lead emissions by key source categories are represented in Table 7.

Table 7: Key source categories for Pb for year 2009

NFR code	Pb Emissions [Mg]	Comulative Total
2 C 5 b Lead production	3,9033	28,78
1 A 3 b i Road transport: Passenger cars	3,2500	52,75
2 C 5 d Zinc production	2,5476	71,53
2 C 1 Iron and steel production	2,2891	88,41
2 C 5 a Copper production	0,8422	94,62
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)	0,2447	96,43
1 A 1 a Public electricity and heat production	0,2042	97,93
6 C a Clinical wasteincineration (d)	0,1440	98,99
1 A 4 b i Residential: Stationary plants	0,0558	99,40
1 A 3 a ii (i) Civil aviation (Domestic, LTO)	0,0267	99,60
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,0202	99,75
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,0085	99,81
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,0075	99,87
2 A 1 Cement production	0,0067	99,92
6 C b Industrial waste incineration (d)	0,0039	99,95
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	0,0028	99,97
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,0021	99,98
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0,0019	100,00
1 A 3 c Railways	0,0004	100,00
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	0,0000	100,00

2.5.1.7 Cadmium (Cd) pollutant

The key sources with the highest contribution to Cd emissions are: 1 A 3 b i Road transport: Passenger cars with a share of 28.34%, 1 A 4 b i Residential: Stationary plants with a share of 19.16%, 2 C 5 b Lead Production with a share of 13.41%, 2 A 1 Cement production and with a share of 7.73%, 1 A 1 a Public electricity and heat production with a share of 6.08% and 2 C 5 a Copper Production with a share of 5.79%. This key sources together contribute 80.51% to the total amount, which is 0.582 Mg Cd. Key source categories for Cd for year 2009 are represented in Table 8.

Table 8: Key source categories for Cd for year 2009

NFR code	Cd Emissions [Mg]	Comulative Total
1 A 3 b i Road transport: Passenger cars	0,1650	28,34
1 A 4 b i Residential: Stationary plants	0,1115	47,50
2 C 5 b Lead production	0,0781	60,91
2 A 1 Cement production	0,0450	68,64
1 A 1 a Public electricity and heat production	0,0354	74,72
2 C 5 a Copper production	0,0337	80,51
2 C 5 d Zinc production	0,0255	84,88
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,0243	89,05
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,0147	91,58
2 C 1 Iron and steel production	0,0137	93,94
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)	0,0103	95,71
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,0058	96,70
6 C a Clinical wasteincineration (d)	0,0058	97,69
1 A 3 a ii (i) Civil aviation (Domestic, LTO)	0,0047	98,50
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,0044	99,25
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	0,0021	99,62
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0,0015	99,87
1 A 3 c Railways	0,0006	99,97
6 C b Industrial waste incineration (d)	0,0002	100,00

2.5.1.8 Mercury (Hg) pollutant

The key sources with the highest contribution to Hg emissions are 1 A 1 a Public Electricity and Heat Production with a share of 20.07%, 1 A 4 b i Residential: Stationary plants with a share of 15.89%, 1 A 3 b i Road transport: Passenger cars with a share of 12.08%, 2 C 5 d Zinc production with a share of 11.72%, 2 C 5 a Copper Production with a share of 11.35% and 2 C 5 b Lead production with a share of 9.57%. All key sources together contribute 80.68% to the total amount, which is 0,816 Mg Hg. Key source categories for Hg for year 2009 are represented in

Table 9.

Table 9: Key source categories for Hg for year 2008

NFR code	Hg Emissions [Mg]	Comulative Total
1 A 1 a Public electricity and heat production	0,1638	20,07
1 A 4 b i Residential: Stationary plants	0,1296	35,96
1 A 3 b i Road transport: Passenger cars	0,0986	48,04
2 C 5 d Zinc production	0,0955	59,76
2 C 5 a Copper production	0,0926	71,11
2 C 5 b Lead production	0,0781	80,68
2 A 1 Cement production	0,0731	89,64
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,0254	92,76
2 C 1 Iron and steel production	0,0183	95,01
6 C a Clinical wasteincineration (d)	0,0160	96,97
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	0,0133	98,60
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,0038	99,07
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)	0,0034	99,49
1 A 4 a i Commercial / institutional: Stationary	0,0026	99,80
1 A 3 c Railways	0,0007	99,89
6 C b Industrial waste incineration (d)	0,0004	99,94
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0,0002	99,96
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,0001	99,97
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,0001	99,98
1 A 3 a ii (i) Civil aviation (Domestic, LTO)	0,0001	100,00
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	0,0000	100,00

2.5.1.9 Particulates (PM2.5) pollutant

The key source with the highest contribution to PM2.5 emissions is 1 A 4 b i Residential: Stationary plants with a share of 74.19%, 1 A 2 f i Stationary combustion in manufacturing industries and construction: Othe, with a share of 4.52% and 1 A 3 b i Road transport: Passenger cars with a share of 4.21%. All key sources together contribute 82.92% to the total amount, which is 12.780 Gg PM2.5. Key source categories for PM2.5 for year 2009 are represented in Table 10.

Table 10: Key source categories for PM2.5 for year 2009

NFR code	PM2.5 Emissions [Gg]	Comulative Total
1 A 4 b i Residential: Stationary plants	9,4813	74,19
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,5786	78,71
1 A 3 b i Road transport: Passenger cars	0,5380	82,92
1 A 3 b iii Road transport:, Heavy duty vehicles	0,2814	85,13
1 A 3 b vi Road transport: Automobile tyre and brake wear	0,2384	86,99
4 D 2 a Farm-level agricultural operations including storage, handling and transport of agricultural products	0,2299	88,79
1 A 1 a Public electricity and heat production	0,1863	90,25

1 A 3 b ii Road transport:Light duty vehicles	0,1763	91,63
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,1741	92,99
1 A 4 a i Commercial / institutional: Stationary	0,1461	94,13
1 A 3 b vii Road transport: Automobile road abrasion	0,1346	95,19
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,1066	96,02
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,1057	96,85
1 A 2 f ii Mobile Combustion in manufacturing industries and construction: (Please specify in your IIR)	0,0722	97,41
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)	0,0562	97,85
2 A 1 Cement production	0,0441	98,20
4 B 8 Swine	0,0326	98,45
4 B 1 b Cattle non-dairy	0,0318	98,70
4 B 9 b Broilers	0,0295	98,93
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	0,0189	99,08
1 A 3 c Railways	0,0164	99,21
1 B 1 a Fugitive emission from solid fuels: Coal mining and handling	0,0163	99,34
4 B 9 a Laying hens	0,0129	99,44
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	0,0126	99,54
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0,0102	99,62
4 B 1 a Cattle dairy	0,0100	99,69
1 A 3 b iv Road transport: Mopeds & motorcycles	0,0100	99,77
2 C 3 Aluminum production	0,0083	99,84
4 B 9 c Turkeys	0,0052	99,88
2 A 2 Lime production	0,0049	99,92
2 C 5 a Copper production	0,0035	99,94
6 A Solid waste disposal on land	0,0029	99,97
4 B 6 Horses	0,0024	99,99
4 B 9 d Other poultry	0,0007	99,99
2 C 5 b Lead production	0,0005	100,00

2.5.1.10 PM10 pollutant

The key sources with the highest contribution to PM10 emissions are: 1 A 4 b i Residential: Stationary plants with a share of 60.05%, 4 D 2 a Farm-level agricultural operations including storage, handling and transport of agricultural products with a share of 13.06%, 1 A 2 f i Stationary combustion in manufacturing industries and construction: Other with a share of 3.84% and 1 A 3 b i Road transport: Passenger cars with a share of 3.41% All key sources together contribute 80.36% to the total amount, which is 15.790 Gg PM10. Key source categories for PM10 for year 2009 are represented in Table 10.

Table 11: Key source categories for PM10 for year 2009

NFR code	PM2.5 Emissions [Gg]	Comulative Total
1 A 4 b i Residential: Stationary plants	9,4813	60,05
4 D 2 a Farm-level agricultural operations including storage, handling and transport of agricultural products	2,0627	73,11
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,6068	76,95

1 A 3 b i Road transport: Passenger cars	0,5380	80,36
1 A 3 b vi Road transport: Automobile tyre and brake wear	0,4444	83,17
1 A 1 a Public electricity and heat production	0,3439	85,35
1 A 3 b iii Road transport:, Heavy duty vehicles	0,2814	87,13
1 A 3 b vii Road transport: Automobile road abrasion	0,2475	88,70
1 A 4 a i Commercial / institutional: Stationary	0,1903	89,91
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,1896	91,11
1 A 3 b ii Road transport:Light duty vehicles	0,1763	92,22
4 B 8 Swine	0,1468	93,15
4 B 1 b Cattle non-dairy	0,1434	94,06
4 B 9 b Broilers	0,1328	94,90
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,1080	95,59
1 B 1 a Fugitive emission from solid fuels: Coal mining and handling	0,1070	96,26
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,1066	96,94
2 A 1 Cement production	0,0801	97,45
1 A 2 f ii Mobile Combustion in manufacturing industries and construction: (Please specify in your IIR)	0,0722	97,90
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)	0,0636	98,31
4 B 9 a Laying hens	0,0581	98,68
4 B 1 a Cattle dairy	0,0451	98,96
4 B 9 c Turkeys	0,0235	99,11
2 A 2 Lime production	0,0235	99,26
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	0,0207	99,39
2 C 3 Aluminum production	0,0190	99,51
1 A 3 c Railways	0,0173	99,62
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	0,0148	99,71
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0,0128	99,80
1 A 3 b iv Road transport: Mopeds & motorcycles	0,0100	99,86
6 A Solid waste disposal on land	0,0093	99,92
2 C 5 a Copper production	0,0048	99,95
4 B 6 Horses	0,0035	99,97
4 B 9 d Other poultry	0,0032	99,99
2 C 5 b Lead production	0,0007	100,00

2.5.1.11 Total suspended particulates (TSP) pollutant

The key sources with the highest contribution to TSP emissions are 1 A 4 b i Residential: Stationary plants with a share of 48.38% and 4 D 2 a Farm-level agricultural operations including storage, handling and transport of agricultural products with a share of 22.17%, 1 A 2 f i Stationary combustion in manufacturing industries and construction: Other with a share of 3.12%, 1 A 3 b vi Road transport: Automobile tyre and brake wear with a share of 2.84%, 1 A 3 b i Road transport: Passenger cars with a share of 2.61% and 1 A 3 b vii Road transport: Automobile road abrasion cars with a share of 2.4% . All key sources together contribute 81.52% to the total amount, which is 20,637 Gg TSP. Key source categories for TSP for year 2009 are represented in Table 12.

Table 12: Key source categories for TSP for year 2009

NFR code	PM2.5 Emissions [Gg]	Comulative Total
1 A 4 b i Residential: Stationary plants	9,9848	48,38
4 D 2 a Farm-level agricultural operations including storage, handling and transport of agricultural products	4,5743	70,55
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,6445	73,67
1 A 3 b vi Road transport: Automobile tyre and brake wear	0,5860	76,51
1 A 3 b i Road transport: Passenger cars	0,5380	79,12
1 A 3 b vii Road transport: Automobile road abrasion	0,4949	81,52
1 A 1 a Public electricity and heat production	0,4595	83,74
4 B 8 Swine	0,3259	85,32
4 B 1 b Cattle non-dairy	0,3184	86,86
4 B 9 b Broilers	0,2948	88,29
1 A 3 b iii Road transport:, Heavy duty vehicles	0,2814	89,66
1 A 4 a i Commercial / institutional: Stationary	0,2433	90,84
1 B 1 a Fugitive emission from solid fuels: Coal mining and handling	0,2179	91,89
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,2052	92,89
1 A 3 b ii Road transport:Light duty vehicles	0,1763	93,74
2 D 3 Wood processing	0,1567	94,50
4 B 9 a Laying hens	0,1289	95,12
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,1144	95,68
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,1066	96,20
4 B 1 a Cattle dairy	0,1001	96,68
2 A 1 Cement production	0,0881	97,11
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)	0,0792	97,49
1 A 2 f ii Mobile Combustion in manufacturing industries and construction: (Please specify in your IIR)	0,0723	97,84
2 C 1 Iron and steel production	0,0653	98,16
2 A 2 Lime production	0,0578	98,44
4 B 9 c Turkeys	0,0523	98,69
2 B 5 a Other chemical industry (Please specify the sources included/excluded in the notes column to the right)	0,0465	98,92
2 D 1 Pulp and paper	0,0287	99,06
3 C Chemical products	0,0260	99,18
2 C 3 Aluminum production	0,0238	99,30
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	0,0224	99,41
6 A Solid waste disposal on land	0,0197	99,50
1 A 3 c Railways	0,0182	99,59
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	0,0174	99,67
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0,0159	99,75
2 D 2 Food and drink	0,0146	99,82
1 A 3 b iv Road transport: Mopeds & motorcycles	0,0100	99,87
4 B 9 d Other poultry	0,0070	99,90
2 C 5 a Copper production	0,0060	99,93
3 A 2 Industrial coating application	0,0059	99,96
3 D 3 Other product use	0,0035	99,98
2 C 2 Ferroalloys production	0,0025	99,99
2 C 5 b Lead production	0,0008	100,00

2.5.1.12 Polychlorinated Biphenyls (PCB) pollutant

The key source with the highest contribution to PCB emissions is 3 D 3 Other product use with a share of 56.96% and 1 A 1 a Public Electricity and Heat Production with a share of 27.54%. Both sources together contribute 84.5% to the total amount, which is 64.982 kg PCB. Key source categories for PCB for year 2009 are represented in Table 13.

Table 13: Key source categories for PCB for year 2009

NFR code	PCB Emissions [kg]	Comulative Total
3 D 3 Other product use	37,0128	56,96
1 A 1 a Public electricity and heat production	17,9002	84,50
1 A 4 b i Residential: Stationary plants	3,9035	90,51
2 A 1 Cement production	2,9244	95,01
2 C 1 Iron and steel production	1,6482	97,55
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,7070	98,64
2 A 2 Lime production	0,2547	99,03
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)	0,1785	99,30
2 C 3 Aluminum production	0,1771	99,58
6 C a Clinical wasteincineration (d)	0,0800	99,70
2 C 5 b Lead production	0,0677	99,80
2 C 5 a Copper production	0,0438	99,87
2 C 5 d Zinc production	0,0331	99,92
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,0208	99,95
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,0158	99,98
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	0,0077	99,99
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0,0052	100,00
6 C b Industrial waste incineration (d)	0,0020	100,00

2.5.1.13 Dioxins/Furans (PCDD/PCDF) pollutant

The key source with the highest contribution to PCDD/PCDF emissions is 1 A 4 b i Residential: Stationary plants with a share of 59.63%, 2 C 1 Iron and Steel Production with a share of 9.37%, 2 C 5 d Zinc production with a share of 6.51% and 1 A 1 a Public electricity and heat production with a share of 6.34%. All key sources together contribute 81.85% to the total amount, which is9.776 g I-Teq PCDD/PCDF. Key source categories for PCDD/PCDF for year 2009 are represented in Table 14.

Table 14: Key source categories for PCDD/PCDF for year 2009

NFR code	PCDD/PCDF Emissions [g I-Teq]	Comulative Total
1 A 4 b i Residential: Stationary plants	5,8299	59,63
2 C 1 Iron and steel production	0,9157	69,00

2 C 5 d Zinc production	0,6369	75,51
1 A 1 a Public electricity and heat production	0,6198	81,85
2 C 5 b Lead production	0,5204	87,18
2 C 5 a Copper production	0,3369	90,62
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,2024	92,69
1 A 4 a i Commercial / institutional: Stationary	0,1835	94,57
2 A 1 Cement production	0,1687	96,30
2 A 2 Lime production	0,0787	97,10
2 C 3 Aluminum production	0,0670	97,79
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,0628	98,43
1 A 3 b i Road transport: Passenger cars	0,0610	99,05
6 C a Clinical wasteincineration (d)	0,0320	99,38
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,0255	99,64
2 D 1 Pulp and paper	0,0156	99,80
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0,0113	99,92
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,0030	99,95
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	0,0025	99,97
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)	0,0012	99,99
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	0,0007	99,99
1 A 3 c Railways	0,0005	100,00
1 A 3 a ii (i) Civil aviation (Domestic, LTO)	0,0002	100,00

2.5.1.14 Polycyclic aromatic hydrocarbons (PAH) pollutant

The key source with the highest contribution to PAH emissions is 1 A 4 b i Residential: Stationary plants with a share of 95.86% to the total amount which is 9,982 Mg PAH. Key source categories for PAH for year 2009 are represented in Table 15.

Table 15: Key source categories for PAH for year 2009

NFR code	PAH Emissions [Mg]	Comulative Total
1 A 4 b i Residential: Stationary plants	9,5691	95,86
2 C 3 Aluminum production	0,1270	97,14
1 A 3 b i Road transport: Passenger cars	0,1190	98,33
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,0868	99,20
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,0566	99,77
1 A 3 c Railways	0,0098	99,86
2 C 1 Iron and steel production	0,0078	99,94
1 A 1 a Public electricity and heat production	0,0052	99,99
3 A 3 Other coating application (Please specify the sources included/excluded in the notes column to the right)	0,0004	100,00
1 A 3 a ii (i) Civil aviation (Domestic, LTO)	0,0001	100,00
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,0001	100,00
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,0001	100,00
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	0,0000	100,00

2.5.1.15 Hexachlorbenzene (HCB) pollutant

The key sources with the highest contribution to HCB emissions are: 1 A 3 b I Road Transport: Passenger cars with a share of 53.52%, 1 A 1 a Public Electricity and Heat Production with a share of 16.57%, and 1 A 4 b i Residential: Stationary plants with a share of 13.79%. All key sources together contribute 83.88% to the total amount. Key source categories for HCB for year 2009 are represented in Table 16.

Table 16: Key source categories for HCB for year 2009

NFR code	HCB Emissions [kg]	Comulative Total
1 A 3 b i Road transport: Passenger cars	0,2753	53,52
1 A 1 a Public electricity and heat production	0,0853	70,09
1 A 4 b i Residential: Stationary plants	0,0710	83,88
6 C a Clinical wasteincineration (d)	0,0357	90,81
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,0216	95,02
2 A 1 Cement production	0,0124	97,42
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0,0072	98,83
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,0033	99,48
1 A 3 c Railways	0,0013	99,73
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,0011	99,95
1 A 3 a ii (i) Civil aviation (Domestic, LTO)	0,0002	99,98
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	0,0001	100,00

2.6 QA/QC and Verification methods

In 2009, Slovenia developed and mostly implemented a Quality Assurance and Quality Control plan and at the beginning of 2009, a QA/QC manager at the inventory agency was designated.

Quality Control (QC) is a system of routine technical activities to measure and control the quality of the inventory as it is being developed. The QC system is designed to:
- provide routine and consistent checks to ensure data integrity, correctness and completeness;
- identify and address errors and omissions;
- document and archive inventory material and record all QC activities.

The general part of this system is incorporated in an Oracle database (ISEE – "Emission inventory" information system) established at the end of 2008. The main purpose of ISEE is:

- to enable collection and archiving of activity data, emission factors and other parameters including descriptions of sources from 1980 on for other pollutants, and from 1986 on for GHG emissions;
- to calculate GHG and other pollutant emissions;
- to automatically fill in reporting tables.

In late 2008, the first two stages of development of ISEE were finished. ISEE enables and ensures that all necessary built-in QA/QC checks have been performed before data and emission estimates are entered in the reporting format tables. It also keeps a record of all changes made to data in the database.

As all calculations are performed in the database with software generated for this purpose, no human errors, common in calculations made in Excel spreadsheets, are expected. After these procedures, the activity data (fuel consumption and NCV) are transferred into the database, while EFs are imported manually. Then emissions are calculated automatically according to the built-in formulas. For 2008, emissions were also calculated in Excel spreadsheets. Both estimates were compared and all differences were carefully investigated and corrected.

During development of the database, the following QC was performed:

Check of methodological and data changes resulting in recalculations
- Check for temporal consistency in time series input data for each source category.
- Check for consistency in the algorithm/method used for calculations throughout the time series.

Completeness checks
- Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory.
- Check that known data gaps that result in incomplete source category emissions estimates are documented.
- Compare estimates to previous estimates: for each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any differences.

Check of activity data, emission factors and other parameters
- Cross-check all input data from each source category for transcription errors.
- Check that units are properly labelled in calculation sheets.
- Check that units are correctly carried through from beginning to end in calculations.
- Check that conversion factors are correct.
- Check that temporal and spatial adjustment factors are used correctly.

Check of emissions estimates
For the entire period 1980–2007, emissions are also calculated in the old way using Excel spreadsheets and in the database using built-in formulas. Both estimates were compared and all differences carefully investigated.
The reasons for differences were the following:
- Formulas for calculation of emissions were not correct.
- Data field was not properly labelled.
- Data relationship was not correct.
- Emissions data were not correctly aggregated from lower reporting levels to higher reporting levels.

All errors were corrected and the accuracy of emissions calculations on all levels is now assured.

QA/QC checks not performed in the database:

Documentation and archiving
All inventory data are now stored in a joint database. Supporting data and references are stored in electronic form and/or hard copy form. Inventory submissions are stored mostly in electronic form at various locations and on various media (network server, RAM, computer hard disk). Access to files is limited in accordance with the security policy. Backup copies on the server are made at regular intervals in accordance with the requirements of the information system. All relevant data from external institutions are also stored at the Environmental Agency.
QA/QC checks of documentation and archiving procedures:
- Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review.

- Check that there is detailed internal documentation to support the estimates and enable duplication of the emissions estimates.
- Check that documentation of the database is adequate and archived.
- Check that bibliographical data references are properly cited in the internal documentation and archived.

Uncertainty
Checks of uncertainty were not performed in 2009 but are foreseen for 2010 according to the QA/QC plan. The checks consist of the following:
- Check that the qualifications of individuals providing expert judgment for uncertainty estimates are appropriate.
- Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly.
- Check that there is detailed internal documentation to support the uncertainty estimates.

In 2006, an additional quality control check point was introduced by forwarding the assessment of verified emission reports from installations included in the National Allocation Plan to the Statistical Office of the Republic of Slovenia (SORS). The role of SORS is to compare data from installations included in the EU-ETS with data from their reporting system and to propose corrective measures, if necessary. The outcome of data consistency checks is used as preliminary information for the Ministry of the Environment and Spatial Planning to perform on-site inspections. The use of (EU) ETS data is described in more detail in the relevant chapter on Energy and Industrial Processes sectors.

QA generally consists of independent third-party review activities to ensure that the inventory represents the best possible estimates of emissions and removals, and to support the effectiveness of the QC program. In the past we have performed only one peer review. In 2006, we received many useful comments from the team preparing our fourth National Communication Report. Although the comments were not presented as an official report, we accepted many of the suggestions and corrected a number of errors. We are planning a sectoral review of our inventory on a yearly basis – one sector per year. In May 2009, a peer review of the Slovenian inventory was performed for the energy sector.

QA/QC procedures performed by other institutions (Slovenian Forestry Institute and Agricultural Institute of Slovenia) are described in the relevant chapters in the NIR (LULUCF, Agriculture). Data based on forest statistics are produced by the Slovenian
Forestry Service, the Slovenian Forestry Institute and SORS. Data based on agricultural statistics are mainly from SORS and the Agricultural Institute. All data were checked.

The Statistical Office of Slovenia (SORS) is our main data provider. In 2005, the European Statistics Code of Practice was adopted, bringing considerable changes to the SORS QA/QC system. The main pillars (factors) of quality are defined and thoroughly described in the Medium-term Programme of Statistical Surveys 2008–2012 (http://www.stat.si/doc/drzstat/SPSR-ang.pdf). The strategic directions from the Medium-term Programme of Statistical Surveys are presented in detail at http://www.stat.si/doc/drzstat/kakovost/TQMStrategy_2006_eng.doc in the Total Quality Management Strategy 2006–2008.

2.6.1 Official consideration and approval of the inventory

Before the inventory is reported to the EU, EEA or UNFCCC Secretariat, it goes through an approval process. The institution designated for approval is the Ministry of Environmental and Spatial Planning.

2.7 Description and interpretation of emission trends by gas

2.7.1 Emission Trends for Main Pollutants

Emission trends for main pollutants (SO_2, NO_x, NH_3, NMVOC and CO) from years 1980 (1990) to 2009 are represented in Table 14. Emissions decreases are: SO_2 95.08%, NO_x (9.33%), NH_3 (11.09%), NMVOC (43.75%) and CO (56.38%). Target values for the year 2010 are SO_2 (27,00 Gg), NO_x (45,00 Gg), NH_3 (20,00 Gg) and NMVOC (40,00 Gg)

Table 17: National total emissions, emission trends (1980-2009) and emission target for year 2010

Year	Emisssions [Gg]				
	SO_2	NO_x	NH_3	NMVOC	CO
1980	234,04	49,80			285,71
1981	254,51	50,98			277,61
1982	255,96	50,28			266,26
1983	270,83	50,04			249,34
1984	249,21	50,22			261,08
1985	239,38	51,48			280,60
1986	246,04	58,16			305,15
1987	226,02	59,29			322,13
1988	214,09	59,72			312,18
1989	215,96	60,17			315,47
1990	198,06	59,82	19,91	55,21	318,54
1991	183,96	54,65	18,76	53,66	315,76
1992	191,30	53,02	19,51	51,40	287,43
1993	188,28	56,14	17,98	52,74	302,18
1994	181,75	58,21	17,92	53,13	294,68
1995	122,43	57,81	18,06	53,54	295,89
1996	113,86	61,36	17,82	57,94	307,95
1997	117,37	61,72	18,12	54,30	279,70
1998	108,41	56,16	18,25	48,29	238,26
1999	94,57	49,28	18,32	45,52	213,29
2000	92,07	49,78	19,37	44,31	199,20
2001	62,91	50,77	19,14	42,96	191,98
2002	62,72	51,28	20,07	41,74	179,65
2003	61,15	49,53	18,84	40,39	173,65
2004	49,01	48,30	17,50	39,73	158,74
2005	39,88	46,69	17,66	37,38	152,35
2006	16,07	46,01	17,88	36,46	139,45
2007	13,96	48,13	18,59	35,03	136,70
2008	12,75	52,95	17,61	33,12	136,41
2009	11,53	45,16	17,70	31,06	124,63
trend 1980(90)-2009	*- 95.08 %*	*- 9.33 %*	*- 11.09 %*	*- 43.75 %*	*- 56.38 %*
Emission target for 2010	***27,00***	***45,00***	***20,00***	***40,00***	*---

2.7.1.1 SO2 Emissions

National SO_2 emissions steadily decreased from the year 1980, when total amount was 234.04 Gg, to 11.53 Gg in 2009. Emissions were reduced by 95.08% mainly due to lower emissions from thermal power plants (use of FGD –flue gas desulphurization) and power cogeneration plants (gas turbines).

In first decade for various reasons, such as introduction of quality fuels, in particular natural gas, warm winters, operation of the Krško Nuclear Power Plant and energy conservation, SO_2 emissions began to decline. In 1995, SO_2 emissions fell considerably, mostly due to the operation of the device for the desulphurization of flue gases in unit 4 of the Šoštanj Thermal Power Plant but also due to lower sulphur contents in liquid fuels, as required by the DIRECTIVE on the Quality of Liquid Fuels as to the Content of Sulphur, lead, and Benzene (OJ 8/95). In the 2001 and 2005, SO_2 emissions again fell considerably, due to the operation of the device for the desulphurization of flue gases (FGD) in unit 5 of the Šoštanj Thermal Power Plant.(2001) and Thermal Power Plant Trbovlje (2005) (Figure 2).

The 2010 national emission ceiling for SO_2 in Slovenia is 27 Gg regarding Gothenburg Protocol and DIRECTIVE 2001/81/ES of the European Parlament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants.

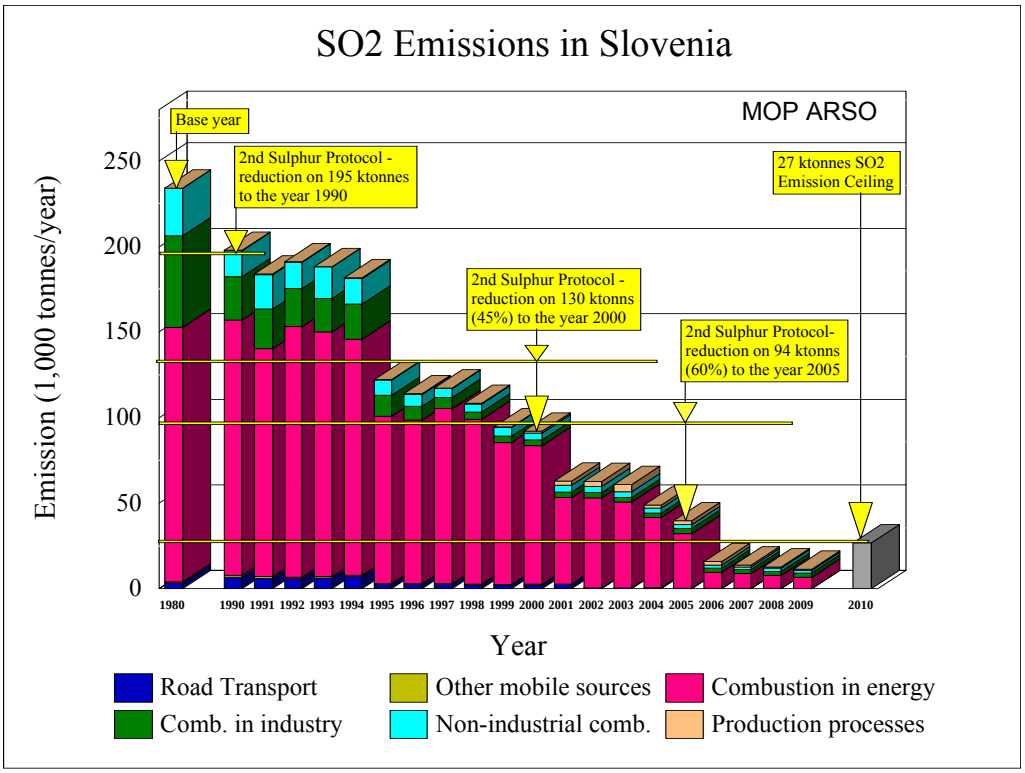

Figure 2: SO2 emissions in Slovenia for years 1980-2009

In 2008 the main sources for SO_2 emissions in Slovenia with a share of 56.88% resulted from combustion in energy, combustion in industry 21.80% and non-industrial combustion 15.17% (Figure 3).

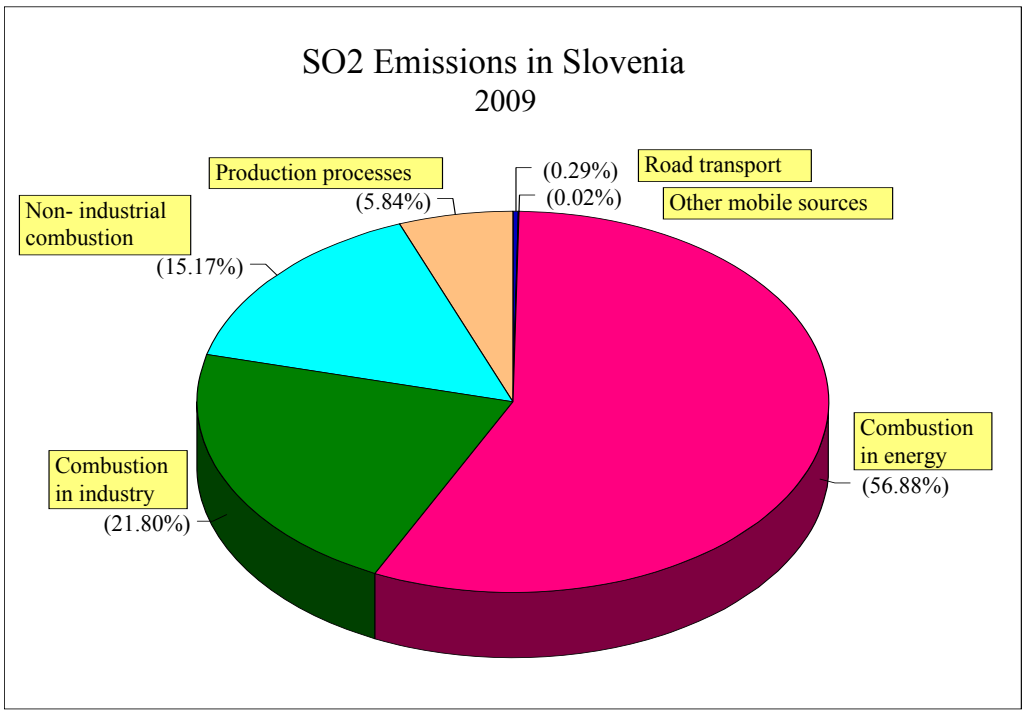

Figure 3: SO_2 emissions in Slovenia divided into sectors for 2009

2.7.1.2 NOX Emissions

Total national NO_x emissions in Slovenia decreased from 59.29 Gg in 1987 to 45.16 Gg in the year 2009 (Figure 4). Emissions of NO_x fluctuated from years 1993-1998.

After 1985, NO_x emissions started to rise, concurrent to the rising numbers of licensed vehicles and the resulting traffic density. In 1991, traffic-originated emissions declined as a result of the interrupted communications with Croatia and areas further south-east. In 1992, NO_x emissions again marked an increase, particulary due to increased road traffic, despite the ever growing numbers of cars with catalytic converters. After 1997, NO_x emissions fell considerably, mostly due to the decline of the fuel tourism along the Italian border. Emissions of NOx decreased from year 2005 due to use of afterburners as primary measure for reduction of emission in Šoštanj thermal power plant and reconstruction of fuel boiler system in Ljubljana power plant. In years 2007 and 2008 increase in NOx emissions is observed due to enlarged transit traffic, decreased in year 2009 due to lover consumption of all fossil fues, especially dissel (Figure 4).

In 2006, Slovenia ratified NO_x Protocol, according to the protocol national emission ceiling target value for NO_x for year 2010 in Slovenia is 45 Gg, which is also in compliance regarding Gothenburg Protocol and DIRECTIVE 2001/81/ES of the European Parlament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants.

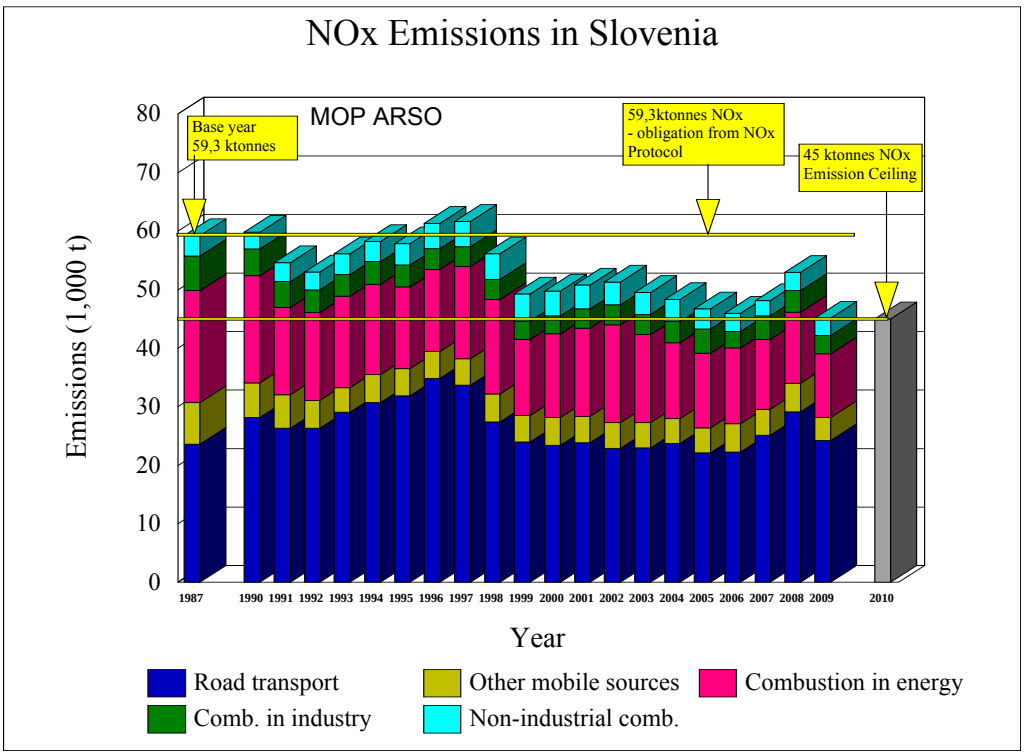

Figure 4: NO_x emissions in Slovenia for years 1987-2009

The main source for NO_x emissions in Slovenia (for year 2009) with a share of 53.70% resulted from Road transport. Another important source with a share of 24.13% was Combustion in energy (Figure 5).

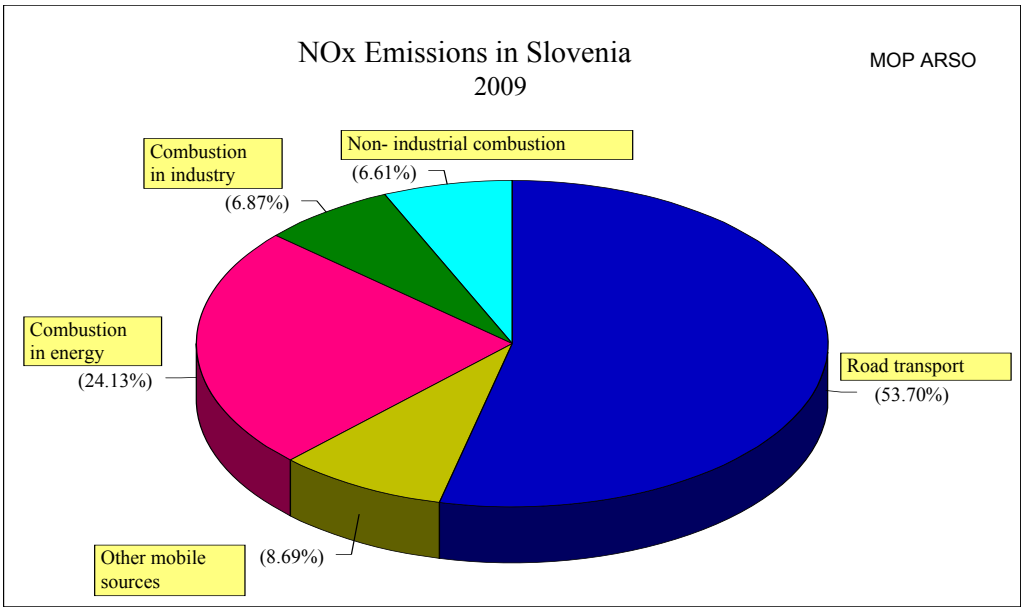

Figure 5: NOx emissions in Slovenia divided into sectors for 2009

2.7.1.3 NMVOC Emissions

National NMVOC emissions started to rise after 1990, concurrent to the rising numbers of licensed vehicles and the resulting traffic density emissions. From the year 1996, when total amount was 57.94 Gg, NMVOC emissions steadily decreased to 31.1 Gg in 2009. Emissions were reduced by 43.75% in comparison with the reference year 1990 (Figure 6).

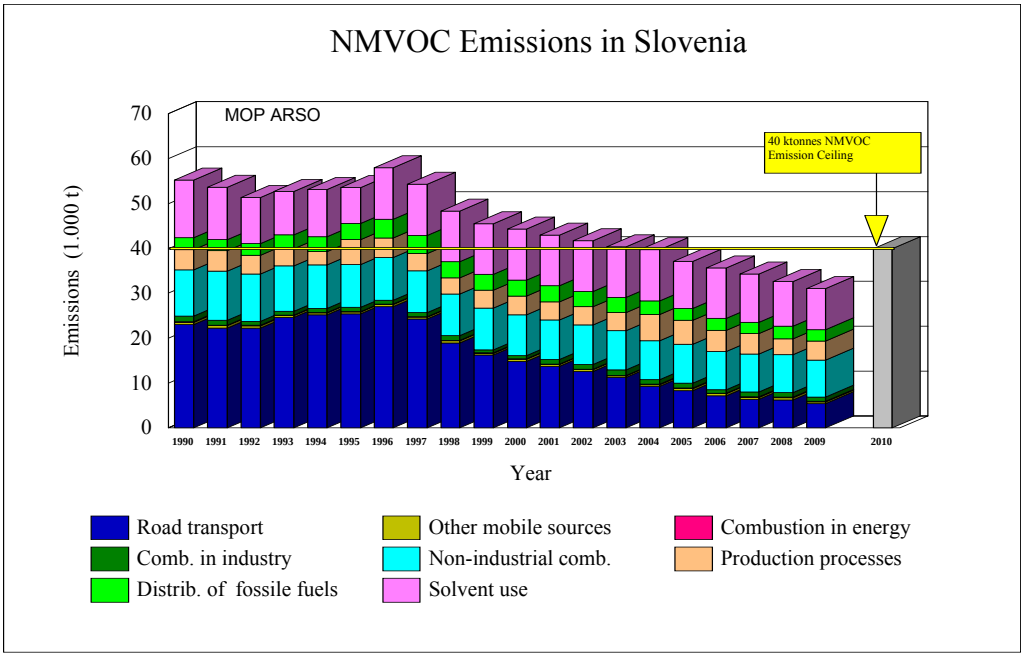

Figure 6: NMVOC emissions in Slovenia for years from 1990 to 2009

In 2009, the main sources for NMVOC emissions in Slovenia are: Solvent use, with a share of 29.5%, Non industrial combustion with a share of 26.65% and Road transport, with a share of 17.55%.

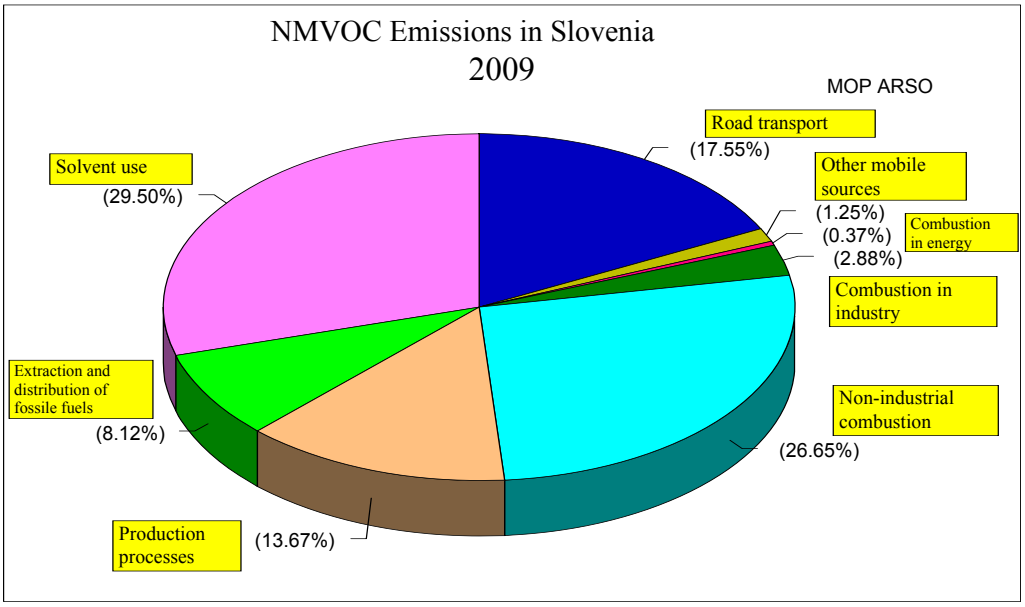

Figure 7: NMVOC emissions in Slovenia divided into sectors for year 2009

2.7.1.4 NH3 Emissions

National NH_3 emissions steadily decreased from the year 1990 with total amount 19.906 Gg to 17.698 Gg in year 2009 (Figure 8). Emissions were reduced by 11.09%, mainly due to decreasing of the livestock populations.

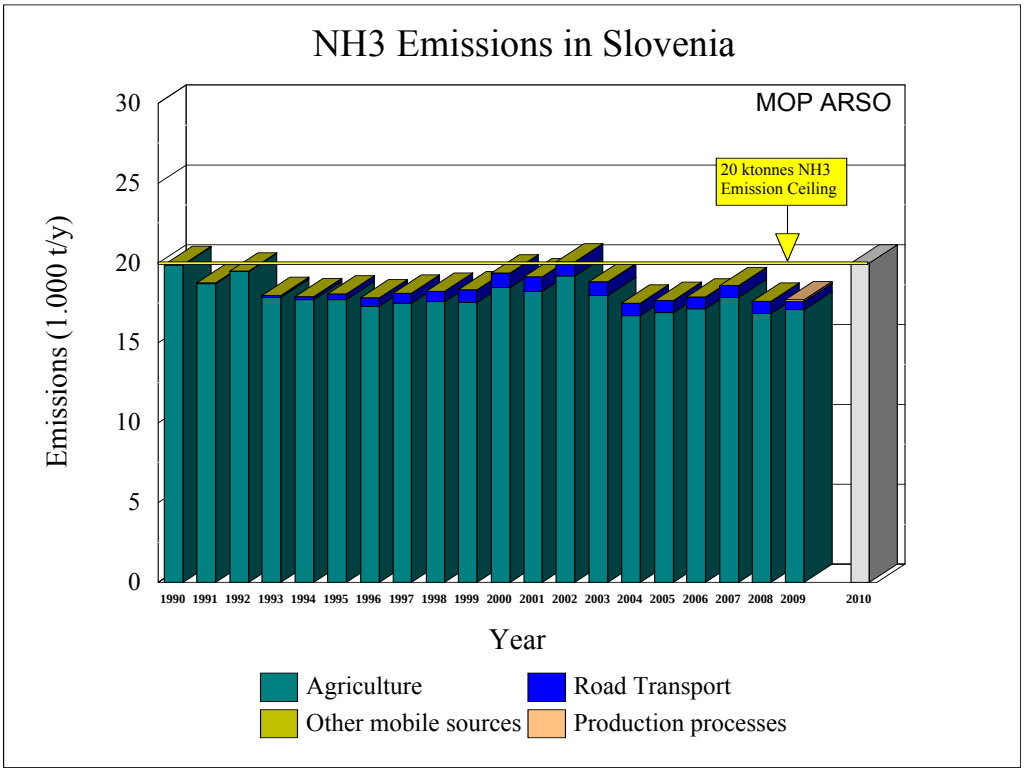

Figure 8: NH_3 emissions in Slovenia from years 1990 to 2009

2.7.1.5 CO Emissions

National CO emissions gradually decreased from the year 1980, when total amount was 285,71Gg, to 124,63 Gg in 2009. Emissions were reduced by 56.38% (**Error! Reference source not found.**).

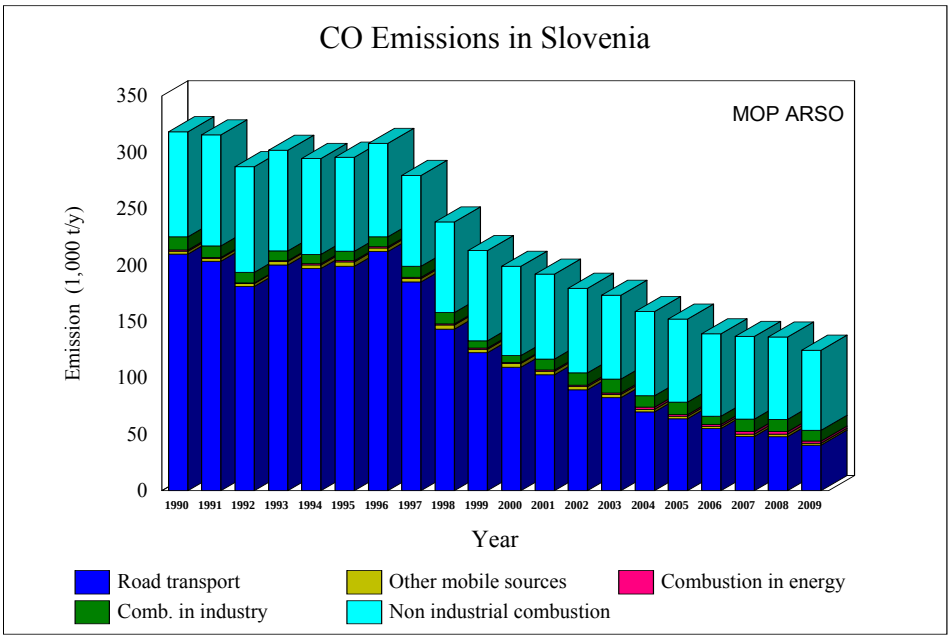

Figure 9: CO emissions in Slovenia from years 1990 to 2009

In 2008, the main sources for CO emissions in Slovenia are: Non industrial combustion with a share of 49.56% and Road transport, with a share of 45.63% (Figure 12).

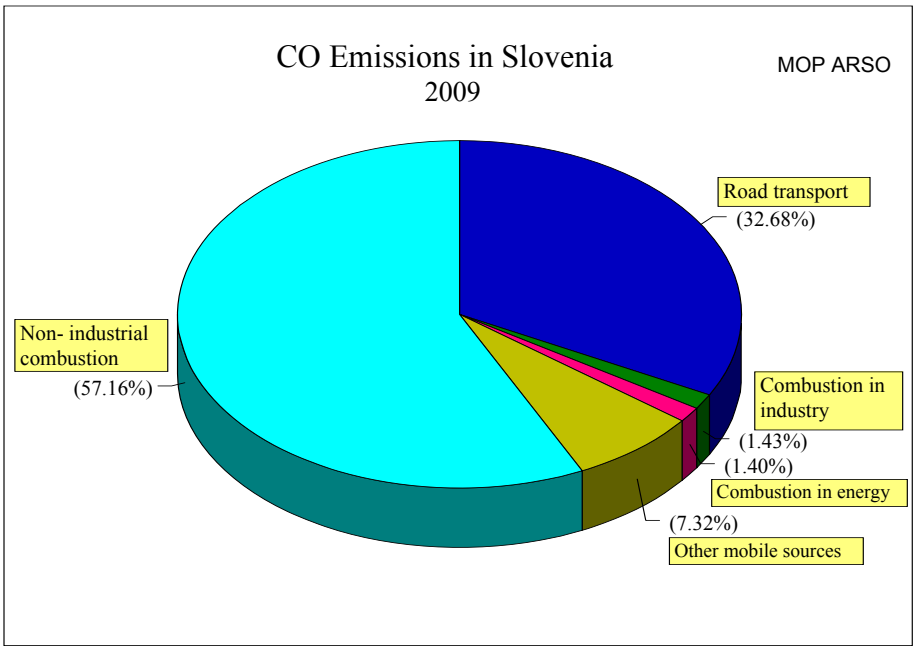

Figure 10: CO emissions in Slovenia divided into sectors for 2009

2.7.2 Emission Trends for Particulate Matter

The most important source of particulate matter emissions (PM2,5, PM10 and TSP) is combustion of wood in stationary residential sector. Other significant sources are: road transport, agriculture, combustion of fossil fuels and production processes. The particulate matter emissions have decreased significant in the year 2008. The reason for the reduced emissions is mainly increased use of cleaning devices at cement and aluminium production plants.
The reduction emission trend from year 2000 to 2009 was 11.88% for PM2,5, 18.52% for PM10 and 18.69% for TSP, respectively (Table 18).

Table 18: National total emissions and emission trends (2000-2009) for PM

Year	Emisssions [Mg]		
	PM2.5	PM10	TSP
2000	14,50	19,38	25,38
2001	14,35	19,01	24,81
2002	14,12	18,60	24,72
2003	14,09	18,17	23,67
2004	13,90	18,28	23,85
2005	14,02	18,53	24,87
2006	13,84	18,19	23,75
2007	14,13	18,45	23,85
2008	13,45	16,56	21,51
2009	12,78	15,79	20,64
Trend (%)	***-11,88***	***-18,52***	***-18,69***

2.7.2.1 PM2.5 Emissions

National PM2.5 emissions gradually decreased from the year 2000, when total amount was 14.5 Gg, to 12.78 Gg in 2009. Emissions were reduced by 11.9% mainly due to lower emissions from aluminium production, thermal power plants (use of FGD –flue gas desulphurization) and power cogeneration plants (gas turbines) and increased use of cleaning devices at production processes sector (Figure 11).

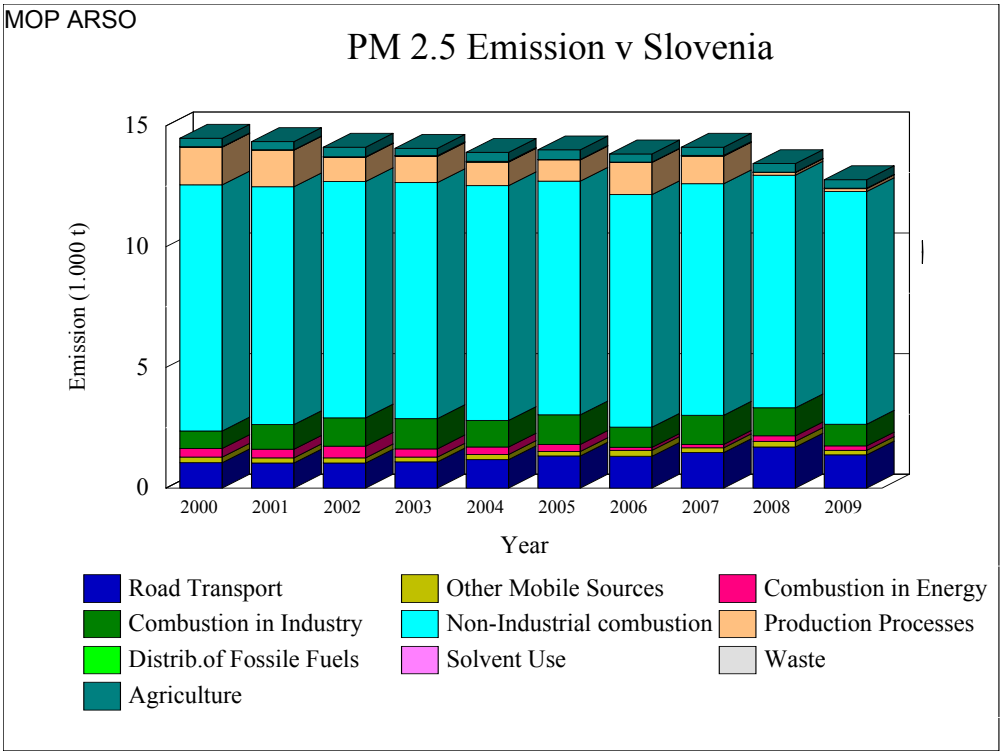

Figure 11: PM2.5 emissions in Slovenia for years 2000 to 2009

In 2009, the main sources for PM2.5 emissions in Slovenia are: Non-industrial combustion with a share of 75.33%, road transport with a share of 10.79% and combustion in industry with a share of 7.04%, (Figure 12).

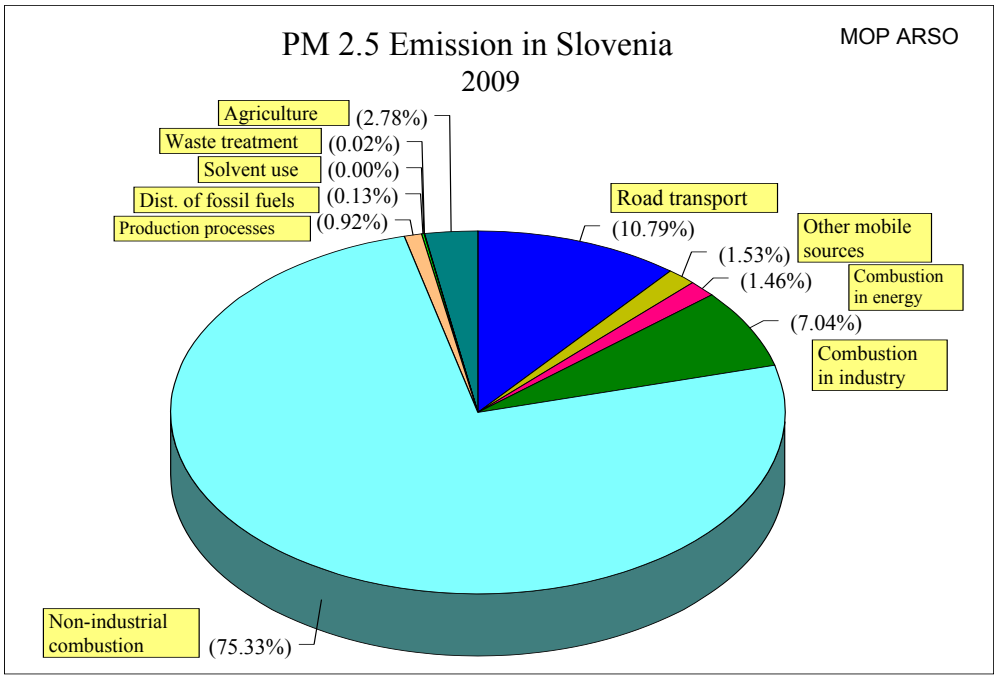

Figure 12: PM2.5 emissions in Slovenia divided into sectors for 2009

2.7.2.2 PM10 Emissions

National PM10 emissions gradually decreased from the year 2000, when total amount was 19.38 Gg, to 15.79 Gg in 2009. Emissions were reduced by 18.52% mainly due to lower emissions from aluminium production, thermal power plants (use of FGD –flue gas desulphurization) and power cogeneration plants (gas turbines) and increased use of cleaning devices at production processes sector (Figure 13).

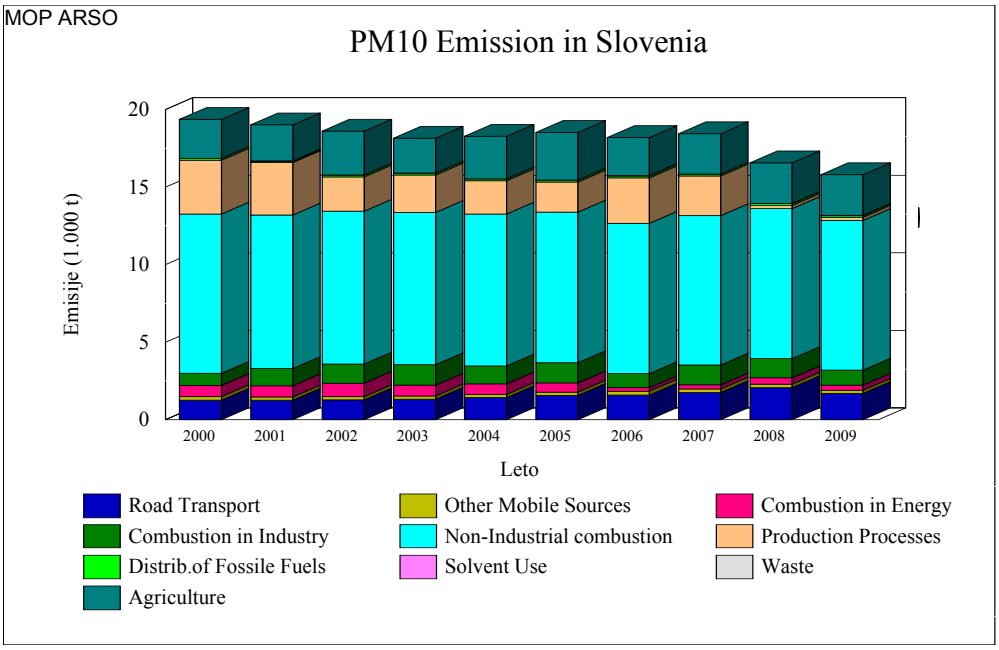

Figure 13: PM10 emissions in Slovenia for years 2000 to 2009

In 2009, the main sources for PM10 emissions in Slovenia are: Non-industrial combustion with a share of 61.25%, agriculture with a share of 16.59%, road transport with a share of 10.75% and combustion in industry with a share of 6.03% (Figure 14).

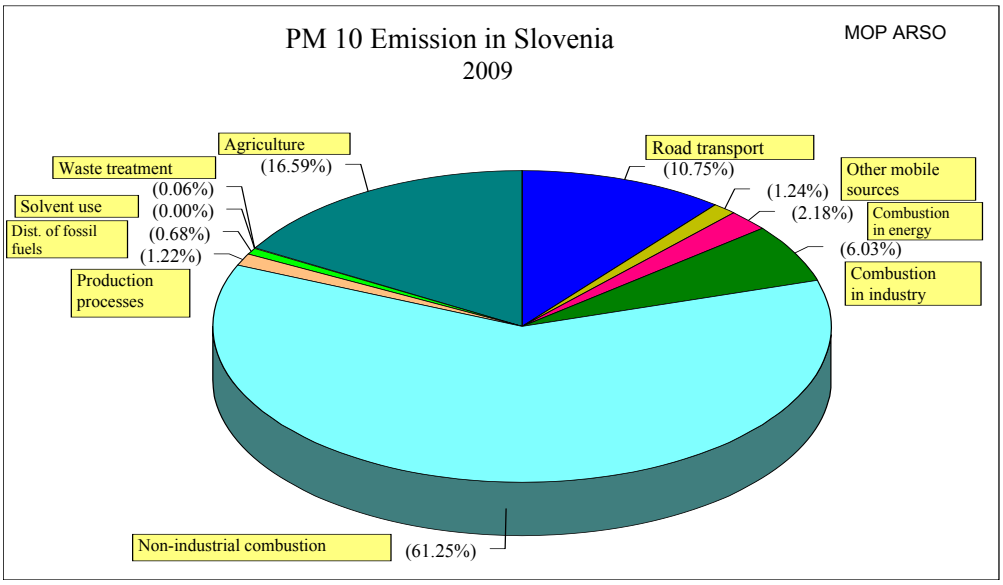

Figure 14: PM10 emissions in Slovenia divided into sectors for 2009

2.7.2.3 TSP Emissions

National TSP emissions gradually decreased from the year 2000, when total amount was 25.38 Gg, to 20.64 Gg in 2009. Emissions were reduced by 18.69% mainly due to lower emissions from aluminium production, thermal power plants (use of FGD –flue gas desulphurization) and power cogeneration plants (gas turbines) and increased use of cleaning devices at production processes sector (Figure 15).

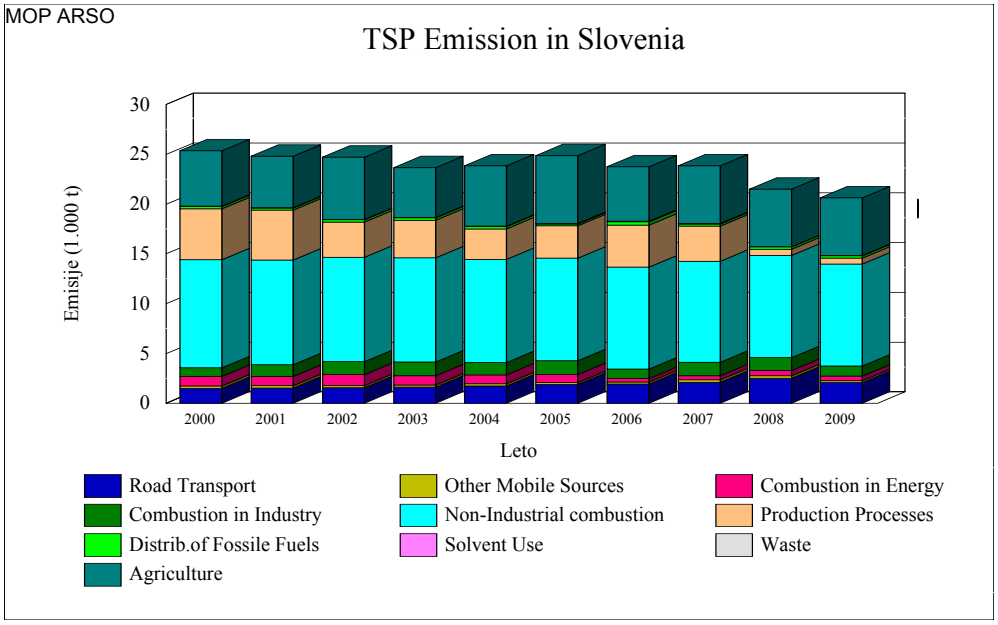

Figure 15: TSP emissions in Slovenia for years 2000 to 2009

In 2009, the main sources for TSP emissions in Slovenia are: Non-industrial combustion with a share of 49.56%, agriculture with a share of 28.11%, road transport with a share of 10.11%, and combustion in industry with a share of 4.94% and (Figure 16).

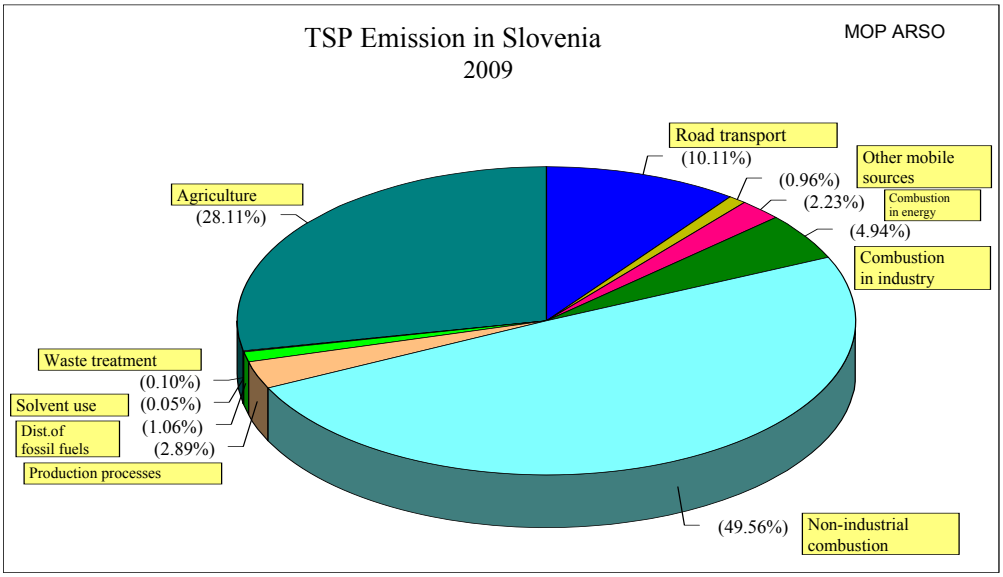

Figure 16: TSP emissions in Slovenia divided into sectors for 2009

2.7.3 Emission Trends for Heavy Metals

In general, the most important sources of heavy metal (Pb, Cd and Hg) emissions are production processes, combustion of fossil fuels and road transport. The heavy metal emissions have decreased substantially in recent years. The reason for the reduced emissions is mainly increased use of gas cleaning devices at power plants. The large reduction in the Pb emission is due to a gradual shift towards unleaded gasoline. Based on estimates of Hg capture by currently installed pollution control equipment (ESP+flue-gas desulphurization-FGD) the emission factor for Hg was corrected according to operation of FGD device and amount of coal used in FGD devise (Hower et al., 2005). Emission factors used for emission calculation of heavy metals are presented in Kanduč, 2009.
The reduction emission trend from year 1990 to 2009 was 30.29% for Hg, 96.20% for Pb and 32.79% for Cd, respectively (Table 19).

Table 19: National total emissions and emission trends (1990-2009) for heavy metals (Pb, Cd and Hg)

Year	Emisssions [Mg/year]		
	Pb	Cd	Hg
1990	357.291	0.866	1.170
1991	328.052	0.744	1.052
1992	358.961	0.674	1.066
1993	387.711	0.670	1.037
1994	395.633	0.671	0.977
1995	259.880	0.674	0.905
1996	108.631	0.662	0.902
1997	97.988	0.632	1.003
1998	79.183	0.565	1.002
1999	68.244	0.593	0.924
2000	63.487	0.588	0.929
2001	57.274	0.557	0.834
2002	13.210	0.466	0.838
2003	9.817	0.454	0.821
2004	10.240	0.424	0.815
2005	13.079	0.528	0.789
2006	14.853	0.550	0.802
2007	14.892	0.613	0.845
2008	15.488	0.639	0.899
2009	13.562	0.582	0.816
Reduction trend (%)	***96.20***	***32.80***	***30.29***

2.7.3.1 Pb Emissions

As it can be observed from Lead (Pb) emissions gradually increased since 1991. In this period from 1992-1994 also a strong increase of consummation of unleaded petrol (in 1996 the share of consumption of unleaded petrol amounted to 60% of leaded petrol to 40%) was observed. In 1995, lead emissions strongly decreased, since the DIRECTIVE on the Quality of Liquid Fuels with regard to the Contents of Sulphur, Lead and Benzene (OJ RS, No 8/95) took into force. The leaded petrol was phased out in July 2001.National Pb emissions decreased from the year 1990, when total amount was 357.29 Mg, to 13.56 Mg in 2009. Emissions were reduced by 96.2%.

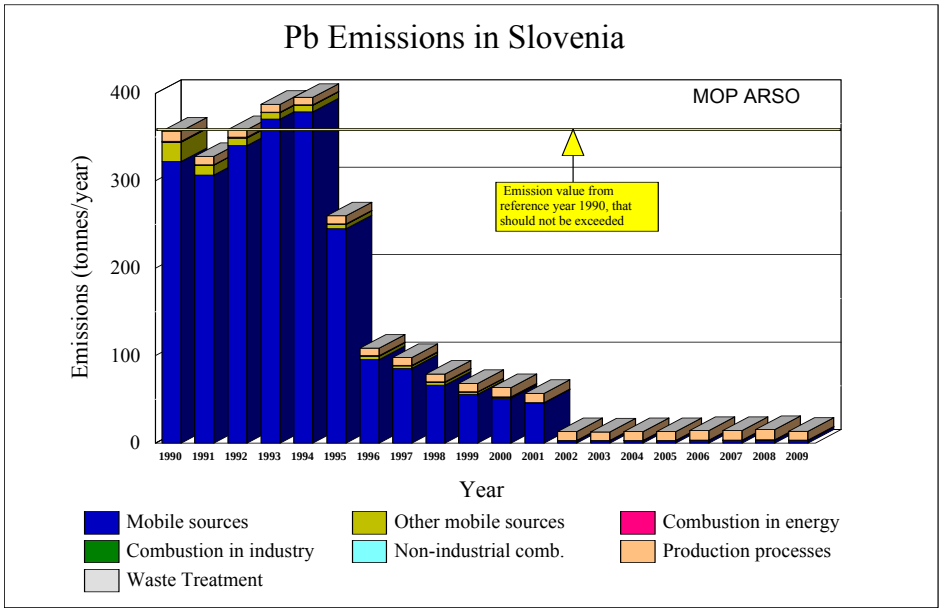

Figure 17: Pb emissions in Slovenia for years 1990 to 2009

In 2008, the main sources for Pb emissions in Slovenia are Production processes with a share of 72.52%, road transport with a share of 23.96% and combustion in energy 1.51% (Figure 18).

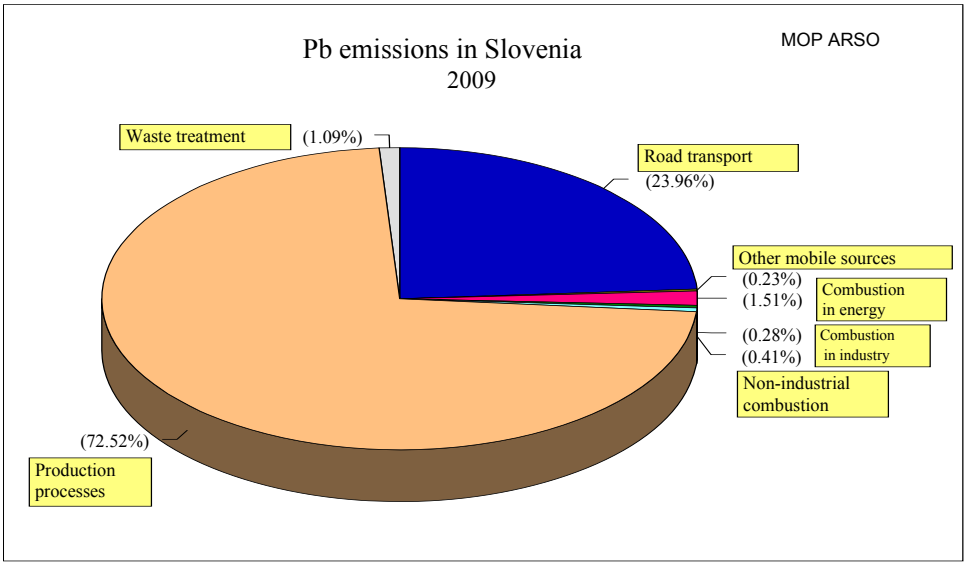

Figure 18: Pb emissions in Slovenia divided into sectors for 2009

2.7.3.2 Cd Emissions

As it can be observed from Figure 18 national Cadmium (Cd) emissions decreased since 1990. After the year 1996, Cd emissions decreased due to lower emission in combustion in industry and non industrial combustion National Cd emissions decreased from the year 1990, when total amount was 0.87 Mg, to 0.58 Mg in 2009. Emissions were reduced by 32.80%.

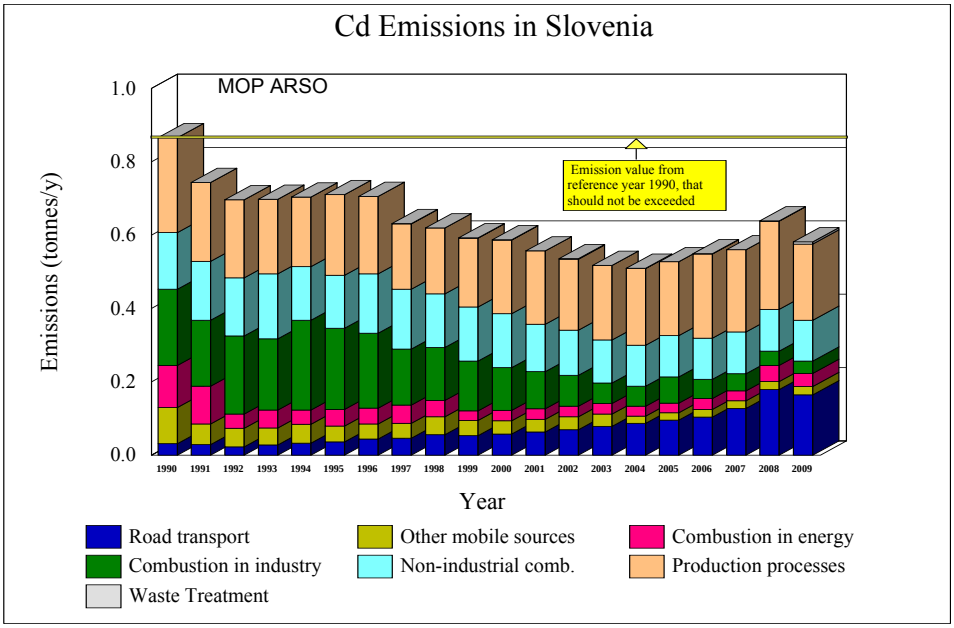

Figure 19: Cd emissions in Slovenia for years from 1990 to 2009

In 2009, the main sources for Cd emissions in Slovenia are: Production processes with a share of 35.68%, Road transport with ashare of 28.34 and Non-industrial combustion with a share of 19.16% (Figure 20).

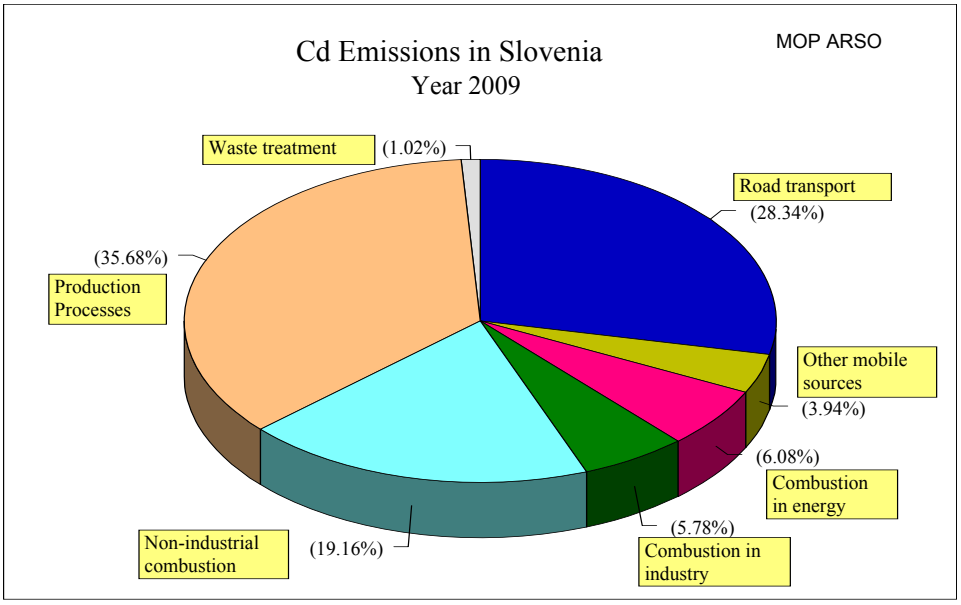

Figure 20: Cd emissions in Slovenia divided into sectors for year 2009

2.7.3.3 Hg Emissions

National emissions of mercury decreased from 1.17 Mg in year 1990 to 0.82 Mg in 2009. Emissions were reduced by 30.29% (Figure 21).

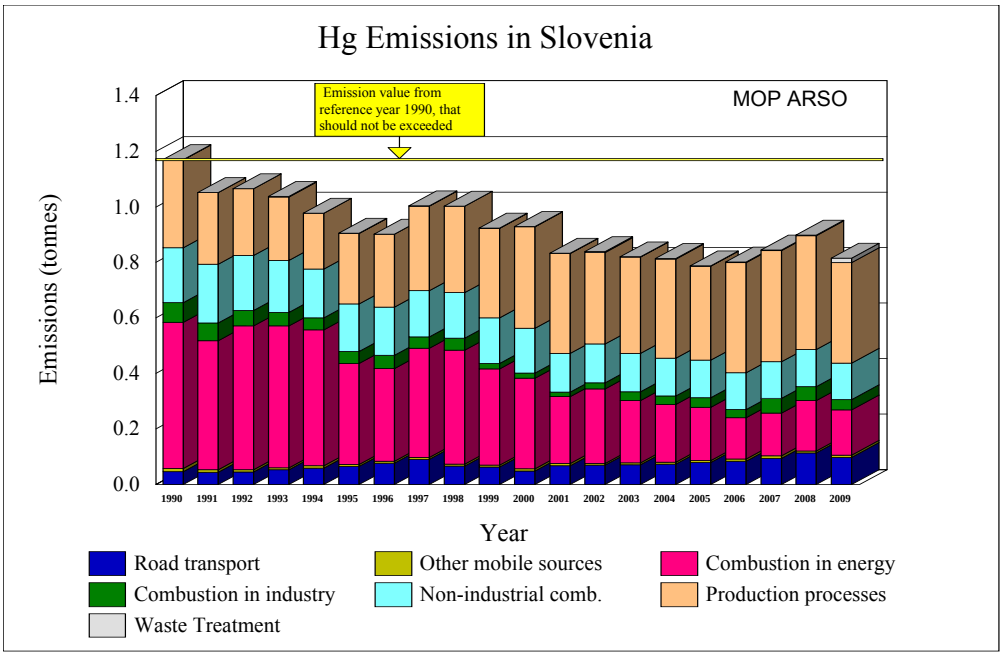

Figure 21: Hg emissions in Slovenia from years 1990 to 2009

In 2009, the main sources for Mercury emissions in Slovenia are: Production processes with a share of 44.28%, Combustion in energy with a share of 20.07% and Non-industrial combustion with a share of 16.2% (Figure 22).

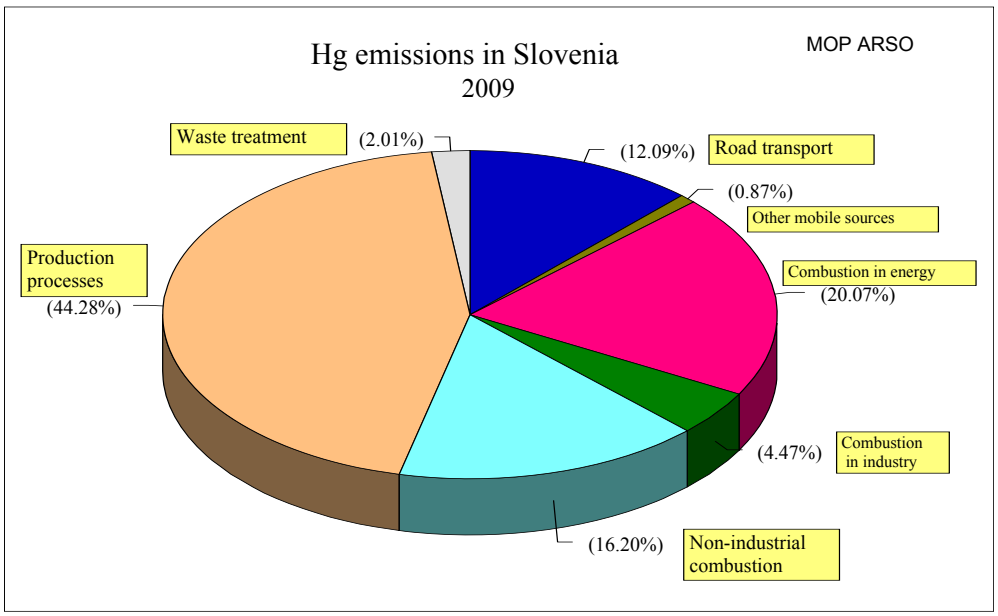

Figure 22: Hg emissions in Slovenia divided into sectors for 2009

2.7.4 Emission Trends for Persistant Organic Pollutants

Persistent Organic Pollutants (POPs) is a common name of a group of pollutants that are semi-volatile, bioaccumulative, persistent and toxic (e. g. Vallack et al., 1998, Jones and de Voogt, 2000). Although the occurrence of POPs at elevated levels is of great environmental concern at contaminated hot spots, the regional and global significance to the problem has received increasing attention in the last decades (Wania and Mackay, 1993, UNECE, 1998, UNEP, 2003). The overall and long-term goal of the Aarhus Protocol on POPs is to eliminate any discharges, emissions and losses of POPs to the environment. Another agreement, which is ratified by Slovenia, is Stockholm Convention on Persistent Organic Pollutants (Breivik et al., 2004). Within these conventions, the establishment of emission inventories for POPs is mandatory and provides the basis for further emission reductions among Parties (e.g. UNEP, 1999/2001, Verstreng and Klein, 2002).

For POPs, the following three policy documents in Slovenia are relevant:

- National Implementation Plan (NIP) as pursuant to article 7 of the Stockholm Convention on Persistent Organic Pollutants (in the governmental procedure for the adoption);
- Action plan of reduction and minimization of releases of PAH, PCDD/DF and HCB (in the governmental procedure for adoption);
- Operational programme concerning management of PCB and PCT for 2009-2012 (adopted by the Government in 2003).

The National Emission Inventory (NEI) for calculation and reporting emissions was established in Slovenia according to EU Directive 2001/81/EU, which was transferred to Decree on the national emission ceilings for atmospheric pollutants (OJ RS No. 24/2005, 92/2007). NEI inventory enables the calculation of the emission data (release data into the atmosphere) for the four main pollutants, heavy metals, particulate matter and POPs according to the EMEP/CORINAIR methodology. The major sources of activity data are the Statistical Office of the Republic of Slovenia and the Ministry of Environment and Spatial Planning; however, the Environmental Agency obtains much of its data through other activities, which are performed under the Environmental Protection Act (OJ RS No. 41/2004).

Example of calculations for PCDD/PCDF is shown by equation:

$E = EF \times A$

E annual emission of a source (g I-TEQ/yr)

EF emission factor (g I-TEQ/kg), defined as the mass of a product or its raw material consumed. A concentration may be used for some sources

A activity rate (kg/yr or t/yr), defined as the mass of a product or its raw material consumed annually or daily

In general, the most accurate way to establish emission rates is to measure them. However in most cases only limited measurements data are available. Therefore several guidebooks, guidelines and scientific literature make proposals for emission estimates when measurements data are lacking e.g. Berdowski et al., 1995, 1997, Parma et al., 1995, Quass and Fermann 1997, Pacyna et al., 2003. In Slovenia emission national emission factors are not available; therefore they were taken from guidebooks. Clearly, for some source categories, the range of various emission factors reported in the literature is variable by two orders of magnitude (Pacyna et al., 2003). Uncertainty of the applied emission factors is one of the key reasons for the substantial uncertainties in the emission estimates, as most activity data are firmly believed to be far more accurate.

Emission factors used for calculation of POPs (HCB, PCB, PAH: benzo(a)pyrene, benzo(k)fluoranthene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene and PCDD/DF) emissions are presented in Kanduč, 2009.

Table 20: National total emissions and emission trends (1980-2009) for POPs (PCB, PCDD/DF, PAH and HCB)

Year	PCB	PCDD/ PCDF	benzo(a) piren	benzo(b) fluoranten	benzo(k) fluoranten	Indeno (1,2,3)piren	PAH	HCB
	kg	g I-Teq	Mg	Mg	Mg	Mg	Mg	kg
1990	448.114	16.261	3.808	4.943	1.819	2.903	13.472	46.552
1991	444.539	16.724	3.907	5.090	1.877	3.058	13.932	40.561
1992	404.394	15.104	3.770	4.910	1.785	2.888	13.353	37.432
1993	379.832	13.886	3.656	4.759	1.713	2.738	12.866	37.424
1994	351.991	12.714	3.568	4.634	1.657	2.619	12.475	37.421
1995	320.712	12.390	3.507	4.556	1.623	2.543	12.229	37.346
1996	303.357	12.248	3.492	4.540	1.613	2.527	12.172	36.120
1997	285.907	11.886	3.440	4.465	1.581	2.453	11.939	37.523
1998	275.785	11.627	3.423	4.439	1.569	2.429	11.860	37.213
1999	242.027	11.106	3.422	4.435	1.564	2.427	11.848	37.734
2000	230.528	11.426	3.410	4.412	1.557	2.406	11.785	38.142
2001	212.998	10.573	2.960	3.826	1.361	2.080	10.227	38.489
2002	184.411	10.501	2.992	3.856	1.395	2.078	10.320	0.302
2003	169.642	10.183	2.947	3.816	1.363	2.073	10.198	0.321
2004	149.593	10.463	2.974	3.822	1.399	2.045	10.239	0.346
2005	123.544	10.268	2.995	3.836	1.402	2.066	10.299	0.397
2006	106.884	10.351	2.993	3.833	1.405	2.055	10.286	0.423
2007	106.954	10.315	3.027	3.884	1.421	2.087	10.420	0.488
2008	73.473	10.590	2.996	3.859	1.395	2.084	10.334	0.548
2009	64.982	9.776	2.887	3.741	1.312	2.041	9.982	0.514
Reduction trend (%)	**85.50**	**39.88**	**24.17**	**24.31**	**27.85**	**29.68**	**25.91**	**98. 89**

The PCB, PCDD/DF, PAH and HCB emissions according to current national legislation, autonomous measures and current ratification status of the POPs protocol indicates in Table 20 that emissions decline substantially from year 1990 to 2009 for PCB (85.50%), PCDD/DF (39.88%), PAH (25.91%) and HCB (98.89%).

2.7.4.1 PAH Emissions

Polycyclic aromatic hydrocarbons (PAHs) are a group of compounds composed of two or more fused aromatic rings. The UNECE POPs Protocol specified that the following 4 PAHs should be used as indicators for the purposes of emission inventories: benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[123-cd]pyrene. Emissions of different PAHs: benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[123-cd]pyrene from year 1990 to 2009 are presented in Figure 23. Among PAHs pollutants the emission of benzo(b)fluoranten is the highest.

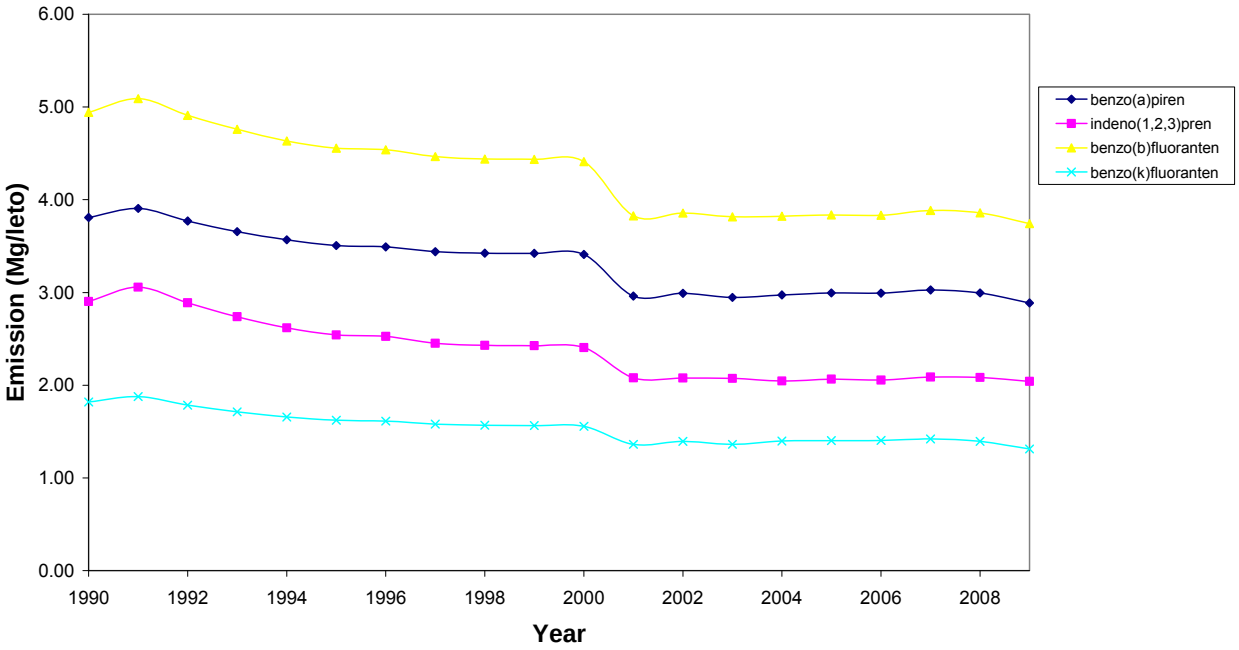

Figure 23: Emissions of benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[123-cd]pyrene from the reference year 1990 to 2009

National PAH emissions decreased from 13.47 Mg (year 1990) to 9.98 Mg in year 2009 (Figure 24). Emissions were reduced by 25.91%.

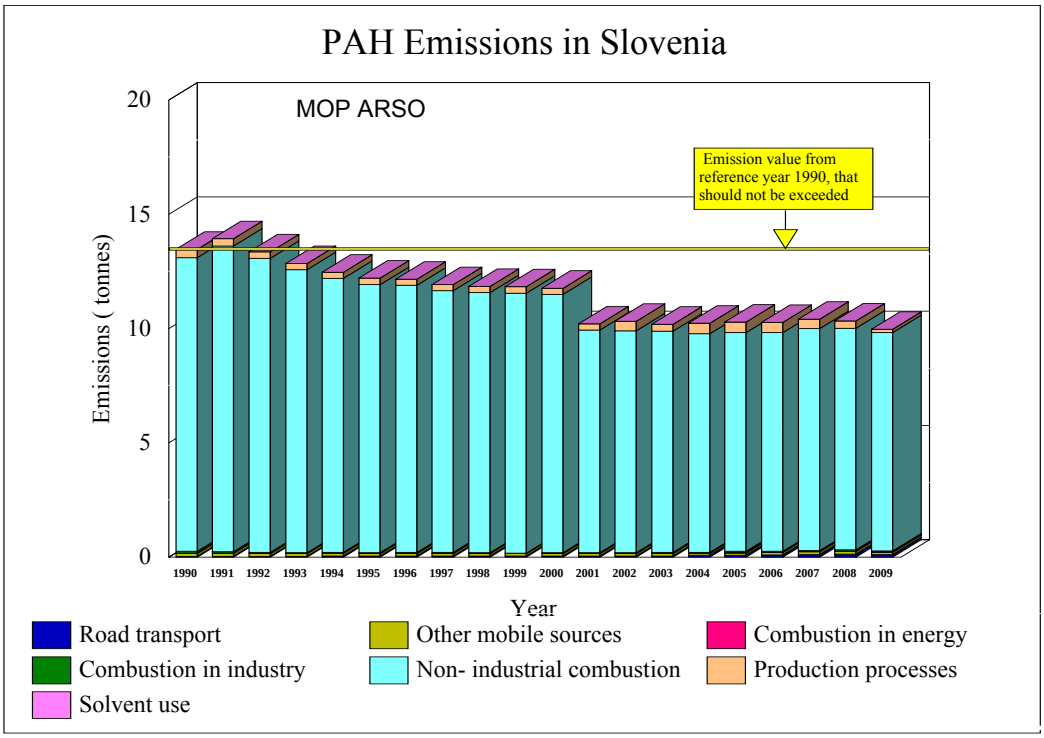

Figure 24: PAH emissions in Slovenia from 1990 to 2009

The main sources for PAH emissions in 2009 is Non industrial combustion, with a share of 95.87%, minor contribution is attributed to production processes, road transport and other mobile sources (Figure 25).

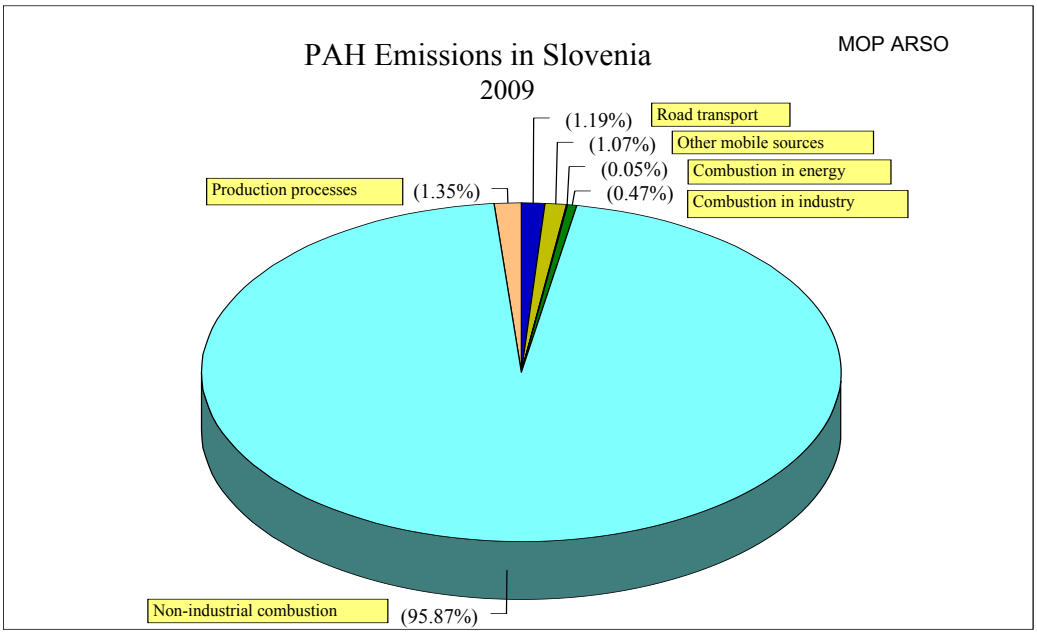

Figure 25: PAH emissions in Slovenia divided into sectors for 2009

2.7.4.2 PCB Emissions

National PCB emissions steadily decreased from the year 1990, when total amount was 448.11 kg, to 64.98 kg in 2009. Emissions were reduced by 85.50%, mainly due to phasing out of electrical equipment containing PCB (Figure 26).

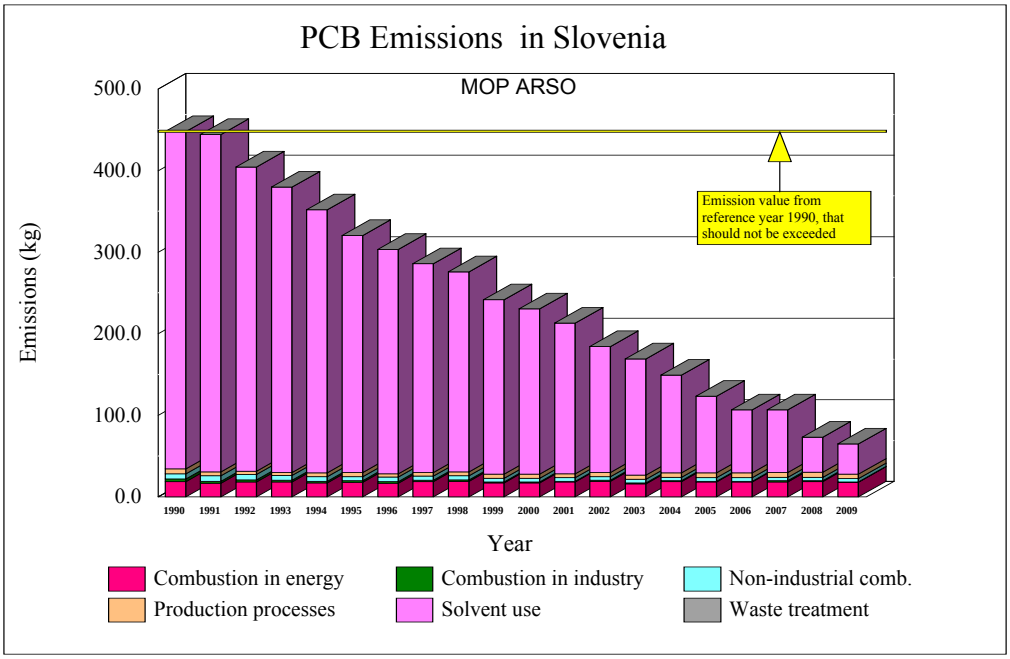

Figure 26: PCB emissions in Slovenia from 1990 to 2009

In 2009, the main sources for PCB emissions in Slovenia are: Solvent use (electrical equipment containing PCB), with a share of 56.96%, Combustion in energy, with a share of 27.55%, and Production processes, with a share of 8.21% (Figure 27).

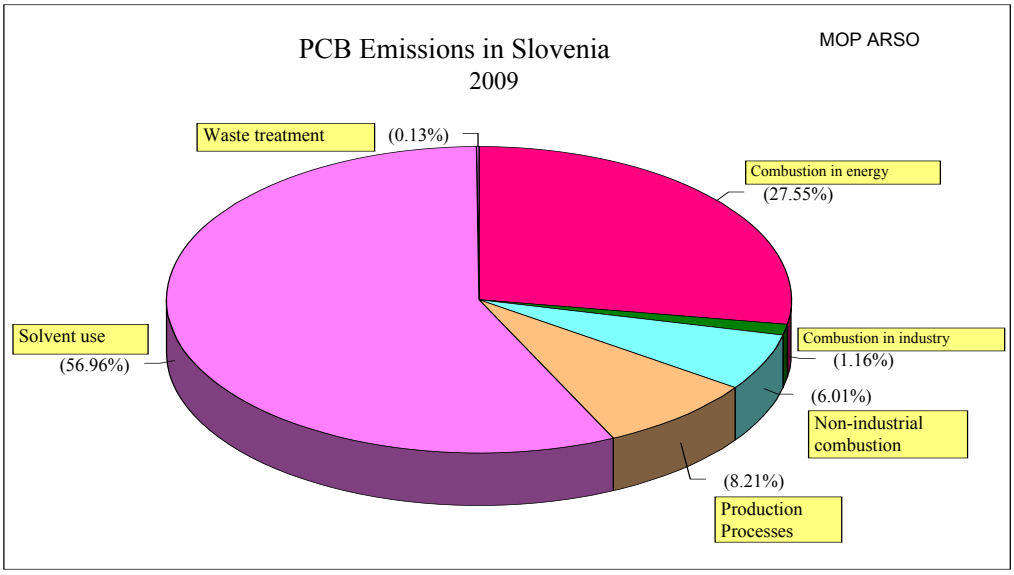

Figure 27: PCB emissions in Slovenia divided into sectors for 2009

2.7.4.3 PCDD/DF Emissions

National Dioxin/Furan emissions steadily decreased from the year 1990, when total amount was 16.26 g I-Teq, to 9.77 g I-Teq in 2009. Emissions were reduced by 39.88% (Figure 28).

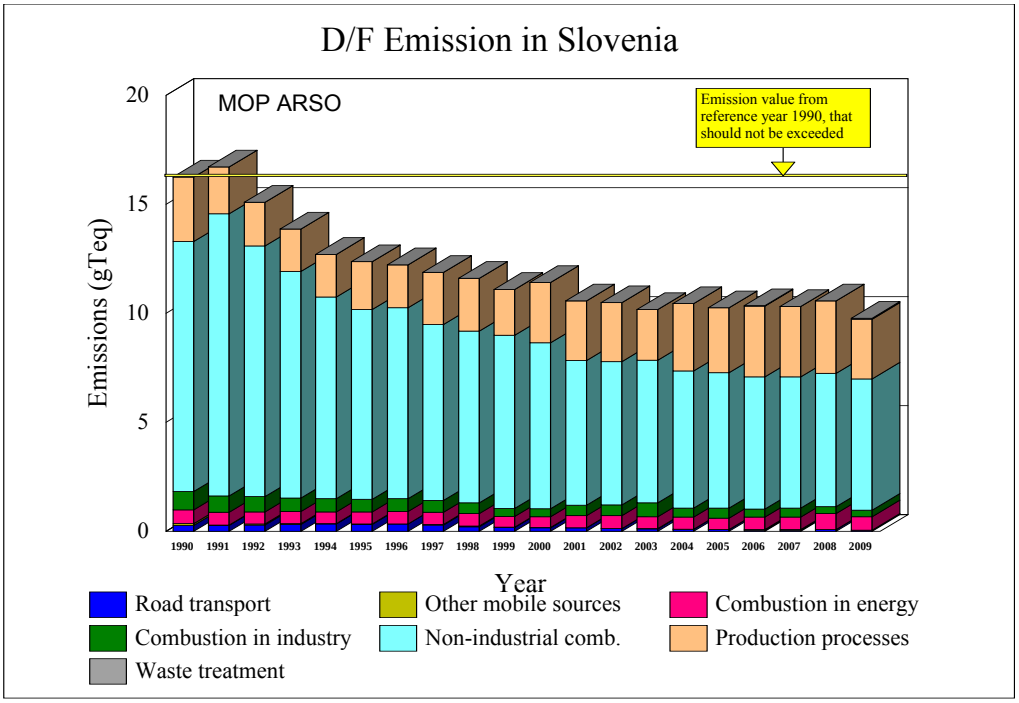

Figure 28: PCDD/DF emissions in Slovenia 1990-2009

In 2009, the main sources for Dioxin/Furan emissions in Slovenia are: Non industrial combustion, with a share of 61.51%, Production processes, with a share of 28.15%, and Combustion in energy, with a share of 6.34% (Figure 29).

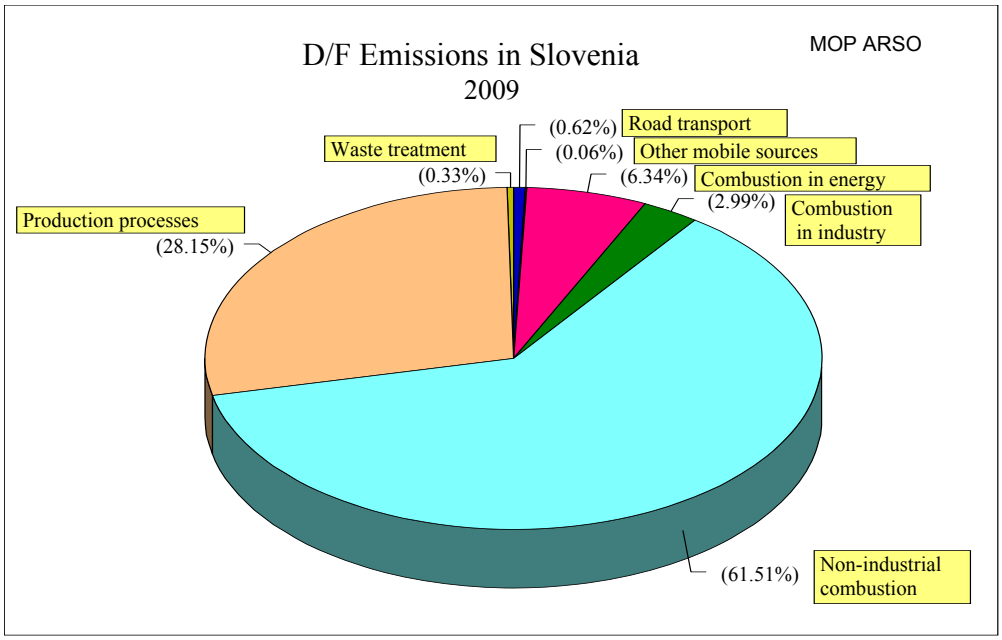

Figure 29: PCDD/DF emissions in Slovenia divided into sectors for year 2009

2.7.4.4 HCB Emissions

National HCB emissions decreased from the year 1990, when total amount was 46.55 kg, to 0.51 kg in 2009 (Figure 30). In 2002, HCB emissions are reduced considerably due to abatement of Hexachloretan in secondary Aluminium production (Homšak, 2007). Emissions were reduced by 98.89%.

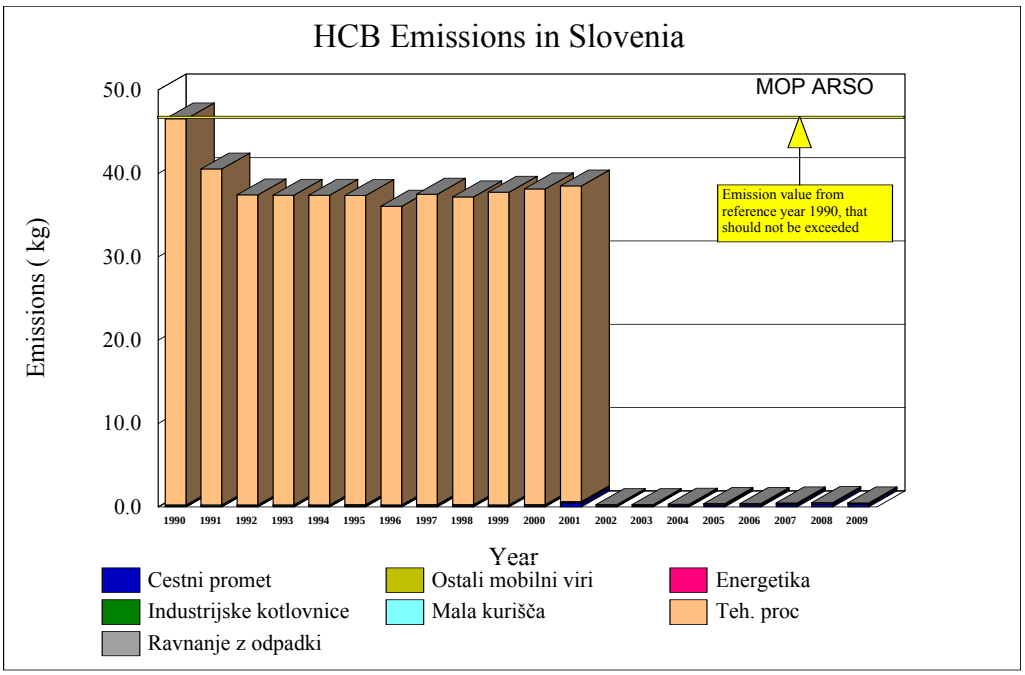

Figure 30: HCB emissions in Slovenia 1990-2009

In 2009, the main sources for HCB emissions in Slovenia are: Road transport, with a share of 53.52%, Combustion in energy, with a share of 16.57% and Non industrial combustion, with a share of 13.8% (Figure 31).

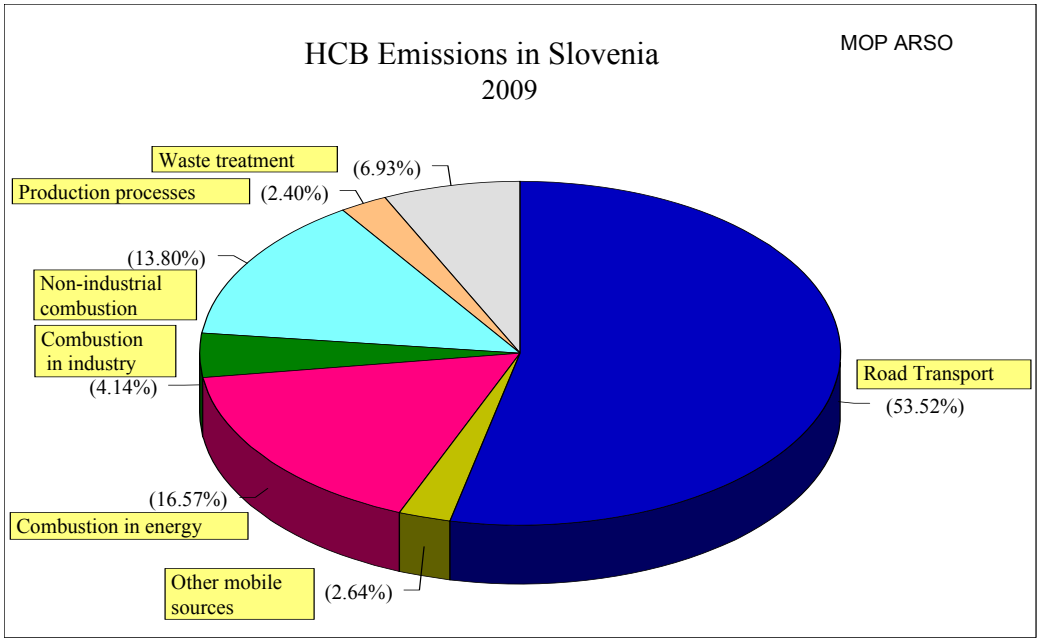

Figure 31: HCB emissions in Slovenia divided into sectors for year 2009

3 ENERGY

3.1 Overview of sector

The energy sector is the most important sector considering major air pollutants air emissions in the Republic of Slovenia. Emissions from this sector arise mostly from fuel combustion and as fugitive emissions from fuels (fugitive emissions in the Republic of Slovenia are of minor importance).

Table 21: Emissions from Energy sector by sources for 2009.

	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO	Pb	Cd	Hg
	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Mg	Mg	Mg
1 Energy	45,157	16,690	10,852	0,482	12,288	12,862	13,992	124,302	3,580	0,370	0,438
A Fuel Combustion	45,157	16,690	10,852	0,482	12,288	12,862	13,992	124,302	3,580	0,370	0,438
1 Energy Industries	10,898	1,679	6,556	0,000	0,187	0,344	0,460	1,422	0,204	0,035	0,164
2 Manufact. Ind. and Constr.	4,234	1,012	2,513	0,000	0,972	1,025	1,092	9,493	0,041	0,038	0,039
3 Transport	24,891	5,516	0,035	0,481	1,395	1,715	2,105	41,473	3,277	0,170	0,099
4 Other Sectors	5,135	8,483	1,749	0,000	9,734	9,778	10,335	71,914	0,058	0,126	0,136
5 Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B Fugitive Emiss. from Fuels	NA	2,523	NA	NA	0,016	0,107	0,218	NA	NA	NA	NA
1 Solid fuels	NA	NA	NA	NA	0,016	0,107	0,218	NA	NA	NA	NA
2 Oil and Natural Gas	NA	2,523	NA	NA	NA	NA	NA	NA	NA	NA	NA

	PCDD/ PCDF	benzo(a) pyrene	benzo(b) fluoran-thene	benzo(k) fluoran-thene	Indeno (1,2,3-cd) pyrene	PAHs Total 1-4	HCB	PCBs
	g I-Teq	Mg	Mg	Mg	Mg	Mg	kg	kg
1 Energy	7,003	2,838	3,701	1,272	2,036	9,847	0,466	22,560
A Fuel Combustion	7,003	2,838	3,701	1,272	2,036	9,847	0,466	22,560
1 Energy Industries	0,620	0,000	0,003	0,003	0,000	0,005	0,085	17,900
2 Manufact. Ind. and Constr.	0,305	0,026	0,016	0,019	0,026	0,087	0,026	0,756
3 Transport	0,062	0,028	0,038	0,035	0,029	0,129	0,277	0,000
4 Other Sectors	6,016	2,784	3,645	1,215	1,981	9,626	0,078	3,903
5 Other	NA	NA	NA	NA	NA	NA	NA	NA
B Fugitive Emiss. from Fuels	NA	NA	NA	NA	NA	NA	NA	NA
1 Solid fuels	NA	NA	NA	NA	NA	NA	NA	NA
2 Oil and Natural Gas	NA	NA	NA	NA	NA	NA	NA	NA

3.2 Fuel

3.2.1 Country-specific issues

An interesting feature of inventories of air emissions for Slovenia is the fact that the chosen 1980 base year goes back to the time when Slovenia was still a part of Yugoslavia. This fact notwithstanding, Slovenia has already at that time had its own electrical energy statistics and annual reports, which have been published annually without any interruptions ever since 1955. Due to the stable functioning system of data collection and economic conditions (no commercially sensitive data) it is correct to say that the energy statistics in particular was exceptionally good and centralized, and the data reliable and trustworthy.

The number of key reporting units prior to 1992 was exceptionally small, since only one enterprise imported natural gas, two enterprises refined petroleum products, while coal import was transacted within the framework of three thermal power plants.

From 1980 to 2006, the terminology in publications has undergone some changes, since after 1991 “Sale to other republics” became „Export”, while „Purchase from other republics” became „Import”. The terminology related to coal remains somewhat special. In national publications, “Lignite” is used only for coal excavated in the pit of Velenje. The coal from other pits is entered as „brown coal” in spite of virtually the same net calorific value (NCV).

This brown coal is combined with imported coals that have a considerably higher net calorific value and, in terms of methodology, truly belong to brown coals.

After 1996, the Statistical Office of the Republic of Slovenia changed the Unified classification of activities for the Standard classification of activities, and that has caused a slight alteration of emissions within the sector Manufacturing Industries and Construction.

3.2.2 Country-specific EFs

Brown coal

Table 22: National emission factors for NOx, SOx, PM 2.5 and PM 10 for domestic brown coal.

		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
EF NOx	g/GJ	225,86	226,21	233,71	238,61	242,16	265,12	231,83	235,22	231,65	199,05
EF SOx	g/GJ	2927,58	3284,36	3284,36	3398,93	3327,50	3250,64	3198,65	3214,89	3166,67	3153,53
		1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
EF NOx	g/GJ	212,25	185,24	220,48	237,27	223,03	192,96	201,32	216,58	190,01	253,21
EF SOx	g/GJ	2978,06	2950,45	3018,57	3153,53	3000,16	3377,78	3867,26	4203,54	4229,74	4275,43
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
EF NOx	g/GJ	247,92	187,97	239,31	233,06	282,08	243,15	235,43	197,54	190,00	170,00
EF SOx	g/GJ	4229,74	4099,44	3894,83	4602,08	4554,79	3076,35	284,07	296,93	289,40	300,00
EF PM2.5	g/GJ	17,05	16,76	26,00	16,00	19,38	18,57	3,50	4,73	7,46	3,40
EF PM10	g/GJ	36,53	35,91	34,70	34,28	41,53	39,80	7,51	10,15	15,99	6,50
EF TSP	g/GJ	48,71	47,88	39,23	45,71	55,37	53,06	10,01	13,53	21,32	8,60

Table 23: National emission factors for NOx, SOx, PM 2.5 and PM 10 for imported brown coal.

		1995	1996	1997	1998	1999	2000	2001	
EF NOx	g/GJ	200,00	220,00	280,00	280,00	230,00	210,00	220,00	
EF PM2.5	g/GJ						6,00	6,00	
EF PM10	g/GJ						8,00	8,00	
EF TSP	g/GJ						9,00	9,00	
		2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
EF NOx	g/GJ	190,00	180,00	164,02	162,97	177,38	154,61	156,86	170,00
EF PM2.5	g/GJ	13,30	6,70	6,70					2,20
EF PM10	g/GJ	17,80	8,90	8,90					3,90
EF TSP	g/GJ	20,00	10,00	10,00					5,70

Lignite

Table 24: National emission factors for NOx, SOx, CO, PM 2.5, PM10 and TSP for domestic lignite from Velenje pit.

		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
EF NOx	g/GJ	364,85	368,97	356,81	346,68	349,12	342,26	344,39	363,89	351,48	372,76
EF SOx	g/GJ	2638,89	2647,37	2647,37	2570,24	2575,60	2619,30	2630,46	2559,59	2616,53	2515,27
EF CO	g/GJ	13,78	14,45	13,31	12,84	13,01	12,83	12,57	13,48	12,82	14,20
		1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
EF NOx	g/GJ	346,05	319,35	271,16	292,99	314,32	269,89	295,55	298,06	290,92	251,85
EF SOx	g/GJ	2517,84	2474,95	2407,41	2452,83	2479,92	1378,66	1489,82	1367,70	1339,51	1319,67
EF CO	g/GJ	13,19	12,93	13,04	13,22	13,41	20,29	18,19	19,01	17,86	16,26
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
EF NOx	g/GJ	273,86	268,50	283,91	264,14	206,29	208,61	205,27	183,93	188,61	177.00
EF SOx	g/GJ	1170,24	425,71	508,67	322,49	184,91	238,46	139,30	115,12	103,87	101,00
EF CO	g/GJ	14,26	16,31	20,69	24,98	30,21	19,79	18,59	27,33	23,20	20,0
EF PM2.5	g/GJ	4,26	3,85	4,92	4,06	3,41	2,68	1,24	1,59	1,71	1,40
EF PM10	g/GJ	9,12	8,25	10,54	8,71	7,31	5,74	2,67	3,41	3,66	3,10
EF TSP	g/GJ	12,16	11,00	14,06	11,61	9,74	7,66	3,56	5,53	4,89	4,6

3.2.3 Energy Industries

3.2.3.1 Public Electricity and Heat Production (NFR 1A1a)

This chapter presents the consumption of fuels and emissions of greenhouse gases in:

- Public Electricity and Heat Production (NFR 1A1a)
- Petroleum Refining (NFR 1A1b)
- Manufacture of solid fuels and Other energy Industries (NFR 1A1c)

Public electricity and heat production is the most important category in this sub-sector other two categories have consisted mainly from fuel consumption in one refinery and in fuel consumption for coal mining activities.

In this sector, there are three big point sources in the Republic of Slovenia, which represent the backbone of the production of electrical energy from thermal power plants. All three plants use coal for the production of electrical energy. Two of these thermal power plants (the Šoštanj Thermal Power Plant - TEŠ and the Trbovlje Thermal Power Plant - TET) are located beside coal pits. Since 2003, CHP Ljubljana – TE-TOL uses exclusively imported coal with high net calorific value and low sulphur contents for the production of electrical energy and heat.

Table 25: National emission factors for domestic lignite from Velenje pit.

Power plant	Location	Unit	Year	Power (MW)	Main fuel type
TEŠ	Šoštanj	A/1 (1)	1956	105.0	Lignite
TEŠ	Šoštanj	A/2 (2)	1956	105.0	Lignite
TEŠ	Šoštanj	A/3 (3)	1960	125.0	Lignite
TEŠ	Šoštanj	A/4 (4)	1971	125.0	Lignite

TEŠ	Šoštanj	B/4 (5)	1977	740.0	Lignite
TEŠ	Šoštanj	C/5 (6)	1977	920.0	Lignite
TE-TOL	Ljubljana	D/1 (1)	1967	137.0	Imported coal
TE-TOL	Ljubljana	D/2 (2)	1967	137.0	Imported coal
TE-TOL	Ljubljana	D/3 (3)	1984	207.0	Imported coal
TET	Trbovlje	F/4 (4)	1968	350.0	Domestic coal

Besides these three thermal power plants we have also one small plant Brestanica – TEB which use natural gas and operate mainly as back up plant when more electricity is needed or when any other plant is on refit.

Methodology

To estimate emissions from Public Electricity and Heat Production, the following methodology has been adopted.

E (t) = m (t) x NCV (TJ/kt) x EF (g/GJ) *Equation 1*

E - emission
m - Quantity of Fuel Combusted
NCV - Net Calorific value
EF - emission factor per energy of Fuel

E (t) = m (t) x EF (g/GJ) *Equation 2*

E - emission
m - Quantity of Fuel Combusted
EF - emission factor per Quantity of Fuel

To estimate SOx emissions in same cases the following two equations were used:

EF_{SO2} = [S] x 20000 / NCV *Equation 3*

EF_{SO2} - SO2 emission factor
[S] – percent sulphur
NCV - Net Calorific value
2 – ratio of the RMM of SO2 to Sulphur

EF_{SO2} = [S] x 19000 / NCV *Equation 4*

EF_{SO2} - SO2 emission factor
[S] – percent sulphur
NCV - Net Calorific value
1.9 – ratio of the RMM of SO2 to Sulphur, considering 5% absorbtion in the ash

Activity data

The main source of data for all energy industries in the Republic of Slovenia for the period 1986-2003 is LEG – Annual Energy Statistics of the Energy Sector of the Republic of Slovenia. As LEG is not published early enough to enable us to calculate GHG inventory on time in 2005 we have for the first time received data for 2004 directly from Statistical Office of the Republic of Slovenia in electronic format before they are published. This excel sheets are going to be our source of data for all fuel consumption in the future. From 2005 the verified reports from ETS have been used for four power plants. To make it more clear, the sub-sector Public Electricity and Heat Plants has in national inventories been disaggregated into:

- Public power plants (TE Šoštanj, TE Trbovlje, TE Brestanica)
- Public CHP (TE-TO Ljubljana)
- Public heat plants (Heat Plants listed in LEG Dt/1)

Now only data from Public heat plants are taken from SORS.

a) Public power plants and
b) Public CHP (combined heat and power generation plants)

For the period 1980-1992, data on the consumption of fuels for individual public power plants are collected in LEG Table EL/9-0 or Table EL/7-0, respectively. In 2009 for the period 1993-2004 data about solid fuel consumption have been taken from official reports which are yearly prepared for individual plant by Electro-institute Milan Vidmar while other types of fuel are still from LEG. From 2005 data are from verified ETS reports.

c) Power cogeneration plants and public heat plants

The category comprises all power cogeneration plants and public heat plants. For 1980-2003 data have been taken from LEG Table Dt/1. In 1986, only data for JP Energetika, Ljubljana exist, for 1996 for instance data already included fuel consumption in 15 public heat plants.

For 2004 individual data for 6 Power cogeneration plants and 28 public heat plants were obtained for the first time in electronic format. (E2LP_04.xls and E3L_04.xls). Data in this format are going to be available also in the future.

Data on the consumption of fuels in power cogeneration plants and public heat plants only started to be published on a regular basis after 1987, therefore for period 1980-1986 only data on the consumption of natural gas have been taken into account (all consumption in the Electricity Generating Industries sector is attributed to the consumption in power cogeneration plants), for other fuels, data for 1987 have been taken (the first successive year when they were available). With regard to small quantities of consumed fuels, the estimated uncertainty is small.

Net calorific values

Net calorific values have been taken from SORS, The values for solid fuel varies from year to year but for the liquid and gaseous fuel almost the same values have been used for the entire period as these types of fuel don't change a lot from year to year.

Table 26: NCVs for the fuel used in energy industry.

Year	Lignite (Velenje)	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Gas Oil	Residual Fuel Oil	LPG	Natural Gas	Wood and Other Biomass
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/Mm3	TJ/kt
1980	9,360	12,980		41,800	39,700	46,050	33,500	12,170
1981	9,330	11,570		41,800	39,700	46,050	34,100	12,170
1982	9,330	11,570		41,900	39,800	46,050	33,490	12,170
1983	9,610	11,180		41,900	39,800	46,050	33,800	12,170
1984	9,590	11,420		41,900	40,000	46,050	33,500	12,170
1985	9,430	11,690		41,900	39,800	46,050	33,500	12,170
1986	9,390	11,880		41,820	39,740	46,050	33,500	12,170
1987	9,650	11,820		41,870	39,800	46,050	33,500	12,170
1988	9,440	12,000		41,870	39,800	46,050	34,080	12,170
1989	9,820	12,050		41,870	39,900	46,050	34,100	12,170
1990	9,810	12,760		41,870	39,800	46,050	34,100	12,170
1991	9,980	12,879		41,880	39,800	46,050	34,100	12,170

1992	10,260	12,589		41,900	39,900	46,050	34,100	12,170
1993	10,070	13,351		41,900	39,800	46,050	34,100	12,170
1994	9,960	12,666		41,900	39,860	46,050	34,100	12,170
1995	10,220	10,000	15,546	41,900	40,000	46,050	34,100	12,170
1996	9,690	11,300	16,107	41,900	40,000	46,050	34,100	12,170
1997	9,610	11,300	16,422	41,900	40,000	46,050	34,080	12,170
1998	10,010	11,230	16,924	41,900	40,000	46,050	34,080	12,170
1999	9,690	11,110	16,649	41,900	40,000	46,050	34,080	12,170
2000	10,170	11,230	16,308	41,900	40,000	46,050	34,080	12,170
2001	10,660	10,660	17,416	41,900	40,000	46,050	34,080	12,170
2002	10,350	11,220	17,927	41,900	40,000	46,050	34,080	12,170
2003	10,138	11,560	18,057	41,900	40,000	46,050	34,080	12,170
2004	10,301	11,680	18,676	41,900	40,000	46,050	34,080	12,170
2005	10,803	11,724	18,180	41,900	40,000	46,050	34,080	12,170
2006	11,132	10,880	18,874	42,600	41,420	46,050	34,080	9,764
2007	11,258	11,629	17,941	42,600	41,420	46,050	34,072	9,141
2008	10,949	10,641	17,381	42,600	41,420	46,050	34,096	11,512
2009	10,894	11,894	17,872	42,600	41,420	46,050	34,080	11,869

Emission factors

We have used country specific NOx, SOx, PM EFs for domestic lignite, domestic brown coal and imported brown coal. Emission factors for all other fuels have been taken for:

- Main pollutants and PM from EMEP EEA Emission Inventory Guidebook 2009
- for Heavy metals (Hg, Cd and Pb) from van der Most and Veldt,1992
- For HCB from Pacyna et al., 1999
- For PAHs, PCB and PCDD/DF from Pacyna et al., 2003, and Berdowski et al., 1995

Table 27: Emission factors used for the period 1980-2009.

Pollutant	Unit	Lignite (Velenje)	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Gas Oil	Residual Fuel Oil	LPG	Natural Gas	Wood and Other Biomass
EF NOx	g/GJ	Table	Table	Table	190.000	190.000	125.000	125.000	200.000
EF SOx	g/GJ	Table	Table	Equation 4	Equation 3	Equation 3	Equation 3		
EF CO	g/GJ	Table	14.000	14.000	5.000	5.000	15.000	39.000	258.000
EF NMVOC	g/GJ	1.700	1.700	1.700	0.800	0.800	0.800	1.500	7.300
EF PM2.5	g/GJ	Table	Table	Table	13.000	13.000	1.000	0.900	33.000
EF PM10	g/GJ	Table	Table	Table	18.000	18.000	2.000	0.900	38.000
EF TSP	g/GJ	Table	Table	Table	25.000	25000.000	3.000	0.900	51.000
EF Pb	g/t	0.040	0.040	0.040		1.300			0.050
EF Cd	g/t	0.004	0.004	0.004		1.000			0.100
EF Hg	g/t				0.014	0.014			0.113
EF PAH	g/t	0.000025	0.000025	0.000025		0.036530			0.038265
EF Benzo a pyrene	g/t	0.000004	0.000004	0.000004		0.004680			0.000095
EF Benzo b fluoranthene	g/t	0.000007	0.000007	0.000007		0.020300			0.019000
EF Benzo k fluoranthene	g/t	0.000007	0.000007	0.000007		0.003980			0.019000
EF Indeno 123 cd pyrene	g/t	0.000007	0.000007	0.000007		0.007570			0.000170

According to expert judgement from literature (Hower et al., 2005) emission factor for Hg emisssions from coal combustion for lignite and brown coal was corrected. Prescribed emission factor without FGD (flue-gas desulfurization) applied is 0.1 g/t, while estimated of Hg capture by currently installed pollution control equipement range from 47-81% hg capture for ESP (electrostatic precipitators) and FGD (Hower et al., 2005). National emission factors for domestic lignite and domestic brown coal are presented for years from 1990 to 2009 in Table 28 and Table 29.

Table 28: National emission factors for Hg for domestic lignite from Velenje pit.

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
EF Hg	g/GJ	0,100	0,100	0,100	0,100	0,100	0,064	0,063	0,069	0,070	0,064
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
EF Hg	g/GJ	0,058	0,032	0,036	0,027	0,023	0,025	0,021	0,022	0,022	0,022

Table 29: National emission factors for Hg for domestic brown coal.

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
EF Hg	g/GJ	0,100	0,100	0,100	0,100	0,100	0,100	0,100	0,100	0,100	0,100
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
EF Hg	g/GJ	0,100	0,100	0,100	0,100	0,100	0,074	0,019	0,019	0,019	0,019

Table 30: National emission factors for Hg for imported brown coal.

		1990	1996	1997	1998	1999	2000	2001	2002
EF Hg	g/GJ	0,100	0,100	0,100	0,100	0,100	0,100	0,100	0,100
		2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	
EF Hg	g/GJ	0,100	0,100	0,074	0,019	0,019	0,019	0,019	

Source specific QA/QC activities

For four thermal power plants the aggregated fuel from SORS data are compared with the sum of fuel used from verified ETS reports. The NCV values are also checked. In case these numbers are not the same the ETS data are taken in account for emission inventory and notification to SORS is made to correct their data.

Recalculations

Very small corrections have been made to emissions for the period 1980-2008 due to some corrections of country-specific emission factors.

Future improvements

No improvements are planned for this sector.

3.2.3.2 Petroleum Refining

This chapter presents the entire consumption of fuels in oil industry; however the main representative of this sector is only one company – the Nafta Lendava Refinery. According to statistical methodology in the period 1986-1996 this sector also included quantities of fuels that were consumed for the production of electric energy in this sector.

Methodology

To estimate emissions from Petroleum Refining, the same methodology as in Energy Industries was used.

Activity data

Data on the consumption of fuels in this sector for the period 1986-2003 have been collected in LEG – Annual Energy Statistics of the Energy Sector of the Republic of Slovenia.

Data for 2004-2007 have been from SORS and are in file E_PE-M YYYY.xls.

Consumptions for individual energy products, collected in tables LEG as follows:
For the period 1986-1996 under „Oil Industry"
From 1997 onwards under „DF–Production of coke, refined petroleum products and nuclear fuel"
- For the consumption of liquid fuels Table Tg/3 or Table Pg/6 for LPG
- For the consumption of solid fuels Table Pr/6
- For the consumption of gaseous fuels Table Pg/6

For the period 1992 to 1994, LEG reported substantial consumption of residual fuel oil and gas oil in the category Internal Consumption and Losses (LEG Table Zb/1). These quantities were supposed to have been consumed in the Nafta Lendava Refinery. consequently. They were added to the consumption in the oil industry. For the years 1986, 1990, 1991, 1995, and 1996 in this category (Internal Consumption and Losses), the consumption of residual fuel oil and gas oil has not been reported. The consumption of residual fuel oil in the oil industry amounted to:
For 1992: 6180+ 15100=21280 t
For 1993: 5713+ 8000=13713 t
For 1994: 3125+ 8200=11325 t
In 1995 and 1996 the values of consumption of natural gas from tables Zb/1 and Zb/3 in LEG show a discrepancy. The difference is the consumption of natural gas in Nafta Lendava.

After 1996, data on the consumption in this sector have been included in the industrial sector DF – Production of coke, refined petroleum products, and nuclear fuel. With regard to the fact that in the Republic of Slovenia there is neither any production of coke nor nuclear fuel, data for period 1997-2004 are comparable to the period 1986-1996.

Net calorific values

Table 31: NCVs for the fuel used in petroleum refining.

Year	Gas Oil	Residual Fuel Oil	Natural Gas
	TJ/kt	TJ/kt	MJ/Sm3
1980	41,800	39,700	33,500
1981	41,800	39,700	34,100
1982	41,900	39,800	33,490
1983	41,900	39,800	33,800

1984	41,900	40,000	33,500
1985	41,900	39,800	33,500
1986	41,820	39,740	33,500
1987	41,870	39,800	33,500
1988	41,870	39,800	34,080
1989	41,870	39,800	34,100
1990	41,870	39,800	34,100
1991	41,880	39,800	34,100
1992	41,900	39,900	34,100
1993	41,900	39,800	34,100
1994	41,900	39,860	34,100
1995	41,900	40,000	34,100
1996	41,900	40,000	34,100
1997	41,900	40,000	34,080
1998	41,900	40,000	34,080
1999	41,900	40,000	34,080
2000	41,900	40,000	34,080
2001	41,900	40,000	34,080
2002	41,900	40,000	34,080
2003	41,900	40,000	34,080
2004	41,900	40,000	34,080
2005	41,900	40,000	34,080
2006	41,900	40,000	34,080
2007	41,900	40,000	34,080
2008	41,900	40,000	34,080
2009	41,900	40,000	34,080

Emission factors

Table 32: Emission factors used for the period 1980-2009.

Pollutant	Unit	Gas Oil	Residual Fuel Oil	Natural Gas
EF NOx	g/GJ	140,000	140,000	100,000
EF SOx	g/GJ	Equation 3	Equation 3	
EF CO	g/GJ	5,000	5,000	39,000
EF NMVOC	g/GJ	0,800	0,800	1,500
EF PM2.5	g/GJ	13,000	13,000	0,900
EF PM10	g/GJ	18,000	18,000	0,900
EF TSP	g/GJ	25,000	25000,000	0,900
EF Pb	g/t		1,300	
EF Cd	g/t		1,000	
EF Hg	g/t	0,014	0,014	
EF PAH	g/t		0,036530	
EF Benzo a pyrene	g/t		0,004680	
EF Benzo b fluoranthene	g/t		0,020300	
EF Benzo k fluoranthene	g/t		0,003980	
EF Indeno 123 cd pyrene	g/t		0,007570	

Emission factors have been taken for:

- NOx from Default Emission Factors Handbook 2010
- Other main pollutants and PM from EMEP EEA Emission Inventory Guidebook 2009
- Van der Most and Veldt, 1992
- Pacyna et al., 2003

Recalculations

No recalculations have been performed in this category.

Future improvements

No improvements are planned for this category.

3.2.3.3 Manufacture of solid fuels and Other energy Industries

This sector covers the consumption of fuels reported in LEG under "Coal-mining" or after 1997 under CA – Production of energy commodities, only.

Methodology

To estimate emissions from Petroleum Refining, the same methodology as in Energy Industries was used.

Activity data

Consumptions according to individual energy products are collected in LEG tables as follows:

For the period 1986-1996 under „Coal-mining"
From 1997 onwards under „CA–Production of energy commodities"
- For the consumption of liquid fuels Table Tg/3 or Table Pg/6 for LPG
- For the consumption of solid fuels Table Pr/6
- For the consumption gaseous fuels Table Pg/6

Data for 2004-2007 have been from SORS.

Net calorific values

Table 33: NCVs for the fuel used in Manufacture of solid fuels and other

Year	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Gas Oil	Residual Fuel Oil	LPG	Natural Gas
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/Mm3
1980	12,980		41,800	39,700	46,050	33,500
1981	11,570		41,800	39,700	46,050	34,100
1982	11,570		41,900	39,800	46,050	33,490
1983	11,180		41,900	39,800	46,050	33,800
1984	11,420		41,900	40,000	46,050	33,500
1985	11,690		41,900	39,800	46,050	33,500
1986	11,880		41,820	39,740	46,000	33,500
1987	11,820		41,870	39,800	46,000	33,500

1988	12,000		41,870	39,800	46,000	34,080
1989	12,050		41,870	39,900	46,000	34,100
1990	12,760		41,870	39,800	46,000	34,100
1991	12,879		41,880	39,800	46,000	34,100
1992	12,589		41,900	39,900	46,000	34,100
1993	13,351		41,900	39,800	46,000	34,100
1994	12,666		41,900	39,860	46,000	34,100
1995		17,404	41,900	40,000	46,000	34,100
1996		16,353	41,900	40,000	46,000	34,100
1997		17,712	41,900	40,000	46,050	34,080
1998		20,664	41,900	40,000	46,050	34,080
1999		20,806	41,900	40,000	46,050	34,080
2000		20,782	41,900	40,000	46,050	34,080
2001		20,947	41,900	40,000	46,050	34,080
2002			41,900	40,000	46,050	34,080
2003			41,900	40,000	46,050	34,080
2004			41,900	40,000	46,050	34,080
2005			41,900	40,000	46,050	34,080
2006			42,600	40,000	46,050	34,080
2007			42,600	40,000	46,050	34,080
2008			42,600	40,000	46,050	34,080
2009			42,600	40,000	46,050	34,080

Emission factors

Table 34: Emission factors used for the period 1980-2009.

Pollutant	Unit	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Gas Oil	Residual Fuel Oil	LPG	Natural Gas
EF NOx	g/GJ	150,000	150,000	140,000	140,000	120,000	100,000
EF SOx	g/GJ	Equation 4	Equation 4	Equation 3	Equation 3	Equation 3	
EF CO	g/GJ	14,000	14,000	5,000	5,000	15,000	39,000
EF NMVOC	g/GJ	1,700	1,700	0,800	0,800	0,800	1,500
EF PM2.5	g/GJ	9,000	9,000	13,000	13,000	1,000	0,900
EF PM10	g/GJ	20,000	20,000	18,000	18,000	2,000	0,900
EF TSP	g/GJ	30,000	30,000	25,000	25,000	3,000	0,900
EF Pb	g/t	0,040	0,040		1,300		
EF Cd	g/t	0,004	0,004		1,000		
EF Hg	g/t			0,014	0,014		
EF PAH	g/t	0,000025	0,000025		0,036530		
EF Benzo a pyrene	g/t	0,000004	0,000004		0,004680		
EF Benzo b fluoranthene	g/t	0,000007	0,000007		0,020300		
EF Benzo k fluoranthene	g/t	0,000007	0,000007		0,003980		
EF Indeno 123 cd pyrene	g/t	0,000007	0,000007		0,007570		

Emission factors have been taken for:

- NOx from Default Emission Factors Handbook 2010
- Other main pollutants and PM from EMEP EEA Emission Inventory Guidebook 2009
- for Heavy metals from van der Most and Veldt, 1992
- For PAHs from Pacyna et al., 2003

Recalculations

No recalculations have been performed in this sector.

Future improvements

No improvements are planned for this sector.

3.2.4 Manufacturing Industries and Construction

This chapter presents the consumption of fuels and emissions of air pollutants in five specific types of industry, all other are hidden under other industry where also fuel for construction industry is included. For the reason, that in “other” a big number of enterprises are included, this is the most important for air emissions (main pollutants, PM and POPs). The most important industry under other is non-metal production which including cement and lime production as two of the most important fuel consumers. For Heavy metals the ‘Iron and steel’ is the sub-sector that contributes the largest part.

Table 35: Emissions from Energy sector by sources for 2009.

	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO	Pb	Cd	Hg
	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Mg	Mg	Mg
1 A 2 Manufact. Ind. and Constr.	4,234	1,012	2,513	0,000	0,972	1,025	1,092	9,493	0,041	0,038	0,039
a Iron and steel	0,210	0,020	0,094	0,000	0,019	0,021	0,022	0,199	0,000	NA	0,013
b Non-ferrous metals	0,151	0,012	0,081	0,000	0,013	0,015	0,017	0,101	0,003	0,002	0,000
c Chemicals	0,321	0,107	0,100	0,000	0,106	0,108	0,114	1,131	0,009	0,004	0,000
d Pulp, Paper and Print	0,604	0,148	0,252	0,000	0,174	0,190	0,205	1,526	0,007	0,006	0,000
e Food processing, Bev. and Tob.	0,161	0,010	0,069	0,000	0,010	0,013	0,016	0,059	0,002	0,001	0,000
f i Other	1,654	0,597	1,917	0,000	0,579	0,607	0,644	6,107	0,020	0,024	0,025
f ii Mobile Combustion	1,132	0,117	0,000	0,000	0,072	0,072	0,072	0,370	NE	NE	NE

	PCDD/ PCDF	benzo(a) pyrene	benzo(b) fluoran-thene	benzo(k) fluoran-thene	Indeno (1,2,3-cd) pyrene	PAHs Total 1-4	HCB	PCBs
	g I-Teq	Mg	Mg	Mg	Mg	Mg	kg	kg
1 A 2 Manufact. Ind. and Constr.	0,305	0,026	0,016	0,019	0,026	0,087	0,026	0,756
a Iron and steel	0,001	NA	NA	NA	NA	NA	0,000	0,000
b Non-ferrous metals	0,002	0,000	0,000	0,000	0,000	0,000	NA	0,008
c Chemicals	0,063	0,000	0,000	0,000	0,000	0,000	0,003	0,016
d Pulp, Paper and Print	0,026	0,000	0,000	0,000	0,000	0,000	0,001	0,021
e Food processing, Bev. and Tob.	0,011	0,000	0,000	0,000	0,000	NA	NA	0,005
f i Other	0,202	0,026	0,016	0,019	0,026	0,087	0,022	0,707
f ii Mobile Combustion	NA	NE	NE	NE	NE	NE	NE	NA

Methodology

Emissions from combustion in manufacturing industries and construction were estimated using the Tier 1 methodology described in EMEP EEA Emission Inventory Guidebook, 2009. The following formulas were used:

$$E(t) = m(t) \times NCV(TJ/kt) \times EF(g/GJ) \qquad \textit{Equation 1}$$

E - emission
m - Quantity of Fuel Combusted
NCV - Net Calorific value
EF - emission factor per energy of Fuel

E (t) = m (t) x EF (g/GJ) *Equation 2*

E - emission
m - Quantity of Fuel Combusted
EF - emission factor per Quantity of Fuel

To estimate SOx emissions in same cases the following two equations were used:

EF_{SO2} = [S] x 20000 / NCV *Equation 3*

EF_{SO2} - SO2 emission factor
[S] – percent sulphur
NCV - Net Calorific value
2 – ratio of the RMM of SO2 to Sulphur

EF_{SO2} = [S] x 19000 / NCV *Equation 4*

EF_{SO2} - SO2 emission factor
[S] – percent sulphur
NCV - Net Calorific value
1.9 – ratio of the RMM of SO2 to Sulphur, considering 5% absorbtion in the ash

The total emission for this sub-sector is the sum of different industrial activities, using diverse fuels and combustion technologies.

Activity data

The consumption in both categories has to be disaggregated in accordance with the classification of activities applied in IPCC guidelines. The classification applied in LEG has been taken as the basis.

PERIOD 1986-1996:

Table 36: Conversion Table between national energy statistics (LEG) and CRF

NFR CATEGORY	LEG Classification (1980-1996)
Iron and Steel	Iron and Steel Production
Non-Ferrous Metals	Non-Ferrous Metals
Chemicals	Chemical Industry
Pulp, Paper and Print	Pulp and Paper Industry
Print Industry	Print Industry
Food Processing. Beverages and Tobacco	Food Processing Industry
Tobacco Industry	Tobacco Industry
Other	Other

Table 37: Conversion table between national energy statistics (LEG) and CRF

NFR CATEGORY	LEG Classification (1980-1996)
Other	Other Metal Industry
	Non-metal industry
	Shipbuilding
	Electrical Industry
	Construction
	Timber Industry
	Textile Industry

	Leather Industry
	Rubber Industry
	Recycling
	Other Industry

PERIOD 1997-2003:

In 1997, LEG began to publish data according to the Standard Classification of Activities, which in some categories differs from the classification, which had been used until 1996. Most activities are defined in a similar manner, but for certain activities, this is not possible. The next table shows the distribution of activities in accordance with the IPCC classification.

Table 38: Conversion table between national energy statistics (LEG) and NFR

NFR CATEGORY	LEG Classification - SCA category
Iron and Steel	DJ - Production of metals and metal products
Non-Ferrous Metals	
Chemicals	DG - Production of chemicals
Pulp. Paper and Print	DE - Production of fibres, pulp, paper, and cardboard
Food Processing. Beverages and Tobacco	DA – Production of food, beverages, and tobacco products
Other	Other

In this section, the group “Other” is a sum of activity data in the following categories:

Table 39: Conversion table between national energy statistics (LEG) and NFR

NFR CATEGORY	LEG Classification
	DI - Production of non-metal mineral products
	DB - Production of textiles
	DC - Production of leather and leather goods
	DD – Wood-processing and woodworking
	DH - Production of rubber products
Other	DK - Production of machines and devices
	DL - Production of electrical and optical equipment
	DM – Production of vehicles and vessels
	DN - Production of furniture. not included elsewhere
	F - Construction

For consumption in individual industrial sectors there are detailed (disaggregated) data, the values of which in Slovenia are strongly dependant on the mode of reporting and features of individual industrial sectors characterized by high concentration (values depending on the consumption in one or two factories). Data from basic sources hint at some relatively big changes in the consumption of fuels in some sectors. Therefore, it is necessary to direct the attention to some of the most important changes, particularly with regard to the consumption of natural gas:

YEARS 2004 – 2009

For the year 2004 we have obtained very detailed data about fuel consumption in industry in electronic format. The list of fuel collected including 24 different fuels. The non-

energy and energy use of fuels are reported separately. Data about fuel consumption and NCV are reported on the lowest level of disaggregation possible.

For this reason from 2004 on fuel consumption in iron and steel industry and in non-ferrous metals industry can be separated according to the rules presented in the following tables.

The following table is valid until 2007 and the next two tables since 2008 as new version of SCA classification have been used by SORS.

Table 40: Table for disaggregation of fuel in DJ sector (manufacture of basic metals and fabricated metal products)

SCA category	ISIC category	Description
DJ 27.1	Iron and Steel	Manufacture of basic iron and steel and of ferrous alloys
DJ 27.2	Iron and Steel	Manufacture of tubes
DJ 27.3	Iron and Steel	Other first processing of iron and steel
DJ 27.4	Non-ferrous Metal	Manufacture of basic precious and non-ferrous metals
DJ 27.510	Iron and Steel	Casting of iron
DJ 27.520	Iron and Steel	Casting of steel
DJ 27.530	Non-ferrous Metal	Casting of light metal
DJ 27.540	Non-ferrous Metal	Casting of other non-ferrous metal
DJ 28	Other industry	Manufacture of fabricated metal products, except machinery and equipment

Table 41: Table for disaggregation of fuel in DJ sector (manufacture of basic metals and fabricated metal products)

SCA 2008, V2	ISIC category	Description
C 24.1	Iron and Steel	Manufacture of basic iron and steel and of ferrous alloys
C 24.2	Iron and Steel	Manufacture of tubes, pipes, hollow profiles and related fittings, of steel
C 24.3	Iron and Steel	Manufacture of other products of first processing of steel
C 24.4	Non-ferrous Metal	Manufacture of basic precious and non-ferrous metals
C 24.51	Iron and Steel	Casting of iron
C 24.52	Iron and Steel	Casting of steel
C 24.53	Non-ferrous Metal	Casting of light metal
C 24.54	Non-ferrous Metal	Casting of other non-ferrous metal

Table 42: Conversion table between national energy statistics and CRF

NFR CATEGORY	LEG Classification
Other	C 23 - Manufacture of other non-metallic mineral products C 25 - Manufacture of metallic products
	C 13 - Manufacture of textiles C 14 - Manufacture of wearing apparel
	C 15 - Manufacture of leather and related products
	C 16 - Manufacture of wood and of products of wood and cork, except furniture, manufacture of articles of straw and plaiting materials C 21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations
	C 22 - Manufacture of rubber and plastic products
	C 28 - Production of machines and devices
	C 26 - Production of electrical and optical equipment C 27

	C 29 - Production of vehicles C 30 - Production of vessels
	C 31 - Production of furniture C 32 - not included elsewhere C 33 -
	F - Construction

Inclusion of auto producers into Manufacturing Industries sector

In accordance with IPCC Reference manual, the item Industry reports the consumption of fuels in the group industrial power plants (auto producers – enterprises that generate electric energy for internal consumption and/or heat for sale) as well as other consumption in industry (except in production processes) .

In the 1980 -1996 period, the consumption of fuels by auto producers in LEG was recorded under Electric utilities – Industry, and in the period 1997- 2003 under Conversion – Auto producers.

Period 1986-2000

Because there are no published of data on auto producers at the level of industrial branches for the period 1980-2000, on the basis of which it would be possible to assign the consumption of fuel to each individual industrial branch, for each kind of fuel a different (most appropriate) approach was used.

- Lignite

Total consumption is attributed to pulp and paper industry. The paper mill in Krško uses lignite in its power cogeneration plant. In the documents of the Statistical Office of the Republic of Slovenia, the total consumption is attributed to the consumption in thermal power plants, while in LEG one half of the consumption is attributed to the consumption in industry, the other half to industrial thermal power plants. In this report, half is reported as consumption in pulp and paper industry (heat), half as consumption in industrial power plants in pulp and paper industry. Consumption of lignite in other sectors has not been reported.

- Brown Coal

Consumption of brown coal in industrial power plants in the monitored period was reported only in 1986. Since quantities are quite small (1272 t), consumption is reported in the sector “Other”.

- Residual Fuel Oil

Consumption of residual fuel oil in industrial power plants in the monitored period was low (from 0 to 10176 t). Since quantities are quite small. consumption is reported in sector “Other”.

- Gas Oil and Natural Gas

The majority of industrial thermal power plants use gas oil or natural gas. Total quantities of consumed gas oil and natural gas are disaggregated according to the produced quantities of electric energy in those power plants according to the following procedure:

1. Determine which power plants use gas oil or natural gas
2. Add up the quantities of electric energy produced in those power plants
3. Allocate fractions of consumed residual fuel oil or natural gas, respectively. according to produced quantities of energy in individual power plants
4. Define the sector to which individual power plants belong.

Period 2000-2007

Recently, we have commenced to treat auto producers individually, since the

Statistical Office of the Republic of Slovenia, which prepares data for LEG, has completed its database. Now, aggregated data on the consumption of fuels by auto producers at the level of industrial branches are available, where the sums of individual fuels correspond to the consumption of auto producers from LEG.

Net calorific values

Net calorific values have been taken from SORS, The values for solid fuel varies from year to year but for the liquid and gaseous fuel almost the same values have been used for the entire period as these types of fuel don't change a lot from year to year.

Table 43: NCVs for the fuel used in manufacturing industry and construction.

Year	Lignite (Velenje)	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Other Bituminous	Anthracite	Coke	Petroleum coke
	TJ/kt	TJ/kt	TJ/kt	Coal	TJ/kt	TJ/kt	TJ/kt
1980	9,360	12,980		27,210	31,820	29,310	31,000
1981	9,330	11,570		27,210	31,820	29,310	31,000
1982	9,330	11,570		27,210	31,820	29,310	31,000
1983	9,610	11,180		27,210	31,820	29,310	31,000
1984	9,590	11,420		27,210	31,820	29,310	31,000
1985	9,430	11,690		27,860	31,900	29,310	31,000
1986	9,390	11,880		27,570	29,250	29,300	31,000
1987	9,650	11,820		27,570	29,250	29,300	31,000
1988	9,440	12,000		27,570	29,250	29,300	31,000
1989	9,820	12,050		27,570	29,250	29,300	31,000
1990	9,810	12,760		27,570	29,250	29,300	31,000
1991	9,980	12,879		25,000	29,250	29,300	31,000
1992	10,260	12,589		25,000	29,250	29,300	31,000
1993	10,070	13,351		25,000	29,250	29,300	31,000
1994	9,960	12,666		25,000	29,250	29,300	31,000
1995	10,220		17,404	25,000	29,310	29,310	31,000
1996	9,690		16,353	25,000	29,310	29,310	31,000
1997	9,610		17,712	25,000	29,310	29,310	31,000
1998	10,010		20,664	25,000	29,310	29,310	31,000
1999	9,690		20,806	25,000	29,310	29,310	31,000
2000	10,170		20,782	25,000	29,310	29,310	31,000
2001	10,660		20,947	25,000	29,310	29,310	31,000
2002	10,350		21,000	25,000	29,310	29,310	31,000
2003	10,138		21,570	25,000	29,310	29,310	31,000
2004	10,301		19,908		29,400	28,490	29,927
2005			20,381	25,150		27,900	29,927
2006			20,108	25,770		29,440	32,223
2007			20,387	24,460		29,370	31,949
2008			18,623	24,310		29,870	31,949
2009	10,894		17,872	23,896		29,670	32,498

Year	Gas Oil	Residual Fuel Oil	Diesel	LPG	Natural Gas	Wood and Other Biomass
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/Mm3	TJ/kt
1980	41,800	39,700	42,700	46,050	33,500	12,170
1981	41,800	39,700	42,700	46,050	34,100	12,170

1982	41,900	39,800	42,700	46,000	33,490	12,170
1983	41,900	39,800	42,700	46,000	33,800	12,170
1984	41,900	40,000	42,700	46,000	33,500	12,170
1985	41,900	39,800	42,700	46,050	33,500	12,170
1986	41,820	39,740	42,700	46,000	33,500	12,170
1987	41,780	39,800	42,700	46,000	33,500	12,170
1988	41,710	39,800	42,700	46,000	34,080	12,170
1989	41,850	39,800	42,700	46,000	34,100	12,170
1990	41,870	39,800	42,700	46,000	34,100	12,170
1991	41,880	39,800	42,700	46,000	34,100	12,170
1992	41,900	39,900	42,700	46,000	34,100	12,170
1993	41,900	39,800	42,700	46,000	34,100	12,170
1994	41,900	39,860	42,700	46,000	34,100	12,170
1995	41,900	40,000	42,700	46,000	34,100	12,170
1996	41,900	40,000	42,700	46,000	34,100	12,170
1997	41,900	40,000	42,700	46,050	34,080	12,170
1998	41,900	40,000	42,700	46,050	34,080	12,170
1999	41,900	40,000	42,700	46,050	34,080	12,170
2000	41,900	40,000	42,700	46,050	34,080	12,170
2001	41,900	40,000	42,700	46,050	34,080	12,170
2002	41,900	40,000	42,700	46,050	34,080	12,170
2003	41,900	40,000	42,700	46,050	34,080	12,170
2004	41,900	40,000	42,700	46,050	34,080	12,170
2005	42,600	41,420	42,700	46,050	34,080	12,170
2006	42,600	41,420	42,700	46,050	34,080	12,170
2007	42,600	41,420	42,700	46,050	34,080	12,170
2008	42,600	41,420	42,700	46,050	34,080	12,170
2009	42,600	41,420	42,600	46,050	34,080	11,869

Net calorific values have been taken from SORS, The values for solid fuel varies from year to year but for the liquid and gaseous fuel almost the same values have been used for the entire period as these types of fuel don't change a lot from year to year.

Table 44: NCVs for the solid fuel used in manufacturing industry and construction in 2009.

Industry - 2008	**Sub-bituminous Coal - imported**	**Other Bituminous**	**Coke**
Iron and steel			29,670
Pulp. Paper and Print	17,872		
Other	19,430	23,896	29,670

Emission factors

Emission factors have been taken for:

- main pollutants and PM from EMEP EEA Emission Inventory Guidebook 2009
- van der Most and Veldt, 1992
- Pacyna et al., 2003
- Berdowski et al., 1995

Table 45: EFs for the fuel used in manufacturing industry and construction.

Pollutant	Unit	Lignite (Velenje)	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Other Bituminous	Anthracite	Coke
EF NOx	g/GJ	173,000	173,000	173,000	173,000	173,000	173,000
EF SOx	g/GJ	Equation 4	Equation 4	Equation 4	Equation 4	Equation 4	Equation 4
EF CO	g/GJ	931,000	931,000	931,000	931,000	931,000	931,000
EF NMVOC	g/GJ	88,000	88,000	88,000	88,000	88,000	88,000
EF PM2.5	g/GJ	108,000	108,000	108,000	108,000	108,000	108,000
EF PM10	g/GJ	117,000	117,000	117,000	117,000	117,000	117,000
EF TSP	g/GJ	124,000	124,000	124,000	124,000	124,000	124,000
EF Pb	g/t	0,240	0,240	0,240	0,240	0,240	
EF Cd	g/t	0,040	0,040	0,040	0,040	0,040	
EF Hg	g/t	0,100	0,100	0,100	0,100	0,100	
EF PAH	g/t	0,065	0,065	0,065	0,065		
EF Benzo a pyrene	g/t	0,001	0,001	0,001	0,001		
EF Benzo b fluoranthene	g/t	0,023	0,023	0,023	0,023		
EF Benzo k fluoranthene	g/t	0,023	0,023	0,023	0,023		
EF Indeno 123 cd pyrene	g/t	0,018	0,018	0,018	0,018		
PCB	g/t	0,004	0,004	0,004	0,004	0,036	

Pollutant	Unit	Gas Oil	Residual Fuel Oil	LPG	Natural Gas	Wood and Other Biomass
EF NOx	g/GJ	100,000	190,000	100,000	70,000	150,000
EF SOx	g/GJ	Equation 3	Equation 3	Equation 3		
EF CO	g/GJ	40,000	5,000	13,000	25,000	1596,000
EF NMVOC	g/GJ	10,000	0,800	10,000	2,500	146,400
EF PM2.5	g/GJ	16,500	13,000	16,500	0,500	149,100
EF PM10	g/GJ	21,500	18,000	21,500	0,500	149,900
EF TSP	g/GJ	27,500	25000,000	27,500	0,500	156,400
EF Pb	g/t		1,300			0,050
EF Cd	g/t		1,000			0,100
EF Hg	g/t	0,014	0,014			0,113
EF PAH	g/t		0,014910			0,038265
EF Benzo a pyrene	g/t		0,003430			0,000095
EF Benzo b fluoranthene	g/t		0,001810			0,019000
EF Benzo k fluoranthene	g/t		0,002830			0,019000
EF Indeno 123 cd pyrene	g/t		0,006840			0,000170
PCB	g/t		0,003600			0,003500

Recalculations

Very minor changes in NCV and emission factors used for some less important fuel have been also applied.

Future improvements

No improvements are planned for this sector.

3.2.5 Transport

3.2.5.1 Road transport

Introduction

Road transportation is one of the most important emitter of greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). It is also a significant emission source of pollutants associated with trans-boundary, regional and local air problems, comprehending sulphur oxides (SO_x), nitrogen oxides (NO_x), carbon monoxide (CO), non-volatile organic compounds (NMVOC) and are indirectly responsible for the formation of ozone (O_3) in the lower troposphere. Substantial emissions of ammonia (NH_3), particulate matter (PM) and heavy metals also result from this activity.

Methodology

Upgraded version of COPERT methodology was used for estimation of emissions for all air pollutants for road transport sector for the entire 1980-2009 period. COPERT 4 methodology replaced formerly used COPERT III methodology. COPERT 4 methodology was used for the first time for 2010 reporting round of CLRTAP emission data–resubmission in June 2010.

COPERT 4 (version 6.1) methodology has been used for the calculation of national emission estimates from road transport for the entire 1980-2009 period. The methodology is fully incorporated in the computer software programme COPERT 4 which facilitates its application. The actual calculations have been therefore performed by using this computer software.

COPERT 4 estimates emissions of greenhouse gas emissions (CO_2, N_2O, CH_4) as well as of all major air pollutants (CO, NO_x, NMVOC, Particulate Matter (PM), NH_3, SO_2, Heavy metals) produced by different vehicle categories (passenger cars, light duty vehicles, heavy duty trucks, buses, mopeds and motorcycles). The programme also provides speciation of Polyaromatic Hydrocarbons (PAHs) and Persistent Organic pollutants (POPs), Dioxins and Furans. Emissions estimated are distinguished in three sources: emissions produced during thermally stabilized engine operation (hot emissions), emissions occurring during engine start from ambient temperature (cold-start and warming-up effects) and NMVOC emissions due to fuel evaporation. The total emissions are calculated as a product of activity data provided by the user and speed-dependent emission factors calculated by the software.

The COPERT 4 methodology is also part of the EMEP/EEA air pollutant emission inventory guidebook (formerly referred to as the EMEP CORINAIR Guidebook). The Guidebook is prepared by the UNECE/EMEP Task Force on Emission Inventories and Projections (TFEIP) and published by the European Environment Agency. It is intended to support reporting under the UNECE Convention on Long-Range Transboundary Air Pollution and the EU directive on national emission ceilings as well as under United Nations Framework Convention on Climate Change (UNFCCC). The COPERT 4 methodology is fully consistent with the Road Transport chapter of the Guidebook. The use of a software tool to calculate road transport emissions allows for a transparent and standardized, hence consistent and comparable data collecting and emissions reporting procedure, in accordance with the requirements of international conventions and protocols and EU legislation.

Applied methodology is fully described in the following literature:

- COPERT 4 Computer programme to calculate emissions from road transport – User manual (version 5.0), Dimitrios Gkatzoflias, Chariton Kouridis, Leonidas Ntziachristos and Zissis Samaras, ETC/AEM, December 2007
- EMEP/EEA air pollutant emission inventory guidebook — 2009, Technical report No 6/2009, European Environment Agency (2009)

To calculate emissions using the COPERT 4 software, at least the following input data is necessary: vehicle fleet data, mileage data per vehicle category and type of roads, speed data, fuel consumption and fuel characteristic, monthly air minimum and maximum temperatures, fuel vapour pressure.

Vehicle fleet

The COPERT 4 methodology requires a detailed knowledge of the structure of the vehicle fleet composition. Table 46 provides a summary of all vehicle categories and technologies covered by the applied methodology.

Table 46: Summary of vehicle classes covered by the methodology.

Vehicle Type	Class	Legislation
Passenger Cars	Gasoline <1.4l	PRE ECE ECE 15/00-01 ECE 15/02 ECE 15/03 ECE 15/04 Improved Conventional Open Loop Euro 1 - 91/441/EEC Euro 2 - 94/12/EEC Euro 3 - 98/69/EC Stage 2000 Euro 4 - 98/69/EC Stage 2005 Euro 5 – EC 715/2007 Euro 6 – EC 715/2007
	Gasoline 1.4 - 2.0l	
	Gasoline >2.0l	
	Diesel <2.0l	Conventional Euro 1 - 91/441/EEC Euro 2 - 94/12/EEC Euro 3 - 98/69/EC Stage 2000 Euro 4 - 98/69/EC Stage 2005 Euro 5 – EC 715/2007 Euro 6 – EC 715/2007
	Diesel >2.0l	
	LPG	Conventional Euro 1 - 91/441/EEC Euro 2 - 94/12/EC Euro 3 - 98/69/EC Stage 2000 Euro 4 - 98/69/EC Stage 2005 Euro 5 (post 2005)
	2 Stroke	Conventional
	Hybrids Gasoline <1.4l Hybrids Gasoline 1.4-2.0l Hybrid Gasoline >2.0l	Euro 4 - 98/69/EC Stage 2005

Vehicle Type	Class	Legislation
Light Duty Vehicles	Gasoline <3.5t	Conventional Euro 1 - 93/59/EEC Euro 2 - 96/69/EEC Euro 3 - 98/69/EC Stage 2000 Euro 4 - 98/69/EC Stage 2005 Euro 5 – EC 715/2007 Euro 6
	Diesel <3.5t	Conventional Euro 1 - 93/59/EEC

		Euro 2 - 96/69/EC Euro 3 - 98/69/EC Stage 2000 Euro 4 - 98/69/EC Stage 2005 Euro 5 – EC 715/2007 Euro 6
Heavy Duty Trucks	Gasoline >3.5t	Conventional
	Rigid <=7.5t	Conventional Euro I - 91/542/EEC Stage I Euro II - 91/542/EEC Stage II Euro III - 1999/96/EC Stage I Euro IV – 1999/96/EC Stage II Euro V – 1999/96/EC Stage III
	Rigid 7.5-12t	
	Rigid 12-14t	
	Rigid 14-20t	
	Rigid 20-26t	
	Rigid 26-28t	
	Rigid 28-32t	
	Rigid >32t	
	Articulated 14-20t	
	Articulated 20-28t	
	Articulated 28-34t	
	Articulated 34-40t	
	Articulated 40-50t	
	Articulated 50-60t	
Buses	Urban CNG Buses	Conventional Euro I - 91/542/EEC Stage I Euro II - 91/542/EEC Stage II Euro III - 1999/96/EC Stage I Euro IV – 1999/96/EC Stage II Euro V – 1999/96/EC Stage III
	Urban <=15t	
	Urban 15-18t	
	Urban >18t	
	Coaches articulated >18t	
	Coaches standard <=18t	
Mopeds	<50cm³	Conventional97/24/EC Stage I Euro 1 97/24/EC Stage II Euro 2 Euro 3 proposal
Motorcycles	2 Stroke >50cm³	Conventional 97/24/EC – Euro 1 2002/51/EC Stage I Euro 2 2002/51/EC Stage II Euro 3
	4 stroke 50 - 250cm³	
	4 stroke 250 - 750cm³	
	4 stroke >750cm³	

Upgraded version of COPERT requires even more detailed classification compared to older versions. The main difference between COPERT III and COPERT 4 is classification of Heavy Duty Trucks and Buses. Since no national database on detailed COPERT 4 classification is available, we have used information and Worksheet (Matrix) for conversion COPERT III Heavy Duty Trucks and Buses classification into COPERT 4. That matrix was prepared and suggested by researches that developed COPERT methodology. It is published on COPERT web page http://lat.eng.auth.gr/copert/.

The fleet composition for the years 1992−2009 was taken from the official database of registered motor and trailer vehicles in the Republic of Slovenia provided by the Ministry of the Interior. Since no database exists on licensed motor and trailer vehicles in the Republic of Slovenia for the years 1980−1991, an expert estimate has been made on the basis of the annual Statistical Yearbooks, published by Statistical Office of the Republic of Slovenia. The vehicle numbers per all vehicle classes for period 1980−2009 are shown in Annex 1 (*Table1.1 : Road transport : Fleet data (number of vehicles) 1980−2009*).

The vehicle fleet structure is presented in Figure 32. The increase in the total number of passenger cars is mostly due to a growth in the number of diesel passenger cars. After the year 2001 a considerable decline in the number of gasoline passenger cars is observed, and at the same time a rise in the number of diesel passenger cars. LPG passenger cars represent only a small share of all passenger cars. Due to lack of data there is no distribution

between light duty vehicles and heavy duty trucks from 1980 to 1991. Both vehicle classes are considered together as heavy duty trucks. The number of buses has been almost constant between 1980 and 2009. The reason for the significant growth in the number of mopeds from 2002 on is the introduction of mandatory registration for mopeds as well. For motorcycles, the number of vehicles has grown in general throughout the entire period.

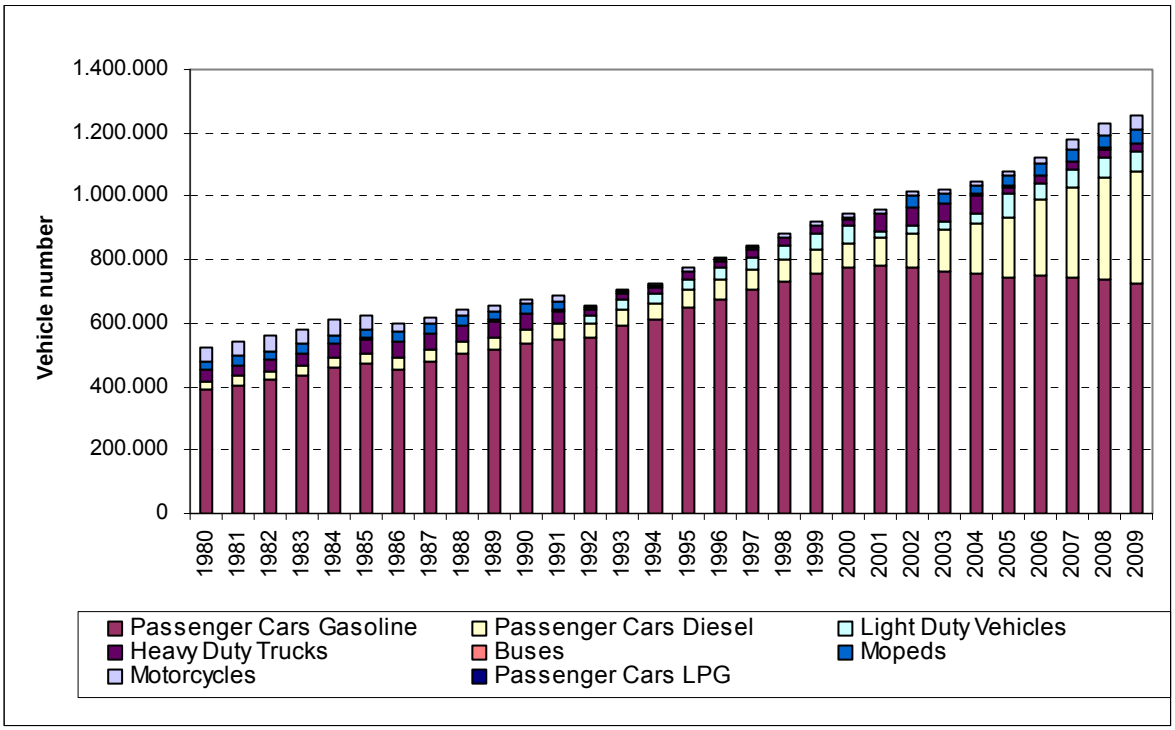

Figure 32: Vehicle fleet 1980–2009.

Mileage and mileage share

In the framework of the COPERT 4 methodology, driving modes are assumed to be classified into urban, rural and highway driving. Driving on Slovene roads has been classified in the following manner:

- urban driving: driving on local urban roads;
- rural driving: driving on main roads, regional roads and local roads;
- highway driving: driving on highways, motorways and high-speed roads.

Mileage on our roads has been classified accordingly as urban, rural and highway driving.

To explain assessments and estimates of mileage made, the following variables and designation marks are used:

- Transport work and mileage:

  Mf_c^k ... mileage per specific vehicle category *k* on the specific road type *c* in the period of one year, equals [Mf_c^k] = km

  N_k ... number of vehicles in individual category *k*

  M^k ... average mileage per one vehicle in the period of one year for the specific category of vehicles on all types of roads, equals [M^k] = km

- Vehicle categories (index *k*) as determined in each individual subsection.

The following equation is valid for all vehicle categories:

$$M^k = \frac{Mf_c^k}{N_k}$$

$$M^k = M_U^k + M_R^k + M_H^k$$

- Driving modes:

U ... urban mode of driving
R ... rural mode of driving
Rdc ... rural mode of driving on state roads
Rlc ... rural mode of driving on local roads
H ... highway mode of driving

- Types of roads:

Dc ... public roads
AC ... highways
HC ... high-speed roads
GC ... main roads
RC ... regional roads
lc ... local roads
LNC ... local rural roads
LUC ... local urban roads

- Mileage shares by individual vehicle category:

$m_U^k = \frac{M_U^k}{M^k}$ ... mileage share in the urban mode of driving [m_U^k] = %

$m_R^k = \frac{M_R^k}{M^k}$ ... mileage share in the rural mode of driving [m_R^k] = %

$m_H^k = \frac{M_H^k}{M^k}$ ... mileage share in the highway mode of driving [m_H^k] = %

- Total mileage of the vehicle fleet by individual vehicle category on public roads:

$$Mf_{dc}^k = Mf_{AC}^k + Mf_{HC}^k + Mf_{GC}^k + Mf_{RC}^k = Mf_{Rdc}^k + Mf_H^k$$

Mileage in the highway mode of driving:

$$Mf_H^k = Mf_{AC}^k + Mf_{HC}^k$$

- Total mileage of the vehicle fleet by individual vehicle category on local roads:

$$Mf_{lc}^k = Mf_{LNC}^k + Mf_{LUC}^k = Mf_U^k + Mf_{Rlc}^k$$

Data on transport work on public roads (Mf_{dc}^k) are available in the Transport publications issued each year by the Ministry of Transport, Directorate of the Republic of Slovenia for Roads. Mileage data on local roads are not available; that is why estimates are made.

Classification of the national road network changed in the year 1998. Until the year 1997 inclusive, state roads were classified into highways, main roads and regional roads. After the year 1998 these same were classified into highways, high-speed roads, main roads

and regional roads. Since 1998 the Mf_{HC}^{k} has been available for all vehicle categories.

The Mf_{AC}^{k}, Mf_{GC}^{k} and Mf_{RC}^{k} are available for passenger cars from 1980 onwards.

The Mf_{AC}^{k}, Mf_{GC}^{k} and Mf_{RC}^{k} are available for buses from 1988−1990 and from 1992 on. For the year 1991 the same values were taken as for the year 1992. For the years 1980−1987 the same values were taken as for the year 1988.

The Mf_{AC}^{k}, Mf_{GC}^{k} and Mf_{RC}^{k} have been estimated for light and mid-size duty vehicles from the year 1992 on.

The Mf_{AC}^{k}, Mf_{GC}^{k} and Mf_{RC}^{k} have been estimated for heavy duty trucks from the year 1992 on.

Light duty vehicles and heavy duty trucks are considered together for the years 1980–1991. Mf_{AC}^{k}, Mf_{GC}^{k} and Mf_{RC}^{k} contain mileage for both categories of duty vehicles.

The Mf_{AC}^{k}, Mf_{GC}^{k} and Mf_{RC}^{k} have been available for motorcycles and mopeds from 1992 on. For the years 1980−1991 the same values were taken as for the year 1992.

The values used are shown in the Annex 1 (*Table 1.2 : Road transport: Mileage data 1980−2009*).

<u>Passenger cars</u>

For assessments on average mileage, passenger cars (PC) were classified into the following five subcategories:

GSm ... passenger cars: gasoline <1.4 l & 2-stroke & LPG
GMe ... passenger cars: gasoline 1.4–2.0 l
GLa ... passenger cars: gasoline >2.0 l
DSm ... passenger cars: diesel <2.0 l
DLa ... passenger cars: diesel >2.0 l

The total mileage by the fleet of passenger cars in the highway mode of driving (Mf_{H}^{PC}) and the total mileage by the fleet of passenger cars made on state roads (Mf_{dc}^{PC}) can be obtained from the statistics from 1992 on. Mileage data for the urban mode of driving (M_{U}^{LdV}) is not available. That is why an estimate of the mileage share in the urban mode of driving m_{U}^{PC} was made. Shares taken are the same for all subcategories of passenger cars.

$$M_{H}^{PC} = \frac{Mf_{H}^{PC}}{N_{PC}}$$

$$m_{H}^{PC} = \frac{5M_{\mathrm{H}}^{PC}}{M^{GSm} + M^{GMe} + M^{GLa} + M^{DSm} + M^{DLa}}$$

$$m_{R}^{PC} = 100 - m_{U}^{PC} - m_{H}^{PC}$$

Statistics on the average amount of mileage for the individual subcategories of passenger cars are not comprehensive. Only the data from the survey conducted by the

Statistical Office of the Republic of Slovenia on the average amount of mileage per vehicle in one year for individual vehicle subcategory for the years 1996 and 2002 is available (M^{GSm} (1996,2002), M^{GMe} (1996,2002), M^{GLa} (1996,2002) , M^{DSm} (1996,2002) , M^{DLa} (1996,2002) . According to the statistical data on the amount of mileage per vehicle in one year for the years 1996 and 2002, the following mileage for individual subcategories of passenger cars has been calculated by using the trend lines for each year from 1980 to 2009 ($M^{GSm}, M^{GMe}, M^{GLa}, M^{DSm}, M^{DLa}$).

Light duty vehicles

For calculations of the average mileage from 1992, light and mid-size duty vehicles are considered as one vehicle category:

LdV ... light duty vehicles

In estimates of average mileage from 1980 to 1991, light duty vehicles, mid-size duty vehicles as well as heavy duty vehicles have been considered together as one category.

The total mileage by the fleet of light duty vehicles in the highway mode of driving (Mf_{H}^{LdV}) and the total mileage made by the fleet of light duty vehicles on the public roads (Mf_{dc}^{LdV}) can be obtained from the statistics from 1992 on. Mileage data for local roads (M_{Rlc}^{LdV}) and mileage data for the urban mode of driving (M_{U}^{LdV}) are not available, so an indirect estimate was made. Mileage on public roads (M_{dc}^{LdV}) was increased by the $Corr_{\mathrm{U+R+H}}^{LdV}$ factor and then the calculations of the mileage in the highway, rural and urban mode of driving, as well as their respective shares were performed. The ratio between the mileage in the rural mode of driving and the mileage in the urban mode of driving was estimated as well (p_R^{LdV}). The $Corr_{\mathrm{U+R+H}}^{LdV}$ and p_R^{LdV} are the same for all the years, 1.5 and 0.7, respectively.

$$M^{LdV} = M_{dc}^{LdV} Corr_{U+R+H}^{LdV} = \frac{Mf_{dc}^{LdV}}{N_{LdV}} Corr_{U+R+H}^{LdV}$$

The average mileage per one vehicle in a year in the highway mode (M_H^{LdV}) of driving can be calculated for light duty vehicles in the following way:

$$M_H^{LdV} = \frac{Mf_H^{LdV}}{N_{LdV}}$$

$$M_{\mathrm{R}}^{LdV} = (M^{LdV} - M_{\mathrm{H}}^{LdV}) p_R^{LdV}$$

$$M_{\mathrm{U}}^{LdV} = (M^{LdV} - M_{\mathrm{H}}^{LdV})(1 - p_R^{LdV})$$

Mileage shares are the following:

$$m_U^{LdV} = \frac{M_{\mathrm{U}}^{LdV}}{M^{LdV}} \qquad m_R^{LdV} = \frac{M_{\mathrm{R}}^{LdV}}{M^{LdV}} \qquad m_H^{LdV} = \frac{M_{\mathrm{H}}^{LdV}}{M^{LdV}}$$

Heavy duty trucks

For calculations of the average mileage from the year 1992 on, heavy duty trucks are

considered as one vehicle category:

HdV ... heavy duty trucks

In estimates of average mileage from 1980 to 1991, light duty vehicles and heavy duty trucks have been considered together as one category. The light duty and mid-size duty vehicles were numbered among heavy duty trucks.

The total mileage of the fleet of heavy duty vehicles in the highway mode of driving (Mf_{H}^{HdV}) and the total mileage made by the fleet of heavy duty vehicles on the public roads (Mf_{dc}^{HdV}) can be obtained from the statistics from 1992 on. For the years from 1980 to 1991 the same values as for the year 1992 were taken. Mileage data for local roads (M_{Rlc}^{HdV}) and on mileage in the urban mode of driving (M_{U}^{HdV}) are not available, so an estimation was made. The mileage on public roads (M_{dc}^{HdV}) was increased by the $Corr_{\mathrm{U+R+H}}^{HdV}$ factor and then the calculations of the mileage in the highway, rural and urban mode of driving, as well as their respective shares were performed. The ratio between the mileage in the rural mode of driving and the mileage in the urban mode of driving was estimated as well (p_R^{HdV}). The $Corr_{\mathrm{U+R+H}}^{HdV}$ and p_R^{HdV} are the same for all years 1.5 and 0.7, respectively.

$$M^{HdV} = M_{dc}^{HdV} Corr_{U+R+H}^{HdV} = \frac{Mf_{dc}^{HdV}}{N_{HdV}} Corr_{U+R+H}^{HdV}$$

The average mileage per one vehicle in a year in the highway mode (M_{H}) of driving can be calculated for heavy duty trucks in the following way:

$$M_H^{HdV} = \frac{Mf_H^{HdV}}{N_{HdV}}$$

$$M_{\mathrm{R}}^{HdV} = (M^{HdV} - M_{\mathrm{H}}^{HdV}) p_R^{HdV}$$

$$M_{\mathrm{U}}^{HdV} = (M^{HdV} - M_{\mathrm{H}}^{HdV})(1 - p_R^{HdV})$$

Average mileage shares are the following:

$$m_U^{HdV} = \frac{M_{\mathrm{U}}^{HdV}}{M^{HdV}} \qquad m_R^{HdV} = \frac{M_{\mathrm{R}}^{HdV}}{M^{HdV}} \qquad m_H^{HdV} = \frac{M_{\mathrm{H}}^{HdV}}{M^{HdV}}$$

<u>Buses</u>

For assessments on average mileage, buses were classified as:

$Ubus$ ... urban buses
$Cbus$ ... coaches

It was assumed that urban buses ($Ubus$) drive only in the urban mode of driving, and that coaches ($Cbus$) do not drive in the urban mode of driving. The total mileage of the fleet of urban buses, or rather the transport work (Mf_{U}^{Ubus}) was obtained from the Statistical Yearbook. The total mileage of the fleet of coaches, or rather the transport work ($Mf_{\mathrm{Rdc,H}}^{Cbus}$) was obtained from the Transport publication.

The average mileage per one vehicle in a year can be calculated for an urban bus in the urban mode of driving in the following way:

$$M_U^{Ubus} = \frac{Mf_U^{Ubus}}{N_{Ubus}} \qquad M_{\mathrm{R}}^{Ubus} = 0$$

The average mileage per one vehicle in a year can be calculated for a coach for the rural mode of driving on public roads (M_{Rdc}) and for the highway mode (M_{H}) in the following way:

$$M_{\mathrm{Rdc},H}^{Cbus} = \frac{Mf_{Rdc,H}^{Cbus}}{N_{Cbus}}$$

The average mileage per one vehicle in a year for the rural mode of driving (M_{R}) is underestimated, since mileage data for the rural mode of driving on local roads (M_{Rlc}) are not available:

$$M_{\mathrm{R}}^{Cbus} \cong M_{\mathrm{Rdc}}^{Cbus}$$

Average mileage shares are the following:

m_U^{Ubus} = 100% $\qquad m_R^{Ubus}$ = 0 $\qquad m_H^{Ubus}$ = 0

m_U^{Cbus} = 0 $\qquad m_R^{Cbus} = \dfrac{M_R^{Cbus}}{M_R^{Cbus} + M_H^{Cbus}} \qquad m_H^{Cbus} = \dfrac{M_H^{Cbus}}{M_R^{Cbus} + M_H^{Cbus}}$

<u>Motorcycles and mopeds</u>
To calculate the average mileage, two-wheeled vehicles were classified as:

MoP ... mopeds
MoT ... motorcycles

It was presumed that mopeds cannot drive on highways: (M_H^{MoP} = 0, m_H^{MoP} = 0). The average mileage per one vehicle in a year for mopeds was estimated (M^{MoP} = 2000 km). Furthermore, the average mileage share of mopeds in the urban (m_U^{MoP}) and rural (m_R^{MoP}) mode of driving were estimated as well. The total mileage of the fleet of motorcycles in the highway mode of driving (Mf_{H}^{MoT}) and the total mileage made by the fleet of motorcycles on the state roads (Mf_{dc}^{MoT}) were obtained from the statistics from 1992 on. For the years from 1980 to 1991 the same values as for the year 1992 were taken. Mileage data for local roads (M_{Rlc}^{MoT}) and for the urban mode of driving (M_{U}^{MoT}) are not available, so an estimation was made. The mileage on state roads (M_{dc}^{MoT}) was increased by the $Corr_{\mathrm{U+R+H}}^{MoT}$ factor and then the calculations of the mileage in the highway, rural and urban mode of driving, as well as their respective shares were performed. The ratio between the mileage of the rural mode of driving and the mileage of the urban mode of driving can was estimated as well (p_R^{MoT}). The $Corr_{\mathrm{U+R+H}}^{MoT}$ and p_R^{MoT} are the same for all years, 1.5 and 0.7, respectively.

$$M^{MoT} = M_{dc}^{MoT} Corr_{U+R+H}^{MoT} = \frac{Mf_{dc}^{MoT}}{N_{MoT}} Corr_{U+R+H}^{MoT}$$

The average mileage per one vehicle in a year in the highway mode (M_{H}) of driving can be calculated for motorcycles in the following way:

$$M_{H}^{MoT} = \frac{Mf_{H}^{MoT}}{N_{MoT}}$$

$$M_{\mathrm{R}}^{MoT} = (M^{MoT} - M_{\mathrm{H}}^{MoT}) p_{R}^{MoT}$$

$$M_{\mathrm{U}}^{MoT} = (M^{MoT} - M_{\mathrm{H}}^{MoT})(1 - p_{R}^{MoT})$$

Average mileage shares are the following:

$$m_{U}^{MoT} = \frac{M_{\mathrm{U}}^{MoT}}{M^{MoT}} \qquad m_{R}^{MoT} = \frac{M_{\mathrm{R}}^{MoT}}{M^{MoT}} \qquad m_{H}^{MoT} = \frac{M_{\mathrm{H}}^{MoT}}{M^{MoT}}$$

Speed

Three driving modes are individualized in accordance with COPERT 4 methodology: urban, rural and highway. For each specific driving mode average speeds has to be set by vehicles type whereas vehicle exhaust emissions and fuel consumption are strongly dependent on speed. Speeds in specific driving modes have been assessed on the basis of the *Road Transport: Speed Data of the Republic of Slovenia* publication, published by the Ministry of Transport. The values used are shown in the Annex 1 *(Table 1.3: Road transport: Speed data 1980−2009*).

Fuel Consumption

Statistical data on the total volume of fuel sold in the Republic of Slovenia is obtained from the Statistical Office of the Republic of Slovenia. From the total volume of fuel sold, the consumption in the fields of agriculture, forestry and civil engineering has been excluded.

As shown in Figure 33 the total fuel consumption in road transport began to grow markedly in the following two periods: during the years 1991–1997 due to fuel being sold to foreigners as a consequence of lower fuel prices in Slovenia, and during the years 1999–2008. During the years 2000–2008 an extensive growth in usage of diesel fuel can be observed. In 2009 a significant decline of gasoline and diesel consumption was observed. In comparison with the year 2008 consumption of gasoline dropped for 8% and diesel for 15%. Lower consumption of fuel was due to the world economical crisis. In the year 2005 sale of diesel fuel exceeded the sale of gasoline. In 2009 the fuel use shares for diesel and gasoline were about 65% and 35%, respectively. The share of liquefied petroleum gas (LPG) was below 0.5%.

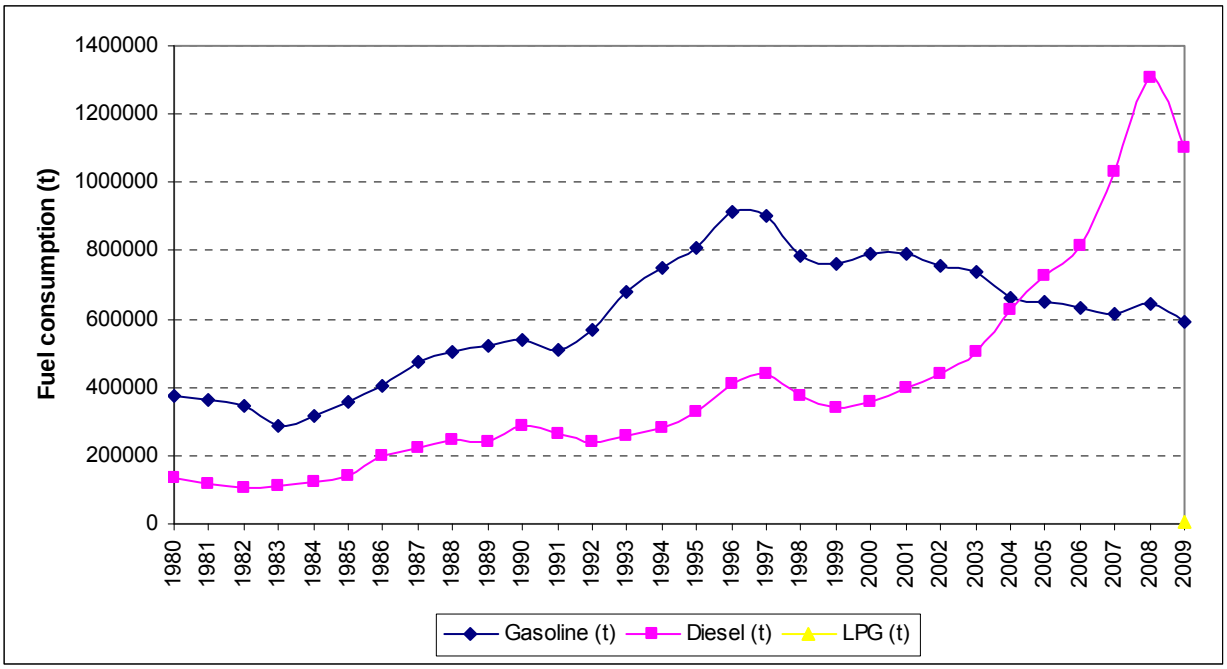

Figure 33: Fuel consumption in road transport for 1980–2009.

As shown in Figure 34 and Figure 35, passenger cars represent the most fuel-consuming vehicle category, followed by heavy duty trucks, light duty vehicles, buses, motorcycles and mopeds, in decreasing order. Fuel consumption for gasoline passenger cars dominates the overall gasoline consumption trend. The development in diesel fuel consumption in recent years is characterised by increasing fuel use for diesel passenger cars and heavy duty trucks, while the fuel use for buses and light duty vehicles, since 1992, has fluctuated. In the category of light duty vehicles and heavy duty trucks, fuel consumption was considered jointly from the year 1980 to 1991. Since 1992 onwards, each vehicle category is treated separately. Due to transparency fuel consumption by types of vehicles in shown in the table in Annex 1 *(Table 1.4: Road transport: Fuel Consumption by types of vehicles 1980−2009).*

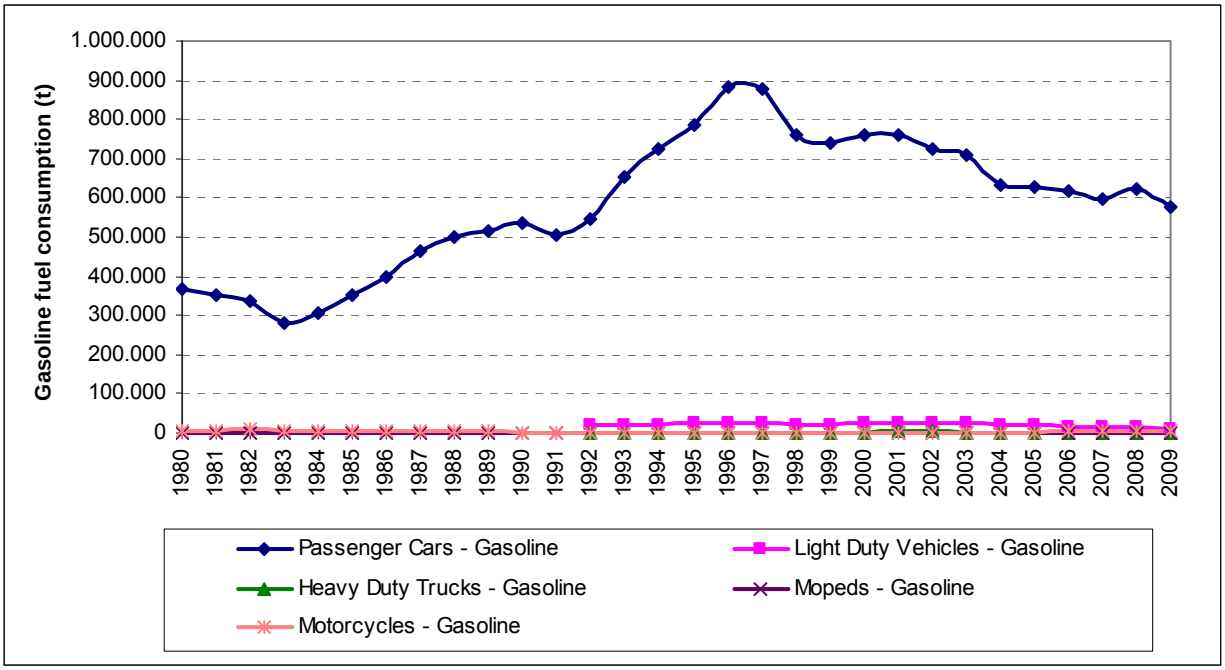

Figure 34: Gasoline fuel consumption per vehicle type for road transport 1980–2009.

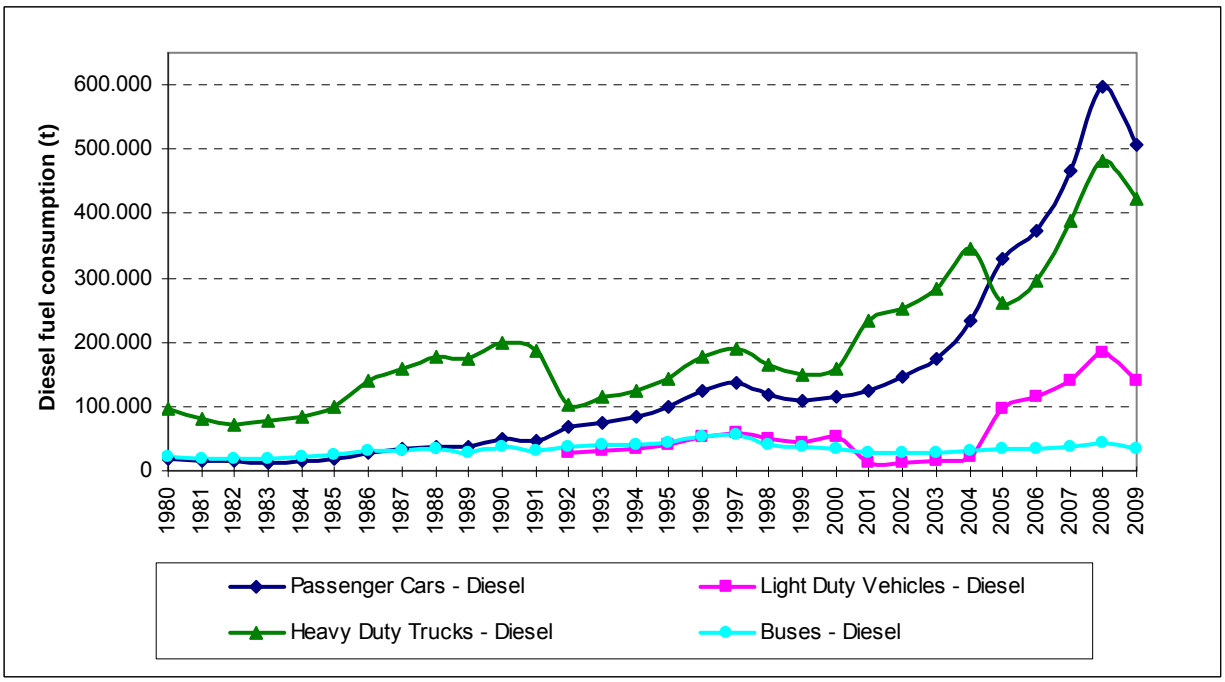

Figure 35: Diesel fuel consumption per vehicle type for road transport 1980–2009.

In 2009, fuel consumption shares for gasoline passenger cars, diesel passenger cars diesel heavy duty trucks were about 34, 30, 25 %, respectively (Figure 36).

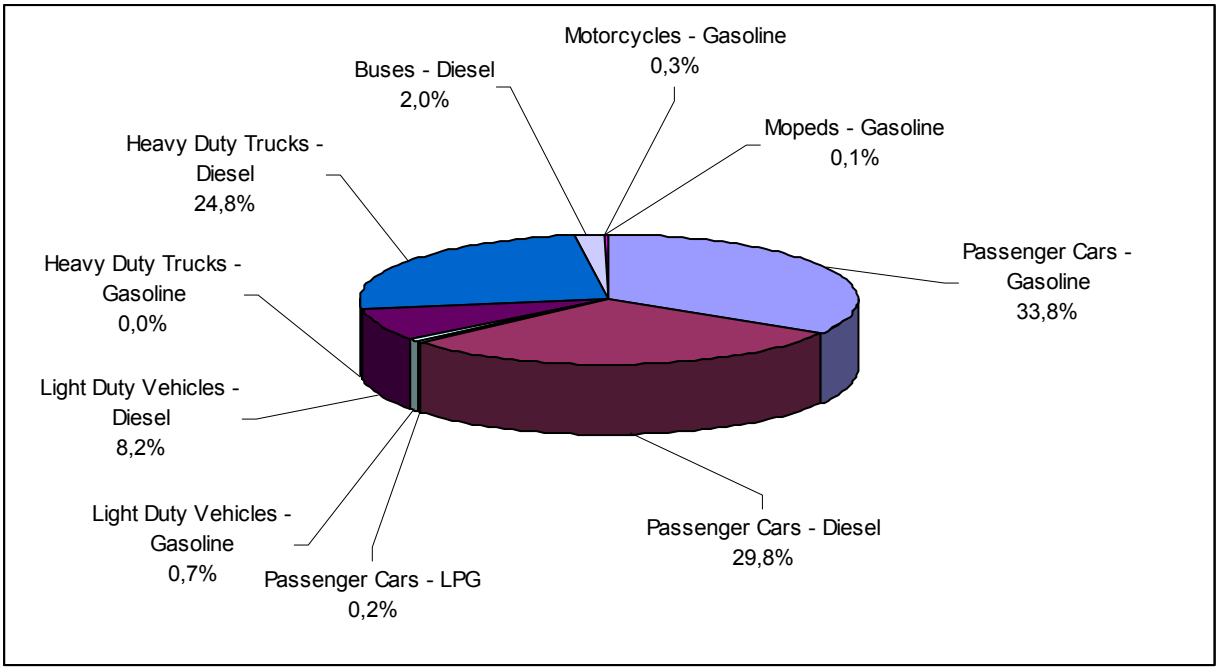

Figure 36: Fuel consumption share per vehicle type for road transport in 2009.

Fuel Characteristics

Sulphur and lead content of liquid fuels and monthly values of fuel volatility (RVP – Reid Vapour Pressure) were taken from Slovene national legislation relating quality of liquid fuels. Leaded gasoline was removed from the market in 2002. All the other physical and chemical data used was proposed as default values by the COPERT 4.

RVP values used were 70 kPa for winter period (1 October – 30 April) and 60 kPa for summer period (1 May – 30 September). The sulphur and lead contents were set as presented in Table 47 and Table 48.

Table 47: Levels of sulphur content in gasoline and diesel fuel.

Fuel	Period	Sulphur [% wt]
Gasoline Leaded	1980-1994	0.1
	1995-2001	0.05
Gasoline Unleaded	1980-1994	0.1
	1995-2001	0.05
	2002-2004	0.015
	2005-2008	0.005
	2009-	0.001
Diesel	1980-1994	1
	1995	0.25
	1996-2001	0.20
	2002-2004	0.035
	2005-2008	0.005
	2009-	0.001

Table 48: Levels of lead content in gasoline.

Fuel	Period	Lead [g/l]
Gasoline Leaded	1980-1994	0.6
	1995	0.4
	1996-2001	0.15
Gasoline Unleaded	1986-1994	0.026
	1995-2001	0.013
	2002-2009	0.005

Monthly minimum and maximum air temperatures

Meteorological data necessary for evaporative emission calculation (annual average minimum temperature and maximum temperature) were taken from *Meteorological Yearbook – Monthly values* of meteorological variables collected by Environmental Agency of the Republic of Slovenia. When the emissions were assessed data for Ljubljana were taken into consideration with the assumption that they are representative enough for the whole of Slovenia. Data are publicly available on Slovene Environmental Agency's website.

Other input data

The average trip length (Ltrip) value corresponds to the mean distance covered in trips started with an engine of ambient temperature (cold start). Mean daily trip distance was set at 12 km in accordance with the recommendation of the COPERT 4. Ltrip value is introduced for the calculation of the Beta value which represents the fraction of the monthly mileage driven before the engine and any exhaust components have reached their nominal operation temperature. Beta values calculated according to the COPERT 4 methodology were used.

All the other required input data (Fuel Injection, Evaporation Control, Evaporation distribution, Monthly canister efficiency, Slope factor, Load factor) used for calculation of emissions using COPERT 4 program were default COPERT 4 data as well.

Emission factors

All emission factors used in the emission inventory for road transport were default emission factors offered by the COPERT 4 program.

Emissions of SO_2, NO_X, CO, NMVOC, NH_3 and PM

From 1980 to 2009, the road transport emissions of SO_2, NMVOC and CO have decreased by 99, 67 and 74%, respectively. In the same period, the emissions of NO_X and NH_3 have increased by 44 % and 2633%, respectively. From 2000 to 2009 the emissions of PM have increased by 23%. Due to the world economical crises and consecutively smaller fuel consumption emissions of all pollutants considerably decreased in 2009.

The gradual lowering of the sulphur content in diesel and gasoline fuel has given rise to a substantial decrease in the road transport emissions of SO_2. In 1995, the sulphur content was reduced from 0.1% (wt) to 0.05% (wt) for gasoline and from 1% (wt) to 0.25% (wt) for diesel. The next clearly indicated emission drop occurred in 2002, when another substantial reduction in sulphur content in gasoline and diesel fuel were carried out. The last reduction of sulphur content in gasoline and diesel was performed in 2009. Sulphur content was reduced to 0.001 % (wt) in both fuels (Figure 37).

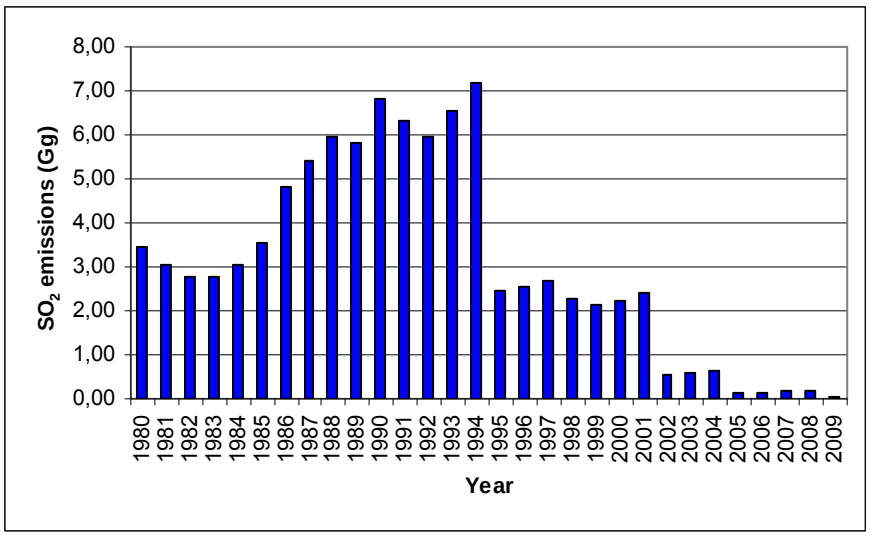

Figure 37: SO_2 emissions (Gg) for road transport 1980−2009.

NO_x emissions have shown a steady decreasing tendency since the introduction of emission efficient EURO 2 and EURO 3 catalyst cars into the Slovene fleet (introduced in 1997 and 2001, respectively). The positive effect of implementation of the stricter EURO standards has been made to no avail, due to the increased motor fuel consumption (Figure 38).

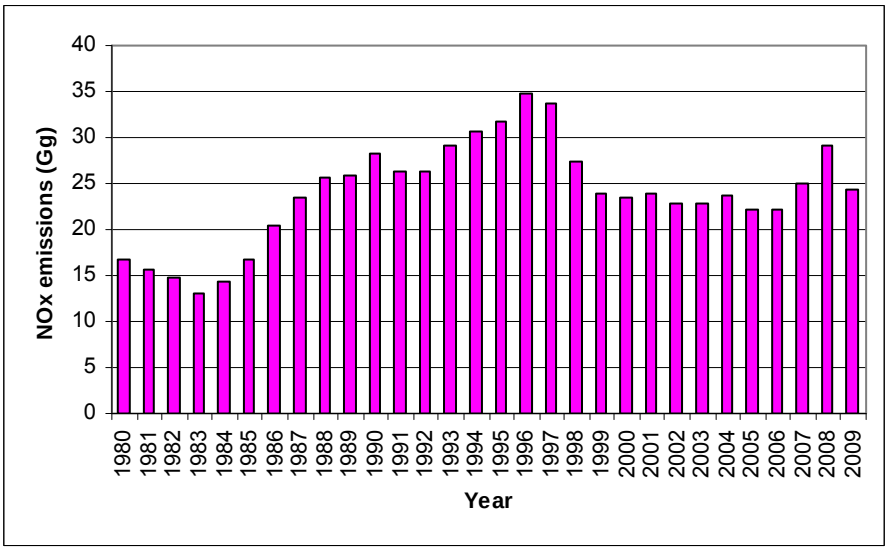

Figure 38: NO_X emissions (Gg) for road transport 1980−2009.

NMVOC and CO emissions have decreased in the last few years due to the growing share of vehicles that meet the stricter EURO standards. NMVOC and CO emission drops are also due to the decreasing share of gasoline passenger cars, as well as the decline in gasoline evaporation (Figure 39 and Figure 40).

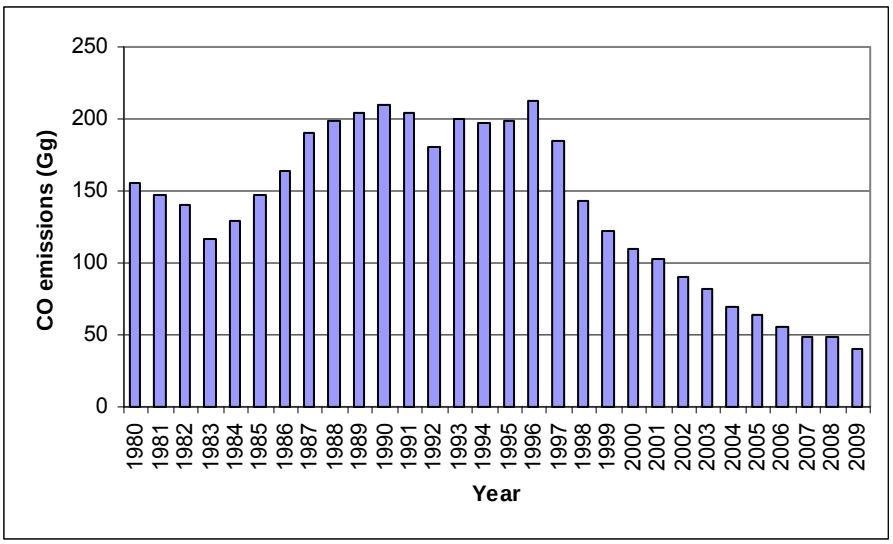

Figure 39: CO emissions (Gg) for road transport 1980−2009.

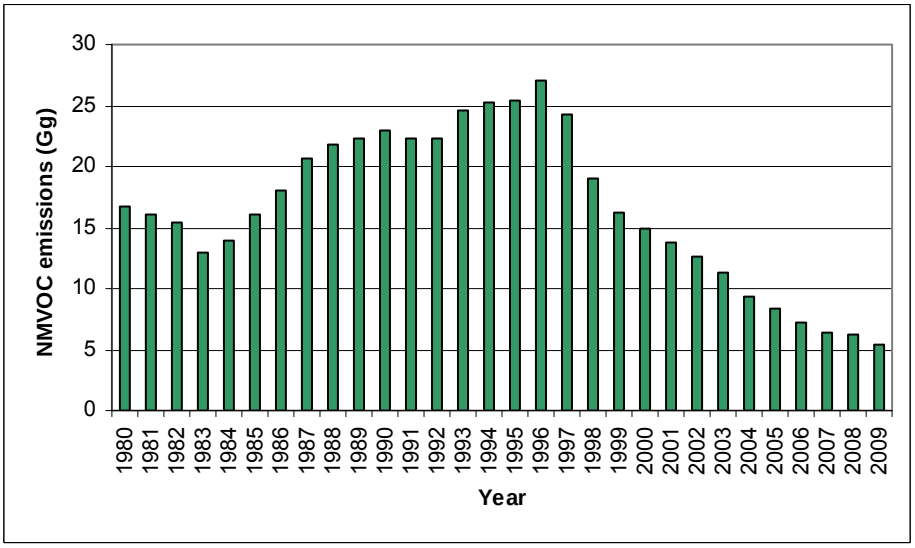

Figure 40: NMVOC emissions (Gg) road transport 1980−2009.

NH_3 emissions have increased rapidly from the year 1993 onward. The significant emission growth is related to the growth in the number of gasoline passenger cars fitted with catalysts. These produce ammonia as a by-product of the catalytic process that reduces emissions of nitrogen oxides. In the last few years the growth in emissions has stabilised, mostly due to the growth in the share of diesel passenger cars and consequently due to greater diesel fuel consumption (Figure 41).

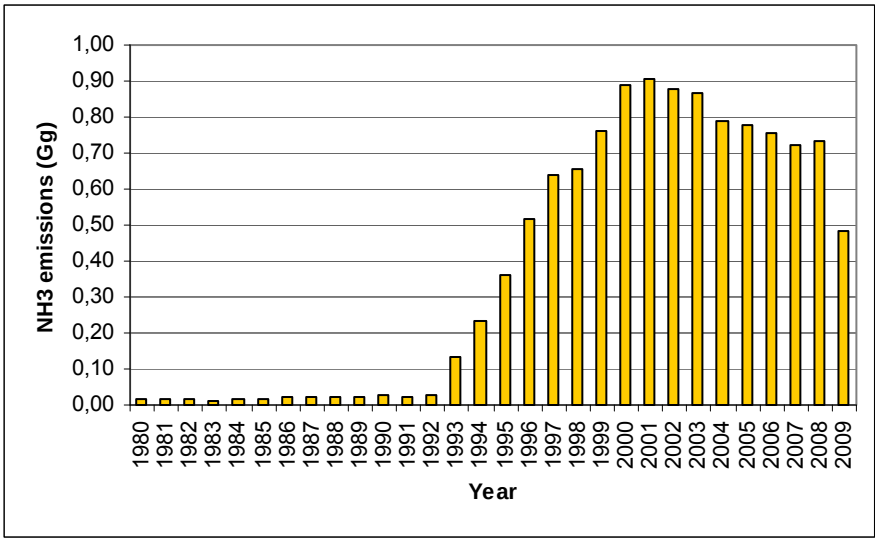

Figure 41: NH_3 emissions (Gg) for road transport 1980−2009.

Particulate emissions in the vehicle exhaust mainly fall in the $PM_{2.5}$ size range. Therefore, all PM emission corresponds to $PM_{2.5}$. PM emission reduction has been achieved due to the growing share of vehicles that meet the stricter EURO standards. Also fuel refinements (mainly sulphur content reduction) played an important role in PM emission (Figure 42).

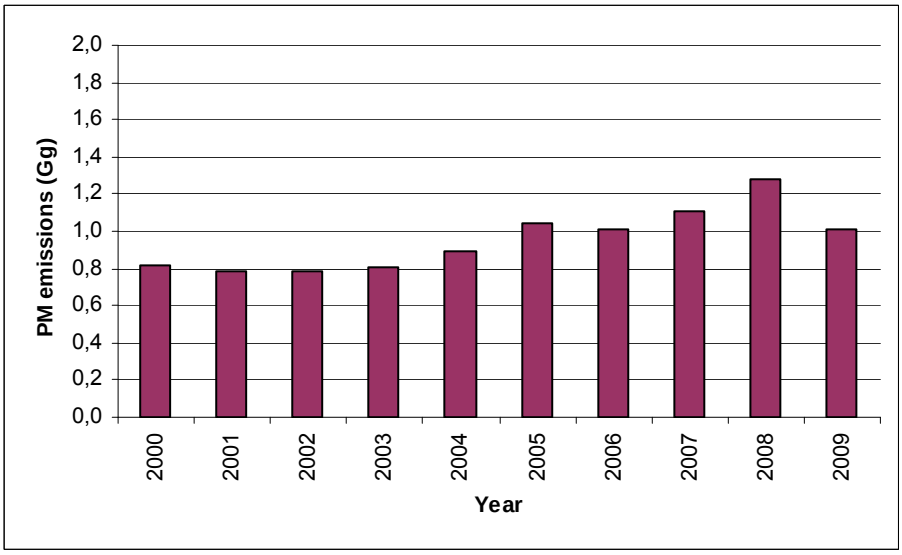

Figure 42: PM emissions (Gg) for road transport 2000−2009.

In 2009, the emission shares for passenger cars, light duty vehicles, heavy duty trucks and 2-wheelers were about 64, 9, 27 and 0.3 %, respectively, for SO_2; 39, 8, 53 and 0.2%, respectively, for NO_x; 85, 4, 6 and 5%, respectively, for CO; 75, 4, 10 and 10%, respectively, for NMVOC; 97, 2, 1 and 0%, respectively, for NH_3; and 54, 18, 28 and 1%, respectively, for PM (Figure 43).

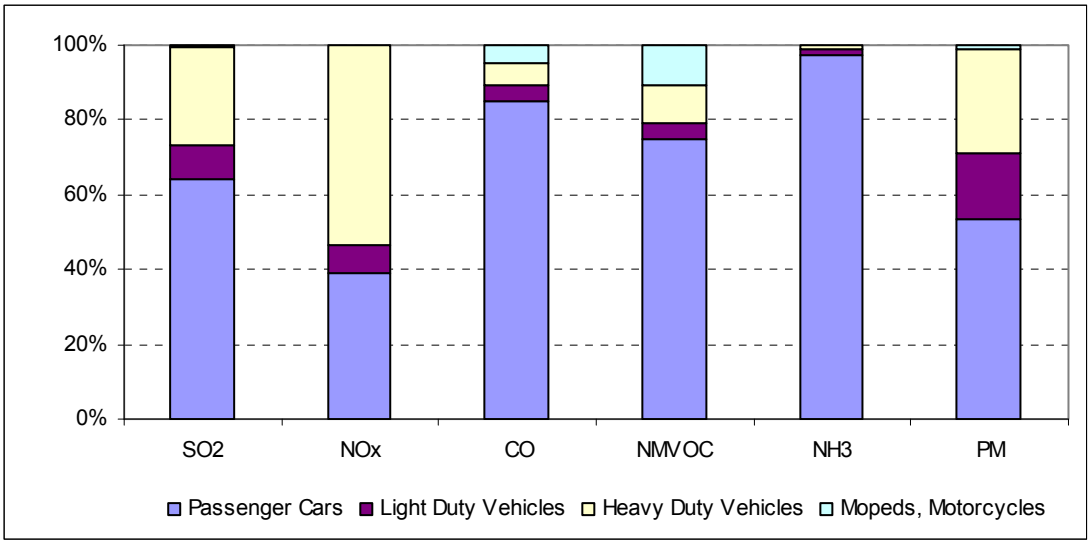

Figure 43: SO_2, NO_X, NMVOC, CO, NH_3 and PM emission shares per vehicle type for road transport for 2009.

Emissions of Pb, Cd, Hg, PAHs, Dioxin/ Furans and HCB

From 1990 to 2009 the road transport emissions of Pb and Dioxin/Furans have decreased by 99 and 79%, respectively. The emission of Hg have increased by 260 %. In the same period, the emissions of Cd and PAHs have increased by 415 and 163 %, respectively. The emissions of HCB have increased by 460%. Road transport emissions of Pb, Cd, Hg PAHs, Dioxin and Furans and HCB for the period 1990−2009 are shown in Figure 44 to Figure 49.

Pb emissions have decreased greatly from 1995-2009. The lowering is due to stricter legislation relating the content of Pb in gasoline fuel. Emissions of Cd have increased in the last few years due to bigger fuel consumption. Total emissions of four PAHs (indeno(1,2,3-cd)pyrene, benzo(k)fluoranthene, benzo(b)fluoranthene, benzo(a)pyrene) have been increasing due to changes in fleet vehicles. Total emissions of dioxins and furans have been decreasing due to growth in the share of diesel passengers cars.

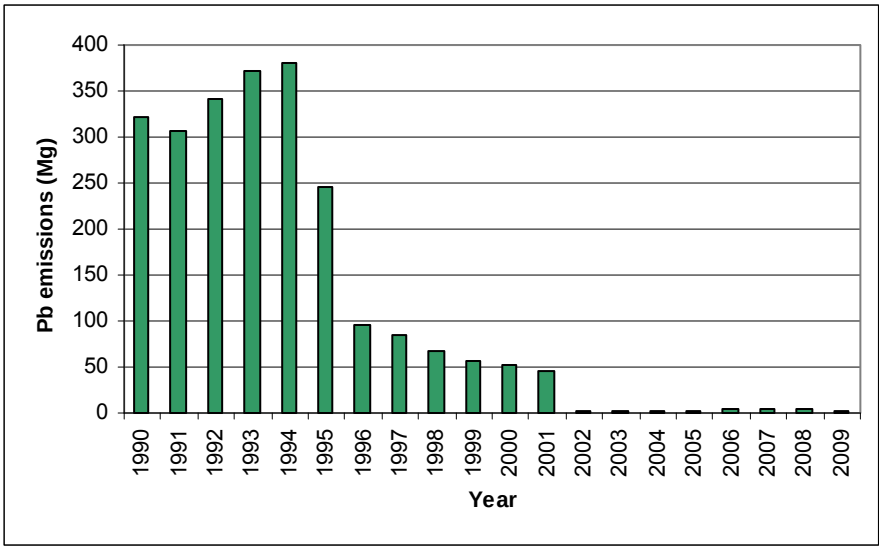

Figure 44: Pb emissions (Mg) for road transport 1990−2009.

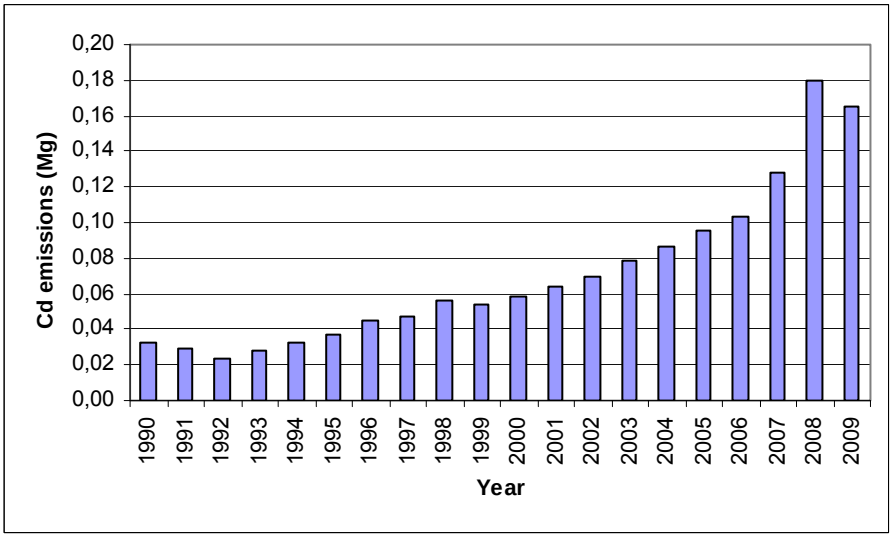

Figure 45: Cd emissions (Mg) for road transport 1990−2009.

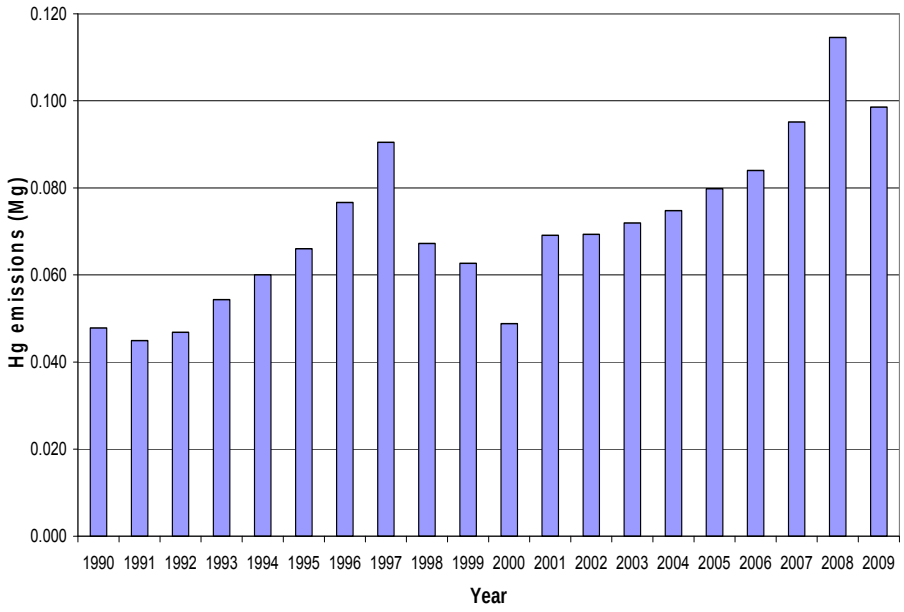

Figure 46: Hg emissions (Mg) for road transport 1990-2009.

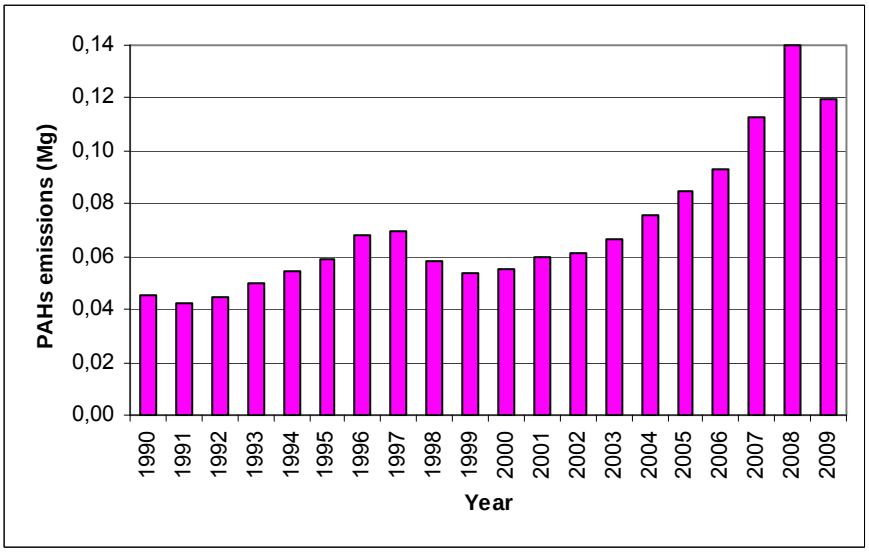

Figure 47: PAHs emissions (Mg) for road transport 1990−2009.

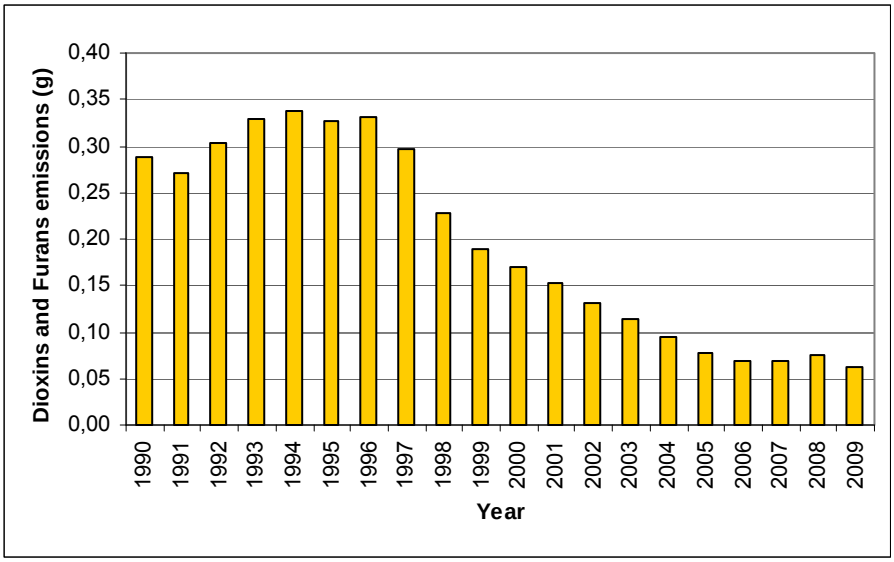

Figure 48: Dioxins and Furans emissions (g) for road transport 1990−2009.

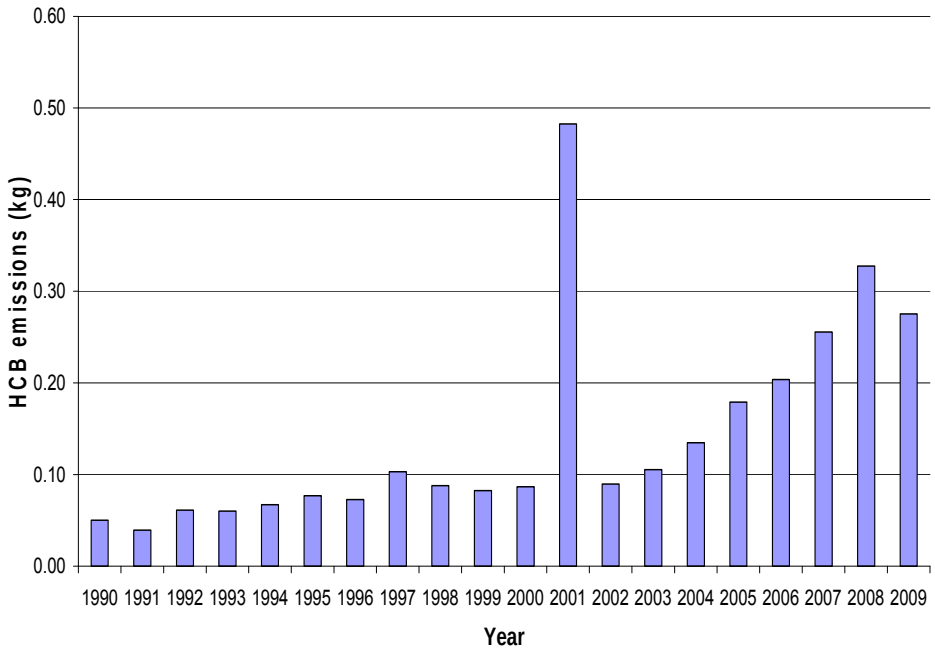

Figure 49: HCB emissions (kg) for road transport 1990-2009.

Emission factor for road transport emissions of Hg was taken from US EPA (1995) 0.014 g/t. Emission factor for HCB emission calculation from road transport was taken from Pacyna et al., 2003 as: 21 ng/km·veh for diesel and 0.024 ng/km·veh for gasoline.

3.2.5.1.1 Uncertainties and time-series consistency

Uncertainty based on expert judgement and is 2% for fuel used and 20% for other activity data. Uncertainties of emission factors are defined by the COPERT 4 program since all emission factors applied were default COPERT 4 emission factors (except for Hg and HCB).

3.2.5.1.2 Recalculations

No recalculations have been performed since last submission. Last submission was resubmission of 1980-2008 data in June 2010.

Resubmission of 1980-2008 data was performed due to use of upgraded version of COPERT methodology. COPERT 4 methodology replaced formerly used COPERT III methodology. In June 2010 recalculations of all air pollutants emissions for the whole period 1980-2008 have been performed. COPERT 4 methodology was used for calculation of 2009 emissions as well.

Upgraded methodology COPERT 4 comprises different emissions factors as well as other characteristics compared to COPERT IIII methodology. Consequently, there are huge differences between emissions calculated with both version of COPERT. The biggest difference was observed for NO_X emissions. COPERT 4 methodology gives for about 40 % higher values than COPERT III. Differences in emissions for other pollutants are smaller. NMVOC and CO emissions calculated with COPERT 4 are about 25 % lower than emissions calculated with COPERT III. Emissions of heavy metals calculated with COPERT 4 are higher due to inclusion of emission arising from tyre and brake wear.

3.2.5.1.3 Planned improvements

The latest version of COPERT 4 methodology (for the time being: version 8) will be used for emission calculation in next submission.

3.2.5.2 Railways

Methodology

To estimate emissions from the railways the following methodology has been adopted.

$$E(t) = m(t) \times EF\ (g/GJ) \qquad \textit{Equation 2}$$

E - emission
m - Quantity of Fuel Combusted
EF - emission factor per Quantity of Fuel

Activity data

The main source of emissions is a consumption of gas oil. The specified data are based on the consumption in the railway transport sector (Ministry of Energy: Statistical Yearbook of Energy Sector in the Republic of Slovenia 1986-2004. Ljubljana: Ministry of Energy. Table Zb/3).

The consumption of brown coal in railway transportation is negligibly small (from 0 to 646 t). This coal is used in only one ‘’archaic’’ steam driven locomotive which is almost 100 years old. According to information from Railway Company, they are trying to avoid using hard coal, due to safety reasons, durability and preservation this piece of history.

Net calorific values

We have used value 42.7 TJ/1000t for gas diesel oil and 12.76 TJ/1000t for brown coal.

Emission factors

In calculating emissions of individual gases, following emission factors have been used.

Table 49: EFs for fuel used in railways.

Pollutant	Unit	Gas Oil	Brown coal
EF NOx	kg/t	52,400	100,000
EF SOx	kg/t	0,700	22,000
EF CO	kg/t	10,700	200,000
EF NMVOC	kg/t	4,650	
EF PM2.5	kg/t	1,370	
EF PM10	kg/t	1,440	
EF TSP	kg/t	1,520	
EF Pb	g/t	0,200	
EF Cd	g/t	0,050	
EF Hg	g/t	0,058	
EF PAH	g/t	0,918	
EF Benzo a pyrene	g/t	0,297	
EF Benzo b fluoranthene	g/t	0,146	
EF Benzo k fluoranthene	g/t	0,178	
EF Indeno 123 cd pyrene	g/t	0,297	

Recalculations

Emissions from the brown coal have been calculated and reported for the firs time.

3.2.5.3 Aviation

Methodology

Most quantities of jet kerosene are consumed outside the territory of Slovenia in international transport, i.e. in the so-called international bunkers; therefore these quantities are excluded from the calculations of national emissions for Slovenia.

To estimate emissions from Aviation, the following methodology has been adopted.

E (t) = m (t) x EF (g/GJ) *Equation 2*

E - emission
m - Quantity of Fuel Combusted
EF - emission factor per Quantity of Fuel

As consumption in Slovenia, the category Aviation Gasoline for Piston Engine Aircraft is taken into account. For 2008 the consumption of jet kerosene in Slovenian army and police has been obtained and included in domestic aviation. According to the data from Slovenian Army about 15% jet kerosene were used on international missions.

Net calorific values

We have used value 43.54 TJ/1000t for aviation gasoline and jet kerosene.

Emission factors

In calculating emissions of individual gases, following emission factors have been used.

Table 50: EFs for fuel used in Aviation.

Pollutant	Unit	Kerosene	Gasoline
EF NOx	kg/t	8,300	4,000
EF SOx	kg/t	0,800	1,000
EF CO	kg/t	11,800	1200,000
EF NMVOC	kg/t	0,500	19,000
EF Pb	g/t		0,017
EF Cd	g/t		3,000
EF Hg	g/t	0,058	0,058
EF PAH	g/t		0,070
EF Benzo a pyrene	g/t		0,011
EF Benzo b fluoranthene	g/t		0,042
EF Benzo k fluoranthene	g/t		0,006
EF Indeno 123 cd pyrene	g/t		0,011

Recalculations

No changes have been made to this source.

Future Improvements

No improvement is planned for this category.

3.2.6 Other Sectors

This chapter presents the consumption of fuels and air emissions in:

- Commercial / Institutional sector
- Residential sector
- Agriculture and forestry

3.2.6.1 Commercial/Institutional Sector

3.2.6.2 Residential Sector

Methodology

To estimate emissions from both sectors the following methodology has been adopted.

E (t) = m (t) x NCV (TJ/kt) x EF (g/GJ) *Equation 1*

E - emission
m - Quantity of Fuel Combusted
NCV - Net Calorific value
EF - emission factor per energy of Fuel

E (t) = m (t) x EF (g/GJ) *Equation 2*

E - emission
m - Quantity of Fuel Combusted
EF - emission factor per Quantity of Fuel

To estimate SOx emissions the following equation was used:

EF_{SO2} = [S] x 20000 / NCV *Equation 3*

EF_{SO2} - SO2 emission factor
[S] – percent sulphur
NCV - Net Calorific value
2 – ratio of the RMM of SO2 to Sulphur

Activity data

The consumption of fuels in the commercial sector and households has been in our basic source of data (Statistical Yearbook of Electricity Generating Industries) combined under “Široka potrošnja”. Disaggregation into these two categories has been done within the framework of the research project done at the end of the year by the Institute of Energy Industries (Gasperic, Dornik 1998). Data from that research project have been corrected in the following points:

Table 51: Estimates of Inappropriate Consumption of Fuel Oil in Commercial Sector and Households

	Other Consu. (LEG)	Estimate of "Inappropriate" Use of Res. Fuel Oil subtracted from Other Cons (LEG) & added to Road Transport	Other Consumption	Split of "Inappropriate" Use of Fuel Oil		Actual Consumption of Res. Fuel Oil in Other Consumption	
				Resid.	Comm./ Inst.	Resid.	Comm./ Inst.
	A	B	C=A-B	D=0.8xB	E=0.2xB	F+G=C	
	(tonnes)	(tonnes)	(tonnes)	80%	20%	(tonnes)	(tonnes)
1986	157.835	36.121	121.714	28.897	7.224	72.117	49.597
1990	310.342	96.020	214.322	76.816	19.204	121.803	92.519
1991	327.577	80.733	246.844	64.586	16.147	145.063	101.781
1992	300.726	59.608	241.118	47.686	11.922	144.779	96.339
1993	411.782	744	411.038	595	149	262.945	148.093
1994	432.591	1.141	431.450	913	228	275.945	155.505
1995	512.171	-23.212	535.383	-	-	342.645	192.738
1996	625.621	-79.731	705.352	-	-	451.425	253.927
1997	697.066	0	697.066	-	-	446.084	250.982
1998	718.587	0	718.587	-	-	459.896	258.691
1999	755.417	0	755.417	-	-	483.467	271.950
2000	674.464	0	674.464	-	-	431.657	242.807
2001	684.636	0	684.636	-	-	438.167	246.469
2002	658.761	0	658.761	-	-	421.607	237.154
2003	633.476	0	633.476	-	-	405.425	228.051
2004	620.586	0	620.586	-	-	397.175	223.411
2005	553.409	0	553.409	-	-	345.255	208.154

Until 2005 "other Consumption" in this report is presented as consumption in households.

- Quantities of fuel oil which have been consumed in road transport as gas oil and which have been estimated in the research project "Assessment of Emissions of Greenhouse Gases in Road Traffic" (Institute of Transport Technology, 1999) are subtracted from the sector "Široka Potrošnja", namely 80 % from sector Consumption in Households and 20 % from Consumption in Commercial Sector

All quantities of residual fuel oil that are reported in LEG as consumed in Other consumption, are in this report presented as consumption in the commercial/institutional sector. In the energy statistics of Slovenia, this item is a balance category; consequently, it will be positive in some years, negative in other years. Quantities used in calculating emissions for this report (either positive or negative values) have been taken from LEG.

Net calorific values

Net calorific values have been taken from SORS, The values for solid fuel varies from year to year but for the liquid and gaseous fuel almost the same values have been used for the entire period as these types of fuel don't change a lot from year to year.

Table 52: NCVs for the fuel used in Commercial Sector and Households.

Year	Lignite (Velenje)	Sub-bituminous Coal - domestic	Sub-bituminous Coal - imported	Gas Oil	Residual Fuel Oil	LPG	Natural Gas	Wood and Other Biomass
	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/kt	TJ/Mm3	TJ/kt
1980	9,36	12,98		41,80	39,70	46,05	33,50	12,17
1981	9,33	11,57		41,80	39,70	46,05	34,10	12,17
1982	9,33	11,57		41,90	39,80	46,00	33,49	12,17
1983	9,61	11,18		41,90	39,80	46,00	33,80	12,17
1984	9,59	11,42		41,90	40,00	46,00	33,50	12,17
1985	9,43	11,69		41,90	39,80	46,05	33,50	12,17
1986	9,39	11,88		41,82	39,74	46,00	33,50	12,17
1987	9,65	11,82		41,78	39,80	46,00	33,50	12,17
1988	9,44	12,00		41,71	39,80	46,00	34,08	12,17
1989	9,82	12,05		41,85	39,90	46,00	34,10	12,17
1990	9,81	12,76		41,87	39,80	46,00	34,10	12,17
1991	9,98	12,88		41,88	39,80	46,00	34,10	12,17
1992	10,26	12,59		41,90	39,90	46,00	34,10	12,17
1993	10,07	13,35		41,90	39,80	46,00	34,10	12,17
1994	9,96	12,67		41,90	39,86	46,00	34,10	12,17
1995	10,22		17,40	41,90	40,00	46,00	34,10	12,17
1996	9,69		16,35	41,90	40,00	46,00	34,10	12,17
1997	9,61		18,20	41,90	40,00	46,05	34,08	12,17
1998	10,01		18,53	41,90	40,00	46,05	34,08	12,17
1999	9,69		18,56	41,90	40,00	46,05	34,08	12,17
2000	10,17		17,98	41,90	40,00	46,05	34,08	12,17
2001	10,66		18,83	41,90	40,00	46,05	34,08	12,17
2002	10,35		19,00	41,90	40,00	46,05	34,08	12,17
2003	10,14		19,00	41,90	40,00	46,05	34,08	12,17
2004	10,30		19,00	41,90	40,00	46,05	34,08	12,17
2005	10,80	11,72		41,90	40,00	46,05	34,08	12,17
2006				41,90	40,00	46,05	34,08	12,17
2007				41,90	40,00	46,05	34,08	12,17
2008				41,90	40,00	46,05	34,08	12,17
2009				42,60	42,60	46,05	34,08	11,87

Emission factors

Emission factors have been taken for:

- main pollutants and PM from EMEP EEA Emission Inventory Guidebook 2009
- Heavy metals from van der Most and Veldt, 1992
- PAH from Pacyna et al., 2003
- PCB from Berdowski et al., 1995

Table 53: EFs for the fuel used in Households.

Pollutant	Unit	Lignite (Velenje)	Sub-bituminous Coal - domestic	Gas Oil	LPG	Natural Gas	Wood and Other Biomass
EF NOx	g/GJ	110,000	110,000	68,000	68,000	57,000	74,500
EF SOx	g/GJ	Equation 4	Equation 4	Equation 4	Equation 4		
EF CO	g/GJ	4600,000	4600,000	46,000	46,000	31,000	5300,000
EF NMVOC	g/GJ	484,000	484,000	15,000	15,000	10,500	600,000
EF PM2.5	g/GJ	398,000	398,000	3,700	3,700	0,500	695,000
EF PM10	g/GJ	404,000	404,000	3,700	3,700	0,500	695,000
EF TSP	g/GJ	444,000	444,000	6,000	6,000	0,500	730,000
EF Pb	g/t	0,240	0,240				0,050
EF Cd	g/t	0,040	0,040				0,100
EF Hg	g/t	0,100	0,100	0,014			0,113
EF PAH	g/t	3,630	3,630				8,580000
EF Benzo a pyrene	g/t	0,845	0,845				2,480000
EF Benzo b fluoranthene	g/t	1,150	1,150				3,260000
EF Benzo k fluoranthene	g/t	0,525	0,525				1,080000
EF Indeno 123 cd pyrene	g/t	1,110	1,110				1,760000
PCB	g/t	0,004	0,004				0,003500

Table 54: EFs for the fuel used in Commercial Sector.

Pollutant	Unit	Lignite (Velenje)	Sub-bituminous Coal - domestic	Gas Oil	Residual Fuel Oil	Natural Gas	Wood and Other Biomass
EF NOx	g/GJ	173,000	173,000	100,000	100,000	70,000	150,000
EF SOx	g/GJ	Equation 4	Equation 4	Equation 4	Equation 4		
EF CO	g/GJ	931,000	931,000	40,000	40,000	25,000	1600,000
EF NMVOC	g/GJ	88,000	88,000	10,000	10,000	2,500	146,000
EF PM2.5	g/GJ	108,000	108,000	16,500	16,500	0,500	149,000
EF PM10	g/GJ	117,000	117,000	21,500	21,500	0,500	150,000
EF TSP	g/GJ	124,000	124,000	27,500	27,500	0,500	156,000
EF Pb	g/t	0,240	0,240		1,300		0,050
EF Cd	g/t	0,040	0,040		1,000		0,100
EF Hg	g/t	0,100	0,100	0,014	0,014		0,113
EF PAH	g/t	3,63	3,63		0		8,580000
EF Benzo a pyrene	g/t	0,845	0,845				2,480000
EF Benzo b fluoranthene	g/t	1,150	1,150				3,260000
EF Benzo k fluoranthene	g/t	0,525	0,525				1,080000
EF Indeno 123 cd pyrene	g/t	1,110	1,110				1,760000
PCB	g/t	0,004	0,004				0,003500

Recalculations

No changes have been made on this sector.

Future Improvements

No improvement is planned for this sector.

3.2.6.3 Agriculture and Forestry

This chapter should present all consumption of fuel in agriculture, forestry, and fishing.

However, only the consumption of fuel for mobile sources in these sectors is presented here. Not enough data are available for the consumption of fuel in stationary sources in Slovenia; consequently, these quantities are included in the Commercial / Institutional sector.

Methodology

Emissions for all pollutants emissions are estimated by means of the following formulas:

E (t) = m (t) x NCV (TJ/kt) x EF (g/GJ) *Equation 1*

E - emission
m - Quantity of Fuel Combusted
NCV - Net Calorific value
EF - emission factor per energy of Fuel

E (t) = m (t) x EF (g/GJ) *Equation 2*

E - emission
m - Quantity of Fuel Combusted
EF - emission factor per Quantity of Fuel

To estimate SOx emissions the following equation was used:

EF_{SO2} = [S] x 20000 / NCV *Equation 3*

EF_{SO2} - SO2 emission factor
[S] – percent sulphur
NCV - Net Calorific value
2 – ratio of the RMM of SO2 to Sulphur

Activity data

The consumption of fuels till year 2000 in agriculture is taken from the research project ”The Consumption of Fuels in Agriculture” by the Slovenian Agriculture Institute, October 2003. For estimation of fuel consumption in Agriculture from year 2000 onwards, we used the same energy intensity (fuel consumption/ha of land) as it was in year 2000.

Table 55: Estimate of Consumption of Gasoline in Agriculture.

	1986	1990	2000	2005	2006	2007	2008	2009
Cultivated Land in State owned Agriculture ent. (1000 ha)	70,00	77,00	62,00	-	-	-	-	-
Total Cultivated Land (1000 ha)	647,00	653,00	509,00	485,00	485,00	489,00	489,00	489,00
Consumption of Gasoline in State owned Agriculture ent. (1000 t)	1,30	1,09	0,70	-	-	-	-	-
Consumption of Gasoline per Hectare of Cultivated Land (t/1000 ha)	18,60	14,10	10,50	7,10	7,10	7,10	7,10	7,10
Estimated Consumption of Gasoline in Total Agriculture (1000 t)	12,00	9,20	3,63	3,46	3,46	3,48	3,40	3,40

Table 56: Estimate of Consumption of Diesel in Agriculture.

	1986	1990	2000	2005	2006	2007	2008	2009
Consumption of Diesel in State owned Agriculture ent. (1000 t)	14,60	12,60	-	-	-	-	-	-
Consumption of Diesel per Hectare of Cultivated Land in State owned Agriculture ent. (t/1000 ha)	208,60	163,50	123,00	123,00	123,00	123,00	123,00	123,00
Estimated consumption of Diesel Fuels in Total Agriculture (1000 t)	135,00	107,00	62,60	59,70	59,70	60,11	60,11	60,11

The consumption of fuels in the entire forestry is estimated on the basis of the consumption of fuel in the state-owned logging enterprises.

For the state-owned sector, data are available for the consumption of fuel and cut, for private sector only data on cut. First, the consumption per m3 of cut in state owned logging enterprises (4.8 tonnes /1000 m3) is estimated. Based on these estimates and data on total cut, the estimate of consumption in the whole of forestry is calculated. For forestry, there are no separate data on the consumption of gasoline and gas, only the total consumption. Consequently, the split is done considering the split in agriculture (10 % gasoline, 90 % gas oil), presuming that the same amount of fuels is consumed per m3 of felled wood in private forestry as in social forestry.

Table 57: The Calculation of the Consumption of Fuels in State Owned Forest

	1990	2000	2005	2006	2007	2008	2009
Consumption of Fuel in State owned Forest (tons)	5922	2808	2971	3405	3405	3405	3405
Cut in State owned Forest (1000 m3)	1230	907	919	997	1100	1100	1100
Consumption of Fuel per Cut Quantities (tons per 1000 m3)	4,80	3,10	3,20	2,90	3,10	3,10	3,10
Total Cut (1000 m3)	2435	2609	3236	3718	3242	3242	3242
Total Consumption of Fuel in Forestry (1000 t)	11,720	8,080	10,453	10,867	10,135	10,135	10,135
Gasoline (10 %) (tones)	1,172	0,808	0,917	0,981	0,825	0,825	0,825
Diesel (90 %) (tones)	10,548	7,272	9,536	9,886	9,310	9,310	9,310

Source of activity data:

Data needed for estimation of consumption of fuels in Agriculture and Forestry is available for years from 1986 to 2004 (Statistical Office of the Republic of Slovenia: Statistical Yearbook RS, Statistical Office of the Republic of Slovenia, Ljubljana).

Source of calorific values: Ministry of Energy: Statisticni letopis energetskega gospodarstva republike Slovenije 1986-2003. Ljubljana: Ministry of Energy,Table Zb/3, Table Zb/1.

Net calorific values

We have used value 43.8 TJ/1000t for gasoline and 42.7 TJ/1000t for gas diesel oil. Until 1998 a heavy fuel oil has been used in agriculture with NCV 40 TJ/1000t.

Emission factors

Table 58: EFs for SOx of the Consumption of Fuels in Agriculture and Forestry.

	unit	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989

EF SOx	g/GJ	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
	unit	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
EF SOx	g/GJ	6,0	6,0	6,0	6,0	6,0	5,0	4,0	4,0	4,0	4,0
	unit	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
EF SOx	g/GJ	4,0	2,0	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7

For other pollutants emission factors have been taken for:

- main pollutants and PM from EMEP EEA Emission Inventory Guidebook 2009
- Heavy metals from van der Most and Veldt, 1992
- PAHs from Pacyna et al., 2003
- PCB from Berdowski et al., 1995

Table 59: EFs of the Consumption of Fuels in Agriculture and Forestry.

Pollutant	Unit	Gasoline (leaded)	Gasoline (unleaded)	Gas/Diesel Oil
EF NOx	kg/t	2,765	2,765	35,043
EF CO	kg/t	620,793	620,793	10,939
EF NMVOC	kg/t	242,197	242,197	3,366
EF NH3	kg/t	0,003	0,003	0,008
EF PM2.5	kg/t			1,738
EF PM10	kg/t			1,738
EF TSP	kg/t			1,738
EF Pb	g/t	800,000	0,017	0,033
EF Cd	g/t	3,000	3,000	0,050
EF Hg	g/t	0,058	0,058	0,058
EF PAH	g/t	0,070	0,070	0,918
EF Benzo a pyrene	g/t	0,011	0,011	0,297
EF Benzo b fluoranthene	g/t	0,042	0,042	0,146
EF Benzo k fluoranthene	g/t	0,006	0,006	0,178
EF Indeno 123 cd pyrene	g/t	0,011	0,011	0,297

Recalculations

No changes have been made on this sector.

Future Improvements

No improvement is planned for this sector.

3.2.7 Source specific QA/QC and verification

The source category QA/QC is covered with general QC procedures described in the chapter 2.6 Our main source specific QA/QC activity is comparison of the ETS data with statistical data.

For four thermal power plants the aggregated fuel from SORS data are compared with the sum of fuel used from verified ETS reports. The NCV values are also checked. If case these numbers are not the same the ETS data are taken in account for GHG inventory and notification to SORS is made to correct their data.

In other cases where connection between both set of data is uniform, the data from

Statistical office are substitute with data from verified reports from installations included in ETS, if necessary. ETS data are also used for different types of waste used as a fuel. The list of waste types is not always complete in the SORS data.

Additional QA activity is reference approach. Before entering data into database, the sum of each fuel from disaggregated data is compared toward energy balance data, reported in the Joint Questioner. As data in JQ are round on 1000 units the difference should be 500units or less. If it is bigger the reasons for this is trying to find out.

4 INDUSTRIAL PROCESSES (NFR sector 2)

Industrial activities not related to energy, produce various air emissions. Emission sources are industrial production processes in which raw materials are chemically or physically transformed. In this transformation, many different pollutants into air are released, such as NO_x, VOC, CO, NH_3,HCl, HF, SO_2, metals and their compounds, HM and POPs.

Due to the intertwined nature of procedures in industry and characteristics of individual reported units, it is in certain cases difficult to distinguish if certain emissions originate from the consumption of fuels for energy purposes or from the consumption of raw materials in industrial processes. The main criterion is the purpose for which a raw material or fuel is used.

MINERAL INDUSTRY (NFR: 2. A)

The sub-sector includes production of cement, lime, container glass/glass wool, mineral wool, other production (consumption of limestone), and roofing and road paving with asphalt. The activity data are primarily based on information from Statistical Office of the Republic of Slovenia and/or plant communication data.

4.1 Cement Production (NFR: 2.A.1)

Source category description

During the manufacturing process natural raw materials are finely ground and then transformed into cement clinker in a kiln system at high temperatures. The clinkers are cooled and ground together with additions into a fine powder known as cement. Cement is a hydraulic binder, i.e. it hardens when mixed with water. Cement is used to bind sand and gravel together in concrete.

The basic raw material for the production of cement is marl, which is a homogeneous mixture of limestone and clay and which originated in past geological periods through sedimentation. As there is no longer enough natural marl for mass production, the cement production mix, which must contain 75-78% of calcium carbonate ($CaCO_3$), is prepared by mixing limestone and clay components: from such with 35% of $CaCO_3$ to limestone with more than 95% of $CaCO_3$. The limestone, which is a source of CaO, normally has an admixture of dolomite, which introduces MgO into the system. Clay components are bearers of SiO_2, Al_2O_3, and Fe_2O_3. Blast furnace slag, silica sand, bauxite, and gypsum are added to the homogenized mix during grinding.

Raw meal powder is fed into the cement kiln through a heat exchange unit. Natural gas, fuel oil, petroleum coke, coal dust, waste oils, and tyres are used as fuels in the clinker calcination process.

The production of clinker takes place in a kiln system in which the minerals of the raw mix are
transformed at high temperatures into new minerals with hydraulic properties. The fine particles of the raw mix move from the cool end to the hot end of the kiln system and the combustion gases move the other way from the hot end to the cold end. This results in an efficient transfer of heat and energy to the raw mix and an efficient removal of pollutants and ash from the combustion process. During the passage of the kiln system the raw mix is dried, pre-heated, calcined and sintered to clinker, which is rapidly cooled with air and stored. The basic chemistry of the cement manufacturing process begins with decomposition of calcium carbonate at about 900 ˚C to leave calcium oxide (CaO) and liberated gaseous carbon dioxide (CO_2); this process is known as calcination. This is followed by the clinkering process in which the calcium oxide reacts at a high temperature (typically 1400–1500 ˚C) with silica, alumina, and ferrous oxide to form the silicates, aluminates and ferrites of calcium that constitute the clinker. The clinker is then rapidly cooled.

Sulphur oxides emissions result from sulphur, which is present both in fuel and in some constituent materials such as clay. Most of the SO_2 that is formed during calcination will usually be absorbed and long-term immobilized in clinker and later in cement.

In Slovenia are located two major cement plants (Cementarna Anhovo and Cementarna LaFarge), producing Portland cement with average annually production 873099 t/year of clinker (Figure 50).

Portland cement is produced by inter-grinding cement clinker and sulphates such as gypsum and anhydrite. Sulphates are required to achieve the desired setting properties of the cement.

Methodology

To estimate emissions from Cement Production, the following methodology has been adopted:

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \qquad \textit{Equation 5}$$

$E_{pollutant}$ – the emission of the specified pollutant
$AR_{production}$ – the activity rate for the production
$EF_{pollutant}$ – the emission factor for this pollutant

Activity data

Activity data used for emission calculation are data on the annual production of clinker obtained from the Statistical Office of the Republic of Slovenia for the period 1986–1998, and directly from the cement production plants (Cementarna Anhovo and Cementarna LaFarge) that produce cement for the years from 1999 to 2009. Activity data for cement production are shown on Figure 50.

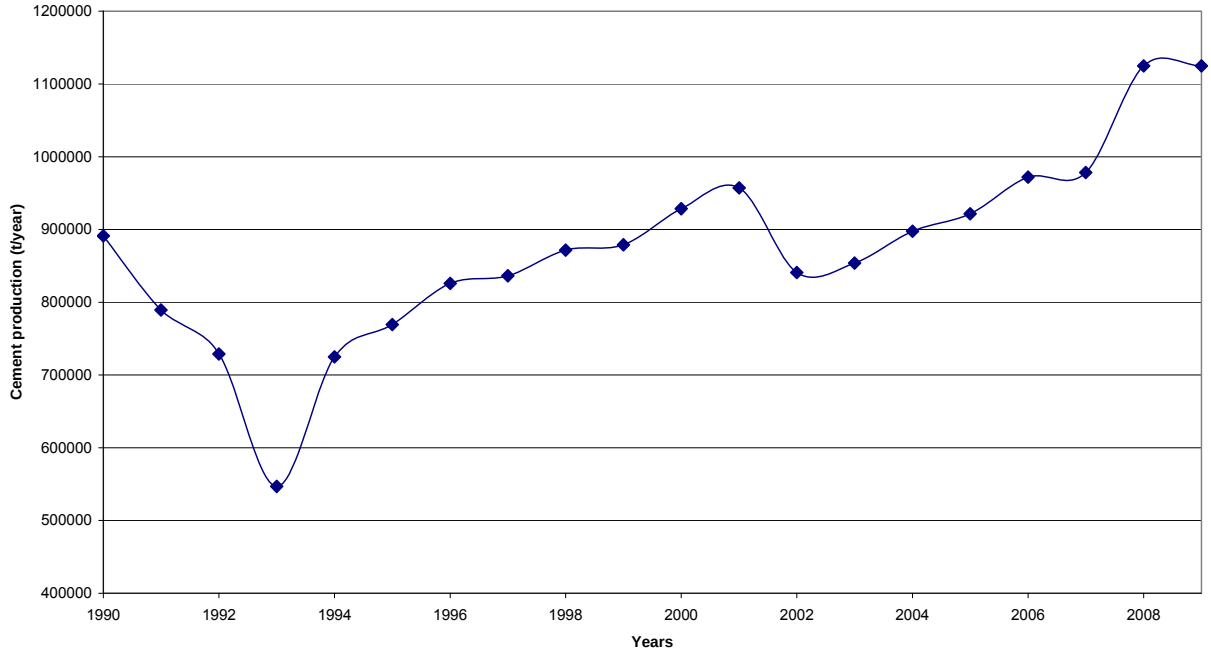

Figure 50: Annul production of clincer in Slovenia

Cement production increased from 891067 t/year to 1124760 t/year during the period 1990 to 2009.

Emission factors

EFs from both before and after 2005 based on plant specific production conditions. The same sources of raw material and methodology were used for calculation both before and after 2005 EFs
Emission factors used for calculation of emissions from cement production for main pollutants and particulate matter, HM and POPs are presented in Table 60 and Table 61.

Table 60: Emission factors used for calculation of emissions from cement production for main pollutants and particulate matter.

	unit	1986-2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
EF SOx	(kg/t)	0,3	1,035	1,219	2,143	1,018	1,173	0,686	0,029	0,045	0,045
EF PM2.5	(kg/t)	0,11	0,11	0,11	0,11	0,11	0,09	0,09	0,07	0,055	0,055
EF PM10	(kg/t)	0,2	0,2	0,2	0,2	0,2	0,16	0,16	0,13	0,1	0,1
EF TSP	(kg/t)	0,22	0,22	0,22	0,22	0,22	0,18	0,18	0,15	0,11	0,11

Table 61: Emission factors used for calculation of emissions from cement production for HM and POPs.

period	EF Pb (g/t)	EF Cd (g/t)	EF Hg (g/t)	EF PCB (mg/t)	EF DF (µg I-TEQ/t)	EF HCB (µg/t)
1990-2009	0,006	0,040	0,065	2,600	0,150	11,000

Emission factors for HM (Pb, Cd and Hg) pollutants are obtained from van der Most and Veldt, 1992 (Table 2.8.1). Emission factors are obtained from Pacyna et al., 2003, Quass

and Freeman, 1997 for POPs pollutants and are not reported in the latest edition of EMEP/EEA emission inventory guidebook 2009.

Source specific recalculations

No recalculation has been done for this source.

Source-specific planned improvements

No improvements are planned for this source.

4.2 Lime Production (2.A.2 Lime production)

Source category description

Lime (CaO) is the high-temperature product of the calcination of limestone. The production occurs in vertical and rotary kilns fired by coal, oil or natural gas. Calcium limestone contains 97–98 % calcium carbonate on a dry basis. Atmospheric emissions in the lime manufacturing industry include particulate emissions from the mining, handling, crushing, screening and calcining of the limestone and emissions of air pollutants generated during fuel combustion in kilns.
Lime is generated by heating the input raw material, i.e. limestone, to high temperature (900-1200°C). During this process, limestone is converted into CaO. Pollutants released are sulphur oxides (SOx), nitrogen oxides (NOx), volatile organic compounds (non-methane VOC and methane (CH_4)), carbon monoxide (CO), carbon dioxide (CO_2), nitrous oxide (N_2O) and particulate matter (PM).
In Slovenia, there are three major lime producers (Zagorje, Kresnice and Kamniška Bistrica) and some minors all over the country.

Methodology

To estimate emissions from Lime Production, the following methodology has been adopted.

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \qquad \textit{Equation 5}$$

$E_{pollutant}$ – the emission of the specified pollutant
$AR_{production}$ – the activity rate for the production
$EF_{pollutant}$ – the emission factor for this pollutant

Activity data

Activity data for emission calculations were obtained from lime plants. The same sources of raw material and methodology were used for calculation both, before and after 2005. Before the year 2005 the lime producers have reported data directly to Agency of the Republic of Slovenia, after 2005, when Slovenia entered into EU ETS scheme, they have reported data via EU ETS. To calculate emissions from lime production after 2005 we have been using data obtained by ETS . These data have been annually verified by independent verifiers.

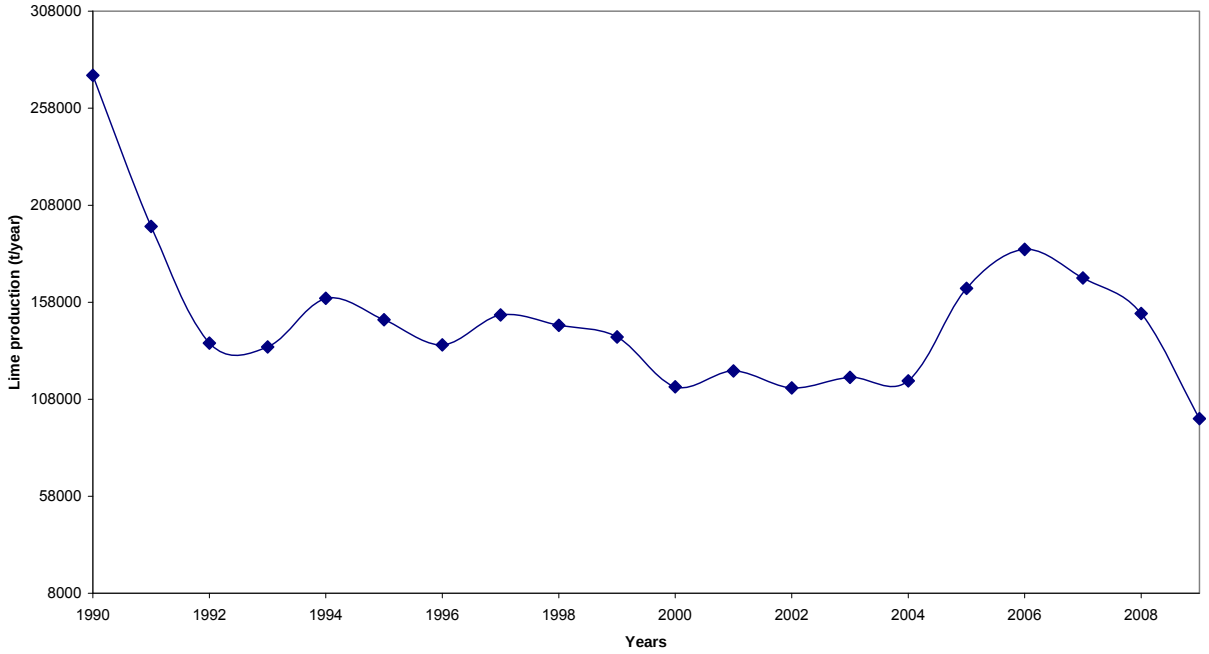

Figure 51: Annual production of lime in Slovenia

Production of lime decresed from 275000 t/year to 97970 t/year during the period 1990 - 2009.

Emission factors

Table 62: Emission factors used for calculation of emissions from lime production for PM, PCB and DF.

period	EF PM2.5 (kg/t)	EF PM10 (kg/t)	EF TSP (kg/t)	EF PCB (mg/t)	EF DF (µg I-TEQ/t)
1990-2009	0,050	0,240	0,590	2,600	0,070

Emission factors for PCB and DF emission calculations are not given in EMEP/EEA emission inventory guidebook, but were obtained from Berdowski et al., 1995 and UNEP, 2003.

Recalculations

No recalculations have been performed for this source.

Planned improvements

No improvements are planned for this source.

METAL PRODUCTION (NFR: 2C)

4.3 Iron and Steel Production (NFR: 2.C.1)

Source category description

Iron is produced through the reduction of iron oxide (ore) using metallurgical coke as the reducing agent in a blast furnace. Steel is then subsequently made from iron and scrap in other furnaces. The production of steel is a multiphase process, and some phases give rise to air emissions. Most emissions occur in smelting iron scrap in electric arc furnace (EAF). The furnace is first filled with steel scrap, and then limestone and/or dolomite are added to allow the slag to form. The furnace utilizes electric heating through graphite electrodes. For increased productivity in the initial phase of melting, oxygen lances and a carbon injection system are used. From a metallurgical point of view, oxygen is used to reduce the carbon content in the molten metal and for removing other undesired elements. Decarburising is performed also in secondary phases in a ladle furnace.

Methodology

To estimate emissions from Lime Production, the following methodology has been adopted.

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \qquad \textit{Equation 5}$$

$E_{pollutant}$ – the emission of the specified pollutant
$AR_{production}$ – the activity rate for the production
$EF_{pollutant}$ – the emission factor for this pollutant

Activity data

In Slovenia, there are three iron and steel producers. Primary production from ore existed only in the 1986 and 1987, after 1990 steel production is based on utilization of scrap iron and steel. In the period 1986–1987 production of pig iron from ore still occurred, the disaggregation into the consumption of fuel as an additive and the consumption of fuel as an energy product was impossible. So for these two years the decision was taken to attribute all coke, which is consumed in the production of iron and steel, to the energy sector as fuel consumption. When this production was discontinued and a new electric arc furnace started production in 1988, the only source of process emissions in this category was production of steel from scrap iron in the EAF. We assumed that energy source in this type of industry is only electricity and emissions from coke and other material are all process emissions.

The consequence is, that all coke consumption for the years 1986–1987 is allocated to the energy sector, whereas for the period 1988–2009 is all coke consumption included in the industrial processes sector.

Data on the amount and carbon content of input and output material were obtained from three iron and steel producers. In our case, input materials were mostly coke (including FAT coke), graphite electrodes and scrap iron. More detailed data were available from 1999 on, which enabled us to determine our own emission factor. For the period 2005-2008 data obtained from EU ETS have been used.

Emission factors

For calculating PM emissions from Iron and Steel production / Electric arc furnace we used country specific EFs.

Table 63: Emission factors used for calculation of emissions from Iron and Steel production / Electric arc furnace for PM.

	unit	2000	2001	2002	2003	2004	2005	2006	2007	2008
EF PM2.5	**(g/t)**	183,81	222,80	208,61	62,82	69,28	56,88	25,22	33,22	30,16
EF PM10	**(g/t)**	210,07	254,63	238,41	71,79	79,17	65,01	28,82	37,96	34,47
EF TSP	**(g/t)**	262,59	318,28	298,01	89,74	98,97	81,26	36,03	47,45	43,09

For calculating other air emissions from Iron and Steel production / Electric arc furnace we used EFs from the following table.

NOTE: Emission of PM substances into air are obtained from REMIS database
Data in REMIS data base are obtained in compliance with Rules on initial measurements and operational monitoring of the emission of substances into the atmosphere from the stationary pollution sources and on the conditions for their implementation (OJ RS, No. 108/08). Each year all obligators must provide report on implementation of emission monitoring of substances into air. Estimation of annual emission includes emission of substances into air, which are based on measurements of emissions of substances into air

Table 64: Emission factors used for calculation of emissions from Iron and Steel production / Electric arc furnace for HM, PCB and DF.

period	EF Pb (g/t)	EF Cd (g/t)	EF Hg (g/t)	EF PCB (mg/t)	EF DF (µg I-TEQ/t)
1990-2009	5,00	0,03	0,04	3,60	2,00

Emission factors are obtained for Pb and Cd emission calculations from van der Most and Veldt 1992 and for Hg from Pacyna and Pacyna 2002. Emission factors for PCB are obtained from EMEP/EEA emission inventory guidebook 2009 and for PCDD/DF from Berdowski et al., 1995.

Recalculations

No recalculations have been performed in this category.

Future improvements

No improvements are planned for this category.

4.4 Ferroalloys Production (NFR 2.C.2)

Source category description

Ferroalloy are concentrated alloys of iron and one or more metals such as silicon, manganese, chromium, molybdenum, vanadium and tungsten. These alloys are used for deoxidising and altering the material properties of steel. Ferroalloy production involves a metallurgical reduction process which results in significant carbon dioxide emissions.

In ferroalloy production, raw ores, coke and slagging materials are smelted together under high temperature. Usually, alloy formation occurs in electric arc furnaces, where heating is accomplished by passing current through graphite electrodes. Carbon reduction of the metallic oxides occurs as both coke and graphite electrodes are consumed. Carbon captures the oxygen from the metal oxides to form carbon monoxide, while the ores are reduced to molten base metals. The component metals then combine in the solution. Carbon monoxide is then converted to carbon dioxide.

Methodology

To estimate emissions from Ferroalloys Production, the following methodology has been adopted.

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \qquad \textit{Equation 5}$$

$E_{pollutant}$ – the emission of the specified pollutant
$AR_{production}$ – the activity rate for the production
$EF_{pollutant}$ – the emission factor for this pollutant

Activity data

Slovenia had only one producer of ferroalloys, producing mostly FeSi and FeSi inoculants, FeCr, SiCa, as well as some other ferroalloys. This factory was closed down in the first quarter of 2008 and consequently the production of ferroalloys was discontinued in 2008 as well. Input data on fuel consumption for the entire period have been obtained from that producer. The producer has also supplied data on the quantities and type of ferroalloys produced and has thus enabled us to verify them by calculating emissions in accordance with alternative method. A comparison of the two methods has yielded very similar results. Due to this, the main environmental impact of producing ferroalloys is the emission of dust (TSP – total suspended particulate matter) and fumes from the smelting processes. Depending on the raw material and the process used, other emissions to air are sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), carbon dioxide (CO_2), polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and volatile metals. The formation of dioxins in the combustion zone and in the cooling part of the off-gas treatment system may be possible. Heavy metals are carried into the process as trace elements in the raw material. Part of the heavy metals will escape as metal vapour. This process depends heavily on the type of ferroalloy produced and the temperature of the smelting process.

Emission factors

period	EF TSP (kg/t)	EF Pb (g/t)
1990-2009	0,590	2,500

Emission factor for Pb emission calculation was taken from van der Most and Veldt, 1992.

Recalculations

No recalculations have been performed in this category.

Future improvements

No improvements are planned for this category.

4.5 Aluminium Production (NFR 2.C.3)

Source category description

Aluminium is produced in two phases. Firstly, alumina (Al_2O_3) is extracted from bauxite ore. Aluminium is then produced in the second phase in an electrochemical process in the electrolysis cells, where alumina disintegrates into its components: aluminium and oxygen. Molten aluminium gathers at the cathode while oxygen reacts with carbon in the anode, causing the consumption of anodes, which have to be replaced.
The most important pollutants emitted from the primary aluminium electrolysis process are sulphur dioxide (SO2), carbon monoxide (CO), polycyclic aromatic hydrocarbons (PAHs) and the greenhouse gas carbon dioxide (CO2). Polyfluorinated hydrocarbons and fluorides are also produced during the electrolysis process.

Methodology

To estimate emissions from Aluminium Production, the following methodology has been adopted.

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \qquad \textit{Equation 5}$$

$E_{pollutant}$ – the emission of the specified pollutant
$AR_{production}$ – the activity rate for the production
$EF_{pollutant}$ – the emission factor for this pollutant

Activity data

In Slovenia, there is one aluminium producer Talum, Kidričevo. Since the base year 1990, the production of aluminium has undergone numerous modernisations, resulting in reduced air emissions from this source in spite of increased production. Good communication has been established between aluminium producer and emission of PAHs into air (Homšak, 2007).

Technology used in production of aluminium since Slovenian aluminium plant was established:
- 1954 start of electrolysis unit A,
- 1963 start of electrolysis unit B,
- 1988 start of electrolysis unit C and technological reconstruction in electrolysis unit B,
- 1991 discontinuance of electrolysis unit A,
- 2002 start of operation of doubled electrolysis unit C,

- 21.12.2007 discontinuance of electrolysis unit B,
- 2009 reduction of production in electrolysis unit C due to economical crisis.

In 1986, aluminium producer had two electrolysis units, A and B, both using Søderberg Horizontal Stud anode reduction cells. The annual production of aluminium in electrolysis unit A amounted to 21220 t, in electrolysis unit B to 23180 t, the total annual production amounted to 44400 t of aluminium. In 1986, the production of aluminium included the production of alumina, but that was discontinued in 1991 for reasons of economy and ecology, and since then alumina has been purchased on foreign markets. In 1991, the production in electrolysis unit A was discontinued as well.

In 1988 a new electrolysis unit C with an annual production capacity of 40,000 t of aluminium was built and its electrolysis technology was taken from Aluminium Pechiney. Simultaneously, reduction cells in electrolysis unit B were reconstructed to use prebaked anodes.

In 2002 upgrading the aluminium production that includes the construction of the second half of the electrolysis unit C with an annual production capacity of 40,000 t of aluminium was carried out. Due to the high costs for electricity used a plant had to wind up production in pot B in the end of 2007. In 2008 only doubled electrolysis unit C with technological improved point feeding prebaked anode Pechiney was in operation. Annual production of aluminium amounted to 83,328 t.

Emission factors

For calculating PM emissions from Aluminium production we used country specific EFs.

Table 65: Emission factors used for calculation of emissions from aluminium production for SOx.

	unit	1992	1993	1994	1995	1996	1997	1998	1999	2000
EF SOx	(kg/t)	44,72	41,91	17,49	12,82	13,25	12,77	12,87	12,69	19,25
	unit	2001	2002	2003	2004	2005	2006	2007	2008	
EF SOx	(kg/t)	18,99	17,65	21,07	8,86	10,92	11,69	10,41	7,89	

Table 66: Emission factors used for calculation of emissions from aluminium production for PM.

	unit	2000	2001	2002	2003	2004	2005	2006	2007	2008
EF PM2.5	(kg/t)	18,49	17,97	8,02	7,88	6,83	6,13	9,90	9,21	0,14
EF PM10	(kg/t)	42,26	41,06	18,32	18,01	15,60	14,01	22,64	21,06	0,31
EF TSP	(kg/t)	52,83	51,33	22,90	22,51	19,51	17,52	28,30	26,33	0,39

NOTE: Emission of SOx and PM substances into air are obtained from REMIS database
Data in REMIS data base are obtained in compliance with Rules on initial measurements and operational monitoring of the emission of substances into the atmosphere from the stationary pollution sources and on the conditions for their implementation (OJ RS, No. 108/08). Each year all obligators must provide report on implementation of emission monitoring of substances into air. Estimation of annual emission includes emission of substances into air, which are based on measurements of emissions of substances into air
For calculating other air emissions from Aluminium production we used EFs from the following table.

Table 67: Emission factors used for calculation of emissions from aluminium production for PAHs, PCB and DF.

period	EF PAH (mg/t)	EF Benzo a pyrene (mg/t)	EFBenzo b fluoranthene (mg/t)	EFBenzo k fluoranthene (mg/t)	EF Indeno 123 cd pyrene (mg/t)	EF PCB (mg/t)	EF DF (µg I-TEQ/t)
1990-2009	3670,00	1200,00	1160,00	1160,00	150,00	2,60	2,00

Till year 2002 we used also emission factor for HCB emission calculation 0.5 µg/t (Pacyna et al., 1999). According to report of unintensioully emissions of POPs in production of primary aluminium (Homšak, 2007) the chemicals that formed HCB stopped using in the process in year 2002.
Other emission factors for PAH calculations are obtained from Berdowski et al., 1995 and Pacyna et al., 2003 for PCDD/DF calculations.

Recalculations

No recalculations have been performed in this category.

Future improvements

No improvements are planned for this category.

4.6 Copper Production (NFR 2. C. 5 a)

Source category description

In Slovenia we have secondary copper production. The recycling of copper is the most comprehensive among the non-ferrous metals. The copper
metal scrap can be in the form of:
• copper scrap, such as fabrication rejects, wire scrap, plumbing scrap, apparatus, electrical systems or products from cable processing;
• alloy scrap, such as brass, gunmetal, bronze, in the form of radiators, fittings, machine parts,
turnings or shredder metals;
• copper-iron scrap like electric motors or parts thereof, plated scrap, circuit elements and switchboard units, telephone scrap, transformers and shredder materials.
Another large group of copper-containing materials is composed of oxidised materials, including
drosses, ashes, slags, scales, ball mill fines, catalysts as well as materials resulting from pollution control systems.

Methodology

To estimate emissions from Copper Production, the following methodology has been adopted.

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \qquad \textit{Equation 5}$$

$E_{pollutant}$ – the emission of the specified pollutant
$AR_{production}$ – the activity rate for the production
$EF_{pollutant}$ – the emission factor for this pollutant

Activity data

Activity data for emission calculations were obtained from Statictical Office of the Republic of Slovenia.

Emission factors

For calculating air emissions from Copper production we used EFs from the following table.

Table 68: Emission factors used for calculation of emissions from copper production for PM, HM, PCB and DF.

period	EF PM2.5 (g/t)	EF PM10 (g/t)	EF TSP (g/t)	EF Pb (g/t)	EF Cd (g/t)	EF Hg (g/t)	EF PCB (mg/t)	EF DF (µg I-TEQ/t)
1990-2009	190	260	320	50,00	2,00	5,50	2,40	20,00

Emission factors for Pb, Cd and Hg were obtained from Pacyna and Pacyna 2002 and for PCB and PCDD/DF from Berdowski et al., 1995 and Pacyna et al., 2003.

Recalculations

No recalculations have been performed in this category.

Future improvements

No improvements are planned for this category.

4.7 Lead Production (NFR 2.C5 b)

Source category description

A secondary lead smelter is defined as any plant or factory, in which lead-bearing scrap or lead-
bearing materials, other than lead-bearing concentrates (ores) derived from a mining operation, is processed by metallurgical or chemical methods into refined lead, lead alloys or lead oxide.

Methodology

To estimate emissions from Lead Production, the following methodology has been adopted.

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \qquad \textit{Equation 5}$$

$E_{pollutant}$ – the emission of the specified pollutant
$AR_{production}$ – the activity rate for the production
$EF_{pollutant}$ – the emission factor for this pollutant

Activity data

Activity data for emission calculations were obtained from Statictical Office of the Republic of Slovenia.

Emission factors

For calculating air emissions from Lead production we used EFs from the following tables.

Table 69: Emission factors used for calculation of emissions from Lead production for PM.

	unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
EF PM2.5	(kg/t)	200	200	200	200	200	200	200	20	20	20
EF PM10	(kg/t)	400	400	400	400	400	400	400	28	28	28
EF TSP	(kg/t)	500	500	500	500	500	500	500	29	29	29

Table 70: Emission factors used for calculation of emissions from Lead production for HM, PCB and DF.

period	EF Pb (g/t)	EF Cd (g/t)	EF Hg (g/t)	EF PCB (mg/t)	EF DF (µg I-TEQ/t)
1990-2009	150,0	3,0	3,0	2,6	20,0

Emission factors for Pb, Cd and Hg were obtained from Pacyna and Pacyna 2002 and for PCB and PCDD/DF from Berdowski et al., 1995 and Pacyna et al., 2003.

Recalculations

No recalculations have been performed in this category.

Future improvements

No improvements are planned for this category.

4.8 Zinc Production (NFR 2.2.5.d)

Source category description

A secondary zinc smelter is defined as any plant or factory in which zinc-bearing scrap or zinc-bearing materials, other than zinc-bearing concentrates (ores) derived from a mining operation, are processed. In practice, primary smelters often also use zinc scrap or recycled dust as input material. Zinc recovery involves three general operations performed on scrap, namely pre-treatment, melting, and refining. Scrap metal is delivered to the secondary zinc processor as ingots, rejected castings, flashing and other mixed metal scrap containing zinc.
Among the various process steps the melting furnace operation represents the most important
source of atmospheric emissions. In general, continuous and periodical emissions can be distinguished. Continuous emissions are connected with the process as such, whereas periodical emissions occur e.g. during charging, heating, skimming or cleaning operations. The most important factors influencing emissions from scrap pre-treatment and melting are:

- the composition of the raw material, in particular the content of organic and chlorinated compounds which affects the formation of dioxins and furans;
- the utilisation of flux powder;
- the furnace type — direct heating with a mixture of process and combustion waste gases reduces the content of organic compounds released from the bath;
- the bath temperature — a temperature above 600 °C creates significant emissions of zinc oxide;
- the fuel type — in general, natural gas or light fuel oil are used.

Continuous emissions from the melting furnace consist of combustion waste gases and gaseous

effluents from the bath. The specific gas flow amounts to about 1 000 m3 (STP)/Mg zinc produced.

Methodology

To estimate emissions from Zinc Production, the following methodology has been adopted.

$E_{pollutant} = AR_{production} \times EF_{pollutant}$ *Equation 5*

$E_{pollutant}$ – the emission of the specified pollutant
$AR_{production}$ – the activity rate for the production
$EF_{pollutant}$ – the emission factor for this pollutant

Activity data

Activity data for emission calculations were obtained from Statictical Office of the Republic of Slovenia.

Emission factors

For calculating air emissions from Zinc production we used EFs from the following tables.

Table 71: Emission factors used for calculation of emissions from Zinc production for PM.

	unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
EF PM2.5	**(kg/t)**	200	200	200	200	200	200	200	22	22	22
EF PM10	**(kg/t)**	400	400	400	400	400	400	400	30	30	30
EF TSP	**(kg/t)**	500	500	500	500	500	500	500	39	39	39

Table 72: Emission factors used for calculation of emissions from Zinc production for HM, PCB and DF.

period	EF Pb (g/t)	EF Cd (g/t)	EF Hg (g/t)	EF PCB (mg/t)	EF DF (µg I-TEQ/t)
1990-2009	200,0	2,0	7,5	2,6	50,0

Emission factors for Pb, Cd and Hg were obtained from Pacyna and Pacyna 2002 and for PCB and PCDD/DF from Berdowski et al., 1995 and Pacyna et al., 2003.

Recalculations

No recalculations have been performed in this category.

Future improvements

No improvements are planned for this category.

4.9 Other Production Processes (NFR 2 D)

4.9.1 Pulp and paper (NFR 2.D.1)

Source category description

Paper is essentially a sheet of cellulose fibres with a number of added constituents to affect the quality of the sheet and its fitness for intended end use. The pulp for papermaking may be produced from virgin fibre by chemical or mechanical means or by the re-pulping of recovered paper (RCF). In the pulping process, the raw cellulose-bearing material is broken down into its individual fibres. Wood is the main raw material but straw, hemp, grass, cotton and other cellulose-bearing materials can be used as well. The precise composition of the wood will vary according to the type and species but the most important constituents are cellulose, hemicelluloses and lignin. In Slovenia, there were 4 pulp and paper plants (Goričane, Količevo, Radeče and Vipap krško) in Slovenia and some of them were closed for operation in last years.
Emissions from paper and pulp production include non-methane volatile organic compounds (NMVOC), sulphur oxides (SOx), particulates, nitrogen oxides (NOx) and carbon monoxide (CO).

Methodology

To estimate emissions from Pulp and paper, the following methodology has been adopted.

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \qquad \textit{Equation 5}$$

$E_{pollutant}$ – the emission of the specified pollutant
$AR_{production}$ – the activity rate for the production
$EF_{pollutant}$ – the emission factor for this pollutant

Activity data

Activity data for emission calculations were obtained from Statictical Office of the Republic of Slovenia.

Emission factors

For calculating air emissions from Pulp and paper we use EFs from the following table.

Table 73: Emission factors used for calculation of emissions from Pulp and paper

period	EF PM2.5 (kg/t)	EF PM10 (kg/t)	EF TSP (kg/t)	EF DF (µg I-TEQ/t)
1990-2009	0,6	0,8	1,0	0,4

Emission factors for PM and TSP are obtained from European Commission 2001.
Emission factor for PCDD/DF was obtained for emission calculation from UNEP, 2003.

Recalculations

No recalculations have been performed in this category.

Future improvements

No improvements are planned for this category.

4.9.2 Food and drink (NFR 2.D.2)

Source category description

Food manufacturing may involve the heating of fats and oils and foodstuffs containing them, the
baking of cereals, flour and beans, fermentation in the making of bread, the cooking of vegetables and meats, and the drying of residues. These processes may occur in sources varying in size from domestic households to manufacturing plants. When making any alcoholic beverage, sugar is converted into ethanol by yeast. This is fermentation. The sugar comes from fruit, cereals or other vegetables. These materials may need to be processes before fermentation. To make spirits, the fermented liquid is then distilled. Alcoholic beverages, particularly spirits and wine, may be stored for a number of years before consumption.
Emissions may occur during any of the four stages which may be needed in the production of an
alcoholic beverage. During preparation of the feedstock, the most important emissions appear to occur during the roasting of cereals and the drying of solid residues. During fermentation, alcohol and other NMVOCs are carried out with the carbon dioxide as it escapes to atmosphere. In some cases, the carbon dioxide may be recovered, reducing the emission of NMVOC as a result.

Methodology

To estimate emissions from Food and drink, the following methodology has been adopted.

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \qquad \textit{Equation 5}$$

$E_{pollutant}$ – the emission of the specified pollutant
$AR_{production}$ – the activity rate for the production
$EF_{pollutant}$ – the emission factor for this pollutant

Activity data

Activity data for emission calculations were obtained from Statictical Office of the Republic of Slovenia.
The relevant activity statistics are based on the national production figures, including:

- total production of bread;
- total production of wine;
- total production of beer;
- total production of spirits.

Emission factors

For calculating NMVOC emissions from Food and drink we used EFs from the following table.

Table 74: Emission factors used for calculation of NMVOC emissions from Food and drink.

period	EF (Wine) kg/hl	EF (Beer) (kg/hl)	EF (Spirits) (kg/hl)	EF (Bread) (kg/t)
1990-2009	0,06	0,08	3,50	3,00

Recalculations

No recalculations have been performed in this category.

Future improvements

No improvements are planned for this category.

4.9.3 Wood processing (NFR: 2.D.3)

Source category description

To protect wood against wood decay fungi and insects and also against weathering, wood preservatives that fully penetrate into wood, need to be applied. In practice, wood preservatives are applied only by brushing. There are three main types of preservative: creosote, organic solvent-based (often referred to as 'light organic solvent-based preservatives (LOSP)') and water borne. Creosote is an oil prepared from coal tar distillation. Creosote contains a high proportion of aromatic compounds such as polycyclic aromatic hydrocarbons (PAHs). Levels of benzo[a]pyrene in some types of creosote are restricted in the EU to 500 ppm as well in Slovenia for industrial use (14th amendment to the Marketing and Use Directive — Creosote (96/60/EEC)).

Methodology

To estimate emissions from Other product use, the following methodology has been adopted.

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \qquad \textit{Equation 5}$$

$E_{pollutant}$ – the emission of the specified pollutant
$AR_{production}$ – the activity rate for the production
$EF_{pollutant}$ – the emission factor for this pollutant

Activity data

Activity data were obtained from Impregnacija Hoče (personal communication).

Emission factors

For calculating PAH emissions from Wood processing we used EFs from the following table.

Table 75: Emission factors used for calculation of PAH emissions from Wood processing

Pollutant	unit	EF
Benzo(a)piren	mg/t	500
Benzo(k)fluoranten	mg/t	250
Benzo(b)fluoranten	mg/t	250
Indeno(1.2,3-cd)piren	mg/t	500

Emission factors were obtained from Berdowski et al., 1995 (Table E), the same emission factors are found in EMEP/EEA emission inventory guidebook, 2009. The reporting in CLRTAP reporting form is performed in NFR 3.D.3.

Recalculations

No recalculations have been performed in this category.

Future improvements

No improvements are planned for this category.

5 Product use (NFR sector 3)

5.1 Chemical Products

Source category description

Emission sources of NMVOC in Slovenia are generated during the production of following products:

- PVC and other plastic
- laques and amiles
- rubber products
- adhesives
- processing of plastic

Methodology

To estimate emissions from Chemical products, the following methodology has been adopted.

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \qquad \textit{Equation 5}$$

$E_{pollutant}$ – the emission of the specified pollutant
$AR_{production}$ – the activity rate for the production
$EF_{pollutant}$ – the emission factor for this pollutant

Activity data

Activity data were obtained from Statistical Offices of Republic of Slovenia.

Emission factors

For calculating NMVOC emissions from Chemical products we used EFs from the following tables.

Table 76: Emission factors used for calculation of NMVOC emissions from Chemical products (except Processing of plastic).

	unit	EF NMVOC
PVC and other plastic	kg/t	5
laques and amiles	kg/t	10
rubber products	kg/t	10
adhesives	kg/t	20

Table 77: Emission factors used for calculation of NMVOC emissions from Processing of plastic.

	unit	period 1990-1995	period 1990-1995
EF NMVOC	kg/t	10	6

NOTE: From the year 2005 emission of NMVOC substances into air are obtained from REMIS database. Data in REMIS data base are obtained in compliance with Decree on limit values for atmospheric emissions of volatile organic compounds from installations using organic solvents (OJ RS, No. 112/05, 37/07, 88/09 in 92/10) and Decree on the emission limit values of halogenated volatile organic compounds into the atmosphere from installations using organic solvents (OJ RS, No. 112/05 in 37/07). Each year all VOC obligators must provide report about solvent management plan (mass balance) for previous year.

Recalculations

No recalculations have been performed in this category.

Future improvements

No improvements are planned for this category.

5.2 Other product use (NFR: 3.D. Other product use, 3.D.3 Other product use)

Source category description

Production of electrical equipment containing PCB (transformers and capacitors) in Slovenia was terminated in January 1985. A study “A Concept of Handling the PCB/PCT in Slovenia” was made in 1999. PCB containing equipment has to be registered to the EARS (Environmental Agency of the Republic of Slovenia - competent authority). It is also obligatory for the proprietors / owners of the PCB equipment to report to the competent authority, whether, when and how the PCB equipment was disposed off and where it was sent according to the principles of shipment of hazardous waste. Slovenia has taken all

necessary measures to ensure that all PCB/PCT containing material in the environment will be disposed until 2012.

Electrical equipment, containing PCB in Slovenia:

- capacitor
- transformer

Methodology

To estimate emissions from Other product use, the following methodology has been adopted.

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \qquad \textit{Equation 5}$$

$E_{pollutant}$ – the emission of the specified pollutant
$AR_{production}$ – the activity rate for the production
$EF_{pollutant}$ – the emission factor for this pollutant

Activity data

Activity data for PCB emission calculations are obtained from EARS (Barbara Štravs Grilc, contact person).

Emission factors

For calculating PCB emissions from Other product electrical equipment use we used EFs from the following table.

Table 78: Emission factors used for calculation of PCB emissions from Other product use – electrical equipment.

	unit	EF PCB
capacitor	%	0,16
transformer	%	0,01

The emission factors for PCB emission calculations from capacitors and transformers are obtained from Berdowski et al., 1995.

Recalculations

No recalculations have been performed in this category.

Future improvements

No improvements are planned for this category.

6 Agriculture (NFR sector 4)

6.1 Manure management (NFR sector 4B)

Ammonia emissions in agriculture were generated from different sources including emissions in animal production, emissions due to fertilization with organic and synthetic fertilizers and emissions due to cultivation of legume crops. The approach suggested by EMEP/CORINAIR (2002) was used to asses the emissions. The methodology is based on principles of nitrogen fluxes. In case of animal production the model starts out with nitrogen excretions followed by emissions from animal housing and manure stores. It was taken into account that only the nitrogen that was not lost from animal houses and manure stores is retained in animal manures.

Emissions in animal production – nitrogen excretion rates

In the first step nitrogen excretion from farm animals was estimated. The estimates have been done on the basis of the data on the number of farm animals in Slovenia and nitrogen excretion rates of individual animal species and categories. Data on the number of farm animals were obtained from the Statistical Office of the Republic of Slovenia (SORS). The nitrogen excretion rates, which were taken into account, are presented in Table 1. In dairy cows the nitrogen excretion has been linked to productivity, i.e. milk production (M). The equation proposed by Menzi et al. (1997) was used:

N excretion (kg/year) = 52.5 + 0.0105 × M (kg/year) (eq. 1)

Table 79: Nitrogen excretion rates for the calculation of ammonia emissions from animal production

Animal category	N excretion (kg/year)	Source
Cattle		
Dairy cows	**81-113**	**Equation 2**
Suckling cows	**78**	**Equation 2, taken into account 2400 kg of milk per year**
Calves, fattening cattle, heifers	**35**	**Menzi et al. (1997)**
Pigs		
Sows[a]	**36**	**EMEP/CORINAIR (2002)**
Fattening pigs	**14**	**EMEP/CORINAIR (2002)**
Small ruminants		
Sheep[b]	**20**	EMEP/CORINAIR (2002)
Goats[c]	**20**	EMEP/CORINAIR (2002)
Horses	**50**	EMEP/CORINAIR (2002)
Poultry		
Laying hens	**0.71**	Menzi et al. (1997)
Broilers	**0.40**	Menzi et al. (1997)
Turkeys	**1.50**	**Döhler et al. (2002)**
Geese	**0.73**	Döhler et al. (2002)
Ducks	**0.60**	Döhler et al. (2002)

[a] Sows and pregnant gilts; the value includes N excretion in piglets and boars
[b] Adult female sheep; the value includes N excretion in lambs and rams
[c] Adult female goats; the value includes N excretion in kids and he-goats

Emissions from animal housing, manure stores and due to fertilization with animal manures in cattle production

Emission factors, which tell us how much of N from animal excreta is lost to the atmosphere in the form of ammonia, depend on manure management systems. Factors, along with some basic information on manure management systems in cattle production, are presented in Table 2. The fraction of individual manure management systems has been estimated on the basis of the results of a farm census done in 2000. Since manure management systems were not reported in the census, data on size and structure of cattle-breeding farms were used instead. It was considered that all farms with less than 10 head of bovine animals have solid manure storage systems, that of farms with 10-19 head of animals, 30% have liquid manure systems and 70% solid manure storage systems, and that all farms with 20 cows or more have liquid manure storage systems. It was assumed that solid manure storage system is also characterized by tied housing system and that liquid manure system is characterized by loose housing system. For 1990, manure storage systems have been estimated according to a similar procedure, but in this case using the results of the 1991 census. Linear regression was used to estimate the changes in manure management systems during the period 1990-2000. The fraction of grazing bovine animals for 1990 has been estimated on the basis of data on grazing animals on mountain pastures end expert estimate on the scale of grazing on intensive grasslands (Verbič et al., 1999). In 2000, all grazing animals on mountain and other pastures have been recorded. This census showed that in 2000, one way, or another, 21% of animals were grazing. This data have been corrected with regard to the length of the grazing season, considering the fact that animals on mountain pastures on the average will graze for 141 days and on other pastures for 210 days. The estimate for 1990 was used for the period 1985-1990 and the estimate for 2000 was used for the period after 2000. For the period 1991-1999 the data on grazing were obtained by linear regression which was calculated on the basis of data for the years 1990 and 2000. It has been estimated that the fraction of grazing animals and the fraction of liquid manure management systems have increased while the fraction of bovine animals in straw based systems has decreased.

Table 80: Emission factors and basic information on manure management systems for the calculation of ammonia emissions in cattle production (Sources for emission factors: Menzi et al., 1997, EMEP/CORINAIR, 2002)

		Tied housing system		**Loose housing system**
	Grazing	**Farmyard manure**	**Liquid fraction (urine)**	**Slurry**
Proportion of soluble N in excrements (in kg/kg total N)*	/	0.30	0.70	0.6
Basic information				
Proportion of covered manure stores	/	0.00	0.90	0.50
Proportion of manure application in favourable weather conditions or immediate incorporation	/	0.20	0.20	0.20
Proportion of farmyard manure used on arable land	/	0.40	/	/
Emission factors (kg NH_3-N/kg N)				
From animal houses or during grazing (proportion of excreted N)	0.05	0.07	0.07	0.154

Emissions from uncovered manure stores (proportion of soluble N remaining after losses from animal houses)	*I*	0.30	0.15	0.15
Emissions from covered manure stores (proportion of soluble N remaining after losses from animal houses)	*I*	0.03	0.015	0.015
Emissions due to manure application – basic coefficients (proportion of soluble N remaining after storage)	*I*	0.60	0.50	0.50
Emissions due to manure application – coefficients for immediate manure incorporation or application in favourable weather conditions (proportion of soluble N remaining after storage)	*I*	0.36	0.30	0.30

Emissions from animal housing, manure stores and due to fertilization with animal manures in pig production

Ammonia emissions in pig production were estimated by the use of emission factors which were proposed by Menzi et al. (1997) or own estimates in case of specific manure treatments (Table 3). There are no data on manure management systems for Slovenia. To obtain reliable estimates the population of pigs was disaggregated into three categories:
a) commercial pig farms,
b) market oriented family farms, and
c) small scale family farms.

Data published by the Statistical Office of the Republic of Slovenia allow a breakdown of the entire herd into commercial pig farms and family farms for the period 1985-2002. For the period 2003 – 2009 the herd was allocated to both segments on the basis of ratio in 2002. Family farms were further divided into market oriented and small scale. In 1986 the estimate of production for market oriented family farms was based on the data on acquisition of pigs from market oriented family farm production, which was published by the Statistical Office of the Republic of Slovenia. The number of swine in small scale family farm production has been estimated from the difference between the entire herd and market oriented production (commercial and market oriented family farms). This type of estimating agreed rather well with the results of the 1991 regular census. For 2000, the number of pigs in the small scale family farm production has been estimated on the basis of the census of agricultural holdings. Pigs that were bred on farms with up to 10 pigs have been considered as small scale family farm production, pigs on family farms that breed more than 10 pigs have been considered as market oriented family farm production. In the period between 1986 and 2000 the proportion of small scale production was obtained by interpolation. After 2000, data on farm structure for the years 2003, 2005 and 2007 have been reported by the Statistical Office. These data were used to estimate the number of pigs on small scale family farms. For the years with non-existing data on farm structure (2001, 2002, 2004, 2006, 2008, 2009) the numbers of pigs on small scale family farms were obtained by interpolating the values for neighbouring years. In the case of the year 2008 and 2009 the estimate was done by extrapolation of values for 2006 and 2007.

For market oriented family farm production, it was considered that 95% of animal excreta were collected in the form of liquid manure and 5% in the form of solid manure. For small

scale family farm production, it was estimated that 95% of pigs is reared in solid manure storage systems and 5% in liquid manure systems. For the big commercial pig farms old-style separators were characteristic for the period 1985 to 1994. App. 20% of solids was separated from liquid manure by the use of these separators. The remainder (80%) was either treated in lagoons (75%) or spread as liquid manure (25%). The time from 1995 to 1999 was a period of introducing new separators and the beginning of operation of anaerobic digesters. Introducing new separators on commercial farms increased the estimated portion of separated solid phase to 40%.

Table 81: Emission factors and basic information on manure management systems for the calculation of ammonia emissions in pig production (Sources for emission factors: Menzi et al., 1997 and national estimates)

	Farmyard manure	Slurry
Proportion of soluble N in excrements (in kg/kg total N)	0.50	0.75
Basic information		
Proportion of manure application in favourable weather conditions or immediate incorporation	0.20	0.20
Proportion of farmyard manure used on arable land	0.40	/
Emission factors (kg NH_3-N/kg N)		
From animal houses (proportion of excreted N)	0.15	0.15
Emissions from uncovered manure stores (proportion of soluble N remaining after losses from animal houses)	0.30	0.12
Emissions due to specific flushing systems and anaerobic lagoon treatment on large farms (proportion of total N remaining after losses from animal houses)	/	0.37
Emissions due to manure application – basic coefficients (proportion of soluble N remaining after storage)	0.60	0.50
Emissions due to manure application – coefficients for immediate manure incorporation or application in favourable weather conditions (proportion of soluble N remaining after storage)	0.36	0.30

Emissions from animal housing, manure stores and due to fertilization with animal manures in poultry production

Emission factors and basic information on poultry rearing systems are given in Table 4. For broilers, turkeys, geese and ducks exclusively floor system on bedding was assumed. For laying hens, combined floor system (1/4) and battery-cage systems (3/4) were assumed for 1990. Assumption was made on the basis of expert estimate. It was also assumed that in 50% the manure is removed daily and stored in tanks (liquid system) while in 50 % it is collected under the batteries (i.e. poultry manure without bedding). After introduction of dung

drying system to certain farms a new estimates were obtained for 2002. The values for years 1991-2001 and 2003-2009 were obtained by interpolation or extrapolation.

Table 82: Emission factors and basic information on manure management systems for the calculation of ammonia emissions in poultry production (Source for emission factors: Menzi et al., 1997)

	Floor system on bedding	Battery system-dung collected under batteries	Battery system-dung belt	Battery system-dung drying system
Information on housing systems for poultry species and categories (% of total flock)				
Laying hens	25.0 (1990) 22.3 (2002)	37.5 (1990) 33.5 (2002)	37.5 (1990) 33.5 (2002)	0.0 (1990) 10.7 (2002)
Broilers	100	100	100	100
Turkeys	100	100	100	100
Geese	100	100	100	100
Ducks	100	100	100	100
Emission factors (kg NH_3-N/kg N)				
From animal houses (proportion of excreted N)	0.40	0.60	0.20	0.06*
Emissions from manure stores (proportion of total N remaining after losses from animal houses)	0.00	0.00	0.20	0.00
Emissions due to manure application – basic coefficients (proportion of total N remaining after storage)	0.25	0.20	0.25	0.25

* Assumed that introduction of dung drying reduces the emission of ammonia by 90 % in comparison to collection under batteries (Menzi et al., 1997)

Emissions from animal housing, manure stores and due to fertilization with animal manures in small ruminants and horses

Ammonia emissions in goats, sheep and horses were estimated using the information presented in Table 5. The proportions of grazing animals were estimated by the means of expert opinion. It was estimated that during the grazing season all sheep, 80% of goats and 50% of horses were grazed. Two hundred and fifty days of grazing season has been considered for sheep and 210 for goats and horses. For the remaining period it has been considered that these animals were kept in straw based systems.

Table 83: Emission factors and basic information on manure management systems for the calculation of ammonia emissions in sheep, goats and horses (Source for emission factors: Menzi et al., 1997)

	Grazing	Keeping indoors
Information on housing systems for sheep, goats and horses (%, corrected for the length of grazing period)		
Sheep	68	32
Goats	46	54
Horses	29	71
Proportion of soluble N in excrements (in kg/kg total N)	0.40	0.40
Emission factors (kg NH_3-N/kg N)		
From animal houses or during grazing (proportion of excreted N)		
Sheep and goats	0.05	0.20*
Horses	0.05	0.07
Emissions from manure stores (proportion of soluble N remaining after losses from animal houses)		
Sheep and goats	/	0
Horses	/	0.30 for solid fraction and 0.0285** for liquid fraction
Emissions due to manure (proportion of soluble N remaining after storage)	/	0.50 for farmyard manure and 0.60 for liquid manure

* Basic factor for solid manure (0.07) was multiplied by 2.2 (because of loose housing) and by 1.3 (because of deep litter) (Menzi et al., 1997)

** Taken into account that 90% of stores are covered and that covering reduces the emissions by 90 %

6.2 Agricultural soils (NFR sectoe 4D)

Emissions due to use of mineral fertilizers

Ammonia emissions due to use mineral fertilizers were assessed according to EMEP/CORINAIR (2002) methodology. Emission factors 0.15 and 0.02 kg NH3-N per kg of N were used for urea and other mineral fertilizers respectively. The consumption of nitrogen from mineral fertilizers in agriculture has been obtained from the Statistical Yearbook (SORS). It was taken into account that 15% of total nitrogen is obtained from urea and the rest from other fertilizers. The estimate is based on the average concentration of N in nitrogen fertilizers which was reported in 1999 (SORS, 1999).

Emissions due to cultivation of legume crops

Ammonia which is released to the atmosphere due to cultivation of legume crops was assessed according to EMEP/CORINAIR (2002) principles. It was taken into account that 1% of symbiotically fixed N is lost. The extent of symbiotic N fixation was estimated on the basis of legume yields (including the mass off crop residues and roots) and their N content. Emission factors for individual legume crops are presented in Table 6. Data on legume yields are regularly reported by Statistical Office of the Republic of Slovenia.

Table 84: Emission factors for the calculation of ammonia emissions due to cultivation of legume crops

Crop	Symbiotic N fixation (in kg/t of yield)	Emissions of NH_3-N (in kg/t of yield)
Fodder peas	76.5	0.77
Dry beans	89.9	0.90
Soya	74.3	0.74
Clover and lucerne	37.0	0.37
Grass-clover mixtures	13.3	0.13
French beans, fresh	11.9	0.12
Peas, fresh	11.9	0.12

7 Waste (NFR sector 6)

7.1 Waste incineration (6 C)

In Slovenia, there are 3 waste incinerations (Pinus, Elan and Lek) and some plants that co-combust wastes (cement plant Anhovo, cement plant LaFarge Trbovlje, Power plant Šoštanj, etc.). In Slovenia, we have small incinerators (< 1 tonne/hr), which incinerate batches of wastes or operate continouslly. A pyrolisis furnace, where the waste is degassed, releasing moisure and volatile components (at temperature 800-900°C), is used in waste incineration process (plant communication data). Emissions in Slovenia include emission abatement equipment, which aim to ensure compliance with emission regulations, addressing the three main environmental impacts of waste incineration/ products of incomplete combustion: acid gas, heavy metal and dioxin emissions. Typical approaches used include: wet scrubbers, fabric filters, and direct input of NaOH (plant communication data).

7.1.1. Clinical waste incineration (NFR 6.C a, SNAP 090207)

Source category description

Hospital waste may be identified as ‘specific hospital waste’ and ‘other hospital waste’. Specific
hospital waste includes human anatomic remains and organ parts, waste contaminated with bacteria, viruses and fungi, and larger quantities of blood. The most significant pollutants from this process are certain heavy metals (e.g. Pb, Cu, Cd, Cr, Ni and Hg). A variety of organic compounds, including PCDD/Fs, chlorobenzenes, chloroethylenes and polycyclic aromatic hydrocarbons (PAHs), are present in hospital waste or can be formed during the combustion and post-combination processes. Organics in the flue gas can exist in the vapour phase or can be condensed or absorbed on fine particulates.
Other pollutants released are HCl, sulphur oxides (SOx), nitrogen oxides (NOx), volatile organic
compounds (non-methane VOCs and methane (CH4)), carbon monoxide (CO), carbon dioxide
(CO2) and nitrous oxide (N2O).

Methodology

To estimate emissions from Waste incineration, the following methodology has been adopted:

$$E_{pollutant} = AR_{waste} \times EF_{pollutant} \qquad \textit{Equation 5}$$

$E_{pollutant}$ – the emission of the specified pollutant
$AR_{production}$ – the activity rate for waste (the amount of waste combustion)
$EF_{pollutant}$ – the emission factor for this pollutant

Activity data

Activity data were obtained from plant communication since year 1990.

Emission factors

Emission factors for HCB, PCB and PCDD/DF are presented in Table 79.

Table 85: Emission factors for HCB, PCB and PCDD/DF

period	EF HCB (mg/t)	EF PCB (mg/t)	EF DF (µg I-TEQ/t)
1990-2009	19	20	1

Emission factors for POPs pollutants (PCB, HCB, PCDD/DF) and calculation were obtained from Pacyna et al., 1999, Pacyna et al., 2003 and EMEP/EEA Emission Inventory Guidebook 2006, 2009.

Source specific recalculations

No recalculation has been done for this source.

Source-specific planned improvements

No improvements are planned for this source.

7.1.2 Industrial waste incineration (NFR 6.C b, SNAP 090202, 090204, 090205,090208)

SNAP classification considering this source contains Incineration of industrial wastes (except flaring, flaring in chemical industries, Incineration of sludges from waste water treatment, Incineration of waste oil).

Source category description

The composition of industrial waste varies considerably. Industrial waste includes any unwanted hazardous/chemical waste such as acids and alkalis, halogenated and other potentially-toxic
compounds, fuels, oils and greases, used filter materials, animal and food wastes. Industrial waste sources include chemical plant, refineries, light and heavy manufacturing, etc.
Industrial waste incinerators are likely to be more significant emitters of dioxins, cadmium and
mercury than many other sources, depending on the type of waste, the combustion efficiency and the degree of abatement. As for incineration of sludges, pollutants released are sulphur oxides (SOx), nitrogen oxides (NOx), volatile organic compounds (non-methane VOC and methane (CH4)), carbon monoxide (CO), carbon dioxide (CO2) and nitrous oxide (N2O).

Methodology

To estimate emissions from Waste incineration, the following methodology has been adopted:

$$E_{pollutant} = AR_{waste} \times EF_{pollutant} \qquad \textit{Equation 5}$$

$E_{pollutant}$ – the emission of the specified pollutant
$AR_{production}$ – the activity rate for waste (the amount of waste combustion)
$EF_{pollutant}$ – the emission factor for this pollutant

Activity data

Activity data were obtained from plant communication since year 1990.

Emission factors for Hg, Pb, Cd, HCB, PCB and PCDD/DF are presented in Table 86.

Table 86: Emission factors for Hg, Pb, Cd, HCB, PCB and DF:

period	EF Hg (g/t)	EF Pb (g/t)	EF Cd (g/t)	EF HCB (mg/t)	EF PCB (mg/t)	EF DF (µg I-TEQ/t)
1990-2009	1	9	0.36	19	20	1

Emission factors for Hg were obtained from Pacyna and Pacyna, 2002, for Hg and Cd from van der Most and Veldt, 1992. Emission factors for POPs pollutants (PCB, HCB, PCDD/DF) and calculation were obtained from Pacyna et al., 1999, Pacyna et al., 2003 and EMEP/EEA Emission Inventory Guidebook 2006 and 2009.

Source specific recalculations

No recalculation has been done for this source.

Source specific planned improvements

No improvements are planned for this source.

Recalculations and Improvements

7.2 Recalculations

Recalculations during time period 1990 – 2009 for all pollutants into air (SO_x, NO_x, NH_3, CO, VOC, Pb, Cd, PM, TSP, PAH and PCDD/DF) was performed since COPERT IV methodology for transport sector was applied last year.

7.3 Planned improvements

Some planned improvements to the emission inventory are discussed below.

The reporting of, and references for, the applied emission factors will be further developed in future inventories. This will include further QA/QC checks on plant specific emission factors.

Uncertainty estimates are based mainly on default uncertainty levels for activity rates and emission factors. Default uncertainty levels will be updated according to the updated EEA Guidebook (EEA 2009).

8 Projections

8.1 Uncertainity of projections

The uncertainty of projections is based on: the uncertainty of statistical data used as a basis for projections (statistical data, emission factors), models used for projections that present a simplified review of the actual events, uncertainty of scenarios of the implementation of policies and measures since the latter are changing with time and it is harder to predict their actual effect due to the influence of numerous factors, and uncertainty of future economic, technological and social development, including the uncertainty of energy prices, growth of energy supply and demand, behaviour of the main players in the energy market, etc.

The result of the emission projections in the sector of energy is largely dependent on the realisation of the considered measures in the area of RES and URE, which will be largely dependent on the available budget funds, where a gap between plans and realisation has been widening in recent years. The dynamics of the transition to natural gas in electrical energy 109 production are largely dependent on future market movements and social problems in reducing the production of coal. Fugitive emissions are also uncertain as a result of the uncertainty of the future coal industry. Uncertainties in this sector don't have an influence on the attainment of the Kyoto commitment of Slovenia, since this sector is included in the EU-ETS.

Source of uncertainties are also the scenarios of the future development of the gross domestic product that have a strong influence on energy consumption and consequently emissions in industry. The scenario used in projections was prepared before the recession, so that for the period 2008-2012 a 4.3 % average annual growth of GDP is stipulated.

Hereby it has to be emphasized that the current financial crisis will have an effect on the reduction of GHG emissions in the Republic of Slovenia; primarily in the industry and energy sectors. Since these two sectors are included in the EU-ETS, the reduction of emissions will not influence the fulfilment of commitments of the Republic of Slovenia, except if the operators of plants would annul the freely allocated coupons; however, this cannot be expected since they may also use them for the fulfilment of their own commitments in the period 2013-2020.

The largest uncertainty for Slovenia in the preparation of projections is the transport sector. In Slovenia, no projections of transport work are prepared that could be used later for the projection of the consumption of energy. Transport projections focus on projections used for the construction of the road network. A large uncertainty for projections in transport is also transit transport, since it cannot be captured by models covering only Slovenia; namely, transit flows originate from elsewhere. A better solution would be a European model. Prices of fuel in Slovenia are also highly significant for transit transport and sales of fuel in Slovenia and consequently consumption of fuel and emissions, since vehicles in transit transport fill their reservoirs where fuel is the cheapest. The estimation for the share of fuels sold to transit transport in 2008 amounts to 17 %.

Uncertainties of estimate emissions in agriculture were assessed according to the IPCC (2000). Uncertainties were assessed by individual sources of emissions, while the total uncertainty was calculated in accordance with rule A in the case of additive amounts, or rule B when the estimation was a product of the data on activities and the emissions coefficient (IPCC, 2000). For the estimation of the uncertainty of base data and emission factors, the manual EMEP/CORINAIR (2002) was used.

8.2 Sensitivity of projections

The sensitivity of projections is analysed with the implementation of several scenarios. The emission projections were prepared on the basis of two scenarios of economic growth and residential construction (+ and ++) and two strategies for the implementation of measures – referential (REF) and intensive (INT). By combining scenarios and strategies we obtained four different projections. Basically there aren't any differences between the individual projections of power and heat generation, since the installed units are based on the plans of companies that are almost independent of economic growth as well as measures for the reduction of emissions by the state. There is a different situation in the industry sector, where emissions are strongly dependent on economic growth. Explanation is needed for lower emissions with regard to the assumed low economic growth and referential strategy of the implementation of measures. This is a result of a high number of units for combined heat and power generation in the intensive strategy of the implementation of measures. Contrary to industry is the situation in other sectors, where the strategy of the implementation of measures has the main influence on emissions.

8.3 Methodology

ENERGY
To prepare emission projections in the IPCC sector of Energy – excluding Transport – a set of models were used in which the main tool is a reference energy ecological model called REESSLO, made in the MESAP environment. In addition to the REES-SLO model this set of models consists of other models as well: a model to assess the market penetration of energy saving final use technologies (PET-SLO), a simulation model for electrical load curves (ELAMSLO) and a model for calculating electricity production balance on a free market (ELBIVIM).
The main information flow between programme packages takes place in the following order:
Firstly, the market shares of certain energy-saving technologies with final users are calculated using a PET-SLO model as a response to changing price signals, financial incentives and information campaigns. The assessment of market shares of certain technologies and their costs serve as input data in the basic model of the reference energy system (REES-SLO) in MESAP. MESAP calculates envisaged final energy use balances and assesses the local production of electricity based on the proportions of different technologies in the final use structure and connections with influential parameters (levels of economic activity in different sectors, number of households, etc.). The final use of electricity divided by sector, purpose, and production in local supply systems (in industrial, distribution and private units) is transferred for processing in the program to analyse the load shape. The ELAM-SLO program simulates the time course of load on the electricity transmission system, taking into account typical users and local producers.
By using the ELBIVIM model, electricity production balances can be calculated on the free electricity market. The proportions of electricity production in individual units calculated in Point 4 and related costs are transferred to the MESAP / REES-SLO model. Other balances are calculated for the whole planning period in the MESAP model: primary and secondary energies, balances of emissions (CO_2, CH_4, N_2O, SO_2 and NO_X) and total costs. Reference Energy-Ecological Model REES-SLO The technology orientated REES-SLO model was developed in the MESAP environment in the form of a linear network model for processes and connections (reference energy system), which enables the consistent modelling of energy use based on the needs of energy services and energy supply according to the Integrated Resource Planning method. A calculation of emissions, costs and other influential phenomena is made simultaneously. The logical process-technological model enables the simulation and evaluation of anticipated instruments and their influences, as the set of instruments are connected within strategies.
The calculation model with a transparent model presentation prevents double counting and an unconnected consideration of effects, and provides a framework for consistent and equal access to the identification of instruments, measures and outputs in different sectors and

subsectors. The model has been used before in the preparation of energy strategies and the National Energy Programme, as well as for specialist papers used as the basis for assessing potential reduction of GHG emissions and to prepare the Operational Programme for Limiting Greenhouse Gas Emissions and long-term balances for the period 2006-2026.

TRANSPORT

Two models have been used for transport emissions. For the assessment of the movements of fuel consumption, an energy model for transport has been prepared. The basis for the calculation of energy use in transport was the estimation of the development of transport work. However, due to the lack of quality projections of this variable in Slovenia, the small size of Slovenia and its exposure to transit flows, this assessment is very uncertain. Results of the European energy model PRIMES have also been used for the preparation of the assessment. On the basis of an assumption on shares of various types of transport and technical characteristics of vehicle fleets, the model calculates the energy use.

Transport emissions were determined by the COPERT model. Methodology for the determination of the common factor for road transport implements data on fuel characteristics, the number of individual types of vehicles, distribution of vehicles with regard to the legislation (EURO standards), driven kilometres by vehicles and road types, average speed of vehicles on various road types as well as emission factors for various road types, vehicles and emission types (hot emission factor – driving with a warmed-up vehicle; cold emission factor – warming up of the vehicle and evaporation of fuel factor).

INDUSTRIAL PROCESSES

The projection of emissions in industrial processes was made on the basis of an industrial production growth projection, taking different emission factors for different activities into account. Also considered were the projections of participants of the emission trading obtained in the preparation process of the national plan for the allocation of emission coupons for the period 2008-2012. Emissions from the production of primary aluminium (CO2, CF4 and C2F6) were used in line with projections by the Talum company, which is the only primary aluminium producer in Slovenia. HFC projections were prepared by a simplified model that included all sources of HFC emissions. The model assumed the most likely development of equipment in the area of cooling techniques and the further development of the vehicle fleet of personal motor vehicles equipped with air-conditioning appliances.

WASTE

Solid waste emission projections were made using IPCC methodology. Emissions for waste deposited before 1977 that were mainly in a disorganized or badly compressed condition, where the covering of landfill was only realised after they were closed, were estimated according to the simplified IPCC methodology. When assessing landfills emissions with waste dumped after 1977, which was partly compressed and compacted, where most landfills were covered at the time, a more accurate IPCC methodology, with time series, was used. The calculation assumed a constant quantity of deposited waste, while the total share of biologically degradable waste was reduced. The composition of the biologically degradable part was constant and was summarised according to the results of screening analyses in Slovenia.

N2O emissions were assessed according to the IPCC methodology with the assumption that all wastewater nitrogen ends up in the water environment.

AGRICULTURE

Agriculture emission projections were carried out according to the methodology prescribed by the IPCC (1997). The IPCC methodology anticipates agriculture emission projections based on statistical data on the physical volume of crop and animal production taking into account specific procedures characteristic of particular countries or areas. Data on the extent of crop production and animal breeding is treated separately, despite their interdependence. The model based on the IPCC methodology does not therefore enable optimization at the level of the agriculture sector as a whole, but only on separate segments. SORS statistical

data and information obtained from experts in the agricultural sector were used for the assessment.

8.4 Bases for the preparation of projections

For the preparation of emission projections from energy sources, the results of long-term energy balances prepared for the period 2006-2026 for the Ministry of the Economy were used. Within the framework of balances, several scenarios were used, composed of two scenarios of economic development, two strategies for the implementation of measures and two scenarios for the development of the electrical-energy sector. The scenario composed of moderate scenario of economic growth (scenario +), intensive scenario of the implementation of measures and a balanced scenario of energy supply[31] was selected for the preparation of projections. The base year for the preparation of long-term balances was 2005. The only exception was the projections for transport, where a preparation of new projections was necessary due to large derogations from the first assessments for fuel consumption in 2008 and projections. New projections for transport were based on 2009 spring forecasts of the GDP growth by IMAD for freight transport and on long-term balance projections for passenger transport. Forecasts of GDP growth/decrease in Romania, Bulgaria, Poland, Hungary and Slovakia were used for transit transport.The basis for the preparation of projections in agriculture is the agriculture development strategy.
The projections stipulate consistent fulfilment of the existing legislation and the implementation of adopted programmes – the Efficiency Energy Action Plan for the Period 2008-2016, the Operational Programme of Environmental and Transport Infrastructure Development for the Period 2007-2013, the Rural Development Programme for the Republic of Slovenia 2007-2013, the Operational Programme on Elimination of Waste with the Objective to Reduce the Quantity of Biodegradable Disposal Waste, etc.

8.5 Results of the projections

Table 87: SO_2 National Projections emissions - with measures (source: IJS-CEU)

	SO_2 – with measures	**2008**	**2010**	**2015**	**2020**	**2025**	**2030**
	NFR sector	[kt]	[kt]	[kt]	[kt]	[kt]	[kt]
1A1	Public electricity and heat production	9,89	9,54	6,86	6,67	6,66	3,59
1A2	Combustion in manufacturing industries	2,27	1,94	2,32	2,58	2,95	3,37
1A3b	Road transport	0,04	0,03	0,04	0,04	0,05	0,05
1A3a,c	Off-road vehicles and other machinery	0,00	0,00	0,00	0,00	0,00	0,00
1A4	Combustion in residential/iInstitutional	1,30	1,22	1,00	0,81	0,66	0,54
1B	Fugitive emission	0,00	0,00	0,00	0,00	0,00	0,00
2	Production processes	1,28	0,65	1,14	1,25	1,26	1,27
3	Solvent use	0,00	0,00	0,00	0,00	0,00	0,00
4	Agriculture	0,00	0,00	0,00	0,00	0,00	0,00
6	Waste	0,00	0,00	0,00	0,00	0,00	0,00
	TOTAL	**14,78**	**13,37**	**11,36**	**11,36**	**11,57**	**8,81**

Table 88: SO_2 National Projections emissions - with additional measures (source: IJS-CEU)

	SO_2 – with additional measures	**2008**	**2010**	**2015**	**2020**	**2025**	**2030**
	NFR sector	[kt]	[kt]	[kt]	[kt]	[kt]	[kt]
1A1	Public electricity and heat production	9,89	9,54	5,80	5,58	4,83	3,71
1A2	Combustion in manufacturing industries	2,27	1,91	2,10	2,13	2,15	1,98
1A3b	Road transport	0,04	0,03	0,03	0,03	0,03	0,03
1A3a,c	Off-road vehicles and other machinery	0,00	0,00	0,00	0,00	0,00	0,00
1A4	Combustion in residential/iInstitutional	1,30	1,21	0,75	0,52	0,39	0,33
1B	Fugitive emission	0,00	0,00	0,00	0,00	0,00	0,00
2	Production processes	1,28	0,65	1,14	1,25	1,26	1,27
3	Solvent use	0,00	0,00	0,00	0,00	0,00	0,00
4	Agriculture	0,00	0,00	0,00	0,00	0,00	0,00
6	Waste	0,00	0,00	0,00	0,00	0,00	0,00
	TOTAL	**14,78**	**13,35**	**9,82**	**9,52**	**8,67**	**7,32**

Table 89: NOx National Projections emissions - with measures (source: IJS-CEU)

	NOx – with measures	**2008**	**2010**	**2015**	**2020**	**2025**	**2030**
	NFR sector	[kt]	[kt]	[kt]	[kt]	[kt]	[kt]
1A1	Public electricity and heat production	12,58	12,49	9,82	6,71	6,71	4,89
1A2	Combustion in manufacturing industries	7,82	5,79	6,69	6,59	6,96	7,42
1A3b	Road transport	32,97	23,20	22,53	15,73	10,54	7,59
1A3a,c	Off-road vehicles and other machinery	0,68	0,68	0,44	0,46	0,42	0,38
1A4	Combustion in residential/iInstitutional	6,69	6,52	6,07	5,60	5,21	4,86
1B	Fugitive emission	0,00	0,00	0,00	0,00	0,00	0,00
2	Production processes	0,00	0,00	0,00	0,00	0,00	0,00
3	Solvent use	0,00	0,00	0,00	0,00	0,00	0,00
4	Agriculture	0,00	0,00	0,00	0,00	0,00	0,00
6	Waste	0,00	0,00	0,00	0,00	0,00	0,00
	TOTAL	**60,74**	**48,68**	**45,55**	**35,09**	**29,83**	**25,15**

Table 90: NOx National Projections emissions - with additional measures (source: IJS-CEU)

	NOx – with additional measures	**2008**	**2010**	**2015**	**2020**	**2025**	**2030**
	NFR sector	[kt]	[kt]	[kt]	[kt]	[kt]	[kt]
1A1	Public electricity and heat production	12,58	12,49	9,38	7,32	6,96	6,26
1A2	Combustion in manufacturing industries	7,82	5,80	6,29	6,00	6,06	6,25
1A3b	Road transport	32,97	22,83	17,22	11,64	7,67	5,53
1A3a,c	Off-road vehicles and other machinery	0,68	0,68	0,45	0,50	0,47	0,42
1A4	Combustion in residential/iInstitutional	6,69	6,53	6,06	5,58	5,22	4,92
1B	Fugitive emission	0,00	0,00	0,00	0,00	0,00	0,00
2	Production processes	0,00	0,00	0,00	0,00	0,00	0,00
3	Solvent use	0,00	0,00	0,00	0,00	0,00	0,00
4	Agriculture	0,00	0,00	0,00	0,00	0,00	0,00
6	Waste	0,00	0,00	0,00	0,00	0,00	0,00
	TOTAL	**60,74**	**48,34**	**39,41**	**31,04**	**26,37**	**23,38**

Table 91:: NMVOC National Projections emissions - with measures (source: IJS-CEU)

	VOC – with measures	2008	2010	2015	2020	2025	2030
	NFR sector	[kt]	[kt]	[kt]	[kt]	[kt]	[kt]
1A1	Public electricity and heat production	0,14	0,14	0,14	0,15	0,15	0,11
1A2	Combustion in manufacturing industries	1,26	1,11	1,26	1,35	1,46	1,58
1A3b	Road transport	6,21	4,50	3,38	2,61	2,15	1,90
1A3a,c	Off-road vehicles and other machinery	0,11	0,11	0,08	0,10	0,10	0,11
1A4	Combustion in residential/iInstitutional	8,31	8,03	7,34	6,69	6,05	5,43
1B	Fugitive emission	2,14	2,06	2,03	1,93	1,86	1,91
2	Production processes	1,02	0,84	0,91	0,91	0,99	1,08
3	Solvent use	13,44	12,27	13,35	13,94	14,44	14,95
4	Agriculture	0,00	0,00	0,00	0,00	0,00	0,00
6	Waste	0,00	0,00	0,00	0,00	0,00	0,00
	TOTAL	**32,63**	**29,05**	**28,49**	**27,69**	**27,21**	**27,08**

Table 92: NMVOC National Projections emissions - with additional measures (source: IJS-CEU)

	VOC – with additional measures	2008	2010	2015	2020	2025	2030
	NFR sector	[kt]	[kt]	[kt]	[kt]	[kt]	[kt]
1A1	Public electricity and heat production	0,14	0,14	0,14	0,15	0,14	0,12
1A2	Combustion in manufacturing industries	1,26	1,12	1,22	1,33	1,42	1,49
1A3b	Road transport	6,21	4,34	2,79	2,05	1,63	1,44
1A3a,c	Off-road vehicles and other machinery	0,11	0,11	0,08	0,11	0,12	0,13
1A4	Combustion in residential/iInstitutional	8,31	8,05	7,69	6,82	5,89	5,08
1B	Fugitive emission	2,14	1,96	1,84	1,66	1,49	1,53
2	Production processes	1,02	0,84	0,91	0,91	0,99	1,08
3	Solvent use	13,44	12,27	13,35	13,94	14,44	14,95
4	Agriculture	0,00	0,00	0,00	0,00	0,00	0,00
6	Waste	0,00	0,00	0,00	0,00	0,00	0,00
	TOTAL	**32,63**	**28,84**	**28,03**	**26,97**	**26,13**	**25,83**

Table 93: NH_3 National Projections emissions - with measures (source: IJS-CEU)

	NH_3 – with measures	2008	2010	2015	2020	2025	2030
	NFR sector	[kt]	[kt]	[kt]	[kt]	[kt]	[kt]
1A1	Public electricity and heat production	0,00	0,00	0,06	0,06	0,06	0,04
1A2	Combustion in manufacturing industries	0,00	0,00	0,00	0,00	0,00	0,00
1A3b	Road transport	0,41	0,33	0,20	0,13	0,12	0,12
1A3a,c	Off-road vehicles and other machinery	0,00	0,00	0,00	0,00	0,00	0,00
1A4	Combustion in residential/iInstitutional	0,05	0,05	0,05	0,05	0,05	0,04
1B	Fugitive emission	0,00	0,00	0,00	0,00	0,00	0,00
2	Production processes	0,00	0,00	0,00	0,00	0,00	0,00
3	Solvent use	0,00	0,00	0,00	0,00	0,00	0,00
4	Agriculture	16,87	17,93	17,76	18,05	18,33	18,60
6	Waste	0,00	0,00	0,00	0,00	0,00	0,00
	TOTAL	**17,34**	**18,31**	**18,07**	**18,29**	**18,55**	**18,80**

Table 94: NH_3 National Projections emissions - with additional measures (source: IJS-CEU)

	NH_3 – with additional measures	**2008**	**2010**	**2015**	**2020**	**2025**	**2030**
	NFR sector	[kt]	[kt]	[kt]	[kt]	[kt]	[kt]
1A1	Public electricity and heat production	0,00	0,00	0,05	0,05	0,05	0,04
1A2	Combustion in manufacturing industries	0,00	0,00	0,00	0,00	0,00	0,00
1A3b	Road transport	0,41	0,32	0,17	0,11	0,09	0,09
1A3a,c	Off-road vehicles and other machinery	0,00	0,00	0,00	0,00	0,00	0,00
1A4	Combustion in residential/iInstitutional	0,05	0,05	0,06	0,05	0,05	0,05
1B	Fugitive emission	0,00	0,00	0,00	0,00	0,00	0,00
2	Production processes	0,00	0,00	0,00	0,00	0,00	0,00
3	Solvent use	0,00	0,00	0,00	0,00	0,00	0,00
4	Agriculture	16,87	17,82	17,39	17,40	17,68	17,96
6	Waste	0,00	0,00	0,00	0,00	0,00	0,00
	TOTAL	**17,34**	**18,19**	**17,67**	**17,62**	**17,87**	**18,13**

Table 95: PM_TSP National Projections emissions - with measures (source: IJS-CEU)

	PM_TSP – with measures	**2008**	**2010**	**2015**	**2020**	**2025**	**2030**
	NFR sector	[kt]	[kt]	[kt]	[kt]	[kt]	[kt]
1A1	Public electricity and heat production	0,39	0,38	0,34	0,40	0,41	0,31
1A2	Combustion in manufacturing industries	0,85	0,79	0,85	0,87	0,92	0,97
1A3b	Road transport	2,51	2,14	2,17	2,07	1,96	2,00
1A3a,c	Off-road vehicles and other machinery	0,14	0,12	0,12	0,13	0,14	0,15
1A4	Combustion in residential/iInstitutional	7,47	7,11	6,27	5,47	4,69	3,91
1B	Fugitive emission	0,23	0,23	0,24	0,24	0,24	0,14
2	Production processes	0,74	0,54	0,67	0,69	0,72	0,73
3	Solvent use	0,00	0,00	0,00	0,00	0,00	0,00
4	Agriculture	5,78	5,93	5,98	5,99	6,00	6,01
6	Waste	0,02	0,01	0,01	0,01	0,01	0,01
	TOTAL	**18,12**	**17,25**	**16,65**	**15,87**	**15,08**	**14,24**

Table 96: PM_TSP National Projections emissions - with additional measures (source: IJS-CEU)

	TSP – with additional measures	**2008**	**2010**	**2015**	**2020**	**2025**	**2030**
	NFR sector	[kt]	[kt]	[kt]	[kt]	[kt]	[kt]
1A1	Public electricity and heat production	0,39	0,38	0,35	0,45	0,44	0,41
1A2	Combustion in manufacturing industries	0,85	0,79	0,83	0,90	0,98	1,02
1A3b	Road transport	2,51	2,12	2,03	1,98	1,91	1,97
1A3a,c	Off-road vehicles and other machinery	0,14	0,12	0,12	0,14	0,14	0,16
1A4	Combustion in residential/iInstitutional	7,47	7,13	6,40	5,20	4,03	3,04
1B	Fugitive emission	0,23	0,23	0,21	0,21	0,18	0,15
2	Production processes	0,58	0,48	0,59	0,60	0,61	0,62
3	Solvent use	0,00	0,00	0,00	0,00	0,00	0,00
4	Agriculture	5,78	5,93	5,98	5,99	6,00	6,01
6	Waste	0,02	0,01	0,01	0,01	0,01	0,01
	TOTAL	**17,96**	**17,20**	**16,51**	**15,46**	**14,30**	**13,38**

Table 97: PM_10 National Projections emissions - with measures (source: IJS-CEU)

	PM_10 – with measures	2008	2010	2015	2020	2025	2030
	NFR sector	[kt]	[kt]	[kt]	[kt]	[kt]	[kt]
1A1	Public electricity and heat production	0,30	0,30	0,26	0,31	0,31	0,24
1A2	Combustion in manufacturing industries	0,78	0,73	0,79	0,81	0,86	0,90
1A3b	Road transport	2,04	1,68	1,63	1,47	1,33	1,32
1A3a,c	Off-road vehicles and other machinery	0,13	0,11	0,12	0,13	0,14	0,15
1A4	Combustion in residential/iInstitutional	7,03	6,70	5,91	5,17	4,43	3,70
1B	Fugitive emission	0,13	0,12	0,13	0,13	0,13	0,08
2	Production processes	0,44	0,30	0,40	0,42	0,44	0,45
3	Solvent use	0,00	0,00	0,00	0,00	0,00	0,00
4	Agriculture	2,64	2,70	2,72	2,72	2,73	2,73
6	Waste	0,01	0,01	0,01	0,00	0,00	0,00
	TOTAL	**13,50**	**12,64**	**11,97**	**11,15**	**10,35**	**9,56**

Table 98: PM_10 National Projections emissions - with additional measures (source: IJS-CEU)

	PM10–with additional measures	2008	2010	2015	2020	2025	2030
	NFR sector	[kt]	[kt]	[kt]	[kt]	[kt]	[kt]
1A1	Public electricity and heat production	0,30	0,30	0,27	0,34	0,33	0,31
1A2	Combustion in manufacturing industries	0,78	0,74	0,77	0,84	0,92	0,96
1A3b	Road transport	2,04	1,66	1,49	1,37	1,27	1,29
1A3a,c	Off-road vehicles and other machinery	0,13	0,11	0,12	0,13	0,14	0,15
1A4	Combustion in residential/iInstitutional	7,03	6,72	6,05	4,93	3,83	2,89
1B	Fugitive emission	0,13	0,12	0,11	0,11	0,10	0,08
2	Production processes	0,34	0,26	0,34	0,36	0,37	0,38
3	Solvent use	0,00	0,00	0,00	0,00	0,00	0,00
4	Agriculture	2,64	2,70	2,72	2,72	2,73	2,73
6	Waste	0,01	0,01	0,01	0,00	0,00	0,00
	TOTAL	**13,40**	**12,62**	**11,88**	**10,81**	**9,69**	**8,78**

Table 99: PM_2.5 National Projections emissions - with measures (source: IJS-CEU)

	PM_2.5 with measures	2008	2010	2015	2020	2025	2030
	NFR sector	[kt]	[kt]	[kt]	[kt]	[kt]	[kt]
1A1	Public electricity and heat production	0,17	0,17	0,15	0,19	0,19	0,16
1A2	Combustion in manufacturing industries	0,75	0,70	0,75	0,78	0,81	0,85
1A3b	Road transport	1,66	1,30	1,20	0,98	0,81	0,76
1A3a,c	Off-road vehicles and other machinery	0,13	0,11	0,11	0,12	0,13	0,14
1A4	Combustion in residential/iInstitutional	6,97	6,64	5,86	5,13	4,40	3,68
1B	Fugitive emission	0,02	0,02	0,02	0,02	0,02	0,01
2	Production processes	0,28	0,19	0,27	0,28	0,30	0,31
3	Solvent use	0,00	0,00	0,00	0,00	0,00	0,00
4	Agriculture	0,37	0,38	0,38	0,38	0,39	0,39
6	Waste	0,00	0,00	0,00	0,00	0,00	0,00
	TOTAL	**10,34**	**9,51**	**8,75**	**7,88**	**7,04**	**6,29**

Table 100: PM_2.5 Projections emissions - with additional measures (source: IJS-CEU)

	PM2.5-with additional measures	**2008**	**2010**	**2015**	**2020**	**2025**	**2030**
	NFR sector	[kt]	[kt]	[kt]	[kt]	[kt]	[kt]
1A1	Public electricity and heat production	0,17	0,17	0,17	0,23	0,23	0,22
1A2	Combustion in manufacturing industries	0,75	0,70	0,74	0,82	0,90	0,93
1A3b	Road transport	1,66	1,29	1,06	0,88	0,75	0,73
1A3a,c	Off-road vehicles and other machinery	0,13	0,11	0,11	0,13	0,13	0,14
1A4	Combustion in residential/iInstitutional	6,97	6,66	6,01	4,90	3,81	2,87
1B	Fugitive emission	0,02	0,02	0,02	0,02	0,01	0,01
2	Production processes	0,24	0,17	0,24	0,25	0,26	0,27
3	Solvent use	0,00	0,00	0,00	0,00	0,00	0,00
4	Agriculture	0,37	0,38	0,38	0,38	0,39	0,39
6	Waste	0,00	0,00	0,00	0,00	0,00	0,00
	TOTAL	**10,30**	**9,50**	**8,72**	**7,60**	**6,48**	**5,57**

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